63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

The Newcastle Local Municipality

Newcastle Landfill Site Environmental Impact Report (EIR)

in terms of the

National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)

Draft for Authority and Stakeholder Review

18 May – 18 June 2018

April 2018

GCS Project Number: 17-0212

EDTEA DC25/WML/0002/2014:

The Newcastle Local Municipality

Draft for Authority and Stakeholder Review

18 May – 18June 2018

Newcastle Landfill Site Environmental Impact Report (EIR)

In terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) and the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)

April 2018

THE NEWCASTLE MUNICIPALITY
NEWCASTLE KWAZULU-NATAL

EDTEA Reference Number: DC25/WML/0002/2014
GCS Project No: 17-0212

DOCUMENT ISSUE STATUS

Report Issue	Draft for Authority and Stakeholder Review		
GCS Reference Number	GCS Ref – 17-0212		
Title	**Newcastle Landfill Site Environmental Impact Report (EIR)**		
	Name	**Signature**	**Date**
Author	Marica Swart Riana Panaino		May 2018
Document Reviewers	Renee Janse van Rensburg		May 2018
Director	TBC		May 2018

LEGAL NOTICE

DISCLAIMER

Information contained in this report is based on data/information supplied to GCS Water and Environment (Pty) Ltd (GCS) by the applicant, client and other external sources (including previous site investigation data, external specialist studies, and the previously appointed Environmental Assessment Practitioner (EAP). It has been assumed that the information provided to GCS is correct and as such the accuracy of the conclusions made are reliant on the accuracy and completeness of the data supplied. No responsibility is accepted by GCS for incomplete or inaccurate data supplied by the applicant, client and/or other external sources. Opinions expressed in this report apply to the information provided and the site conditions and features that existed at the time of the start of the relevant investigations and the production of this report.

GCS was appointed as EAP after completion of the Scoping Phase of the Environmental Authorisation (EA) process and as such GCS cannot attest to any process related requirements undertaken prior to GCSs' appointment and, as such, all process related activities prior to GCSs' appointment are deemed to have met the requirements of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA).

REQUIREMENTS FOR AN ENVIRONMENTAL IMPACT ASSESSMENT REPORT IN TERMS OF THE 2010 NEMA EIA REGULATIONS (GNR 543)

REQUIREMENTS FOR AN ENVIRONMENTAL IMPACT ASSESSMENT REPORT (GNR543)	SECTION
2) An environmental impact assessment report must contain all information that is necessary for the competent authority to consider the application and to reach a decision contemplated in regulation 35, and must include	
a) details of	
i) the EAP who compiled the report; and	Section 1.3
ii) the expertise of the EAP to carry out an environmental impact assessment;	Section 1.3
b) a detailed description of the proposed activity;	Section 2
c) a description of the property on which the activity is to be undertaken and the location of the activity on the property, or if it is	Section 1.4
i) a linear activity, a description of the route of the activity; or	Section 3.3.2
ii) an ocean-based activity, the coordinates where the activity is to be undertaken;	N/A
d) a description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity;	Section 4
e) details of the public participation process conducted in terms of subregulation (1). Including	Section 5
i) steps undertaken in accordance with the plan of study;	Section 5.3
ii) a list of persons, organisations and organs of state that were registered as interested and affected parties;	Appendix B
iii) a summary of comments received from. and a summary of issues raised by registered interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments; and	Appendix B
iv) copies of any representations and comments received from registered interested and affected parties;	Appendix B
f) a description of the need and desirability of the proposed activity;	Section 9
g) a description of identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the	Section 3

REQUIREMENTS FOR AN ENVIRONMENTAL IMPACT ASSESSMENT REPORT (GNR543)	SECTION
environment and the community that may be affected by the activity;	
h) an indication of the methodology used in determining the significance of potential environmental impacts;	Section 6.1
i) a description and comparative assessment of all alternatives identified during the environmental impact assessment process;	Section 3
j) a summary of the findings and recommendations of any specialist report or report on a specialised process;	Section 4 and Section 6.8
k) a description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures;	Section 6.8
l) an assessment of each identified potentially significant impact; including	Section 6
i) cumulative impacts;	Section 6.7
ii) the nature of the impact;	Section 6.8
iii) the extent and duration of the impact;	Section 6.8
iv) the probability of the impact occurring;	Section 6.8
v) the degree to which the impact can be reversed;	Section 6.8
vi) the degree to which the impact may cause irreplaceable loss of resources; and	Section 6.8
vii) the degree to which the impact can be mitigated;	Section 6.8
m) a description of any assumptions, uncertainties and gaps in knowledge;	Section 8
n) a reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation;	Section 10
o) an environmental impact statement which contains	Section 10
i) a summary of the key findings of the environmental impact assessment; and	Section 10
ii) a comparative assessment of the positive and negative implications of the proposed activity and identified alternatives;	Section 10
p) a draft environmental management programme containing the aspects contemplated in regulation 33;	Appendix D

REQUIREMENTS FOR AN ENVIRONMENTAL IMPACT ASSESSMENT REPORT (GNR543)	SECTION
q) copies of any specialist reports and reports on specialised processes complying with regulation 32;	Appendix E
r) any specific information that may be required by the competent authority; and	Section 8.1
s) any other matters required in terms of sections 24(4)(a) and (b) of the Act.	N/A

CONTENTS PAGE

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 INTRODUCTION AND BACKGROUND

1.1 Background

The Newcastle Local Municipality (NLM) is presently considering land for the establishment of a general waste landfill site to service the municipal area. A number of "candidate sites" have been considered and a preferred site has been selected on account of its geohydrological and geotechnical suitability.

The existing landfill site is rapidly reaching the end of its design life. This is due to the closure of the Madadeni and Osizweni Landfill Sites by the Department of Water and Sanitation (DWS) as a result of non-compliance to the governing legislation. This event resulted in an influx of solid waste to the existing landfill site, which in turn further reduced its anticipated design life. As a result a new landfill site will soon be required once the existing site reaches the end of its design life.

During the initial investigation, the waste stream generated within the NLM administered area amounted to some 106 000 cubic metres per annum (m^3/a), or approximately 290 tons/day (tpd). This waste comprises domestic, garden, commercial and building waste as well as non-hazardous industrial waste. The current waste volume information was obtained from the *"Proposed New Regional Landfill Site Selection Report to Council – Revision 3"* as complied by Knight Piésold Consulting in 2003. A growth rate of 2.5% was applied to determine the amount of waste generated from the envisaged landfill project commencement date. Consequently, the estimated waste load for the new proposed landfill would be approximately 375 tpd.

This Environmental Impact Assessment Report (EIR) has been developed in accordance with the requirements of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA) and the 2010 Environmental Impact Assessment (EIA) Regulations, and the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA).

1.2 Brief Project Description

The proposed Newcastle landfill site would have sufficient capacity for approximately 42 years, and if an annual growth rate of 3% is applied to the estimated daily waste stream of approximately 375 tpd, the air space required for the disposal site, based upon land-filling operations of 260 days/year (d/y), will be in the order of 17 772 million m^3. At an average height of 35 metres (m), the required footprint area would be approximately 55 hectares (ha).

An engineered landfill is proposed. An engineered landfill comprises of landfill cells which are meticulously engineered depressions in the ground which are designed and engineered to contain waste. Landfill cells will be underlain by a containment barrier system to prevent the waste or the leachate from the waste from coming into contact with the environment.

All landfills must be operated in accordance with the following sanitary landfill operating principles:

- Waste must be compacted, and
- Covered at the end of each day's operations.

As such the site will be designed and licensed as a General (G), Large (L) site with a positive water balance (B+), or G:L:B+ facility, or a Class B Landfill as per the NEM:WA National Norms and Standards for Disposal of Waste to Landfill, Government Notice R636 (GN R636). .

Infrastructure that will be constructed as part of the landfill site includes an access road, on-site roads, perimeter fence, guard house, weighbridge, stormwater management infrastructure, leachate management infrastructure, site offices, staff ablutions, a canteen, a workshop and monitoring boreholes. When fully operational, there is a possibility of the recovery of landfill gas, which would require separate authorisation if pursued.

The height of landfill will be limited to a proposed height of 40 m above natural ground level. The area to be developed for landfilling will be subdivided into seven (7) cells as shown in **Figure 1-1**. The construction of these cells will be in seven (7) distinct phases with each cell being constructed, landfilled and covered separately, starting with the construction and operation of Cell No. 1. Each cell has been sized to have airspace for approximately 6 years taking into consideration the anticipated annual growth rate. Cell No.1 will be landfilled to a height of approximately 20 m, at which time construction and landfilling will need to commence in Cell No. 2 to allow for landfilling to the final height of 40 m. This is needed to maintain the required side slopes of 1V:3H.

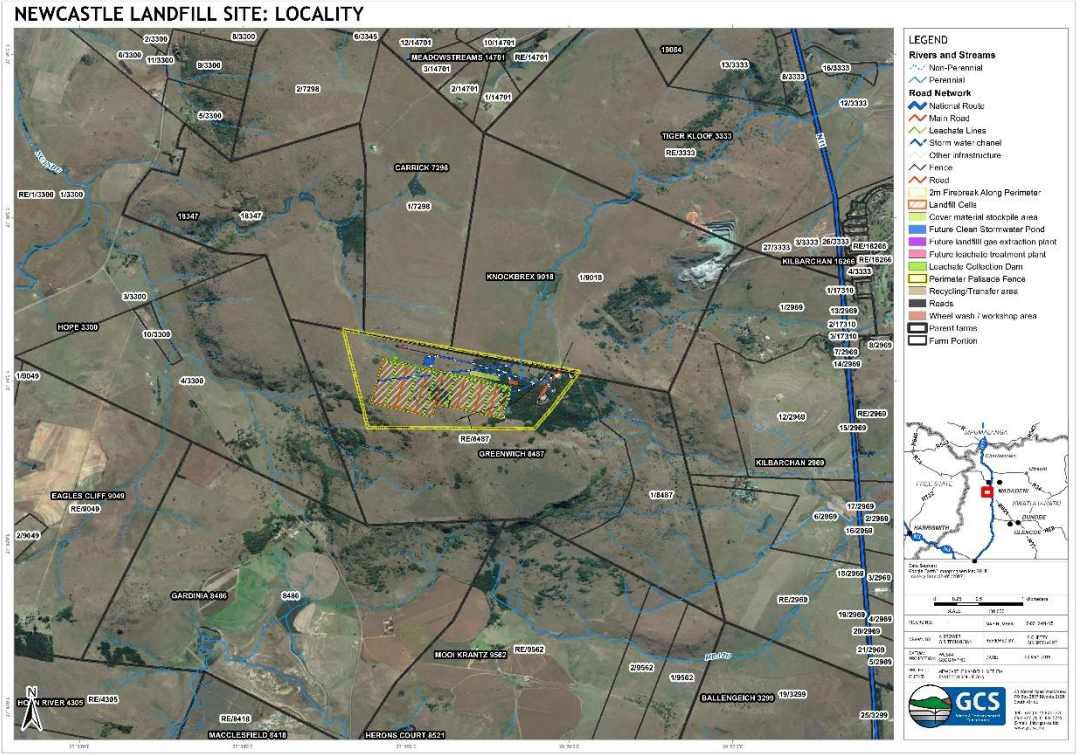


Figure 1-1: Layout of the Proposed Newcastle Local Municipality Landfill Site.

1.3 Contact Details

The contact details of the applicant are provided in **Table 1-1**.

Table 1-1: Name and address of applicant representative.

ITEM	COMPANY CONTACT DETAILS
Name:	Newcastle Local Municipality
Company Representative:	Ntsiki Khathide
Physical Address:	Newcastle Civic Centre, Murchison Street, Newcastle
Telephone No.:	034 328 7600
Facsimile No.:	034 328 3493
E-mail Address:	Ntsiki.Khathide@newcastle.gov.za
Postal Address:	Private Bag X662, Newcastle, 2940

GCS Water and Environment (Pty) Ltd (GCS) have been appointed as the independent Environmental Assessment Practitioners (EAP) to undertake the environmental processes for the EIA phase required to obtain approval for the identified listed activities, as required by the relevant competent authorities. The contact details of the design engineers are provided in **Table 1-2** and the EAP are provided in **Table 1-3**.

Table 1-2: Name and Address of Environmental Assessment Practitioner.

ITEM	COMPANY CONTACT DETAILS
Company Name:	Envitech Solutions (Pty) Ltd
Company Representative:	Mr Nash Dookhi
Physical Address:	Unit B1, 2 Meyrickton Place, Meyrickton Park, Gillitts, 3610, Durban
Telephone No.:	+27 (0)31 023 0981
Facsimile No.:	+27 (0)11 604 3555
E-mail Address:	nash@envitech.co.za
Postal Address:	PO Box 1677, Hillcrest, 3650, Kwa-Zulu Natal

Table 1-3: Name and Address of Environmental Assessment Practitioner.

ITEM	COMPANY CONTACT DETAILS
Company Name:	GCS Water and Environment (Pty) Ltd
Company Representative:	Ms Riana Panaino
Physical Address:	63 Wessels Road, Rivonia, Johannesburg, 2128
Telephone No.:	+27 (0)11 803 5726
Facsimile No.:	+27 (0)11 803 5745
E-mail Address:	rianap@gcs-sa.biz
Postal Address:	PO Box 2597, Rivonia, 2128

The EAP holds a BSc (Honours) in Botany and Zoology and is a registered Professional Natural Scientist (Reg. No. 117170) with the South African Council for Natural Scientific Professions. The EAP has been working in the field of environmental assessment and authorisation for a period of 10 years.

1.4 Description of Land

The proposed general waste landfill site is to be established within the province of KwaZulu-Natal (KZN) approximately 11 kilometres (km) south of NLM in the Amajuba District Municipality (**Figure 1-2**). The preferred site, which is owned by the applicant, is located on a portion of the Farm Greenwich 8784, with a size of approximately 780 ha. The landfill site, including infrastructure, will occupy an area of approximately 180 ha, with the proposed landfill footprint area itself being approximately 55 ha. The site is accessible via a gravel road off the N11 main road located to the east of the site. Site coordinates are 27°50’53.6”S and 29°55’12.2”E.

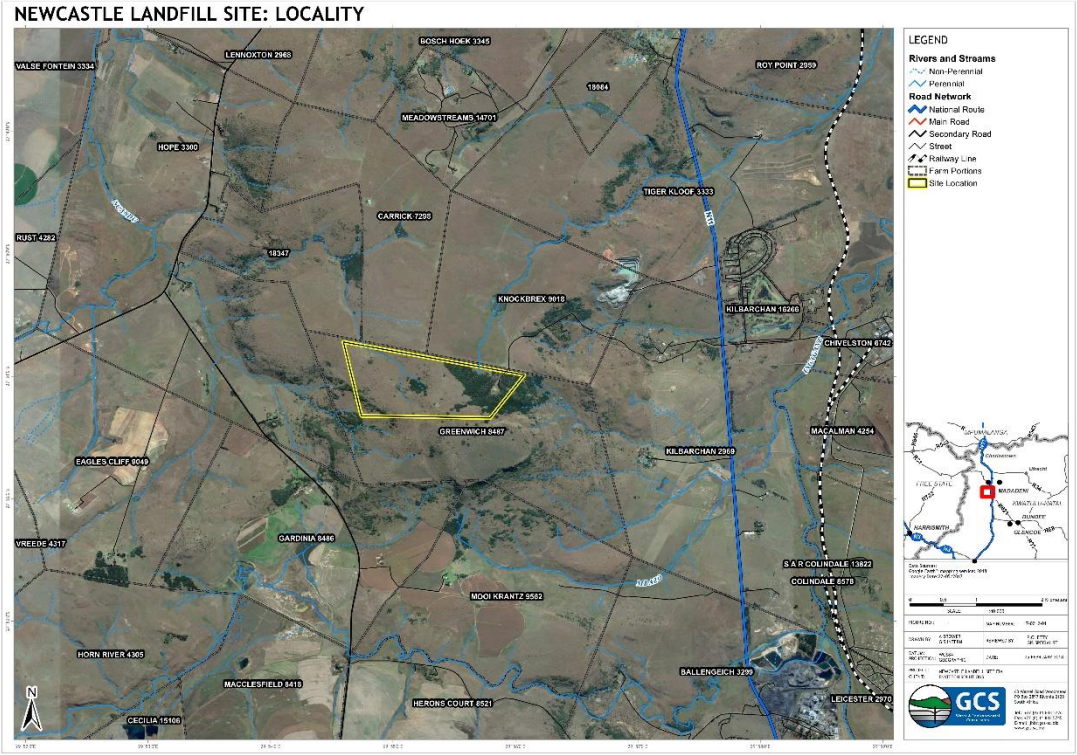


Figure 1-2: Site Locality Map.

The registered description of the properties applicable to the proposed site is provided in **Table 1-4** and Figure 1-3.

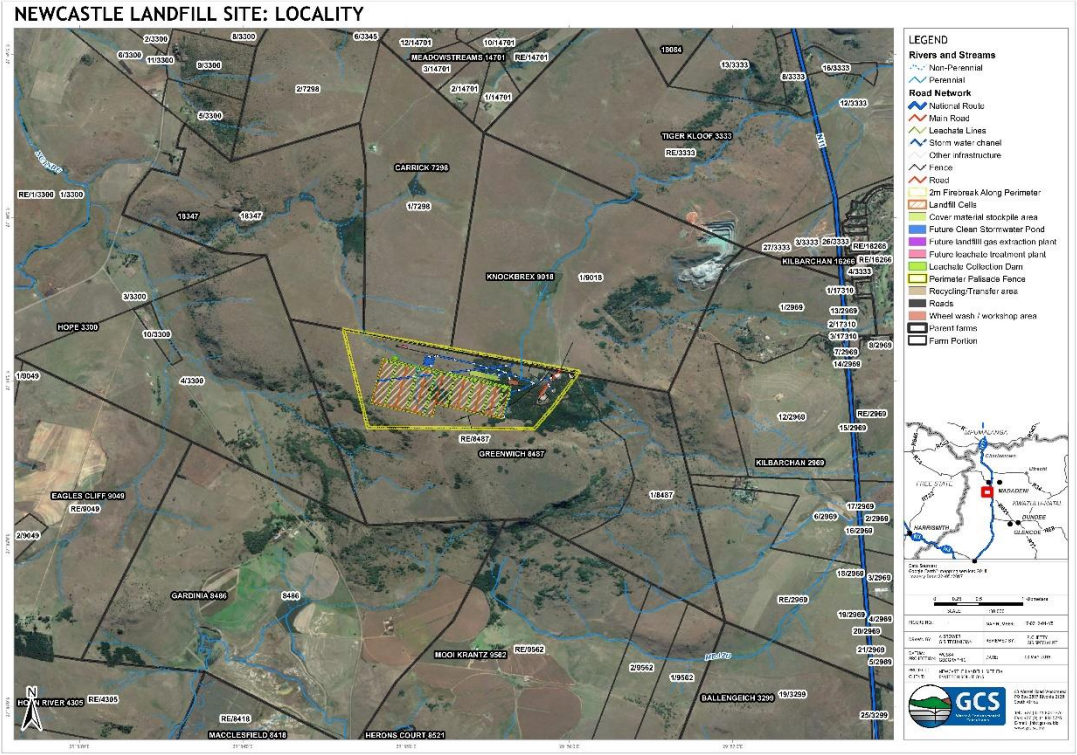


Figure 1-3: Farm portions related to the site

Table 1-4: Land Ownership for the Proposed Landfill Site.

LAND OWNER	FARM NAME, REGISTRATION DIVISION AND PORTION	TITLE DEED	SG CODE
The Newcastle Local Municipality	Greenwich 8487 HS, Portion 0	T40911/2015	N0HS00000000848700000
National Government of the Republic of South Africa	Greenwich 8487 HS, Portion 1	T30956/2012	N0HS00000000848700001

1.5 Legislative Background

For the purposes of this application, various environmental authorisations will be required. A summary of the relevant and applicable legislative structures are provided herewith.

1.5.1 The Constitution of the Republic of South Africa

The Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996) is the supreme act to which all other acts must speak to. The Constitution sets out the rights for every citizen of South Africa and aims to address past social injustices. With respect to the environment, Section 24 of the constitution states that:

"Everyone has the right:

a) To an environment that is not harmful to their health or well-being;
b) To have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:
   i. Prevent pollution and ecological degradation;
   ii. Promote conservation; and
   iii. Secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

All companies are thus duty-bound to constitutional, legislative, and other measures to prevent pollution and ecological degradation, promote conservation and to develop in a sustainable manner.

Two particular judgments deserve consideration in that they contain a comprehensive analysis of the nature and content of the environmental right within the sustainability context. Firstly, the court in BP Southern Africa (Pty) Ltd v MEC for Agriculture, Conservation and Land Affairs 2004 5 SA 124 (WLD) confirmed that environmental interests should be balanced with justifiable economic and social development well beyond the interests of the present living generation.

The court justified the latter with Section 24(b), since this Section requires the environment to be protected for the benefit of present and future generations. The court confirmed the importance of sustainable development and predicted that it will "…play a major role in determining important environmental disputes in the future".

The court in Fuel Retailers Association of Southern Africa v Director General: Environmental Management, Department of Agriculture, Conservation and Environment, Mpumalanga Province 2007 6 SA 4 (CC) attempted to balance these social, environmental and economic concerns by recognising the importance of economic and social development for the well-being of human beings. However, the court emphasised that development and the environment are inexorably linked and development cannot exist upon a weakening environmental base. Consequently, the promotion of development requires the protection of the environment.

The constitutional environmental right elevates the importance of environmental protection and conservation, and emphasises the significance that South Africans attach to a sound and healthy environment.

The constitution also establishes the idea of the Polluter Pays Principal (which is later discussed) and is simply that the party responsible for pollution of the environment remains responsible for financial reparations of the impacts from their activities.

1.5.2 National Environmental Management Act (Act No. 107 of 1998)

1.5.2.1 NEMA Principles

The NEMA provides the framework environmental legislation and establishes an integrated environmental management system for South Africa. It aims to prevent pollution and degradation of South Africa's natural environments while promoting sustainable economic and social development.

Central to NEMA is the idea of Integrated Environmental Management (IEM). IEM seeks to:

- Promote the integration of the principles of environmental management into the making of all decisions;
- Identify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities, with a view to minimising negative impacts, maximising benefits, and promoting compliance with section 2 principles; and
- Ensure that the effects of activities on the environment receive adequate consideration before actions are taken in connection with them.

Any decision taken in respect of the proposed application for environmental authorisation should take into account the principles as set out in Section 2 of NEMA. The principles include:

- The Polluter Pays Principle: The Polluter Pays Principle means that "polluters and users of natural resources (should) bear the full environmental and social costs of their activities". The Polluter Pays Principle can also be described as an economic principle that requires the polluter to be held liable to compensate or pay for pollution prevention, minimisation and remediation. Therefore, the crux of the principle is to impose economic obligations when environmental damage is caused by a polluter and this is achieved by setting minimum rules on liability for environmental damage.
- The Precautionary Principle: The Precautionary Principle provides guidance during development or when anything occurs which might harm the environment and where there is scientific uncertainty. NEMA stipulates and requires "a risk averse and

cautious approach" to be applied and that decision-makers should take into account the limits of current knowledge about the consequences of decisions and actions".

- The Preventative Principle: The Preventive Principle is reflected in the concept that the disturbance of ecosystems and loss of biological diversity are to be "…avoided, or…minimised and remedied". Furthermore, the principle prescribes that the disturbance of the landscape and the nation's cultural heritage is to be avoided, and where it cannot be altogether avoided, must be minimised and remedied. The principle aims to minimise environmental damage by requiring that action be taken at an early stage of the process, and if possible, before such damage actually occurs. Broadly stated, it prohibits any activity which causes or may cause damage to the environment in violation of the duty of care established under environmental law.
- Cradle-to-grave: A Cradle-to-Grave stewardship perspective indicates the adoption of a comprehensive ecological view of the impacts of a process on the environment, commencing with research, development and design through the extraction and use of raw materials, production and processing, storage, distribution and use, to the final disposal of the product and the waste generated as a by-product. The "cradle-to-grave" principle advocates liability as a result of, or caused by, policies, programmes, projects, products, processes, services and activities. Given the general purpose of NEMA, together with the other sustainability principles, this legal liability may include to rectify, remedy or compensate for environmental damage or degradation.

GCS acknowledge that these principles serve as guiding principles because they are binding, enforceable and justiciable. By adhering to these principles, GCS promotes a cautious approach when advising on the activities, processes and daily operations of the Puma Filling Stations and advocates compliance with environmental regulatory measures.

1.5.2.2 NEMA Duty of Care

Chapter 7 of NEMA contains essential provisions dealing with liability for environmental damage in South Africa and two key elements form part thereof; namely: pollution prevention and remediation. A duty of care is contained in Section 28, which encompasses the main liability provision which applies retrospectively and therefore also to historical pollution. Section 28(1) applies to all forms of pollution and is formulated generally by providing a duty of care to avoid, minimise and/or remedy pollution or environmental degradation.

In terms of this subsection, the duty imposes liability on an almost non-exhaustive category of persons, because it refers to "every person". Section 28(2) goes even further and imposes the duty on a range of people including owners or people in control of land or premises and

people who have the right to use the land or premises on which, or in which, an activity or process is, or was, performed or undertaken, or any other situation exists which causes, or is likely to cause, significant pollution or degradation to the environment.

The duty of care imposes strict liability since Section 28(1) requires reasonable persons to take reasonable measures. Subsection (3) provides an indicative range of measures that can be considered as "reasonable measures" and these may include measures to investigate, assess and evaluate the impact on the environment; inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation, contain or prevent the movement of pollutants or the causing of degradation, eliminate any source of the pollution or degradation and to remedy the effects of the pollution or degradation.

One can identify from the wording an obligation to prevent and minimise pollution or degradation and this indicates that remediation is clearly part of South African law. Where a company fails to take reasonable measures to prevent or minimise pollution, it can be directed to do so by the relevant authority and if it does not comply with the directive, measures will be taken by government on its behalf, but at the company's expense. Under Section 34(7), liability is specifically extended to the director of the company concerned in his or her personal capacity, in other words, the director is personally liable.

Furthermore, Section 43 provides that if directors failed to take all reasonable steps to prevent the offence being committed, and monetary advantage was gained, they may be personally liable for damages or compensation, have to pay a fine, or have to comply with remedial measures determined by the Court, and may even have to pay the State's investigative costs.

1.5.2.3 NEMA 2014 Environmental Impact Assessment (EIA) Regulations GN R982

The Department of Environmental Affairs (DEA) has developed a list of activities which are likely to have an impact on the environment. The list of activities were published in 2014 (GN 982) and were separated into three listing notices (GN R983, GN R984 and GN R985) and were amended by the Department in 2017. The amended list of activities (GN R.324, GN R.325 and GN R327) are still referred to as GN R983, GN R984 and GN R985.

Any activity which is listed under these notices requires an environmental assessment to be conducted and approved before the activity can proceed. Activities falling under Listing Notice 1 (GN R983) or Listing Notice 3 (GN R985) require a Basic Assessment (BA) to be

conducted while any activity falling under Listing Notice 2 (GN R984) requires a full Scoping and Environmental Impact Reporting (S&EIR) process to be conducted.

1.5.2.4 NEMA 2010 Environmental Impact Assessment (EIA) Regulations GN R543

The Department of Environmental Affairs (DEA) as the governing body for environmental authorisations in South Africa developed a list of activities which are likely to have an impact on the environment. The concept of "listed activities" was first noted in The Environmental Conservation Act, 1989 (Act No. 73 of 1989) (ECA) which pre-dated the NEMA. ECA Notices (GN R1182, GN R448 and GN R670) were the first promulgated listed activities in South African environmental law. Although the ECA has been largely replaced by the NEMA, certain provisions thereof still remain in force. Under NEMA, the DEA first identified and promulgated listed activities in the 2006 NEMA EIA Regulations (GN R385) and NEMA Notices (GN R386 and GN R 387). The 2006 NEMA EIA Regulations have since been mostly replaced by the 2010 NEMA EIA Regulations (GN R543) and NEMA Notices (GN R544, GN R545 and GN R546).

In line with the transitional arrangements of the NEMA 2014 EIA Regulations, as amended in April 2017, where an application submitted in terms of the previous NEMA regulations, is pending in relation to an activity of which a component of the same activity was not identified under the previous NEMA notices, but is now identified in terms of section 24(2) of the Act, the competent authority must dispense of such application in terms of the previous NEMA regulations and may authorise the activity identified in terms of section 24(2) as if it was applied for, on condition that all impacts of the newly identified activity and requirements of these Regulations have also been considered and adequately assessed.

It is for this reason that this application is still subject to the NEMA 2010 EIA Regulations and associated process timeframes.

1.5.3 National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008)

The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) (NEM:WA) fundamentally reformed the law regulating waste management, and for the first time provides a coherent and integrated legislative framework addressing all the steps in the waste management hierarchy. The objectives of the NEM:WA are to protect health, well-being and the environment by providing reasonable measures for, inter alia, remediating land where contamination presents, or may present, a significant risk of harm to health or the environment. The objectives of the NEM:WA are structured around the steps in the waste management hierarchy, which is the overall approach that informs waste management in South Africa. The waste management hierarchy consists of options for waste management

during the lifecycle of waste, arranged in descending order of priority; i.e. waste avoidance, reduction, re-use, recycling, recovery, treatment, and safe disposal as a last resort.

NEMA, as previously mentioned, introduced a number of additional guiding principles into South African environmental legislation, including the life-cycle approach to waste management, producer responsibility, the precautionary principle and the polluter pays principle (i.e. the sustainability principles as contained in Section 2 of NEMA). Section 5(2) of the NEM:WA stipulates that the Act should be interpreted and guided in accordance with these sustainability principles. The NEM:WA, furthermore, echoes the duty of care provision, in terms of Section 28 of NEMA, by obliging holders of waste to take reasonable measures to implement the waste management hierarchy. Section 16(1) of the NEM:WA provides that:

> "A holder of waste must, within the holder's power, take all reasonable measures to –
>
> a) avoid the generation of waste and where such generation cannot be avoided, to minimise the toxicity and amounts of waste that are generated;
> b) reduce, re-use, recycle and recover waste;
> c) where waste must be disposed of, ensure that the waste is treated and disposed of in an environmentally sound manner;
> d) manage the waste in such a manner that it does not endanger health or the environment or cause a nuisance through noise, odour or visual impacts;
> e) prevent any employee or any person under his or her supervision from contravening this Act; and
> f) prevent the waste from being used for an unauthorised purpose."

While the NEM:WA creates a comprehensive legal framework for waste management, its provisions will be meaningless without measures to monitor and, where necessary, enforce compliance. Compliance monitoring is supported by a range of reporting provisions contained in the NEM:WA. In addition to compliance reports for waste management licences and norms and standards, the NEM:WA has provisions for annual performance reports on the implementation of provincial and local Integrated Waste Management Plans. Industry Waste Management Plans are subject to review at intervals to be determined by the authority that mandated the plan. Furthermore, Environmental Management Inspectors and Waste Management Officers can request a Waste Impact Report where they suspect a contravention of the Act, licence conditions or exemption conditions.

The NEM:WA provides for a licensing regime specific to waste management activities. It replaces the historical system of permits issued in terms of the repealed Section 20 of the ECA. Transitional arrangements allow existing permits granted in terms of ECA to be regarded

as licences in terms of the NEM:WA until the Minister requires a licence application as per the NEM:WA category of the waste management activity (i.e. category A or B). The NEM:WA waste management categories determine the environmental assessment procedure (which is the equivalent of the NEMA EIA regulations' requirements) required to obtain a licence.

Category A activities require a BA process to be undertaken, whilst Category B activities require a S&EIR process to be undertaken.

The recently amended legislation concerning EIAs makes reference to the development of norms and standards which may guide EIA applications and Environmental Authorisations in the future. The production of appropriate norms and standards for specific forms of developments is ongoing and it is anticipated that this will eventually provide the opportunity to further streamline the EIA procedures in relation to particular forms of developments. Depending on the location of developments, it is important to note that applicable Norms and Standards are no different from regulations in law in that they are both equally binding.

The NEM:WA norms and standards have been specified as follows:

- National Norms and Standards (2013) for the (i) Storage of Waste; (ii) Extraction, Flaring or Recovery of Landfill Gas; (iii) Scrapping & Recovery of Motor Vehicles; (iv) Remediation of Contaminated Land;
- Waste Information (WIS) Regulations;
- Waste Classification and Management Regulations, and Norms & Standards for
- Assessment and Disposal of Waste to Landfill (2013); and
- Industry Waste Management Plans.

1.5.3.1 Standards for Extraction, Flaring or Recovery of Landfill Gas, 2013

The standards aim at controlling the extraction, flaring or recovery of landfill gas at facilities in order to prevent or minimise potential negative impacts on the bio-physical and socio-economic environments.

These standards apply to a landfill gas extraction, flaring or recovery facility initiated, constructed or upgraded after the coming into operation of the standards. The standards are applicable throughout the Republic of South Africa and specify requirements for landfill gas extraction, flaring and recovery during the planning, construction, operation and decommissioning phases of the landfill.

This Standard is only applicable if the applicant chooses to undertaken extraction, flaring or recovery of landfill gas which, to GCSs' knowledge, is not planned at this stage in the project

development. Should this change the applicant will need to comply with the Standards and obtain any associated environmental authorisations required prior to initiating the extraction, flaring or recovery of landfill gas.

1.5.3.2 Minimum Requirements for Waste Disposal by Landfill Second Edition, 1998

There have been a number of waste management regulations and policies that have been published recently in order to promote better management of waste and facilities used to manage it. The construction and operation of any facility for the handling, storage or disposal of waste must comply with the following:

- National Norms and Standards for Disposal of Waste to Landfill;
- National Norms and Standards for the Storage of Waste;
- Waste Classification and Management Regulations, Norms and Standards for Assessment and Disposal of Waste to Landfill;
- National Policy in Thermal Treatment of General and Hazardous Waste (where incinerators may be used); and
- National Domestic Waste Collection Standards.

Landfill facilities must also comply with the Minimum Requirements for Waste Disposal by Landfill, (Second Edition 1998) as published by the Department of Water Affairs and Forestry (DWAF) as some of the requirements in the Minimum Requirements are still applicable though there has been new standards published.

The objectives of the Minimum Requirements for Waste Disposal by Landfill can be summarised as follows:

- To improve the standard of waste disposal in South Africa;
- To set guidelines for environmentally acceptable waste disposal for a spectrum of landfill sizes and types; and
- To provide a framework of minimum waste disposal standards within which to work and upon which to build.

The approach to the Minimum Requirements is based on the IEM approach. This promotes, inter alia, the proactive control of pollution, by integrating environmental aspects into the planning of developments.

This approach has been dovetailed with the Environmental Impact Regulations, the required processes and activities must meet the 'Best Practicable Environmental Option' (BPEO). This is the option which provides the most benefit and least damage to the environment as a whole, in both the long and the short term. It is arrived at by the due consideration of

alternatives and costs. The methods and practices used to implement the above processes and activities must be the 'Best Available Technology Not Entailing Excessive Cost' (BATNEEC), where 'excessive cost' is determined by a cost benefit analysis.

1.5.4 National Environmental Management Air Quality Act, 2004 (Act No. 39 of 2004)

The National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM:AQA), as amended, has shifted the approach of air quality management from source-based control to receptor-based control. The main objectives of the Act are to:

- Give effect to everyone's right 'to an environment that is not harmful to their health and well-being'; and
- Protect the environment by providing reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

The Act makes provision for the setting and formulation of National Ambient Air Quality Standards for 'substances or mixtures of substances which present a threat to health, well-being or the environment'. More stringent standards can be established at the provincial and local levels.

The control and management of emissions in the NEM:AQA relates to the listing of activities that are sources of emissions and the issuing of emission licences. Listed activities are defined as activities which 'result in atmospheric emissions and are regarded as having a significant detrimental effect on the environment, including human health'. Listed activities have been identified by the Minister of the DEA and atmospheric emission standards have been established for each of these activities. These listed activities now require an Atmospheric Emission Licence (AEL) to operate. The issuing of AELs for Listed Activities will be the responsibility of the Metropolitan and District Municipalities.

In addition, the Minister may declare any substance contributing to air pollution as a priority pollutant. Any industries or industrial sectors that emit these priority pollutants will be required to implement a Pollution Prevention Plan. Municipalities are required to 'designate an air quality officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality'. The appointed Air Quality Officer is responsible for the issuing of atmospheric emission licences.

This Act is only applicable if it is found that any of the activities taking place at the landfill site trigger any of the identified listed activities requiring issuance of an AEL. This can only

be determined once the landfill site has been established and is operational so is not applicable at this stage.

1.5.5 National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)

The National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003) (NEM:PAA) provides for the protection, conservation and management of ecologically viable areas representative of South Africa's biological diversity and its natural landscapes and seascapes, for the management of those areas in accordance to national norms and standards, as well as for the intergovernmental co-operation and public consultation in matters concerning protected areas. Protected areas are to be conserved for their biodiversity and ecological integrity.

This Act is only applicable if activities fall within any conservancy or protected area, which is not the case with the proposed landfill site development.

1.5.6 National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)

The National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA) provides for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act; the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute (SANBI); and for matters connected therewith.

This Act is only applicable if red data fauna or flora species are identified in the study area.

1.5.7 National Water Act, 1998 (Act No. 36 of 1998)

One of the main and ever-continuing concerns in South Africa is the sustainability of water management, and the costs associated with the prevention and remediation of pollution in a country with an average rainfall far below international standards. The National Water Act, 1998 (Act No. 36 of 1998) (NWA) is one of the government's answers to some of these challenges and functions as sectoral legislation within the framework of NEMA.

The NWA aims to ensure the protection and sustainable use of South Africa's water resources. The three main pillars of the NWA are sustainability, equity and efficiency. The NWA provides for a Section 21 Water Use License (WUL) which a company will have to apply for, before commencing with any water use related activities. Various conditions may be attached to

these licenses and a breach thereof will result in criminal and civil liability. The conditions attached to water use authorisations will function alongside the additional protective measures, duty of care and statutory liability provisions provided by the NWA and other legislation to regulate a whole array of water issues.

Section 19 of the NWA mirrors the provision of Section 28 of NEMA and addresses the prevention and remediation of the effects of pollution. The NWA provides a wide duty of care in that:

> "(1) an owner of land, a person in control of land or a person who occupies or uses the land on which:
>
> a) any activity or process is or was performed or undertaken; or
> b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring."

The NWA also enforces the idea of the Polluter Pay Principle. Section 19(1) of the NWA states that:

> "An owner of land, a person in control of land or a person who occupies or uses the land on which –
>
> a) any activity or process is or was performed or undertaken; or
> b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource, must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring."

According to NWA, water may not be used without prior authorisation from the leading authority, in this case the Department of Water and Sanitation (DWS). Due to the requirements of the NWA, an Integrated Water Use License (IWUL) Application and Integrated Water and Waste Management Plan (IWWMP) needs to be compiled and handed in at the DWS to ensure the legality of the proposed water uses. GCS will be undertaking the development of the required water use licenses as per the NWA.

1.5.8 The National Heritage Resources Act, (Act No. 25 of 1999)

The National Heritage Resources Act, (Act No. 25 of 1999) (NHRA) requires Heritage Resources Impact Assessments for various categories of development stipulated in Section 38 of the Act. It also provides for the grading of heritage resources and the implementation of a three-tier level of responsibilities and functions for heritage resources to be undertaken by the national and Provincial Authorities, depending on the grade of the heritage resource. The Act defines cultural significance, archaeological and paleontological sites and materials (Section 35),

historical sites and structures (Section 34), and graves and burial sites (Section 36) that fall under its jurisdiction. Archaeological sites and material are generally those resources older than a hundred years, including gravestones and grave dressing. Procedures for managing graves and burial grounds are set out in Section 36 of the NHRA. Graves older than 100 years are legislated as archaeological sites and must be dealt with accordingly. Section 38 of the NHRA makes provision for application by developers for permits before any heritage resource may be damaged or destroyed.

This Act is only applicable if any heritage resources such as sites of cultural significance, archaeological and paleontological sites and materials; historical sites and structures; and/or and graves and burial sites are determined to be within the proposed landfill development area.

1.5.9 Penalties Owing to Offences and/or Non-Compliance

Penalties owing to offences or non-compliances under the various environmental legislation is summarised in **Table 1-5**. The applicant should be aware of the penalties associated with offences and/or non-compliances for the proposed landfill site.

Table 1-5: Penalties for Offences and/or Non-compliance.

LEGISLATION	SECTION	FINE
NEMA	Section 24, 31	Fine not exceeding R 5,000,000.00, or imprisonment for a period not exceeding 10 years, or both such fine and such imprisonment.
	Section 28, 30	Fine not exceeding R 1,000,000.00, or imprisonment for a period not exceeding 1 year, or both such a fine and such imprisonment.
	Section 34	Fine not exceeding R 10,000.00, or imprisonment for a period not exceeding 1 year, or both such fine and such imprisonment
NWA	Section 15 and Item 31 of Schedule 4	First Conviction: Fine not exceeding R 100,000.00, or imprisonment for a period not exceeding 5 years, or both such fine and such imprisonment. Second or Subsequent Conviction: Fine not exceeding R 200,000.00, or imprisonment for a period not exceeding 10 years, or both such fine and such imprisonment.
NEM:WA	Section 67 and 68	Liable to a fine up to R 10,000,000.00, or imprisonment up to 10 years, or both, in addition to other penalties that may be imposed in terms of NEMA.

1.6 Environmental Processes

1.6.1 Environmental Process Objectives

In order to mitigate potentially negative impacts and to identify any potential fatal flaws which may render the project environmentally unacceptable, GCS has adopted an integrated, step-by-step process to identify issues of concern and to thoroughly investigate these issues. To ensure that the negative impacts are identified and mitigated in the early stages of the project, and that the positive impacts are maximised, it will be necessary for the environmental study to meet the following aims:

- Follow the guideline process as outlined by the NEMA;
- Provide input in the feasibility phases to ensure that the most technically feasible, and environmentally sound options are selected;
- Ensure that impacts are identified early through investigations to minimize environmental damage and maximise benefits;
- Conduct thorough special investigations that will allow the project team to develop an adequate understanding of the issues to be dealt with;
- Compile an EIA that will identify, evaluate and address the potential impacts;
- Provide ongoing environmental input into the project planning and development;
- Compile an Environmental Management Plan (EMP) that will limit the significance of the negative impacts and maximise the positive aspects;
- Ensure that all relevant Interested and Affected Parties (I&APs) are consulted and involved throughout the project; and
- Ensure that an open and transparent communication structure is in place during the life of the mine.

The environmental process is being undertaken in accordance with the provisions of NEMA, NEM:WA and NWA. Strong emphasis will be placed on these processes to ensure that the processes will be able to run concurrently, and will easily be comparable with no confusion between the different processes. The various environmental authorisation processes being followed for this project are described in the sections which follow.

1.6.2 The NEMA and NEM:WA

Section 24(1) of NEMA requires that the potential consequences of or impacts on the environment of listed activities must be considered, investigated, assessed and reported on to the competent authority. Where EIAs have been identified as the instrument to be utilised in achieving the aforementioned, an application for environmental authorisation needs to be obtained. The identified activities are listed under GN R544, R545, R546 and R547 of the 2010 NEMA EIA Regulations respectively.

The listed activities which are triggered by the proposed landfill site are contained in Listing Notice 1 (GN R544) and Listing Notice 2 (GN R545) of the 2010 NEMA EIA Regulations. Activities contained in Listing Notice 1 require a Basic Assessment (BA) process to be followed whilst activities in Listing Notice 2 require a Scoping and Environmental Impact Reporting (S&EIR) process to be followed. For the purposes of this application all items listed under Listing Notice 1 will be addressed in the required S&EIR process applicable to Listing Notice 2 activities. The KZN Economic Development, Tourism and Environmental Affairs (EDTEA) is regarded as the competent authority and as such a consolidated NEMA and NEM:WA EIR will be developed for proposed application and submitted to the EDTEA for assessment and authorisation.

S&EIR processes entail a comprehensive EIA process which includes a scoping phase and an EIA phase. In the scoping phase, issues and a plan of study for the EIA phase are identified and an Environmental Scoping Report (ESR) is developed. The EIA phase assesses issues identified during the scoping phase and includes development of an EMP. The EMP provides information on the proposed activity and the manner in which potential impacts will be minimised or mitigated. This process is required for all listed activities.

Table 1-6 presents the potential listed activities which may be triggered by the proposed waste landfill facility. Figure 1-4 shows the locations of the proposed triggered activities. When GCS came on board to complete the project, it was found that some listed activities were omitted which should have been included. All activities, including omitted activities, triggered in terms of the NEMA 2010 EIA Regulations are listed in **Table 1-6**. Furthermore, the correlating activities in terms of the NEMA 2014 EIA Regulations have been included in **Table 1-6** for comparative purposes. An updated application form will be submitted to the EDTEA with the Final EIR to align the application form with the activities anticipated on site.

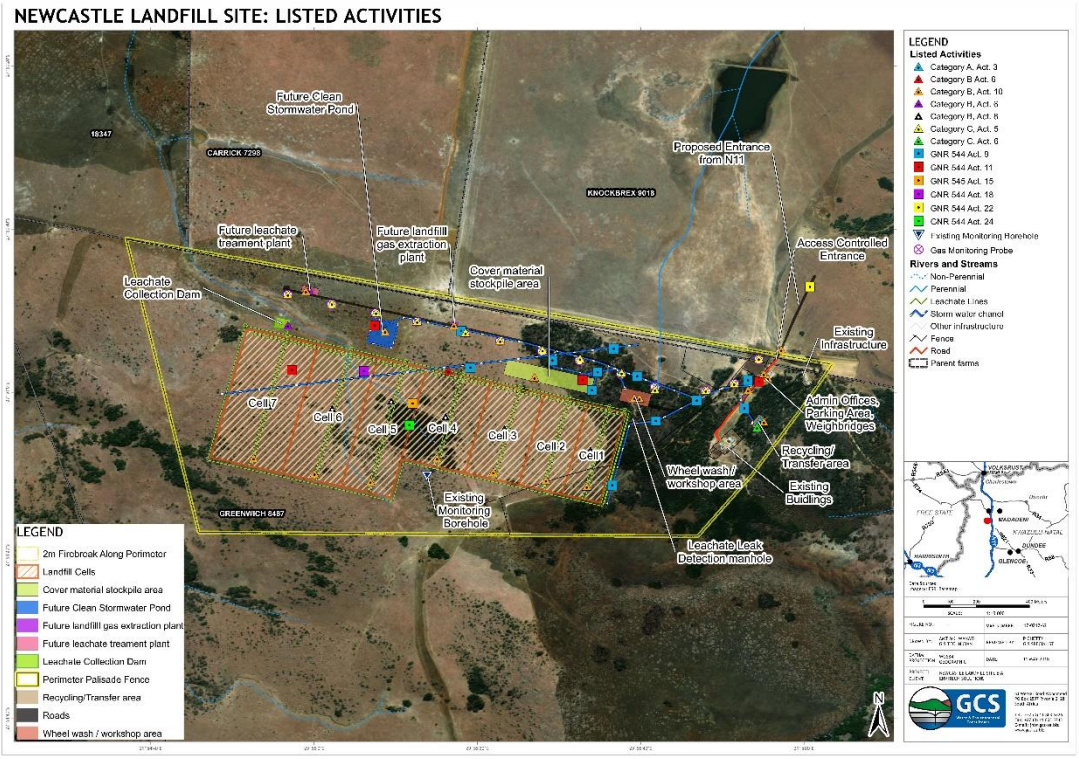


Figure 1-4: Listed activities locations

Table 1-6: Listed Activities in terms of NEMA and NEM:WA.

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
Effluent and storm water management system of the landfill site	GNR 544 Activity 9	The construction of facilities or infrastructure exceeding 1 000 metres in length for the bulk transportation of water, sewage or storm water – (i) with an internal diameter of 0.36 metres or more; or (ii) with a peak throughput of 120 litres per second or more, excluding where: a) such facilities or infrastructure are for bulk transportation of water, sewage or storm water or storm water drainage inside a road reserve; or b) where such construction will occur within urban areas but further than 32 metres from a watercourse, measured from the edge of the watercourse.	GNR 983 Activity 9	The development of infrastructure exceeding 1 000 metres in length for the bulk transportation of water or storm water- (i) with an internal diameter of 0.36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- a) such infrastructure is for bulk transportation of water or storm water or storm water drainage inside a road reserve or railway line reserve; or b) where such development will occur within an urban area.
			GNR 983 Activity 10	The development and related operation of infrastructure exceeding 1 000 metres in length for the bulk transportation of sewage, effluent, process water, waste

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
				water, return water, industrial discharge or slimes- (i) with an internal diameter of 0,36 metres or more; or (ii) with a peak throughput of 120 litres per second or more; excluding where- a) such infrastructure is for the bulk transportation of sewage, effluent, process water, waste water, return water, industrial discharge or slimes inside a road reserve or railway line reserve; or b) where such development will occur within an urban area.
The development of some landfill infrastructure within wetlands and watercourses	GNR 544 Activity 11	The construction of: (i) canals; (ii) channels; (iii) bridges; (iv) dams; (v) weirs; (vi) bulk storm water outlet structures;	GNR 983 Activity 12	The development of- (i) dams or weirs, where the dam or weir, including infrastructure and water surface area, exceeds 100 square metres; or

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
		(vii) marinas; (viii) jetties exceeding 50 square metres in size; (ix) slipways exceeding 50 square metres in size; (x) buildings exceeding 50 square metres in size; or (xi) infrastructure or structures covering 50 square metres or more where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.		(ii) infrastructure or structures with a physical footprint of 100 square metres or more; where such development occurs- a) within a watercourse; b) in front of a development setback; or c) if no development setback exists, within 32 metres of a watercourse, measured from the edge of a watercourse;- excluding- (aa) the development of infrastructure or structures within existing ports or harbours that will not increase the development footprint of the port or harbour; (bb) where such development activities are related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies; (cc) activities listed in activity 14 in Listing Notice 2 of 2014 or activity 14 in

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
				Listing Notice 3 of 2014, in which case that activity applies; (dd) where such development occurs within an urban area; (ee) where such development occurs within existing roads, road reserves or railway line reserves; or (ff) the development of temporary infrastructure or structures where such infrastructure or structures will be removed within 6 weeks of the commencement of development and where indigenous vegetation will not be cleared.
The development of some landfill infrastructure within wetlands and watercourses	GNR 544 Activity 18	The infilling or depositing of any material of more than 5 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from- (i) a watercourse; (ii) the sea; (iii) the seashore;	GNR 983 Activity 19	The infilling or depositing of any material of more than 10 cubic metres into, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock of more than 10 cubic metres from a watercourse; but excluding where such infilling, depositing, dredging, excavation, removal or moving-

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
		(iv) the littoral active zone, an estuary or a distance of 100 metres inland of the highwater mark of the sea or an estuary, whichever distance is the greater but excluding where such infilling, depositing, dredging, excavation, removal or moving i. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or ii. occurs behind the development setback line.		a) will occur behind a development setback; b) is for maintenance purposes undertaken in accordance with a maintenance management plan; c) falls within the ambit of activity 21 in this Notice, in which case that activity applies; d) occurs within existing ports or harbours that will not increase the development footprint of the port or harbour; or e) where such development is related to the development of a port or harbour, in which case activity 26 in Listing Notice 2 of 2014 applies.
Construction of the landfill access road with an estimated width of 7 m and length of 3.5 km	GNR 544 Activity 22	The construction of a road, outside urban areas, (i) with a reserve wider than 13.5m; (ii) where no reserve exists where the road is wider than 8 metres, or	GNR 983 Activity 24	The development of a road- (i) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
		(iii) for which an environmental authorisation was obtained for the route determination in terms of activity 5 in Government Notice 387 of 2006 or activity 18 in Notice 545 of 2010.		of 2006 or activity 18 in Government Notice 545 of 2010; or (ii) with a reserve wider than 13,5 meters, or where no reserve exists where the road is wider than 8 metres; but excluding a road- a) which is identified and included in activity 27 in Listing Notice 2 of 2014; b) where the entire road falls within an urban area; or c) which is 1 kilometre or shorter.
The establishment of a public landfill site	GNR 544 Activity 24	The transformation of land bigger than 1 000 square metres in size, to residential, retail, commercial, industrial or institutional use, where, at the time of the coming into effect of this Schedule such land was zoned open space, conservation or had an equivalent zoning.	-	-
The establishment of a public landfill site	GNR 545 Activity 15	Physical alteration of undeveloped, vacant or derelict land for residential, retail, commercial, recreational,	GNR 984 Activity 15	The clearance of an area of 20 hectares or more of indigenous vegetation, excluding

PROPOSED PROJECT ACTIVITY	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2010 REGULATIONS	DESCRIPTION OF LISTED ACTIVITY (2010)	NOTICE AND ACTIVITY NUMBER IN TERMS OF 2014 REGULATIONS	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2014)
		industrial or institutional use where the total area to be transformed is 20 hectares or more; except where such physical alteration takes place for: (i) linear development activities; or (ii) agriculture or afforestation where activity 16 in this Schedule will apply.		where such clearance of indigenous vegetation is required for- (i) the undertaking of a linear activity; or (ii) maintenance purposes undertaken in accordance with a maintenance management plan.

Table 1.7: Listed Activities in terms of NEM:WA

PROPOSED PROJECT ACTIVITY	GNR 921 of 2013	DESCRIPTION OF ACTIVITY (2013)	GNR 921 of 2013 (as amended in 2017)	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2017)
It is proposed that recycling be undertaken as part of the landfill's operational activities, as it is highlighted as one of the goals of the National Waste Management Strategy (NWMS), which is to	Category A, Activity 3	The recycling of general waste at a facility that has an operational area in excess of 500 m^2, excluding recycling that takes place as an integral part of an integral part of an internal manufacturing process within the same premises	Category A, Activity 3	The recycling of general waste at a facility that has an operational area in excess of 500 m^2, excluding recycling that takes place as an integral part of an internal manufacturing process within the same premises.

PROPOSED PROJECT ACTIVITY	GNR 921 of 2013	DESCRIPTION OF ACTIVITY (2013)	GNR 921 of 2013 (as amended in 2017)	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2017)
promote waste minimization, reuse, recycling and recovery of waste. The recycling facility will be established in future once the waste volumes are being received.				
As part of the operation at the landfill site, there will be leachate and/or wastewater treatment on site	Category B, Activity 6	The treatment of general waste in excess of 100 tons per day calculated as a monthly average, using any form of treatment	Category B, Activity 6	The treatment of general waste in excess of 100 tons per day calculated as a monthly average, using any form of treatment.
The Newcastle Municipality wishes to establish a waste management (landfill) site for the disposal of general waste and it is estimated that 375 tonnes of domestic waste will be handled on a daily basis at the proposed landfill site	Category B, Activity 8	The disposal of general waste to land covering an area in excess of 200 m^2 and with a total capacity not exceeding 25 000 tons	Category B, Activity 8	The disposal of general waste to land covering an area in excess of 200 m^2 and with a total capacity exceeding 25 000 tons
The proposed landfill site will include the construction of associated infrastructure	Category B, Activity 10	The construction of a facility for a waste management activity listed in Category B of	Category B, Activity 10	The construction of a facility for a waste management activity listed in Category B of this

PROPOSED PROJECT ACTIVITY	GNR 921 of 2013	DESCRIPTION OF ACTIVITY (2013)	GNR 921 of 2013 (as amended in 2017)	DESCRIPTION OF SIMILARLY LISTED ACTIVITY (2017)
including an access road, on site roads, perimeter fence, guard house, weighbridge, stormwater management infrastructure, leachate management infrastructure, site offices, staff ablutions, recycling/transfer area, canteen as well as workshop.		this Schedule (not in isolation to associated waste management activity)		Schedule (not in isolation to associated waste management activity)
There is a possibility for landfill gas recovery as soon as the landfill site is fully operational and given that sufficient waste is landfilled to allow for considerable gas recovery	Category C, Activity 5	The extraction, recovery or flaring of landfill gas	Category C, Activity 5	The extraction, recovery or flaring of landfill gas
There is a possibility that sorting will be undertaken at the landfill facility	-	-	Category C, Activity 6	The sorting, shredding, grinding, crushing, screening or baling of general waste at a waste facility that has an operational area that is 1000 m^2 and more

1.6.3 The NWA

The NWA stipulates that activities which have the potential to impact on a water resource require that an Integrated Water Use License (IWUL) be issued by the DWS. In accordance with the requirements of the NWA, an IWUL application will be compiled for the proposed NLM landfill site and submitted to the DWS to ensure the legality of the identified water uses associated with the proposed operation.

It is anticipated that following water uses in terms of Section 21 of the NWA will be applied for at the KZN regional office of the DWS and/or the relevant Catchment Management Agency (CMA) office:

- Section 21(a) – Taking water from a water resource [TBC if abstracting from a borehole];
- Section 21(b) – Storing of water;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(e) – Engaging in a controlled activity (irrigation with waste or water containing waste) [TBC];
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource; and
- Section 21(i) - Altering the bed, banks, course or characteristics of a watercourse.

In addition to the IWUL an Integrated Water and Waste Management Plan (IWWMP) will also be developed and submitted to the DWS for assessment and authorisation. An IWWMP serves as the technical report to motivate the authorisation of the water uses triggered by the proposed general waste landfill site. As there are waste related uses associated with the proposed development, this report will be structured in line with the approved Integrated Water and Waste Management Plan (IWWMP) Operational Guideline compiled by the DWS.

The purpose of the IWWMP includes:

- Compilation of a site specific, implementable, management plan addressing all the identified water use and waste management relates aspects of a specific activity, in order to meet set goals and objectives in accordance with Integrated Water Resource Management (IWRM) principles;
- Provision of a management plan to guide the water user regarding the water and waste related measures which must be implemented on site in a progressive, structured manner in the short, medium and long term;
- Documentation of all the relevant information, as specified in the IWWMP Guideline as compiled by the DWS, to enable DWS to make a decision regarding the authorisation of a water use;

- Clarification of the content of the IWWMP for DWS officials and the water users, as the various regional offices of DWS might have different interpretations regarding the contents of the IWWMP;
- Standardisation of the format of supporting documentation which DWS requires during the submission of an IWUL application;
- Provision of guidance on the content of information required in an IWWMP as part of the water use authorisation process and level of detail that DWS requires to enable them to evaluate the supporting documentation to make a decision on authorising a water use; and;
- Ensuring that a consistent approach is adopted by DWS and the various Regional Offices and CMAs with regards to IWWMPs.

1.7 Environmental Reporting

Based on the outcome of the Environmental Scoping Phase, an EIR and associated EMP Report must be submitted to the EDTEA for consideration and approval.

1.7.1 Environmental Impact Report

The EIR must determine the nature, extent, duration, probability and significance of the environmental, social and cultural impacts of the project, the reasonable alternatives and the required mitigation measures for each impact during the life of the landfill site. Regulation 31(2) of Government Notice R543 of the NEMA 2010 EIA Regulations stipulates that an EIR must contain all necessary information to enable the competent authority to consider the application and to reach a decision. The EIA Report must contain, inter alia, the following:

- A description and comparative assessment of all alternatives identified;
- A description of all environmental issues identified as well as the significance of each issue and an indication if the extent to which the issue could be addressed by the adoption of mitigating measures;
- An Environmental Impact Statement; and
- An Environmental Management Plan.

Furthermore, the criteria which the competent authority will apply, when considering applications in terms of the provisions of NEMA, is enunciated in Regulation 8 of Government Notice R543 of the Regulations. The latter regulation states that consideration must be had for Section 24O, Section 24(4), as well as the need and desirability of the activity. The activities identified in the provisions of NEMA and the NEMA 2010 EIA Regulations thereto pertain to activities which may have a detrimental impact on the environment.

The criteria to be taken into account by the competent authority when considering applications as set out in Section 24O and 24(4) of NEMA includes, inter alia, the following relevant factors:

- Any pollution, environmental impacts or environmental degradation likely to be caused if the application is approved or refused;
- Measures taken to protect the environment from harm as a result of the activity which is the subject of the application;
- Measures taken to prevent, control, abate or mitigate any pollution, substantially detrimental environmental impacts or environmental degradation;
- The ability of the applicant to implement mitigation measures and to comply with any conditions subject to which the application may be granted;
- Where appropriate, any feasible and reasonable alternatives to the activity which is the subject of the application and any feasible and reasonable modifications or changes to the activity that may minimise harm to the environment; and
- Any comments received from organs of state that have jurisdiction over any aspect of the activity which is the subject of the application.

1.7.2 Environmental Management Plan

Each independent specialist was required to identify means of avoiding, mitigating and/or managing the negative impacts in his/her particular field of the investigation. The recommended management strategies are contained in the EMP (Appendix D), where GCS synthesised all recommended management strategies for the proposed listed activities and the operation as a whole. Management strategies are based on the recommendations by specialists in their specific field of study. The management measures will be incorporated into the landfill operations to avoid, or appropriately manage impacts from the outset.

A draft EMP must include details of the person who prepared the EMP and the expertise of that person to prepare an EMP. The draft EMP must, furthermore, include:

- Information on any proposed management or mitigation measures that will be taken to address the environmental impacts that have been identified, including environmental impacts or objectives in respect of –
    - Planning and design;
    - Pre-construction and construction activities;
    - Operation or undertaking of the activity;
    - Rehabilitation of the environment; and
    - Closure, where relevant.
- A detailed description of the aspects of the activity that are covered by the draft EMP;

- An identification of the persons who will be responsible for the implementation of the mitigating measures;
- Where appropriate, time periods within which the measures contemplated in the draft EMP must be implemented; and
- Proposed mechanisms for monitoring compliance with the environmental management plan and reporting thereon.

Whilst the EIR ensures that the needs of the environment (biophysical and socio-economic) are identified, the EMP provides a tool for meeting the objective to reduce or avoid negative environmental impacts associated with a project within a certain environment by providing detailed mitigation measures and management commitments. The EMP will become legally binding on the granting of an environmental authorisation and issuance of a WML.

2 DETAILED PROJECT DESCRIPTION

2.1 Site Infrastructure

There is no existing site infrastructure and no site operations currently taking place on the proposed site. In addition to the proposed landfill cells, the site infrastructure to be constructed will comprise the following:

- Site access and internal roads;
- Perimeter fence, guard house and access control;
- Weighbridge;
- Stormwater management infrastructure;
- Leachate management infrastructure and Pollution Control Dam (PCD);
- Administration buildings;
- Recycling/Transfer area; and
- Workshop and wheel-wash area.

2.1.1 Site Access and Internal Roads

It is proposed that these roads be constructed with an asphalt wearing surface. Details for the site access and internal roads will be confirmed during the detail design stage.

2.1.2 Perimeter Fence, Guard House and Access Control

The proposed perimeter fence will be a 2.4 m high concrete palisade fence to prevent unauthorized entry to the site. The entrance to the site will be access controlled with a proposed security building.

2.1.3 Weighbridge

Two (2) 18 m long weighbridges will be provided to capture the tonnages of all incoming waste streams. The waste data will be captured on a computer using software provided by the weighbridge supplier. The waste data will then be forwarded and captured on the South African Waste Information System (SAWIS).

2.1.4 Administration Buildings

The site will comprise offices for the administrative staff, a laboratory, as well as ablution facilities, a boardroom, change rooms, a canteen and a parking area.

2.1.5 Recycling/Transfer Area

The recycling/transfer area will comprise a hard stand/surface area for the stockpiling of recyclables and a steel portal frame roof structure for the sorting and storage of recyclable materials under all weather conditions.

2.1.6 Workshop and Wheel-wash Area

The workshop and wheel-wash area will comprise of a steel portal frame roof structure on a concrete platform with one (1) wheel washer to clean disposal trucks before they exit the landfill site. A workshop will allow for the on-site maintenance of the plant used in the operations of the landfill.

2.1.7 Leachate Management Infrastructure and PCD

The PCD will be constructed with the required lining system according to the minimum requirements. All storm water run-off from within the waste disposal facility, which may be potentially contaminated, together with the leachate generated by the landfill, will be discharged in the PCD.

The leak detection system will drain to four (4) detection manholes located at the each corner of the PCD. During the initial stages of leachate generation from the waste body, the leachate quality and quantity will be assessed and an appropriate management option will be selected. The possible options include, possible future leachate treatment.

2.1.8 Stormwater Management Infrastructure

The stormwater drainage consists of a clean stormwater management system and contaminated stormwater management system. The contaminated stormwater management system will collect all runoff from uncapped side slopes of the landfill cells and will be directed to the pollution control dam by means of High-Density Polyethylene (HDPE) lined open drains and collection pipes. The clean stormwater will be directed by open earth/concrete drains and discharged downstream. Should there be a need for collection and storage of clean stormwater, for possible dust suppression, an allowance has been made for the future construction of a clean stormwater pond. The drains, dams and ponds will be designed for a 1 in 50 year return period with a minimum 500 millimetre (mm) freeboard.

2.1.9 Conceptual Stormwater Management Plan

A conceptual Stormwater Management Plan (SWMP) was developed for the Newcastle Greenwich landfill site to manage stormflow from clean and dirty water sub-catchments on site. Three (3) dirty water catchments were determined and comprise the proposed landfill

cells area, workshop/wheel wash area and the overburden dump site, while the rest of the site was determined to be clean (**Figure 2-1**). The overburden dump is classified as a dirty water area since exposure of subsurface material to rain and oxygen in the atmosphere results in the occurrence of redox reactions with subsequent precipitation of toxic chemicals. The workshop/wheel wash area is also considered a dirty water area since this is where oils and grease from washed vehicles together with dirty refuse remnants are deposited during the washing process. All these dirty substances need to be managed so that they do not end up in clean water catchments and proximal watercourses.

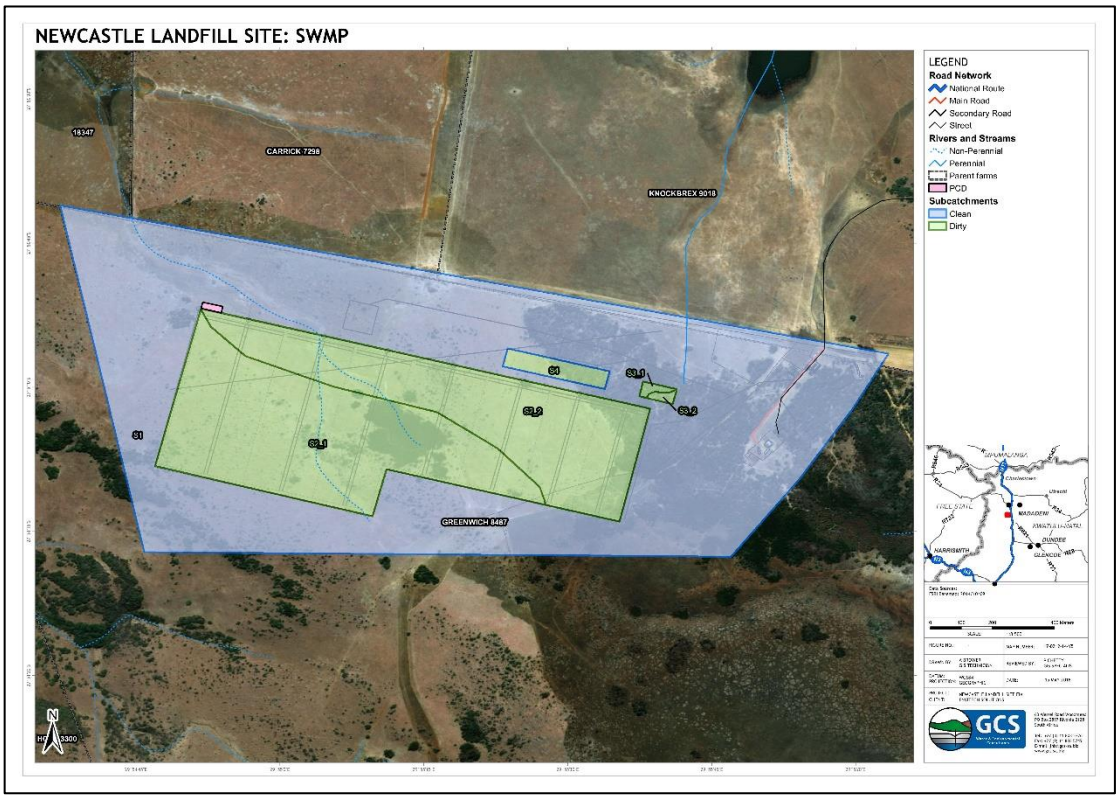


Figure 2-1: Identified dirty and clean water areas within the proposed site.

2.1.9.1 Storm Water Runoff

Manning's 'n' coefficient used in the model for the impervious and pervious areas were 0.013 (concrete float finish) and 0.03 (brush and grass vegetation), respectively (McCuen, 1996). The soils of the proposed site are generally clay-loam. These soils are characterised by moderate infiltration rates where the terrain is gentle to flat and moderate to high runoff where slopes are generally steep. The PCSWMM stormwater modelling software requires these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The clay-loam group resulted in an average capillary suction head of 218.5 mm, a saturated hydraulic conductivity of 3 millimetres per hour (mm/hr) and an initial deficit of

0.143 being used in the stormwater modelling. Modelled peak flows and runoff volumes for modelled stormwater sub-catchments for the 1:50-year recurrence interval flood event are summarised in **Table 2-1**. The 1:50-year design rainfall was calculated at a 1'x1' latitude and longitude grid consisting of 24 points surrounding the Newcastle Greenwich landfill site (Smithers and Schulze, 2000). The 1:50-year design rainfall depth is then disaggregated in PCSWMM into 5-minute rainfall intensities over a 24-hour period.

2.1.9.2 Stormwater Drainage

A network of stormwater drains/conduits were defined to channel stormwater from inlet outlet points. All stormwater infrastructure was conceptually sized to prevent flooding resulting from the 1:50-year design rainfall event. All dirty stormwater drains were defined to have a trapezoidal cross section with side slopes of 1V:1H, while clean water diversion channel have slopes of 1V:2H (**Table 2-2**). Clean water channels were conceptually designed to be grassed earth channels since clean water, which does not contaminate groundwater resources, will be conveyed therein. Stormflow velocities within the clean water earth channels slightly exceed 3 metres per second (m/s) implying potential erosion risks. These stormwater drains should be protected against erosion through use of riprap and/or allowing brush and grass vegetation to grow within them.

Dirty water channels should have a 200 mm HDPE lining (n = 0.011) in order to prevent pollution of groundwater aquifers through seepage as well as to allow fast stormflow to containment structures. Adjoining perimeter berms should be constructed on the periphery of the landfill cells and around the wash bay area. A perimeter berm should be constructed around the cover material stockpile area to prevent possible redox precipitates to nearby watercourses as well as erosion of the cover material stockpile. The stormwater infrastructure should allow for a minimum freeboard of 500 mm. The conceptual design of a typical stormwater drain adjoined to a berm is indicated in **Figure 2-2**.

Table 2-1: Peak flows and runoff volumes for modelled stormwater sub-catchments.

SUB-CATCHMENT	CLASSIFICATION	X-COORDINATE	Y-COORDINATE	AREA (ha)	PRECIPITATION (mm)	INFILTRATION (mm)	RUNOFF DEPTH (mm)	RUNOFF VOLUME (ML)	PEAK RUNOFF (m^3/s)	RUNOFF COEFFICIENT
S1	Clean	29,92173	-27,850312	120,0	148,1	111,82	51,6	30,9	10,56	0,3
S2_1	Dirty	29,917689	-27,851382	32,6	148,1	64,46	9,5	3,1	0,43	0,1
S2_2	Dirty	29,922321	-27,850638	26,4	148,1	64,46	9,5	2,5	0,35	0,1
S3_1	Dirty	29,927479	-27,850057	0,3	148,1	0	134,0	0,4	0,17	0,9
S3_2	Dirty	29,927762	-27,850271	0,2	148,1	0	133,1	0,3	0,14	0,9
S4	Dirty	29,92466	-27,849463	1,8	148,1	64,46	10,6	0,2	0,02	0,1

Table 2-2: Stormwater drains at the proposed site.

DRAIN/ CONDUIT	CLASSIFICATION	LENGTH (m)	CROSS-SECTION	MAX DEPTH (m)	BOTTOM WIDTH (m)	LEFT SLOPE (m/m)	RIGHT SLOPE (m/m)	SLOPE (m/m)	MAX. FLOW (m^3/s)	MAX. VELOCITY (m/s)	MAX. UNIT FLOW ($m^3/s/ha$)
C1	Dirty	1774	TRAPEZOIDAL	1	1	1	1	0,030	0,31	3,20	0,01
C2	Dirty	1888	TRAPEZOIDAL	1	1	1	1	0,028	0,24	2,72	0,01
C3	Dirty	34	TRAPEZOIDAL	1	1	1	1	0,051	0,47	2,92	0,01
C4	Dirty	168	TRAPEZOIDAL	1	1	1	1	0,025	0,17	2,00	0,65
C5	Dirty	124	TRAPEZOIDAL	1	1	1	1	0,041	0,14	1,92	0,64
C6	Dirty	2	TRAPEZOIDAL	1	1	1	1	0,072	0,30	3,52	0,63
C7	Clean	762	TRAPEZOIDAL	1	2	2	2	0,046	3,91	3,26	0,08
C8	Clean	2061	TRAPEZOIDAL	1	2	2	2	0,034	4,59	3,07	0,06

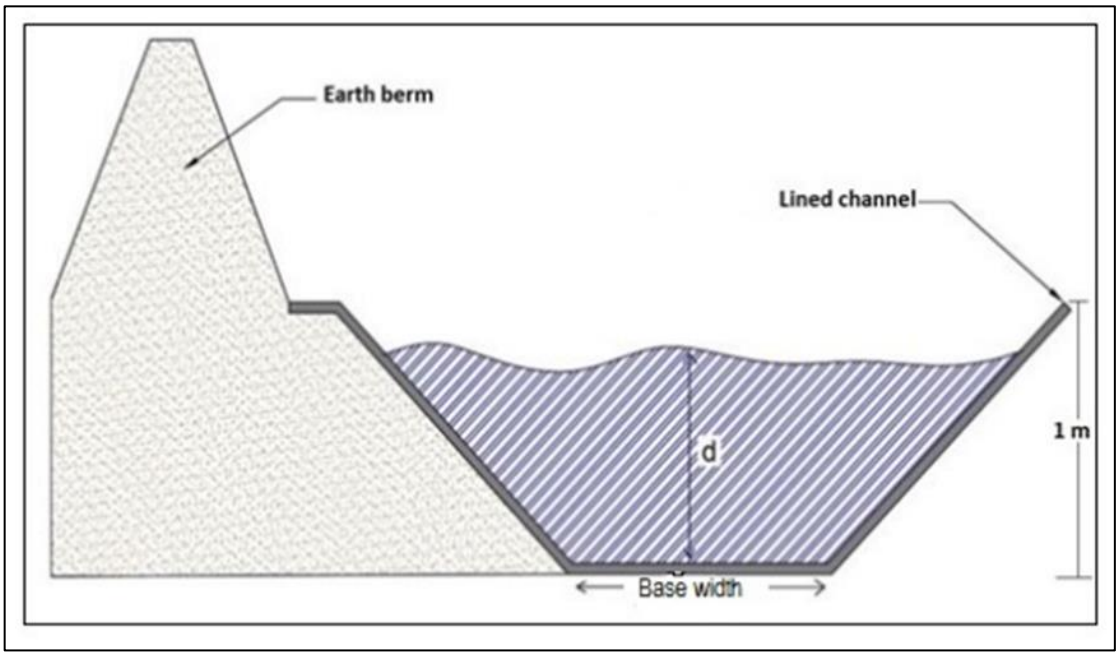


Figure 2-2: Conceptual design of storm water drain with an adjoining berm.

2.1.9.3 Dirty Water Containment Facilities

Dirty stormwater from the proposed landfill site should be contained in a PCD, whilst dirty water from the workshop/wheel wash bay area should temporarily be contained in a sump and be allowed to evaporate or should be pumped directly to the PCD. The storage volumes of the PCD and the sump were modelled to be 5 565 cubic metres (m^3) and 643 m^3, respectively (**Table 2-3**). All the contaminated water in the PCD should be managed by either evaporation or by treatment before being discharged into the natural environment. This dirty water should not be discharged into proximal natural watercourses unless it is treated to an agreed acceptable quality.

Table 2-3: Contaminated water storage structures.

STRUCTURE	LOCATION		CLASSIFICATION	STORAGE VOLUME (m^3)
	X-COORDINATE	Y-COORDINATE		
PCD (OF1)	29.914444	-27.847402	Dirty	5 565
Sump (Optional) (OF2)	29.928171	-27.850046	Dirty	643

The conceptual SWMP indicating proposed stormwater management infrastructure such as berms, drains, sumps and PCDs, together with water flow directions and classification of clean and dirty water areas is presented in **Figure 2-3**.

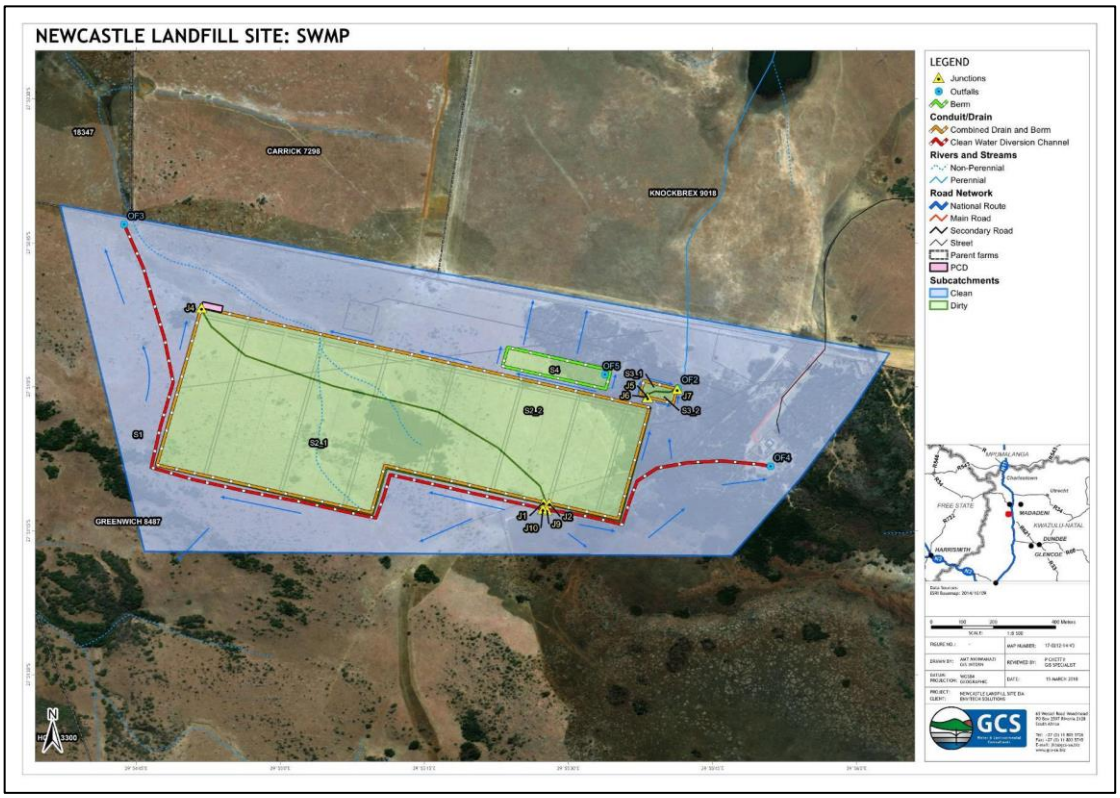


Figure 2-3: Conceptual SWMP for the proposed site.

2.2 Landfill Site Life Calculation

A summary of the landfill site life calculation is presented in **Table 2-4**. This is based on a maximum disposal rate of 445 000 tpa.

Table 2-4: Summary of airspace/site life calculation.

CELL NO.	LIFE OF CELL (YEARS)	GROSS AIRSPACE CAPACITY (m^3)	COVER MATERIAL REQUIREMENT (m^3)	NETT AIRSPACE AVAILABLE (m^3)
1	6.0	1 244 000	311 000	1 555 000
2	6.0	1 453 000	363 000	1 816 000
3	6.0	1 819 000	455 000	2 274 000
4	6.0	2 186 000	546 000	2 732 000
5	6.0	2 423 000	606 000	3 029 000
6	6.0	2 957 000	740 000	3 697 000
7	6.0	3 568 000	892 000	4 460 000
Totals:	**42 years**	**15,650,000 m^3**	**3,913,000 m^3**	**19,563,000 m^3**

The estimated airspace required is 19 563 000 m^3 using the initial rate of deposition of 375 tpd and an annual growth rate of 3.0%. The density of the landfilled waste was assumed to be 1 000 kilograms per cubic metre (kg/m^3).

2.3 Phased Landfill Development

The height of landfill has been limited to a proposed height of 40 m above natural ground level.

The area to be developed for landfilling is subdivided into seven (7) cells as shown in **Figure 1-1**. The construction of these cells will be in seven (7) distinct phases with each cell being constructed, landfilled and covered separately, starting with the construction and operation of Cell No. 1. Each cell has been sized to have airspace for approximately 6 years taking into consideration the annual growth rate.

Cell No.1 will be landfilled to a height of approximately 20 m at which point construction and landfilling will need to commence in Cell No. 2 to allow for landfilling to the final height of 40 m. This is needed to maintain the required side slopes of 1V:3H.

2.3.1 Cell Construction

Cells will be constructed by excavating into the natural ground for achieving the design elevation of the basal area of the cells and filling to form berms and embankments and the outer perimeter of the cell side slopes where required. The cell embankment will be 2 m high and the basal area will have a cross fall of approximately 2% to allow for leachate drainage into the leachate collection system. Excavation of the basal area of each cell will not exceed 2 m below natural ground level at the lowest point as the geotechnical report showed that large boulders may be present.

2.3.1.1 Landfill Liner Systems

The landfill will have engineered liners for the base as well as for the side slope. Details for the proposed landfill basal liner (listed from waste surface to the in-situ base) are as follows (**Figure 2-4**):

- 1 m selected waste to ensure free drainage;
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 200 grams per square metre (g/m^2);
- 300 mm thick 53 mm crushed rock aggregate to leachate drainage layer;
- Needle punched non-woven geotextile as protection layer, minimum nominal mass 1 000 g/m^2;

- 100 mm sand as protection layer;
- 2.0 mm thick double sided textured HDPE liner (coarse texture down);
- Geosynthetic Clay Liner; and
- 200 mm thick base preparation layer rip and re-compacted to 100% of Standard Proctor Density at Optimum Water Content (OMC) to OMC +2% (in-situ clay layer) with subsoil drains.

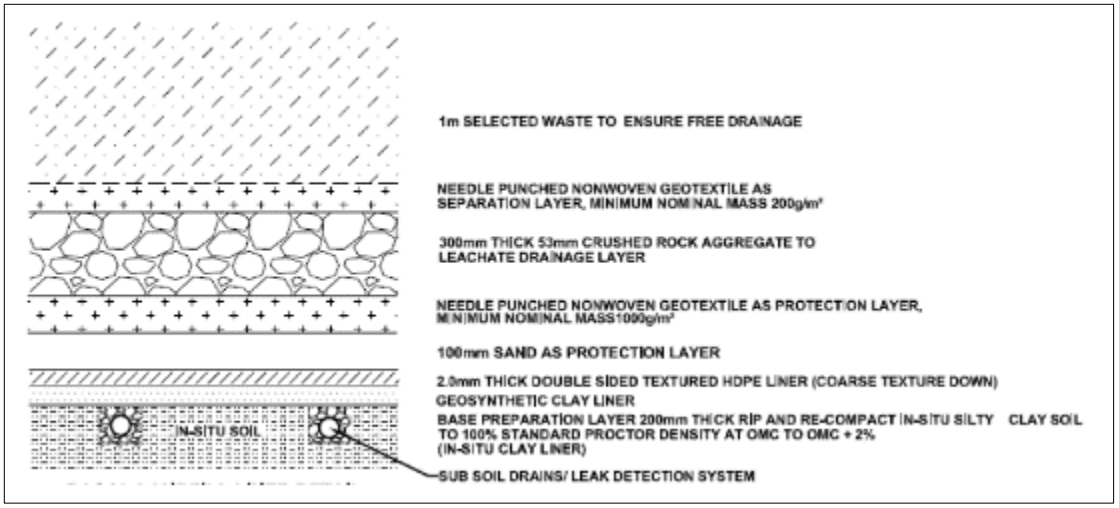


Figure 2-4: Landfill Basal Liner Details.

Details for the proposed landfill side slope liner (listed from waste surface to the in-situ base) are as follows (**Figure 2-5**):

- 1 m selected waste to ensure free drainage;
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 200 g/m^2;
- 300 mm thick 53 mm crushed rock aggregate to leachate drainage layer;
- Needle punched non-woven geotextile as protection layer, minimum nominal mass 1 000 g/m^2;
- 2.0 mm thick double sided textured HDPE liner (coarse texture down); A ND
- Containment berm constructed of clayey soil.

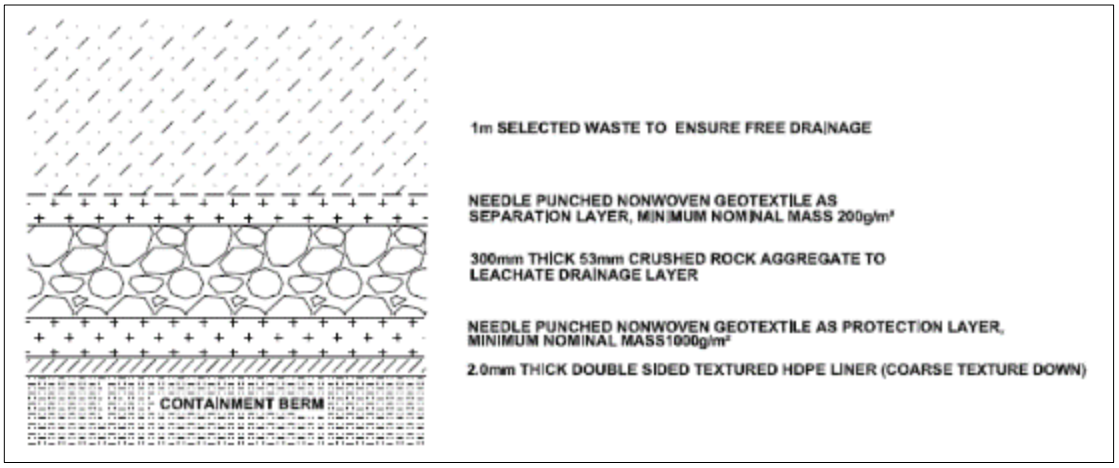


Figure 2-5: Landfill Side Slope Liner Details.

Based on the liner configurations described and the average cell slope lengths of 11 m, the Factor of Safety is greater than 1.5. The Preliminary Design Report which contains more details on the design criteria and assumptions is provided in Appendix F.

2.3.1.2 Leachate Collection System

Provision has been made for the collection of leachate generated from the landfill cell operations using 2 perforated 160 mm Outside Diameter (OD) HDPE pipes in each cell. The pipes will be installed across the length of the cell and all leachate collected will drain into a leachate collection sump, positioned at the lowest point of the cells, from which it will flow via the leachate delivery pipes to the PCD.

The PCD will have engineered liners for the base as well as for the side slope. Proposed details for the PCD basal liner (listed from surface to the in-situ base) (**Figure 2-6**) are as follows:

- Geocell or similar with 150 mm stabilized sand as protection layer;
- 2.0 mm thick double sided textured HDPE liner (coarse texture down);
- Geosynthetic Clay Liner;
- 100 mm sand as cushion layer;
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 200 g/m^2;
- 150 mm thick clean sand to leak detection layer;
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 400 g/m^2;
- 100 mm sand as cushion layer;
- 1.5 mm thick mono-textured HDPE liner;
- Geosynthetic Clay Liner; and

- 200 mm thick base preparation layer rip and re-compacted to 100% of Standard Proctor Density at OMC to OMC + 2% (In-situ clay layer).

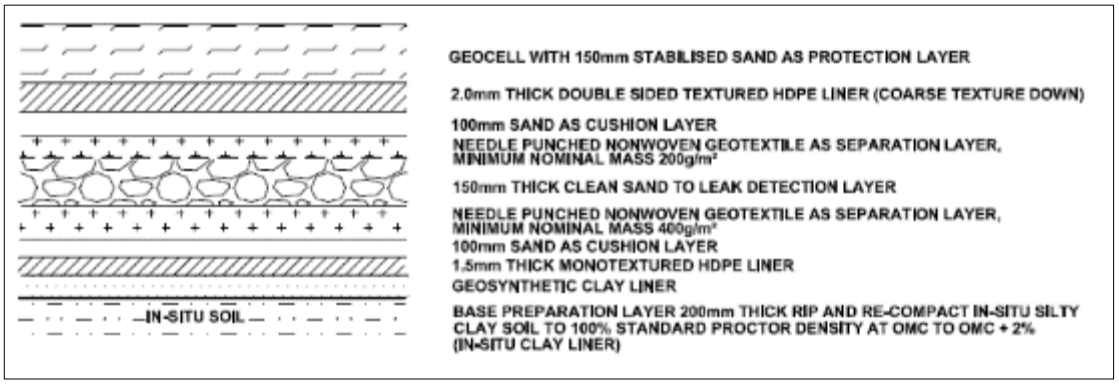


Figure 2-6: PCD Basal Liner Detail.

Details for the proposed PCD side slope liner (listed from surface to the in-situ base) are as follows (**Figure 2-7**):

- Geocell with 150 mm stabilized sand as protection layer;
- 2.0 mm thick double sided textured HDPE liner (coarse texture down);
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 200 g/m^2;
- Geonet or similar to leak detection layer;
- Needle punched non-woven geotextile as separation layer, minimum nominal mass 200 g/m^2;
- 1.5 mm thick mono-textured HDPE liner;
- Geosynthetic Clay Liner; and
- Dam embankment constructed of clayey soil.

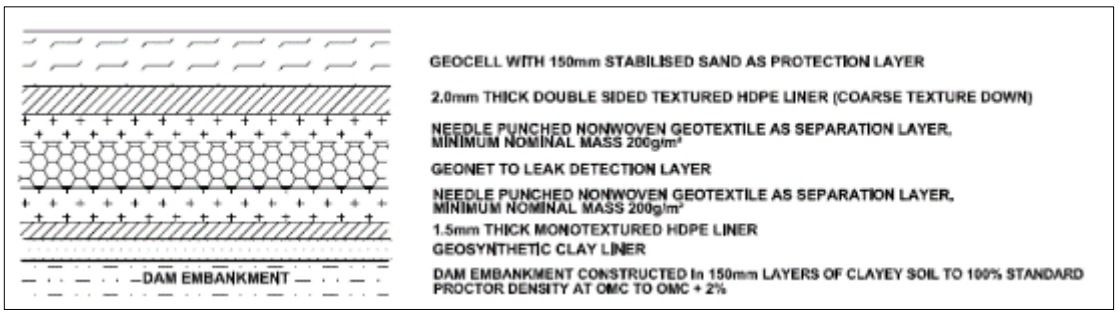


Figure 2-7: PCD Side Slope Liner Detail.

2.3.1.3 Leachate Detection System

The leachate leak detection system located between the HDPE lining layers will consist of a Geonet or similar layer. If the upper barrier layers are breached then the potential contaminant will be collected in this layer and drained via a network of HDPE pipes to four (4) detection manholes located at the each corner of the PCD. These manholes will be inspected on a regular basis.

2.3.1.4 Stormwater Management

DWS requires that stormwater runoff should be managed so that un-contaminated and contaminated stormwater flows are kept separate from each other. Un-contaminated stormwater must be diverted around the site whilst the contaminated stormwater runoff must be contained on site.

Contaminated stormwater runoff emanating from within the site will be collected and discharged into the leachate collection and evaporation dam while clean stormwater will be diverted around the waste body and discharged downstream.

Kindly refer to Section 2.1.9 for the Conceptual Stormwater Management Plan of the site.

2.3.2 Waste Deposition and Compaction

Waste deposition will be conducted in adherence with the proven sanitary landfill principles as per the DWS Minimum Requirements of spreading, compacting and daily covering of waste. In order to reduce the volume of exposed waste to rainfall and the environment and to afford the best compaction, operational cells will be as narrow as conditions permit. The incoming waste tonnage and number of vehicles accommodated during the operating day will determine the practical size of the day to day operating cell.

The waste deposited within a working cell shall be worked up a 1 in 3 slope and spread in a 300 – 400 mm thick layer and shall be compacted with a minimum of three passes with a 25 ton (t) landfill compactor.

At the end of each working day all waste must be contained within the working cell. The entire waste surface shall then be enclosed by cover material having a minimum compacted thickness of 150 mm and a maximum compacted thickness of 250 mm above the mean surface of the waste. In areas not utilised for landfilling purposes for an extended period of time, intermediate cover with a thickness of 300 mm must be placed over the waste body.

2.3.3 Cover Material

Daily cover material will be sourced from the adjacent future cell and the cover material stockpile from the excavation for the working cell. Cover material should be placed and compacted daily in a ratio of 1 part cover material to 4 parts waste.

The estimated quantity of cover material required over the expected life of the landfill is 3 913 000 m^3 based on a 1:4 cover ratio. Approximately 1 118 890 m^3 of cover material will be available from the excavation for the landfill cells and will provide cover material for cells 1, 2, and 3 (±18 operational years) (Table 2-5). The remaining 2 794 110 m^3 will have to be sourced from elsewhere within the NLM and be imported to the site from either nearby quarries and/or new developments.

Table 2-5: Determination of cover material for the proposed site.

Cell No.	Approximate Area (m^2)	Gross Airspace Capacity (m^3)	Approximate Cover Material Requirement (m3)	Approximate Available Cover Material On-Site (m^3)	Accumulative Available Cover Material (m^3)	Nett Airspace Available (m^3)	Life of Cell (years)
1	45490	1 244 000	311 000	90980.0	90980	1 555 000	6
2	52485	1 453 000	363 000	104970.0	195950	1 816 000	6
3	64730	1 819 000	455 000	129460.0	325410	2 274 000	6
4	76980	2 186 000	546 000	153960.0	479370	2 732 000	6
5	84980	2 423 000	606 000	169960.0	649330	3 029 000	6
6	102480	2 957 000	740 000	204960.0	854290	3 697 000	6
7	122475	3 568 000	892 000	244950.0	1099240	4 460 000	6
Clean SW Pond	7825	N/A	N/A	15650.0	1114890	N/A	N/A
Pollution Control Dam	2000	N/A	N/A	4000.0	1118890	N/A	N/A
Totals:	559445	15,650,000 m^3	3,913,000 m^3	1118890		19,563,000 m^3	42 years

2.4 Water Balance

This section describes average water balances (annual average, average 6 wettest months, average 6 driest months, average monthly and average daily) for the proposed Newcastle Greenwich landfill site.

2.4.1 Process Flow Diagram

To set up the average water balance model based on the findings of the site visit, a Process Flow Diagram (PFD) was drafted to provide insight into all water-linked flows within the proposed landfill site infrastructure. The following operational philosophy assumptions were made to develop the PFD and associated water balances:

- Potable water supplied by the NLM will be stored in high quality ultraviolet-resistant polyethylene water tanks on site.
- The available on-site surface water include rainfall and stormflow over the landfill area. Rainfall and stormflow will be channelled and contained in the clean stormwater pond.

- The PCD will play a combined role of containing dirty stormflow and collecting landfill leachate as the Leachate Collection Dam (LCD).
- Dirty water in the PCD will be disposed of entirely by evaporation or will be treated and discharged into the natural environment after meeting recommended discharge standard limits.
- Sewage from potable water users on site will be contained in a septic tank which is occasionally emptied by a licensed honey sucker.
- It was assumed that 15 cubic metres per day (m^3/day) of potable water will be used on site, based on an estimate of 100 persons each consuming 150 litres per day (l/day). The estimated figures were provided by the applicant.
- The region's annual average precipitation depth for the wettest six months for the area is approximately 600 – 830 millimetres per annum (mm/annum), based on 10 years of time series data for Cedara obtained from Agrimet and the South African Weather Bureau (Geomeasure, 2016).
- The evaporation of the wettest six months, as measured using the A-Pan averages (based on 10 years of data) and incorporating an evaporation factor of 0.7, is approximately 490 - 930 mm/annum (Geomeasure, 2016).
- Seepage losses from the PCD were assumed to be zero since this structure will be having a 200 mm HDPE lining.
- The modelled maximum storage capacity of the PCD is 5 565 m^3. This figure was used in the water balance after adaptation to selected time scales (annual, wettest 6 months average, driest 6 months average, monthly average and daily average).

The final PFD, based on the assumptions specified, is presented in **Figure 2-8**.

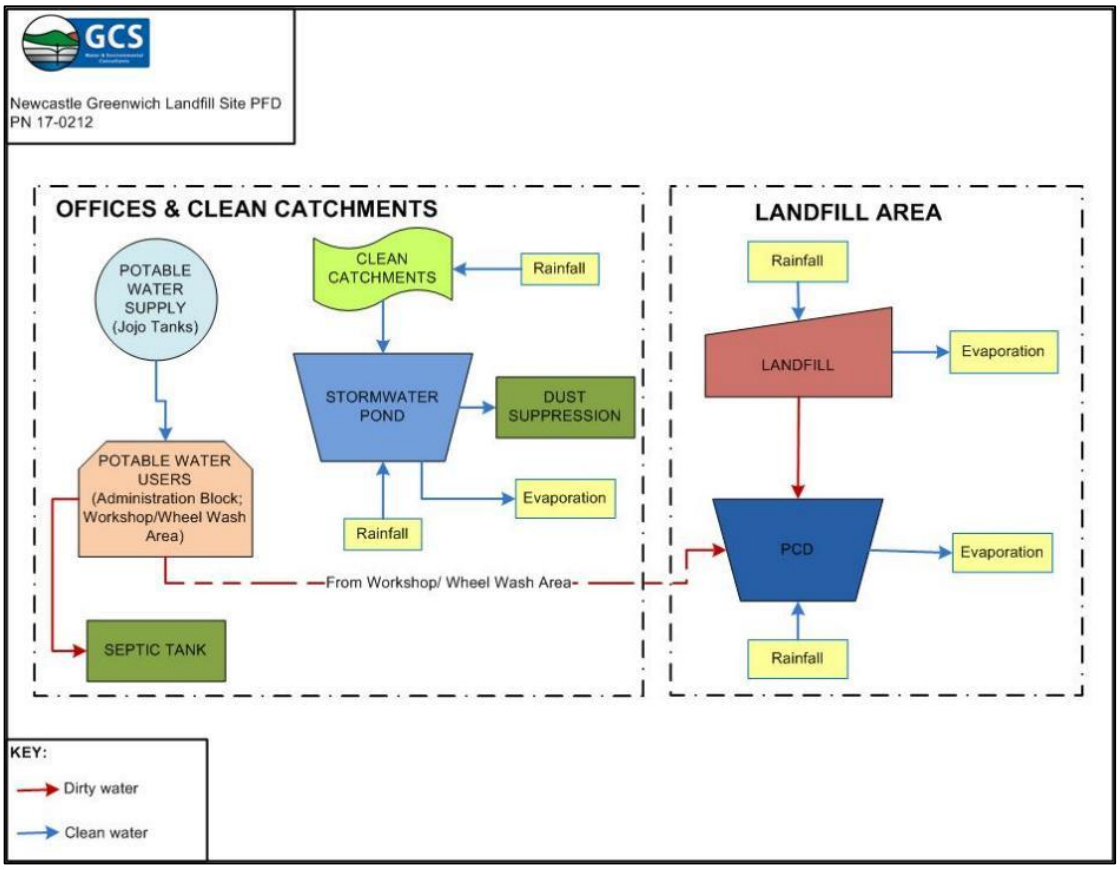


Figure 2-8: Process Flow Diagram for the proposed site.

2.4.2 Calculated Water Balances

The calculated water balances for the proposed Newcastle Greenwich landfill site are presented in **Figure 2-9** - **Figure 2-13**. These water balances provide an overview of all water uses at the proposed site at the aforementioned selected time scales.

The annual water balance indicates that the total amount of potable water required for all operations at the site is equivalent to 19 800 m^3/annum (**Figure 2-9**). This water will cater for administrative offices and workshop consumption as well as use at the wheel wash area.

The average of the wettest 6 months indicates a storage volume of 17 870 m^3 which accounts for direct rainfall on the PCD and stormflow from the landfill (**Figure 2-10**). This volume of dirty water will be allowed to evaporate. This water can also be treated and discharged into the natural environment, if it meets the recommended discharge standard limits. The average of the 6 driest months indicates a PCD dirty water volume of 5 591 m^3 which means that during this dry period, dirty water can be managed entirely by evaporation from the PCD (**Figure 2-11**).

Manageable PCD storage volumes of 1 955 m^3 and 64 m^3 were determined for the monthly and daily averages, respectively, at the proposed site (**Figure 2-12** and **Figure 2-13**).

Average Annual Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ annum)**	**Water Circuit/stream**	**Quantity (m^3/annum)**	
Landfill	From: Rainfall	76 489	To: Evaporation	53 542	
			To: Stormflow to PCD	21 340	
			To: Landfill leachate to PCD	1 606	
	Total	**76 489**		**76 489**	-
PCD	From: Direct Rainfall	515			
	From: Landfill site stormflow	21 340	To: Evaporation	23 462	
	From: Landfill seepage	1 606			
	Total	**23 462**		**23 462**	-
STORMWATER POND	From: Direct Rainfall on Pond	**1 089**			
	From: Clean Catchment Runoff	**2 408**	To: Evaporation	**3 496**	
	Total	**3 496**		**3 496**	-
			To: PCD from Workshop/Wheel Wash Area	1 286	
POTABLE WATER USERS	From: Jojo Tanks	19 800	To: Septic Tank	13 114	
(Administration Offices;			To: Consumption	5 400	
Workshop/Wheel Wash Area)					
	Total	**19 800**		**19 800**	-
Total Water Balance		**123 246**		**123 246**	-

Figure 2-9: Annual average water balance for the proposed **site.**

Average Wettest 6 Months Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ 6 mon)**	**Water Circuit/stream**	**Quantity (m^3/6 mon)**	
Landfill	From: Rainfall	58 260	To: Evaporation	40 782	
			To: Stormflow to PCD	16 254	
			To: Landfill leachate to PCD	1 223	
	Total	**58 260**		**58 260**	-
PCD	From: Direct Rainfall	392			
	From: Landfill site stormflow	16 254	To: Evaporation	17 870	
	From: Landfill seepage	1 223			
	Total	**17 870**		**17 870**	-
STORMWATER POND	From: Direct Rainfall on Pond	829			
	From: Clean Catchment Runoff	1 447	To: Evaporation	2 277	
	Total	**2 277**		**2 277**	-
			To: PCD from Workshop/Wheel Wash Area	643	
POTABLE WATER USERS	From: Jojo Tanks	9 900	To: Septic Tank	6 557	
(Administration Offices;			To: Consumption	2 700	
Workshop/Wheel Wash Area)					
	Total	**9 900**		**9 900**	-
Total Water Balance		**88 306**		**88 306**	-

Figure 2-10: Average wettest 6 months' water balance for the proposed **site.**

Average Driest 6 Months Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ 6 mon)**	**Water Circuit/stream**	**Quantity (m^3/6 mon)**	
Landfill	From: Rainfall	18 229	To: Evaporation	12 760	
			To: Stormflow to PCD	5 086	
			To: Landfill leachate to PCD	383	
	Total	**18 229**		**18 229**	-
PCD	From: Direct Rainfall	123			
	From: Landfill site stormflow	5 086	To: Evaporation	5 591	
	From: Landfill leachate	383			
	Total	**5 591**		**5 591**	-
STORMWATER POND	From: Direct Rainfall on Pond	259			
	From: Clean Catchment Runoff	960	To: Evaporation	1 220	
	Total	**1 220**		**1 220**	-
			To: PCD from Workshop/Wheel Wash Area	643	
POTABLE WATER USERS	From: Jojo Tanks	9 900	To: Septic Tank	6 557	
(Administration Offices;			To: Consumption	2 700	
Workshop/Wheel Wash Area)					
	Total	**9 900**		**9 900**	-
Total Water Balance		**34 940**		**34 940**	-

Figure 2-11: Average driest 6 months' water balance for the proposed **site.**

Average Monthly Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/ month)**	**Water Circuit/stream**	**Quantity (m^3/month)**	
Landfill	From: Rainfall	6 374	To: Evaporation	4 462	
			To: Stormflow to PCD	1 778	
			To: Landfill leachate to PCD	134	
	Total	**6 374**		**6 374**	-
PCD	From: Direct Rainfall	43			
	From: Landfill site stormflow	1 778	To: Evaporation	1 955	
	From: Landfill seepage	134			
	Total	**1 955**		**1 955**	-
STORMWATER POND	From: Direct Rainfall on Pond	**91**			
	From: Clean Catchment Runoff	**201**	To: Evaporation	**291**	
	Total	**291**		**291**	-
			To: PCD from Workshop/Wheel Wash Area	107	
POTABLE WATER USERS	From: Jojo Tanks	1 650	To: Septic Tank	1 093	
(Administration Offices;			To: Consumption	450	
Workshop/Wheel Wash Area)					
	Total	**1 650**		**1 650**	-
Total Water Balance		**10 271**		**10 271**	-

Figure 2-12: Average monthly water balance for the proposed **site.**

Average Daily Water Balance for the Newcastle Greenwich Landfill Site					
Facility Name		**Water In**		**Water Out**	**Balance**
Forzando South Coal Mine	**Water Circuit/stream**	**Quantity (m^3/day)**	**Water Circuit/stream**	**Quantity (m^3/day)**	
Landfill	From: Rainfall	209.4	To: Evaporation	146.6	
			To: Stormflow to PCD	58.4	
			To: Landfill leachate to PCD	4.4	
	Total	**209.4**		**209.4**	-
PCD	From: Direct Rainfall	1.4			
	From: Landfill site stormflow	58.4	To: Evaporation	64.2	
	From: Landfill seepage	4.4		-	
	Total	**64.2**		**64.2**	-
STORMWATER POND	From: Direct Rainfall on Pond	**3.0**			
	From: Clean Catchment Runoff	**6.6**	To: Evaporation	**9.6**	
		9.6		**9.6**	
			To: PCD from Workshop/Wheel Wash Area	3.5	
POTABLE WATER USERS (Administration Offices; Workshop/Wheel Wash Area)	From: Jojo Tanks	54.2	To: Septic Tank	35.9	
			To: Consumption	14.8	
	Total	**54.2**		**54.2**	-
Total Water Balance		**337.4**		**337.4**	-

Figure 2-13: Average daily water balance for the proposed site.

2.5 No-Go Residential Development Areas

In terms of applicable regulations pertaining to landfill development and operation, a no-go developmental area specifically pertaining to residential developments is specified. An 800 m buffer for no residential development has been applied to the proposed landfill site area demarcating where residential development is not to occur (Figure 2-14).

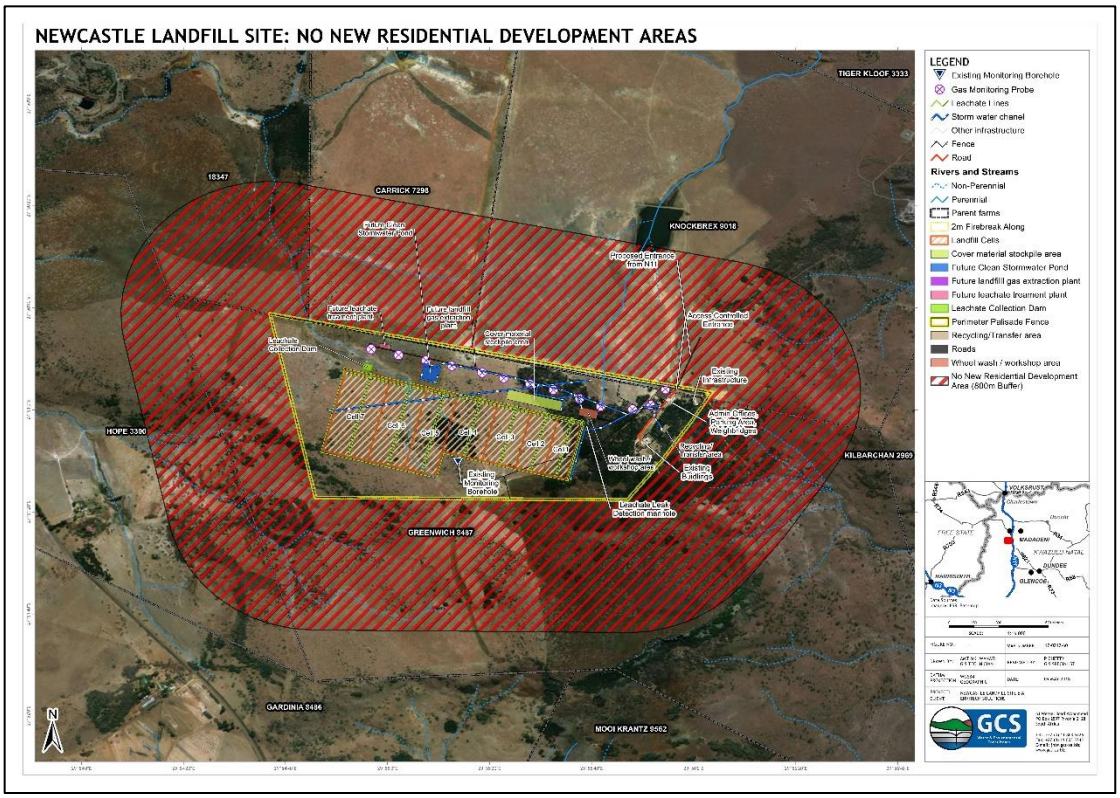


Figure 2-14: No-go residential development area.

3 PROJECT ALTERNATIVES

In terms of the NEMA 2010 EIA Regulations, feasible alternatives are required to be considered as part of the environmental investigations. An alternative in relation to a proposed activity refers to the different means of meeting the general purpose and requirements of the activity (as defined in GNR 543 of the EIA Regulations, 2010), which may include alternatives to:

- The property on which or location where it is proposed to undertake the activity;
- The type of activity to be undertaken;
- The design or layout of the activity;
- The technology to be used in the activity; and
- The operational aspects of the activity.

All identified feasible alternatives are required to be evaluated in terms of social, biophysical, economic and technical factors.

3.1 No-Go Option

The no-go alternative was considered as per requirements of the 2010 EIA Regulations but was identified as not being a favourable option as it may result in poor waste management practices within the Newcastle and surrounding areas. Secondly, the area of Newcastle is in need of a new waste disposal facility as the existing landfill is reaching the end of its lifespan, for the purposes of planning and ensuring that the infrastructure is developed within a sufficient timeframe, the landfill must be established.

The waste loads generated in the area require that a properly designed and sized landfill site which will cater for the management of waste in the years to come.

Due to the above reasons, the no-go alternative was not considered as the preferred option for the proposed development.

The no go alternative will directly result in the following:

- No job creation opportunities,
- No proper waste management in the area of Newcastle and surroundings,
- Absence of infrastructure to manage general waste produced in the area of Newcastle,
- Continuation in operation of waste disposal sites that have not been engineered,
- Occurrence of illegal dumping,
- Undertaking of waste management that does not promote waste hierarchy objectives.

3.2 Alternative Sites Considered for the Landfill Development

A total of thirteen (13) candidate sites were selected and assessed in relation to the proposed landfill development (Figure 3-1). A summary of the decision process and reasons for excluding each site are provided in Figure 3-2.

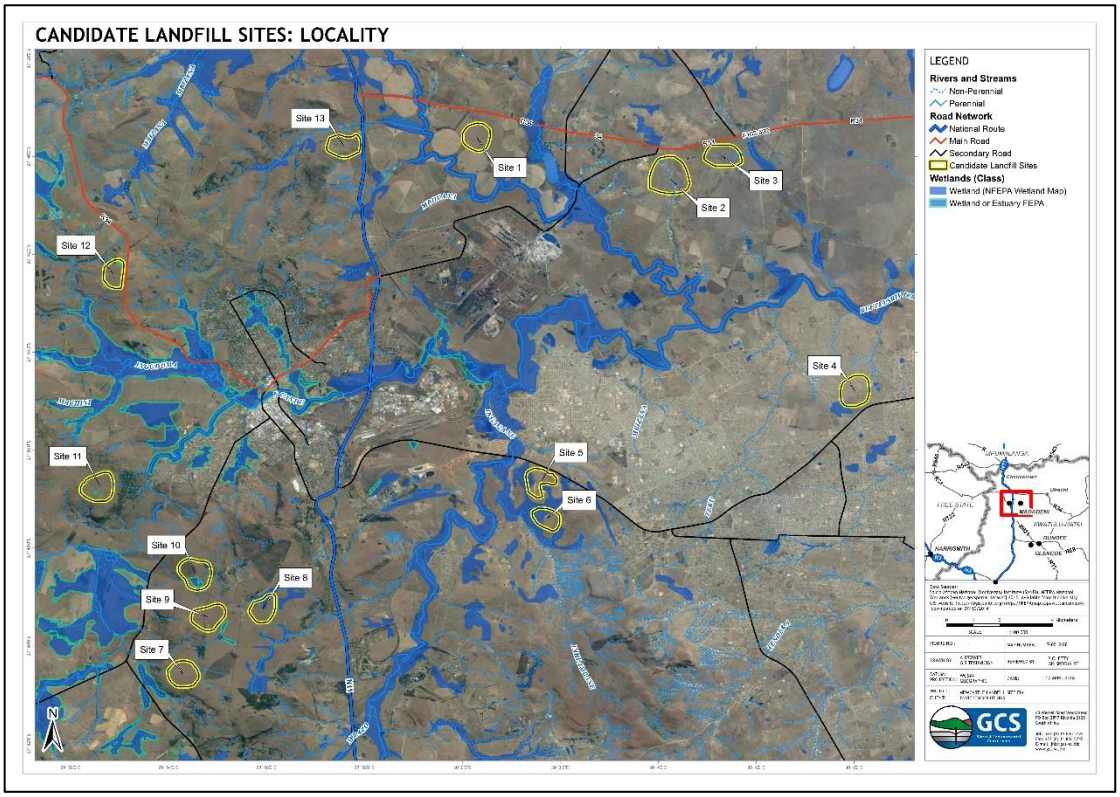


Figure 3-1: Alternative sites investigated.

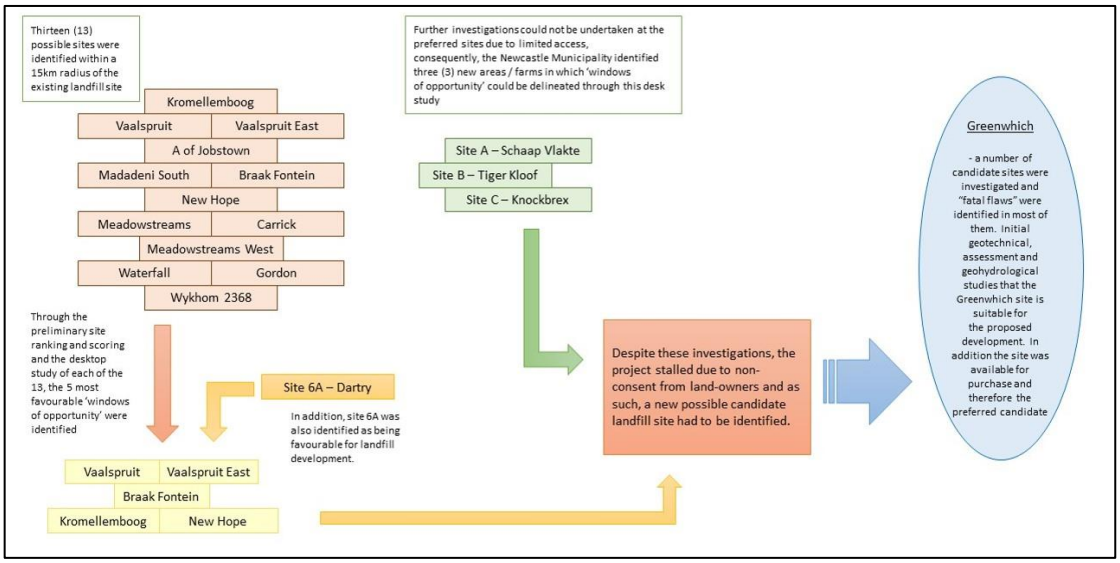


Figure 3-2: Decision map for alternative sites.

3.3 Operational Alternatives

3.3.1 Other Types of Waste Management Treatment Technologies

According to recent studies conducted by the University of KwaZulu-Natal (UKZN) on alternative waste management technologies have been assessed namely:

- Sanitary Landfilling;
- A MRF at the landfill site or disposal facility;
- A MRF and composting treatment plant based on waste data;
- A MRF for the inorganic fraction and an anaerobic digestion for the organic fraction of municipal solid waste;
- A MRF and Mechanical Biological Treatment (MBT) and refuse derived fuels; and
- Incineration and Waste to energy (WTE)

A brief description of the waste management alternatives is provide in **Table 3-1**.

Table 3-1: Brief Description of Waste Management Alternatives.

ALTERNATIVE	BRIEF DESCRIPTION
MRFs and composting	Waste recyclables are sorted, where most inorganic waste is removed from a clean or dirty MRF and the organic matter is composted e.g. garden waste and wood waste.
MRF and anaerobic digestion	Waste is sorted in organic and inorganic fractions, the inorganic fraction is diverted from landfill for recycling and the organic matter is anaerobically digested.
Landfilling and LFGTE (landfill gas to energy)	All waste is sent to landfill, methane gas is extracted and converted to energy source from the organic fraction of the municipal solid waste.
MRF and gasification/pyrolysis	Waste such as metal and glass are removed from the waste stream, all other waste is placed into a waste bin, syngas is extracted and converted into electricity.

Most municipalities in developing countries practice Alternative 1 (MRFs and composting). The MRF and biological treatment would reduce the amount of waste going into landfill and thereby increasing the lifespan of the landfill site, therefore the preliminary design of the landfill site incorporates a waste recycling/transfer area as well as future gas extraction plant. The infrastructure will ensure that reusable waste is not landfilled but recycled thus reducing the amount of waste being landfilled.

This approach also ties with the waste management hierarchy objectives which have landfilling as the last option for waste management.

3.3.2 Access Road Design Specifications

Envitech Solutions and the NLM have identified two (2) possible route options to provide access to the proposed new landfill site.

3.3.2.1 Option 1

This option includes utilising the current access road directly off the N11. The current access will require an upgrade to allow it to be suitable for use as an access to the proposed landfill site. The road length that will require the upgrade is approximately 3.5 km. The route option is presented as the green line in **Figure 3-3**.

3.3.2.2 Option 2

An option that was considered and found not to be viable was the "Hilldrop" route (shown in orange in **Figure 3-3**), this option involves accessing the landfill via Hilldrop Road. This route was not considered to be a viable option as this area is considered to be the tourist hub of Newcastle with a vast number of Bed and Breakfast establishments and is considered to be a sensitive area. Waste trucks passing through this area will not be ideal and will be strongly opposed by the residents of Hilldrop Road.

After discussions between representatives from the South African National Roads Agency Limited (SANRAL), the NLM and Envitech Solutions, it was agreed that Option 1 was the preferred option as it would be most suitable for the intended purpose. SANRAL recommended that the current access road be utilised from the N11 with the condition that the NLM plans to provide an interchange upgrade to the N11 at the intersection in the future (refer to minutes and SANRAL initial comments in Appendix B).

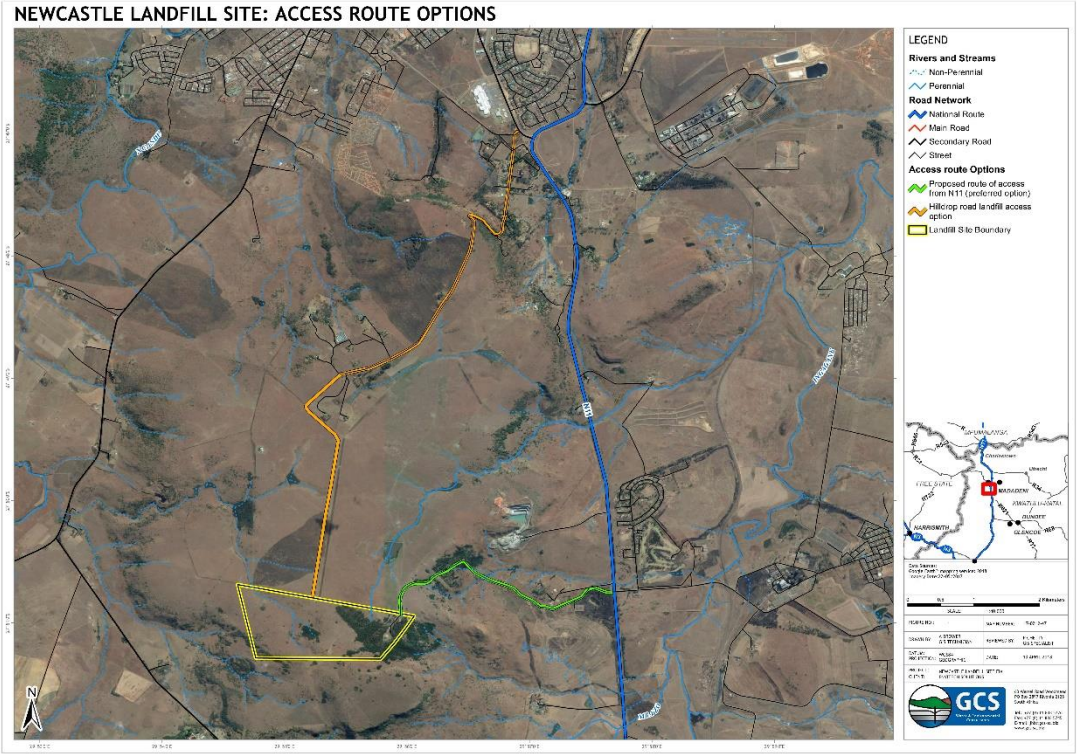


Figure 3-3: Proposed Route Layouts.

4 DETAILED ENVIRONMENTAL DESCRIPTION

This chapter of the report provides a summarised description of the environment as obtained from desktop research, specialist investigations undertaken in 2017/2018, as well as previous assessments undertaken on site. The information plays an important role in identifying the significance of the potential impacts which may occur as a result of the proposed project.

4.1 Geology

According to the 1:250 000 geological map series 2728 Frankfort (Council for Geoscience, 1992), the site is underlain by a dolerite intrusive rock body overlying the sandstone, dark-grey mudstone and shale (coal beds in places) of the Vryheid Formation (Ecca Group of the Karoo Supergroup) (**Figure 4-1**).

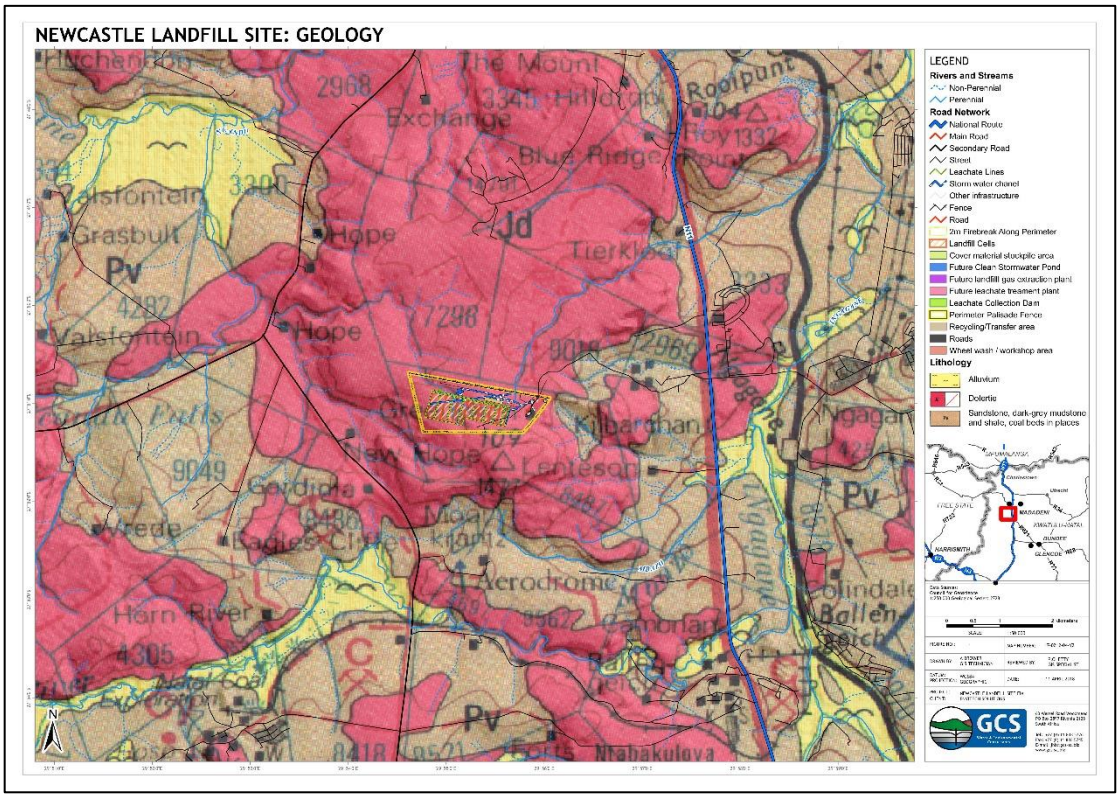


Figure 4-1: Geology.

4.2 Topography

The topography of the surrounding environment includes semi-mountainous terrain, while the proposed development itself lies on an elevated ridge. The elevation ranges from 1 180 – 1 410 meters above mean sea level (mamsl) within a 10 km region of the proposed development. The topography of the area slopes in a general northerly direction. The site is

located on a topographical high with drainage occurring radially in a north westerly and north easterly direction away from a central high located in the southern section of the site (**Figure 4-2**). Several non-perennial drainage lines flow from the centre of the site in a north westerly and north easterly direction towards the Perennial Ncandu and iNgagane rivers. A dam is located north of the site. A graphical illustration of the regional topography from a West to East and North to South cross sectional view of the project area is provided in Figure 4-3.

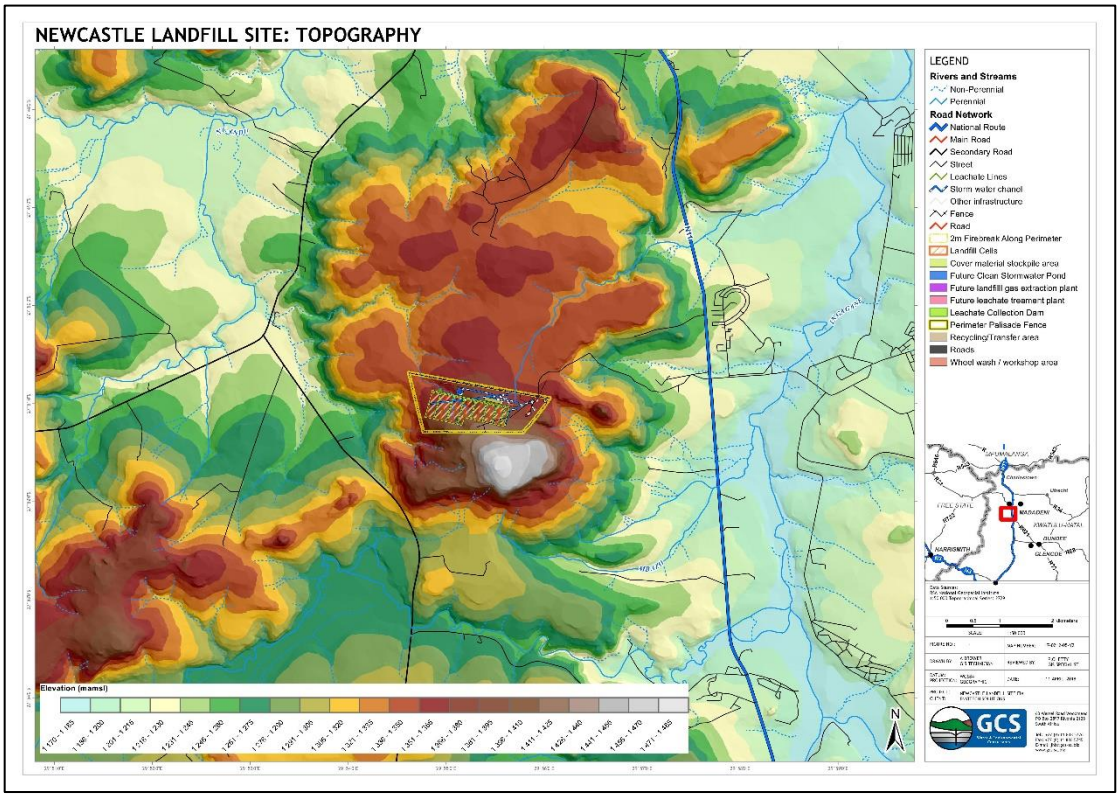


Figure 4-2: Topography.

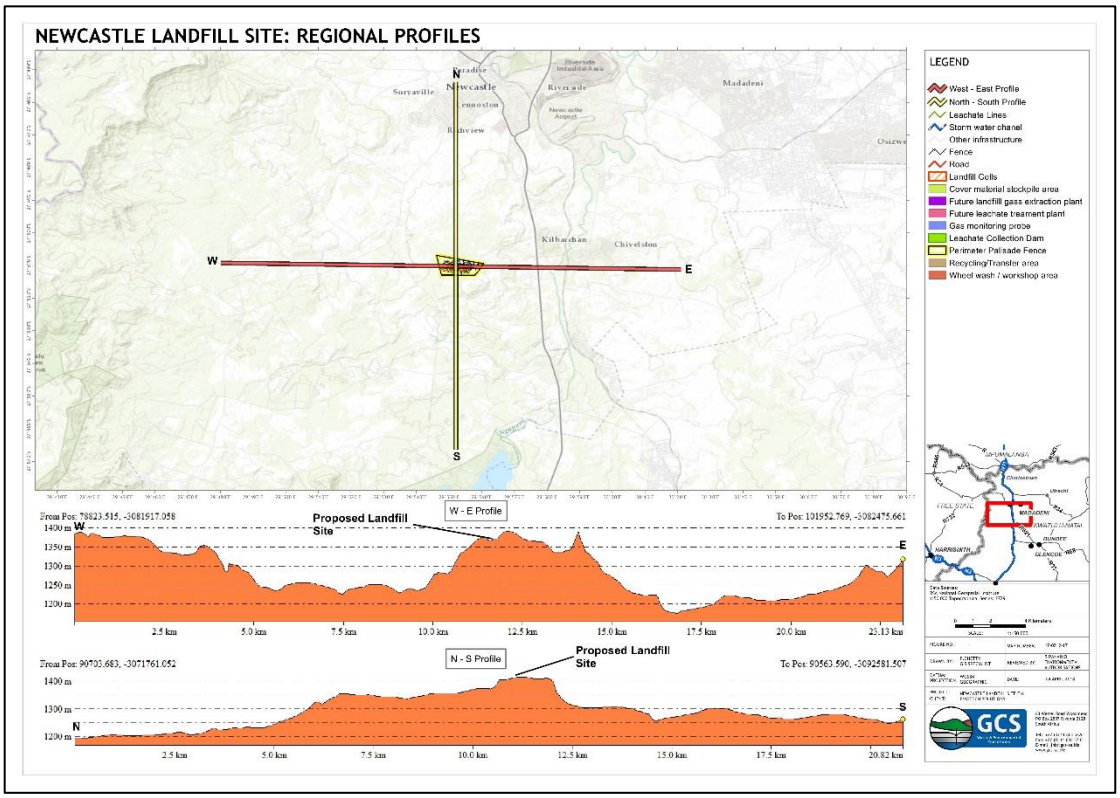


Figure 4-3: Regional Cross Section: Newcastle.

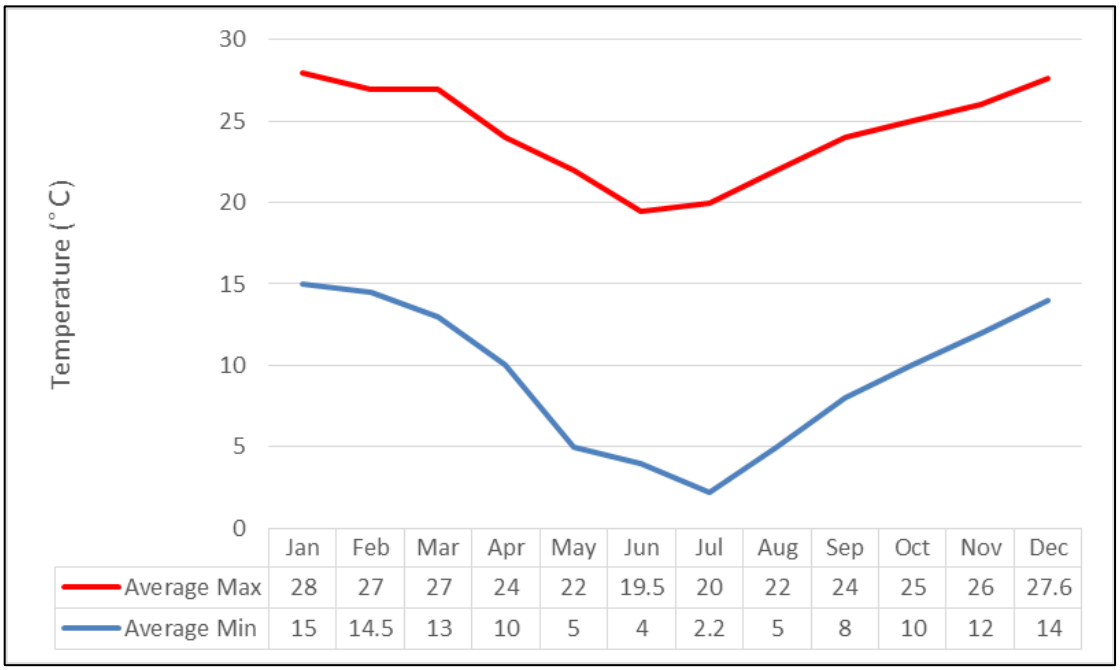
4.3 Climate

4.3.1 Temperature

The Koppen Geiger classification indicates that the study site falls under the Temperate or C-climate category, characterised by cold dry winters and warm summers denoted as Cwb (Peel et al., 2007). Average maximum temperatures are generally in the range 19.5 - 27.6 degrees Celsius (˚C), while average minimum temperatures are in the range of 2.2 - 15˚C (SA Explorer, 2018).Typical monthly average maximum and minimum temperatures for the project area are indicated in **Figure 4-4**.

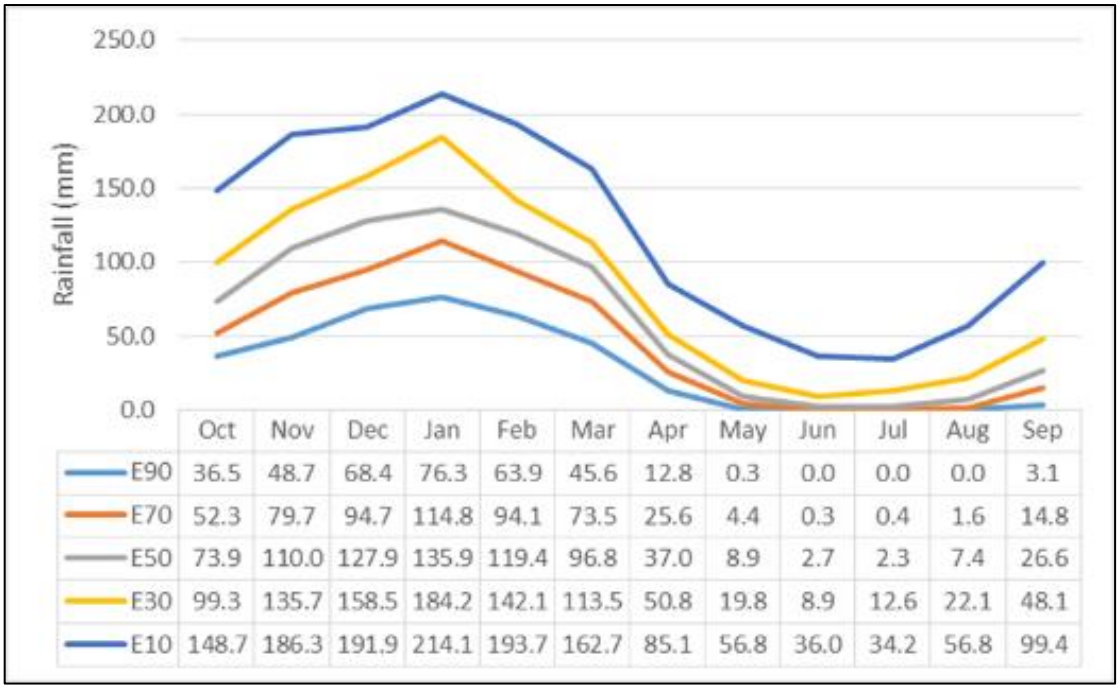
4.3.2 Rainfall

The Mean Annual Precipitation (MAP) for the site is 835 mm whose distribution is indicated in **Figure 4-5** (WRC, 2015). The maximum rainfall likely to be exceeded in 10% of years equals 214.1 mm falling approximately during the month of January. The median rainfall for the wettest month of January is indicated to be 135.9 mm.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Max	28	27	27	24	22	19.5	20	22	24	25	26	27.6
Average Min	15	14.5	13	10	5	4	2.2	5	8	10	12	14

Figure 4-4: Temperature distribution for the site.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
E90	36.5	48.7	68.4	76.3	63.9	45.6	12.8	0.3	0.0	0.0	0.0	3.1
E70	52.3	79.7	94.7	114.8	94.1	73.5	25.6	4.4	0.3	0.4	1.6	14.8
E50	73.9	110.0	127.9	135.9	119.4	96.8	37.0	8.9	2.7	2.3	7.4	26.6
E30	99.3	135.7	158.5	184.2	142.1	113.5	50.8	19.8	8.9	12.6	22.1	48.1
E10	148.7	186.3	191.9	214.1	193.7	162.7	85.1	56.8	36.0	34.2	56.8	99.4

Figure 4-5: Rainfall distribution for the site.

4.3.3 Evaporation

The Mean Annual Evaporation (MAE) for quaternaries V31J and V31K is 1 475 mm which is almost 2 times higher than the MAP of 835 mm (WRC, 2015). This MAE is only an indication of

maximum potential evaporation and not actual evaporation for the region. The average of the potential monthly evaporation trend for the site can be seen in Figure 4-6.

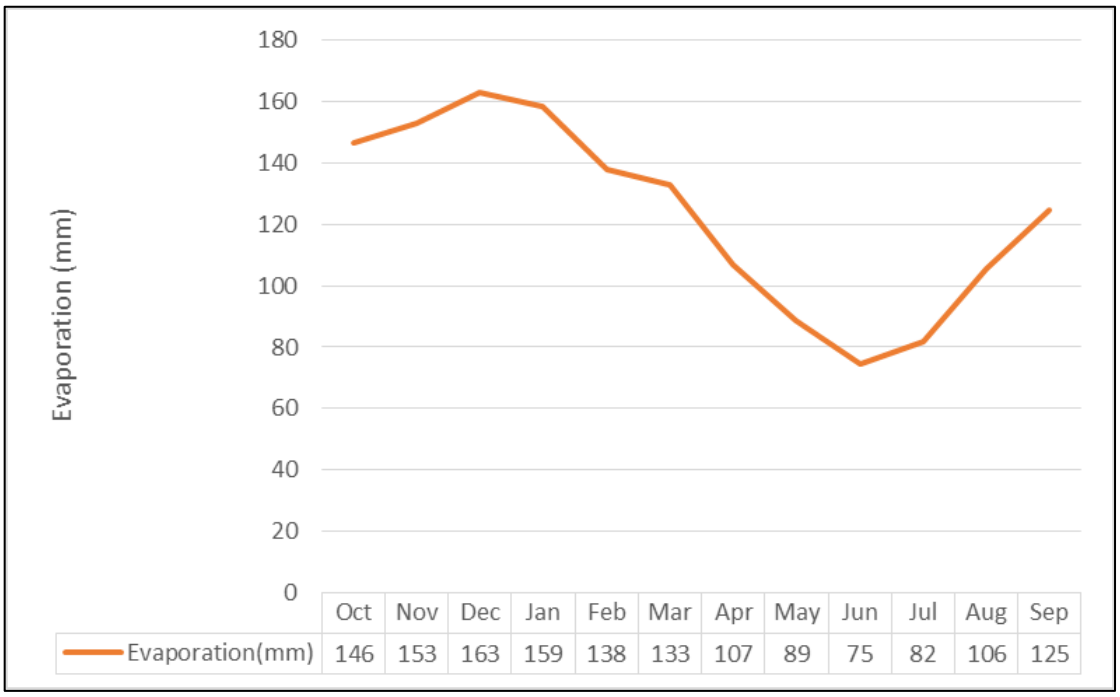


Figure 4-6: Monthly evaporation trend for the site.

4.4 Air Quality

Newcastle is the economic hub of the Amajuba District Municipality. The major existing sources of air pollution in the region of the proposed landfill site are:

- Food production;
- Unpaved roads;
- Textile manufacturing;
- Mining;
- Agriculture;
- Waste disposal;
- Domestic activities; and
- Biomass burning.

Baseline air quality in the area was assessed using secondary data sources from the Amajuba District Municipality Air Quality Management Plan (AQMP). In 2014 there were three (3) privately owned continuous monitoring stations operating in the district and passive monitoring conducted by the Department of Environmental Affairs for Nitrogen Dioxide (NO_2), Particulate Matter (PM), Sulphur Dioxide (SO_2), Ozone (O_3) and Benzene (C_6H_6). The results

of the passive monitoring campaign for NO_2, SO_2, 0_3, and C_6H_6 and are presented in Figure 4-7 - Figure 4-10.

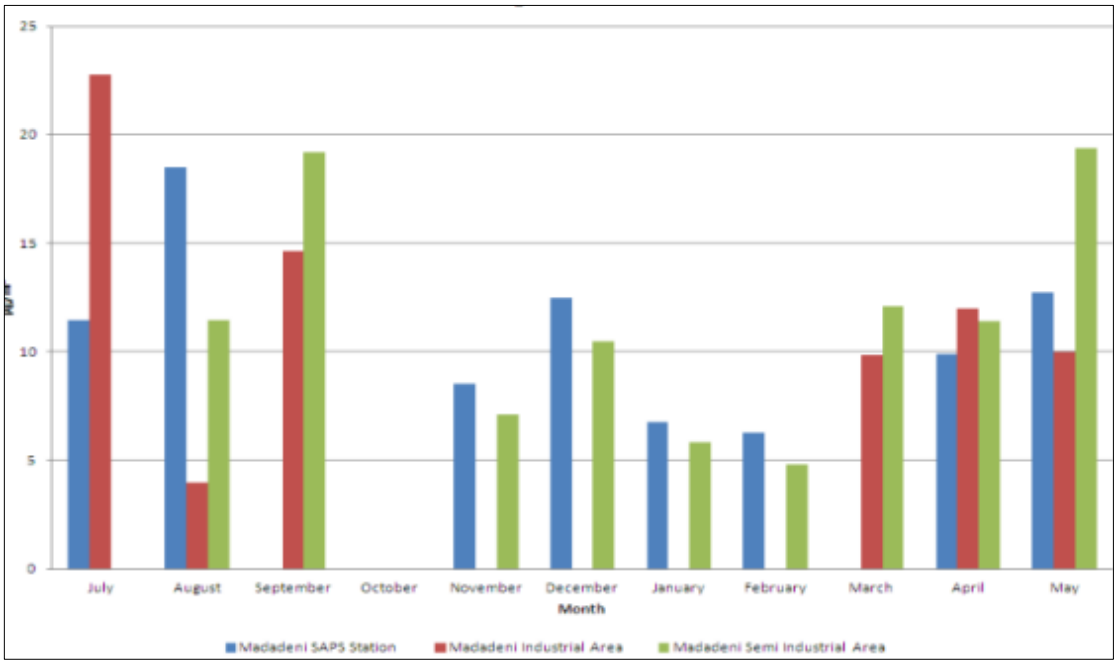


Figure 4-7: Monthly average NO_2 concentrations (July 2012 – May 2013).

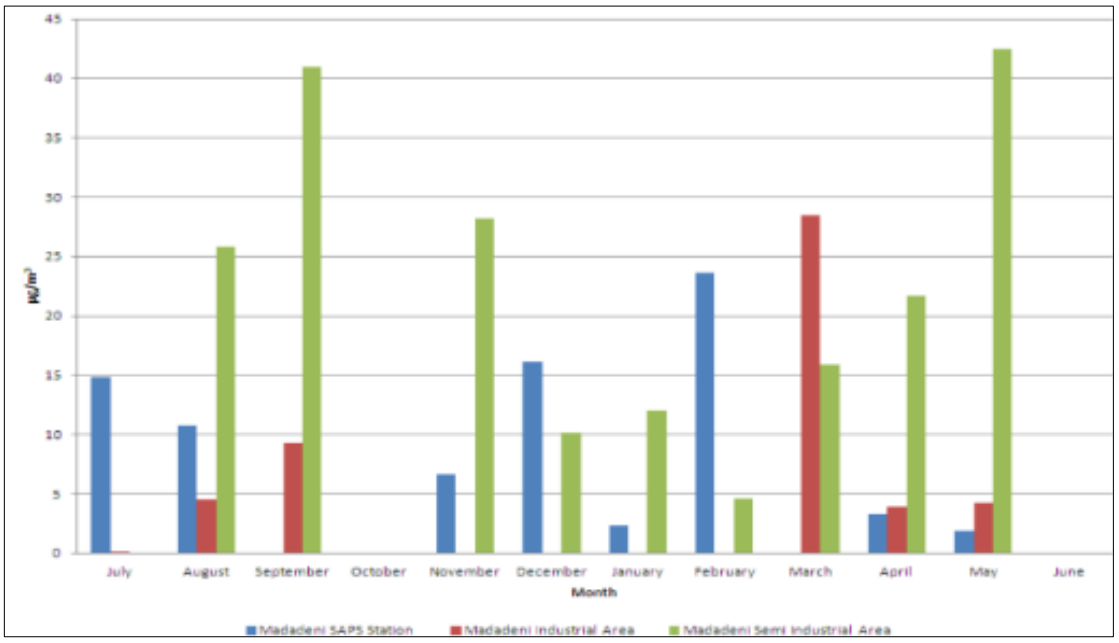


Figure 4-8: Monthly average SO_2 concentrations (July 2012 – May 2013).

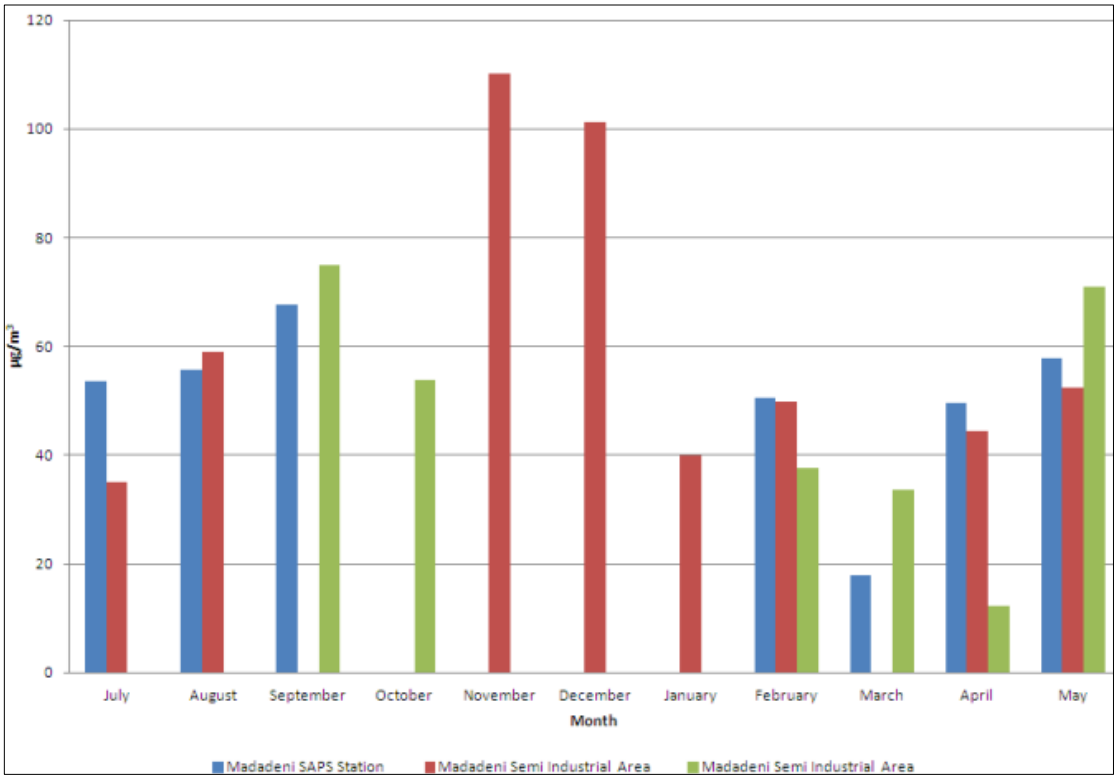


Figure 4-9: Monthly average O_3 concentrations (July 2012 – May 2013).

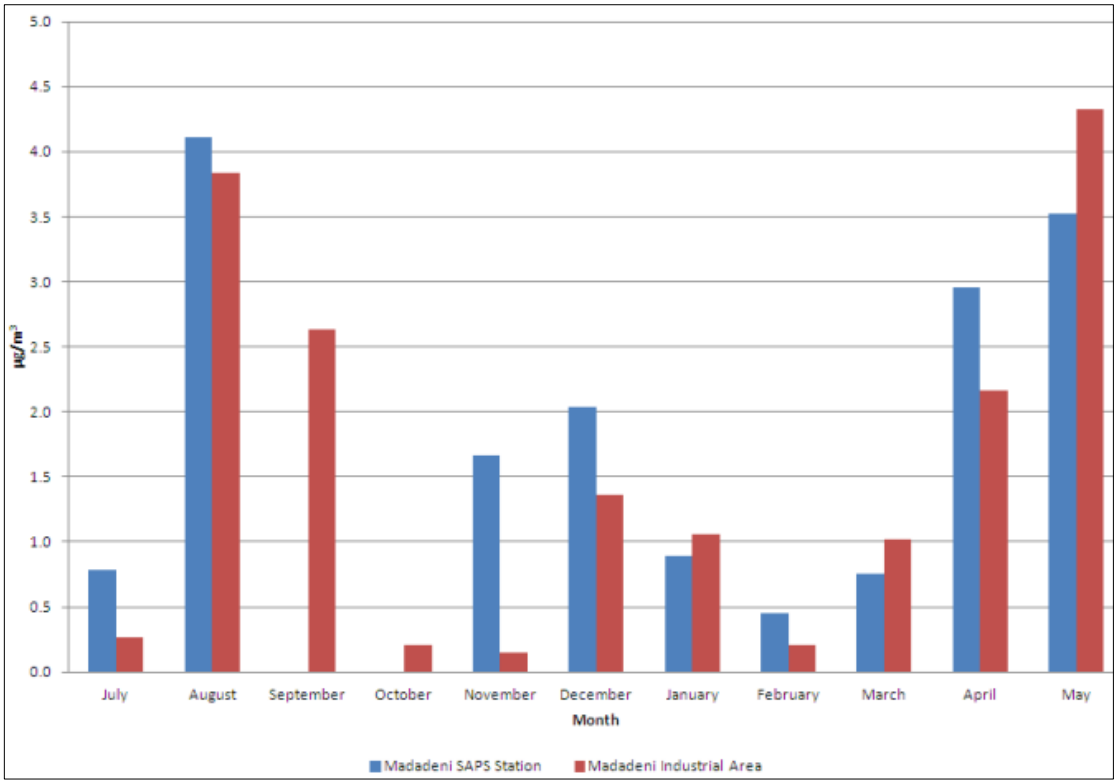


Figure 4-10: Monthly average C_6H_6 concentrations (July 2012 – May 2013).

Daily PM10 concentrations measured by NPC Cimpor for the period 2013-2014 are presented in Figure 4-11.

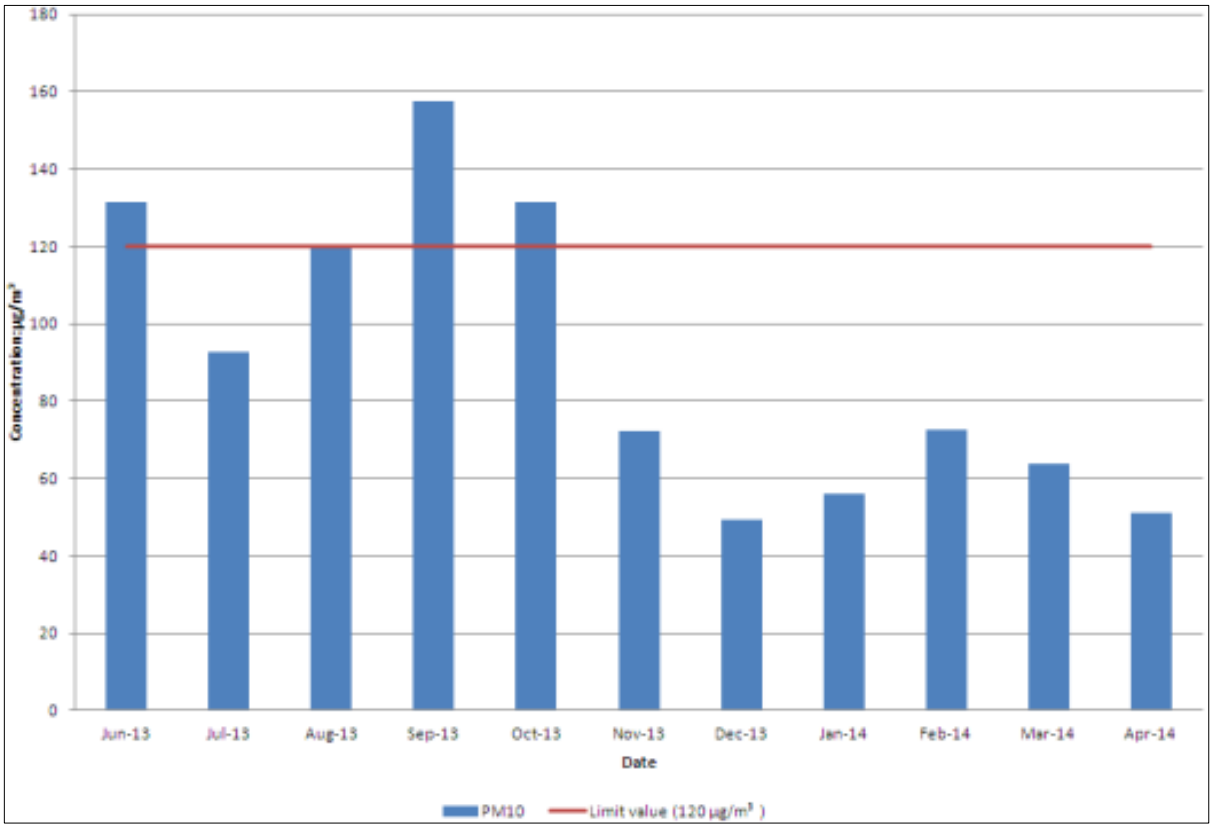


Figure 4-11: Daily PM_{10} concentrations as measured at NPC Cimpor for June 2013 to April 2014.

4.4.1 Meteorological Processes

Meteorological processes will determine the dispersion and dilution potential of pollutants emitted into the atmosphere. The vertical dispersion of pollution is governed by the stability of the atmosphere and the depth of the surface mixing layer. Horizontal dispersion of pollution is defined by dominant wind fields. Therefore, meteorological parameters including temperature, precipitation, wind speed and wind direction are of significance as they will influence the degree to which pollution will accumulate or disperse in the atmosphere.

As per the Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa (DEA, 2014), representativeness of the meteorological data is influenced by the following four factors:

- Proximity of the meteorological site to the area being modelled;
- Complexity of the terrain;

- Exposure of the meteorological measurement site; and
- Period of data collection.

A comprehensive meteorological dataset for the project area, considering the above-mentioned factors, could not be obtained, therefore, 5th-generation Mesoscale Model (MM5) modelled meteorological data was used for the project area. MM5 meteorological data was obtained from Lakes Environmental for the period January 2015 - December 2017. The model provides integrated model meteorological data, which can be used in a wide range of applications. This model is often used to create weather forecasts and climate projections. Details of the meteorological data obtained is summarised in Table 4-1.

Table 4-1: MM5 Meteorological Data Details.

MET DATA INFORMATION	DESCRIPTION
Met data type	MM5 AERMET-Ready (Surface & Upper Air Data)
Datum	WGS 84
Closest Town	Newcastle - South Africa
Latitude	27.859086
Longitude	29.924121
Time zone	UTC/GMT UTC + 2 hour (s)
Period of record	Jan 01, 2015 – Dec 31, 2017
MET STATION PARAMETERS	**DESCRIPTION**
Anemometer height	14 m
Station base elevation	1 352 m
Upper air adjustment	-2 hour (s)
GRID CELL INFORMATION	
Cell centre	27.859086, 29.924121
Cell dimension	12km x 12km
SURFACE MET DATA	**DESCRIPTION**
File format	SAMSON file
Output interval	Hourly
UPPER AIR DATA	**DESCRIPTION**
Format	TD-6201- Fixed Length
Reported in	GMT
Output interval	00Z and 12Z
MODELS USED TO PROCESS MET DATA	
Model used to process data for wind roses	WR Plot
Model used to process data for AERMOD	AERMET

4.4.2 Local Wind Field

Figure 4-12 provides the period wind rose plot for the proposed landfill site for the period January 2015 - December 2017. The predominant wind directions for the period are observed from the west (~11.1%) and the east (~9%). Wind speeds for the three-year period are generally moderate to fast with calm conditions, defined as wind speeds less than 1 metre per second (m/s), observed for 7.99% of the time.

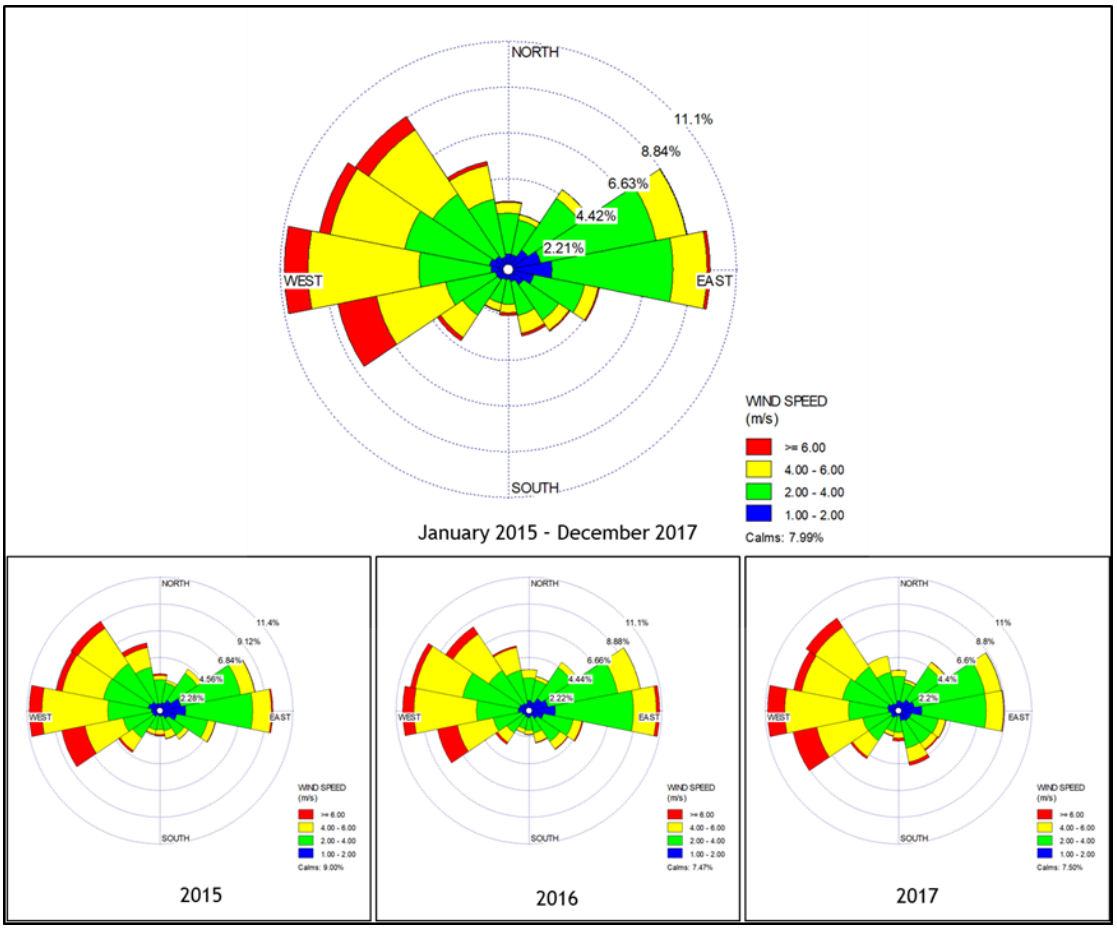


Figure 4-12: Period wind rose plots for the proposed site (January 2015 - December 2017).

Seasonal variation in winds at the proposed landfill site is shown in Figure 4-13. During the winter and autumn seasons, winds originate predominantly from the south-west. Easterly winds are frequent in summer. During the winter season, winds originate predominantly from the north westerly and north-north-westerly sectors. Spring months, in particular, exhibit more variation in wind direction, with prevailing winds observed from the east and westerly quadrants.

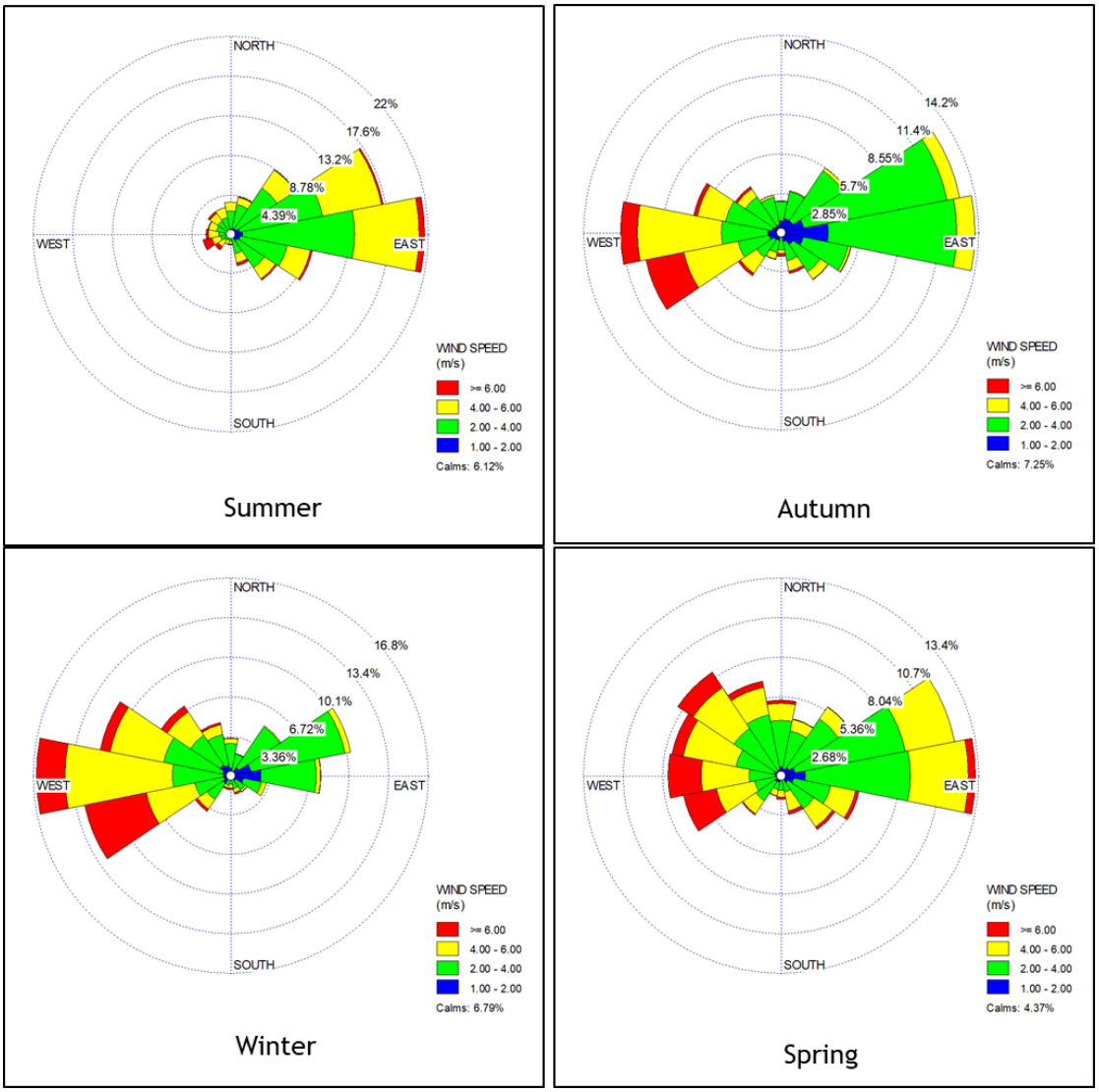


Figure 4-13: Seasonal variation of winds for the proposed site (January 2015 - December 2017).

The morning (AM; 00:00 – 12:00) and evening (PM; 12:00 – 24:00) period wind rose plots for the period January 2015 - December 2017 are given in Figure 4-14 and show diurnal variation in the wind field data. During the morning period, high frequency winds are observed from the west; as opposed to the evening period, where winds are predominantly observed from the east.

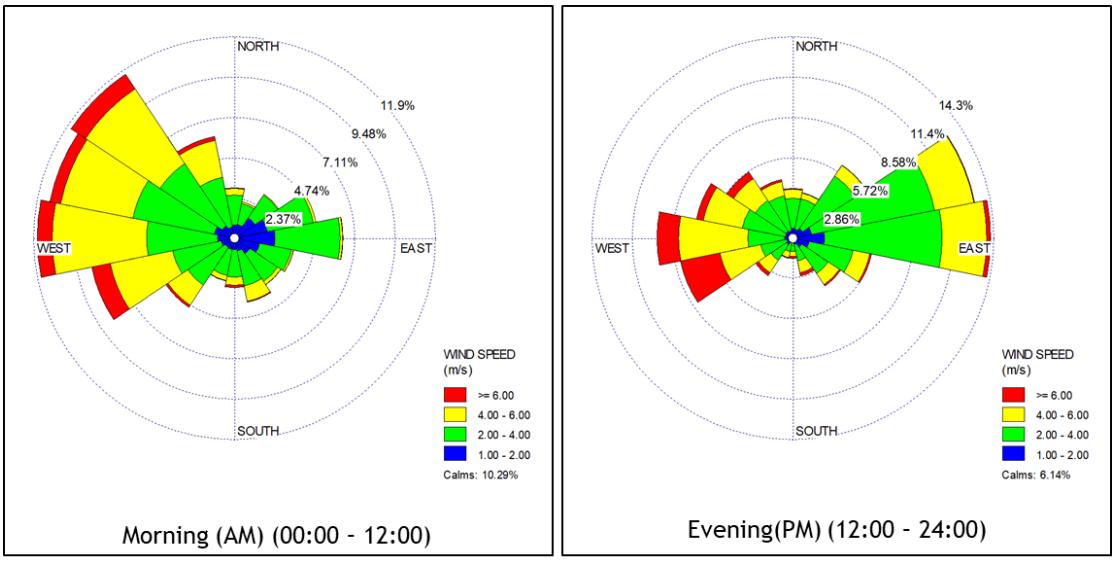


Figure 4-14: Morning (AM) and evening (PM) period wind rose plots for the proposed site (January 2015 – December 2017).

Based on the prevailing wind fields for the period January 2015 - December 2017, emissions from operations at the proposed landfill site will likely be transported towards the east of the site. Moderate to fast wind speeds observed during all time periods may result in effective dispersion and dilution of emissions; however, higher winds speeds can also facilitate fugitive dust emissions from open exposed areas.

4.5 Soils, Land Use and Land Capability

4.5.1 Soils Classification

The proposed Greenwich landfill site is located within soil classification area Ac (Figure 4-15), which comprises of freely drained, red and yellow, dystrophic/mesotrophic, apedal soils. In order to understand the soils within the proposed landfill site an on-site soil survey was undertaken and a total of 25 points (**Figure 4-16**) were sampled using a manual soil auger.

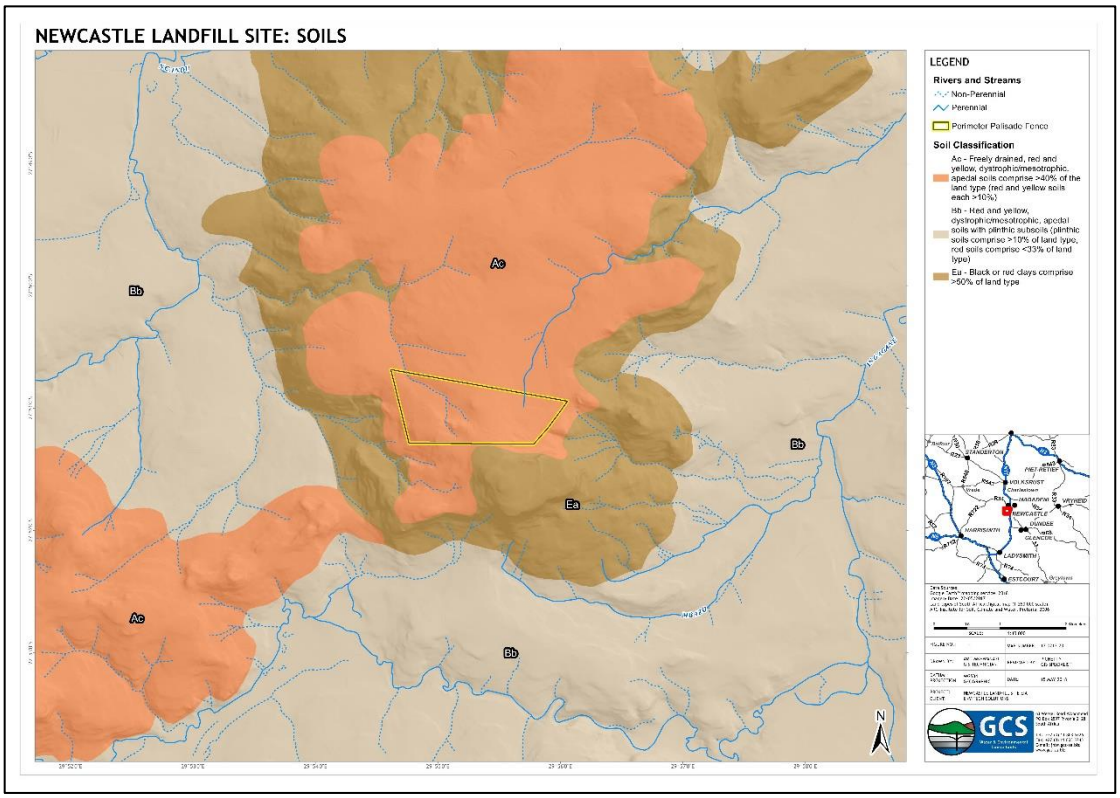


Figure 4-15: General soil types of the greater project area.

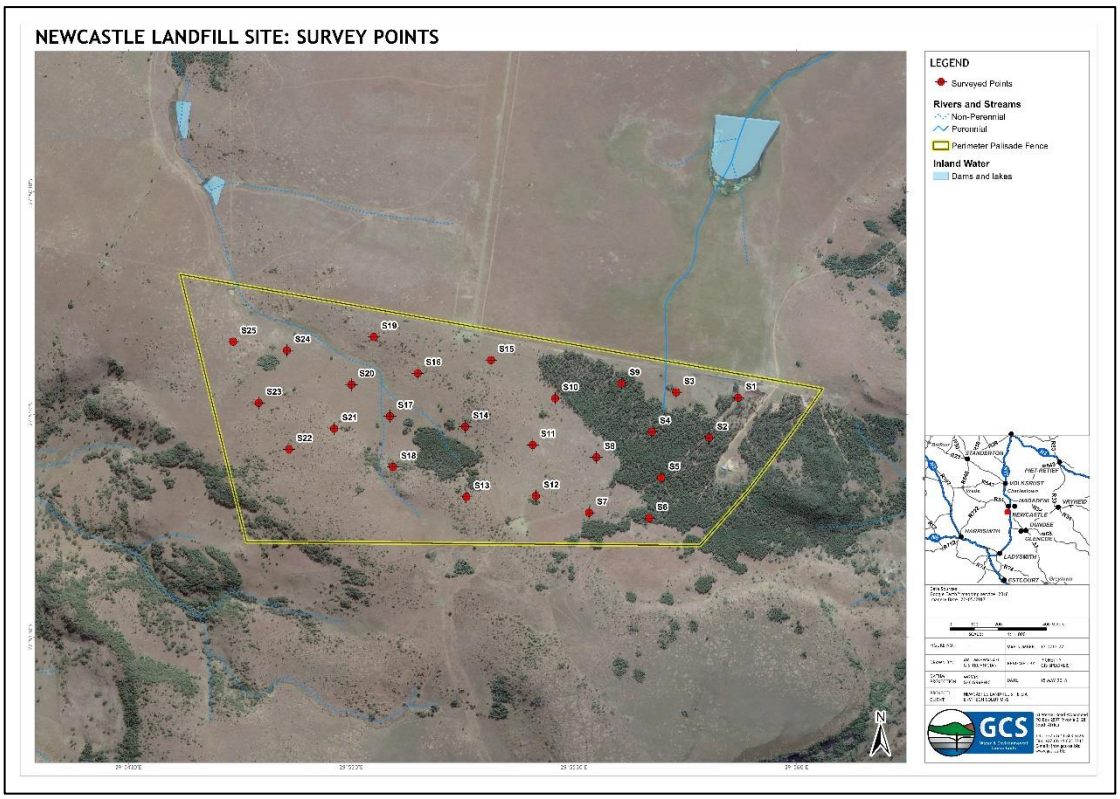


Figure 4-16: Soil Survey Points.

The soil types identified through augering on the proposed site include red well drained soils (Hutton and Inanda), yellow-brown moderately drained soils (Pinedene, Avalon, Magwa, Kranskop and Sweetwater), drainage impaired soils (Katspruit, Glenrosa and Estcourt), and shallow soils (Mispah). The soil types identified on site are presented in **Figure 4-17**.

The Katspruit soils were found to be associated exclusively with the wetland areas alongside the rivers and around the prominent pan features. The hydromorphic nature of these soils renders them highly susceptible to compaction and erosion.

The Avalon soils were found predominantly on the south-east facing slopes. These soils showed high clay content of non-expansive clays. The effective rooting depths of these soils is greater than 1.5 m. These soils are generally found in the mid-slope section and downslope of well drained soils. The yellow-brown B horizon shows limited oxidation of the iron in the soil.

The Magwa soils occur at the lower slopes and are moderately drained, thus the yellow-brown hue. These soils ranged in depth from 80 centimetres (cm) to 1.5 m with rooting depth being limited by the unspecified material. Drainage was also impaired by the unspecified material.

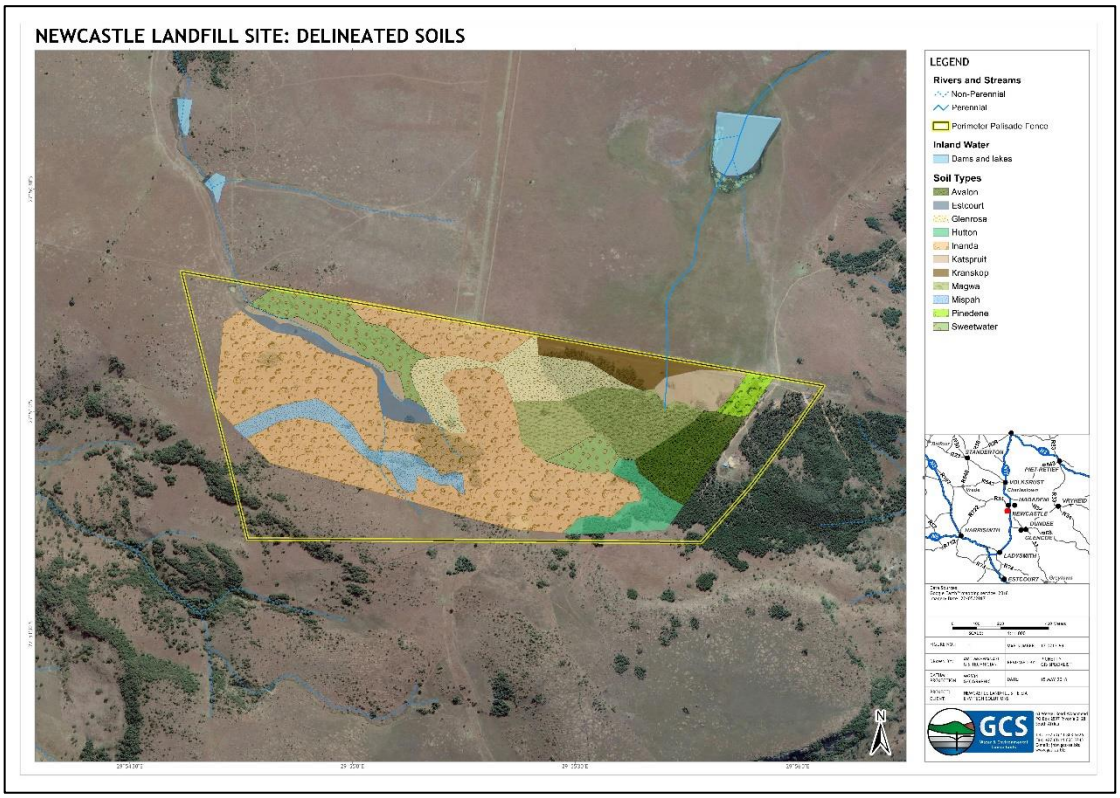


Figure 4-17: Soil types identified at the proposed site.

The Inanda soils are the most predominant soils found on site. These soils were predominantly clayey loams with moderate drainage in the lateral direction. These soils were limited to depths of less than 0.8 m with the unspecified parent material creating an impermeable layer. The steepness of the slopes on which these soils were found allows for good drainage. The Hutton soils found on site were deep and dark red due to the oxidisation of iron from the doleritic parent material. These soils had good structure with a high clay content and rooting depths of over 1 m.

The Sweetwater soils found on the site were greater than 1 m deep, however the neocuntanic horizon in these soils, showed poor structure.

The Glenrosa soils returned effective rooting depths of between 100 - 400 mm. The major constraint with these soils will be tillage, sub-surface drainage and erosion. The restrictive layer associated with these soils is a hard lithocutanic layer in the form of weathered parent material, or rock. The effective soil depth is restricted resulting in reduced soil volumes and, as a result, a depletion in the water holding capacity as well as nutrient availability. Geophysical characteristics of these soils include moderate to high clay percentages (20 - 32%), moderate internal drainage and low water holding capabilities.
The Estcourt soils were found along the side of a river section. This soil returned a shallow effective rooting depth, possibly due to the lack of nutrients in the E-horizon or the impermeable nature of the prismacutanic layer.

Mispah soils, by nature, are very shallow and found on the crests of hills and rocky outcrops. These soils consist only of an A-horizon overlying rock. Due to the shallow nature of this soil, a high susceptible for erosion is noted.

4.5.2 Soil Chemistry

A and B horizon samples were collected from sampling points S6, S7, S17, S23 and S24 and were tested for their chemical properties. The soils were analysed for:

- pH,
- Electrical Conductivity (EC);
- Macro-cations (Magnesium (Mg), Potassium (K), Sodium (Na), Calcium (Ca), Aluminium (Al), and Iron (Fe));
- Anions (Sulphate (SO_4), Nitrate (NO_3), Phosphate (PO_4), and Chlorine (Cl)); and
- Trace elements (Manganese (Mn), Copper (Cu), and Boron (B)).

4.5.2.1 Macro-cations

The Ca and K levels are below the critical levels for plant growth which are expected to be 5 000 – 10 000 milligrams per kilogram (mg/kg) (Bonner and Varner, 1965). The Mg level is below the critical level of 2 000 mg/kg (Bonner and Varner, 1965) (**Figure 4-18**). There is evidence of leaching of these nutrients from the A-horizon to the B-horizon as indicated by higher concentrations of macro-cations in the B-horizon than in the A-horizon.

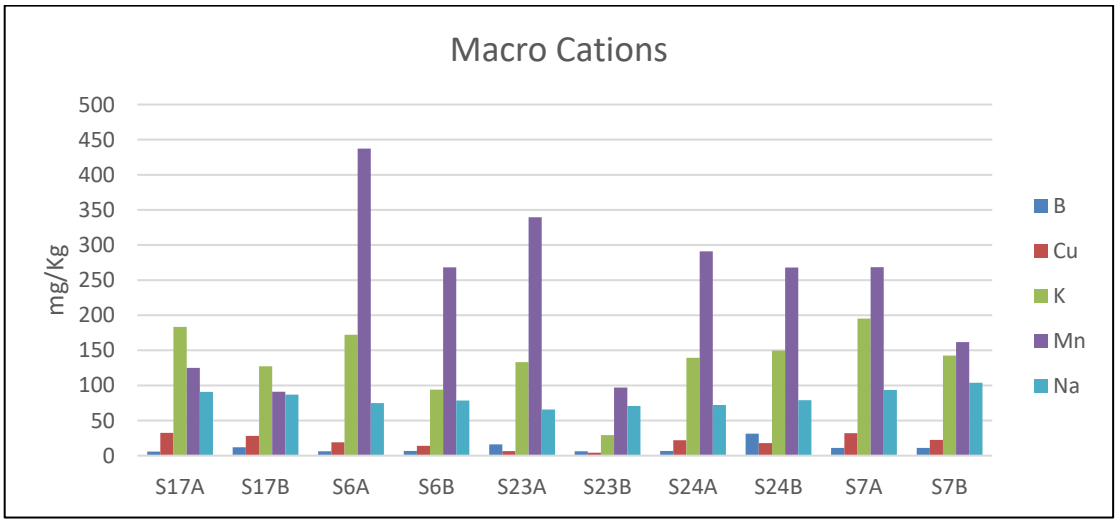


Figure 4-18: Macro-cation chemical analysis for the proposed site.

4.5.2.2 Micro-cations

The concentration of Fe is quite high. Al concentrations in the A-horizons were well above the Al toxicity range of 2 - 3 mg/kg for most plants, with a pH of below 5.5 (Silva, 2012), however this is normal for soils derived from doleritic parent material. pH for the analysed soils ranged between 5.3 and 6.6 on the Greenwich site. pH affects the availability of nutrients as well as the solubility of Al and Fe. At pH levels of below 5.5 Al becomes soluble and leads to Al toxicity in plants. Mn was found to be above the critical level of 50 mg/kg for all the soils analysed (**Figure 4-19**).

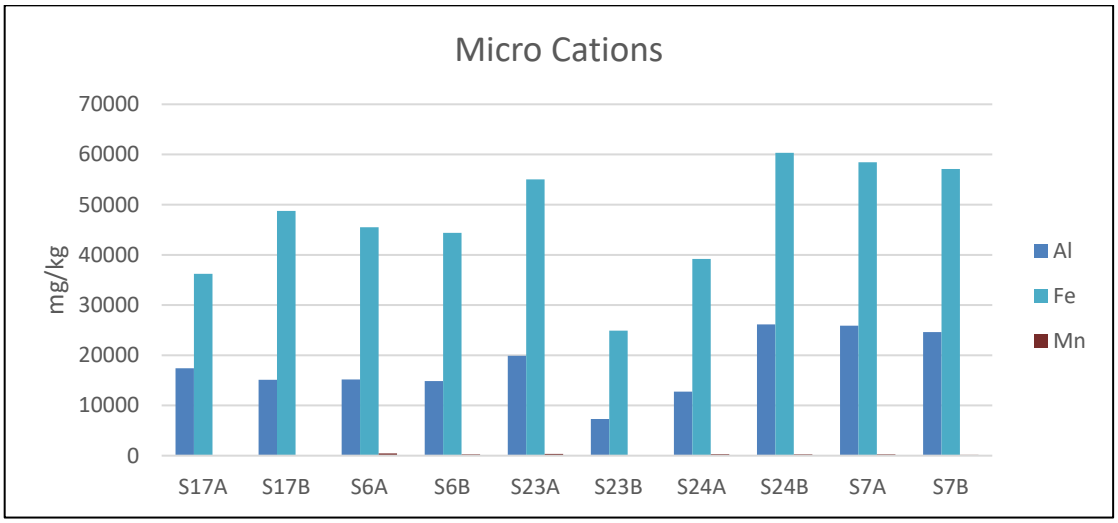


Figure 4-19: Micro-cation nutrient analysis for the proposed site.

4.5.2.3 Anions

NO_3 levels are all below the optimal level of 20 mg/kg (Harivandi et al., 1992) for all the soils analysed, this indicates low fertility of soils. SO_4 is a nutrient critical for protein synthesis and the critical level for SO_4 is 1 000 mg/kg (Little and Nair, 2009). The soil analyses showed concentrations for SO_4 ranging from 140 – 6 000 mg/kg and most of the soils analysed were well above the critical threshold for SO_4 (**Figure 4-20**).

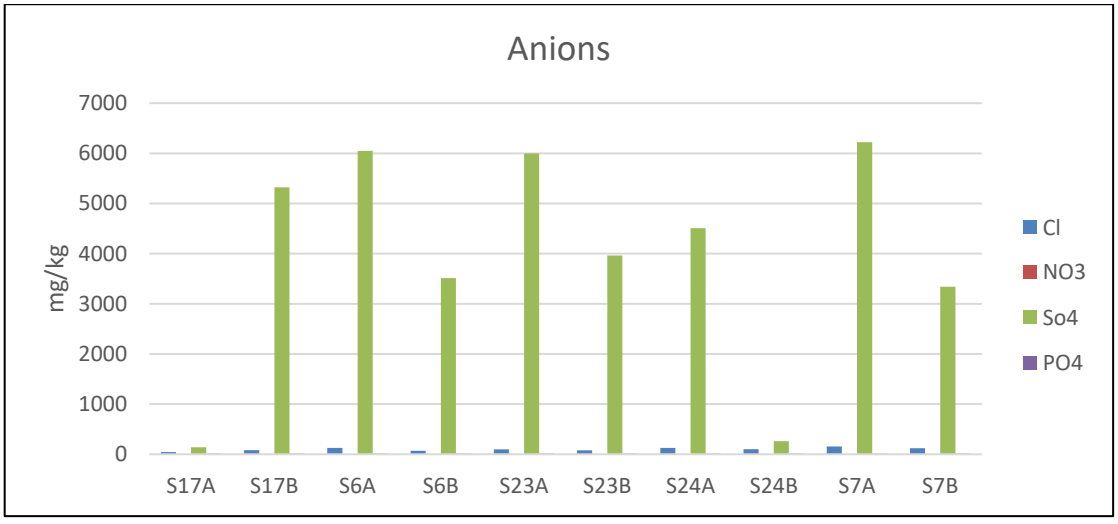


Figure 4-20: Anion analysis for the proposed site.

4.5.3 Land Capability

Land capability can be described as 'the fitness of a given tract of land to sustain a defined use; differences in the degree of capability are determined by the present state of associated

attributes of the area in question' (Schoeman et al., 2002). Land capability generally refers to the ability of a soil to sustain productive agriculture (based on the soil forms identified). Land capability is increasingly becoming a valuable tool in land use planning as many users of land have difficulty interpreting and understanding soil information.

Land capability classes determined by Schoeman et al. (2002) were assigned to the study area and are presented in **Table 4-2** and **Figure 4-21**.

Table 4-2: Land capability at the proposed site.

LAND CAPABILITY CLASS	SOIL FORM	INCREASED INTENSITY OF USE								LAND CAPABILITY GROUPS
VI	Glenrosa	W	F	LG	MG	-	-	-	-	Grazing
I	Inanda	W	F	LG	MG	IG	LC	MC	VIC	Cultivation
VIII	Katspruit	W	-	-	-	-	-	-	-	Wildlife
I	Hutton	W	F	LG	MG	IG	LC	MC	VIC	Cultivation
II	Magwa	W	-	LG	MG	IG	LC	MC	-	Cultivation
III	Avalon	W	-	LG	MG	IG	LC	-	-	Cultivation
V	Sweetwater	W	-	LG	MG	-	-	-	-	Grazing
I	Kranskop	W	F	LG	MG	IG	LC	MC	VIC	Cultivation
III	Pinedene	W	F	LG	MG	IG	LC	-	-	Cultivation
VI	Estcourt	W	F	LG	MG	-	-	-	-	Grazing
VII	Mispah	W	-	-	-	-	-	-	-	Wildlife

W-Wildlife
F- Forestry
LG- Light Grazing
MG- Moderate Grazing
IG- Intensive Grazing
LC- Light Cultivation
MC-Medium Cultivation
VIC-Very Intensive Cultivation

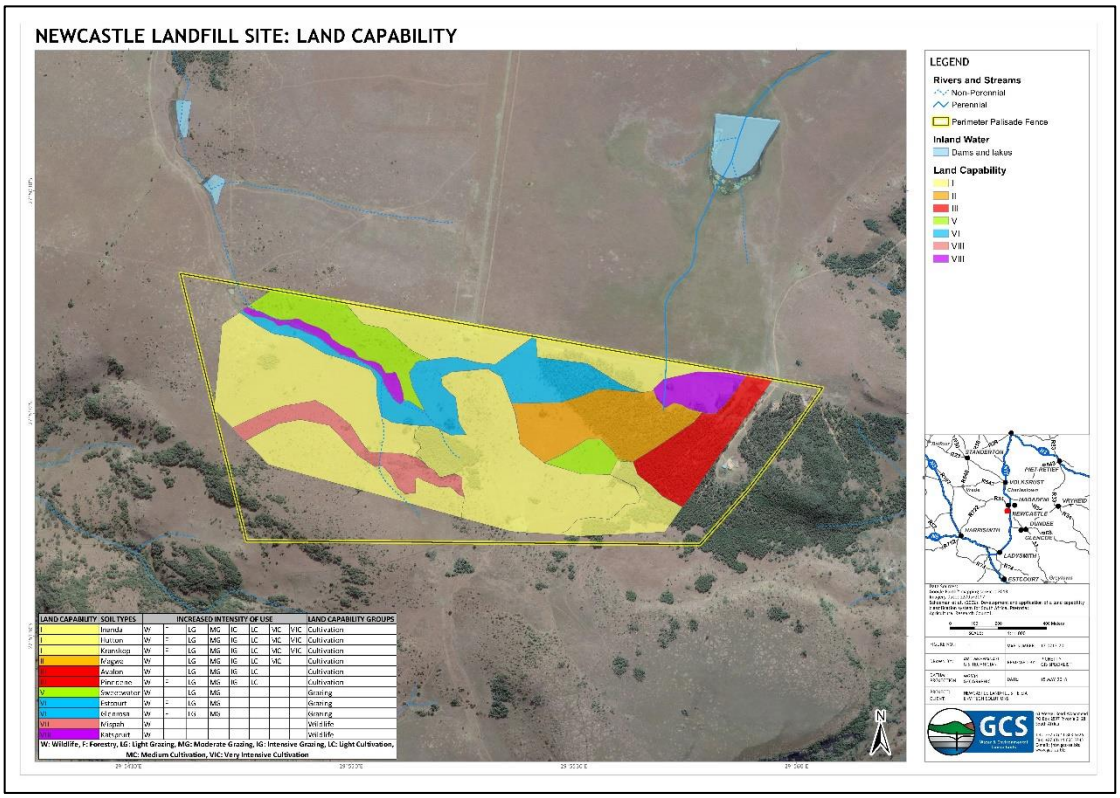


Figure 4-21: Land capability of the proposed site.

4.5.4 Land Suitability

Having taken into consideration the soil form classification, land capability, soil chemistry, climate of the area and physical characteristics identified during the site visit, the soils at the Greenwich project site were determined to fall under suitability Classes I, II, III, VI and VIII. Class V represents the Pinedene and Estcourt soil forms, while the Glenrosa falls within the Suitability Class VII. The Pinedene and the Estcourt soils are limited due to the limited depth and limited aeration in the subsoil. The Hutton, Inanda and Kranskop are capable of intensive agriculture provided good agronomic practices are put in place, this is due to the deep soils, with good drainage and high clay content. The Avalon and Magwa soils are capable soils for agriculture but require adequate runoff control. The Sweetwater, Pinedene and Estcourt soils are capable of being utilized for agriculture but need to be carefully managed due to their erosion potential and lack of drainage. The Glenrosa and Mispah soils can be utilized for light grazing but need to be carefully managed due to the high erosion potential of these soils. Katspruit soils are hydromorphic and are only suitable for wildlife

The determined classes, conservation needs, use suitability and justifications can be seen in **Table 4-3** and **Figure 4-20**.

Table 4-3: Land suitability at the proposed site.

CLASS	SOIL FORM	DEFINITION	CONSERVATION NEED	USE-SUITABILITY
I	Hutton, Inanda, Kranskop	No or few limitations Very high arable potential Very low erosion hazard	Good agronomic practice	Annual cropping
II	Avalon, Magwa	Slight limitations High arable potential Low erosion hazard	Adequate runoff control	Annual cropping with special tillage
III	Sweetwater	Moderate Limitations Low erosion hazard	Special conservation practice and runoff control	Rotation crops and ley (50%)
VI	Pinedene, Estcourt	Moderate limitations Low arable potential Erosion hazard	Moderate conservation practice	Medium term leys (50%)
VII	Glenrosa, Mispah	Severe limitations Low arable potential High erosion hazard	Intensive conservation practice	Long term leys (75%)
VIII	Katspruit	Extreme limitations Not suitable for grazing or forestry	Total protection from agriculture	Wildlife

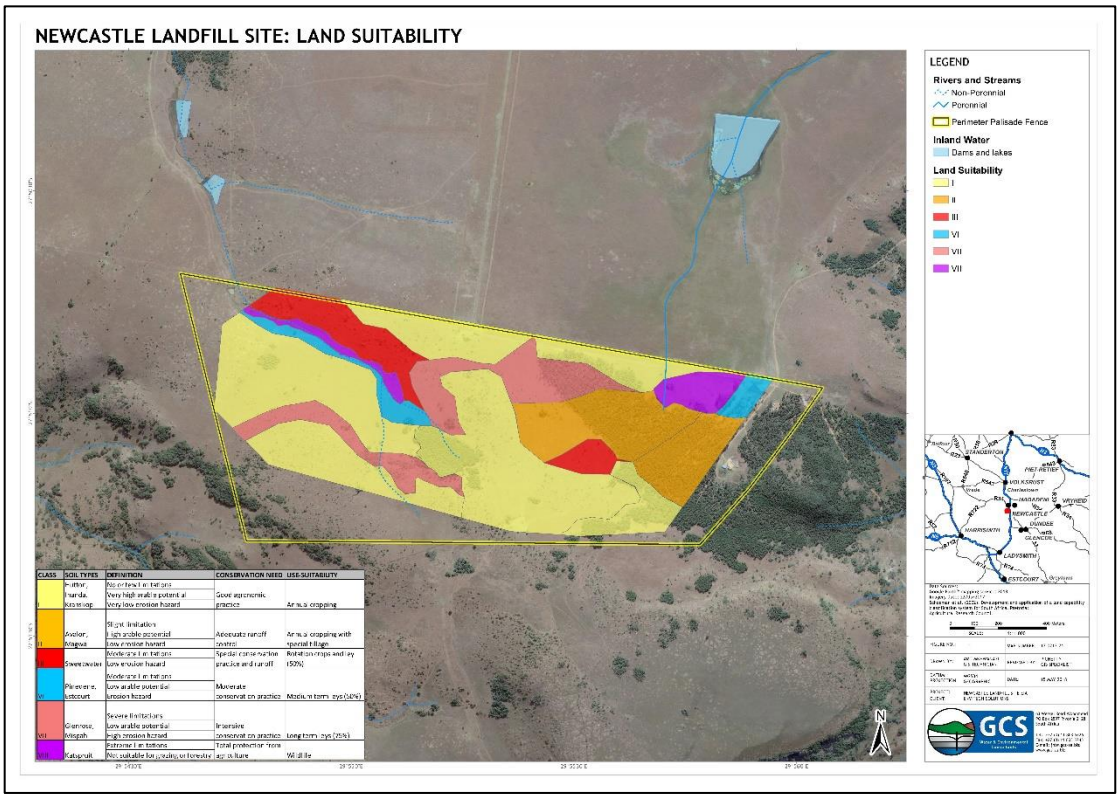


Figure 4-22: Land suitability at the proposed site.

4.6 Wetlands

The proposed project is situated in the quaternary catchments V31J and V31K within the Pongola-Mtamvuna Water Management Area (WMA 4) and lies in the North Eastern Uplands Ecoregion.

The regional vegetation in the project area is the Northern KwaZulu-Natal Moist Grassland Vegetation unit. This vegetation type occurs on moderately undulating plains, including some low hills and pan depressions. The vegetation is a short dense grass land dominated by the usual Highveld grass composition (*Arsitida, Digitaria, Eragrostsis, Themeda, Tristachya* etc.) with small scattered rocky outcrops with, wiry sour grasses and some woody species. Over a quarter (25%) has been transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. No serious alien invasions are reported (Mucina & Rutherford, 2006). The status of the vegetation, as at the time of publishing (Mucina & Rutherford, 2006), is summarised in Table 4-4 and the dominant plant species within each vegetation unit are shown in Table 4-5.

Table 4-4: Vegetation Status.

VEGETATION NAME	ECOLOGICAL STATUS	CONSERVATION STATUS	% OF PROJECT AREA
Northern KwaZulu-Natal Moist Grassland	Moderately Modified	Vulnerable	40%

Table 4-5: Dominant Plant Species.

VEGETATION UNIT	DOMINANT PLANT SPECIES
Northern KwaZulu-Natal Moist Grassland	*Hyparrhenia hirta, Themeda triandra, Cynodon dactylon, Aristida congesta, Vachelia sieberiana var. woodii*

4.6.1 NFEPA Wetlands

There were only two (2) National Freshwater Ecosystem Priority Area (NFEPA) wetlands identified within 500 m of the proposed landfill site. These were classified as a seepage wetland and a wetland flat (Figure 4-23). The seepage wetland was classified as natural system with a wetland condition of AB (Largely Natural). The wetland flat was classified as an artificial system with a wetland condition of Z3 (Severely Modified). The wetlands were classified according the NFEPA database as a Rank 5 and Rank 6 Freshwater Ecosystem Priority Area (FEPA) wetland, respectively (Table 4-6).

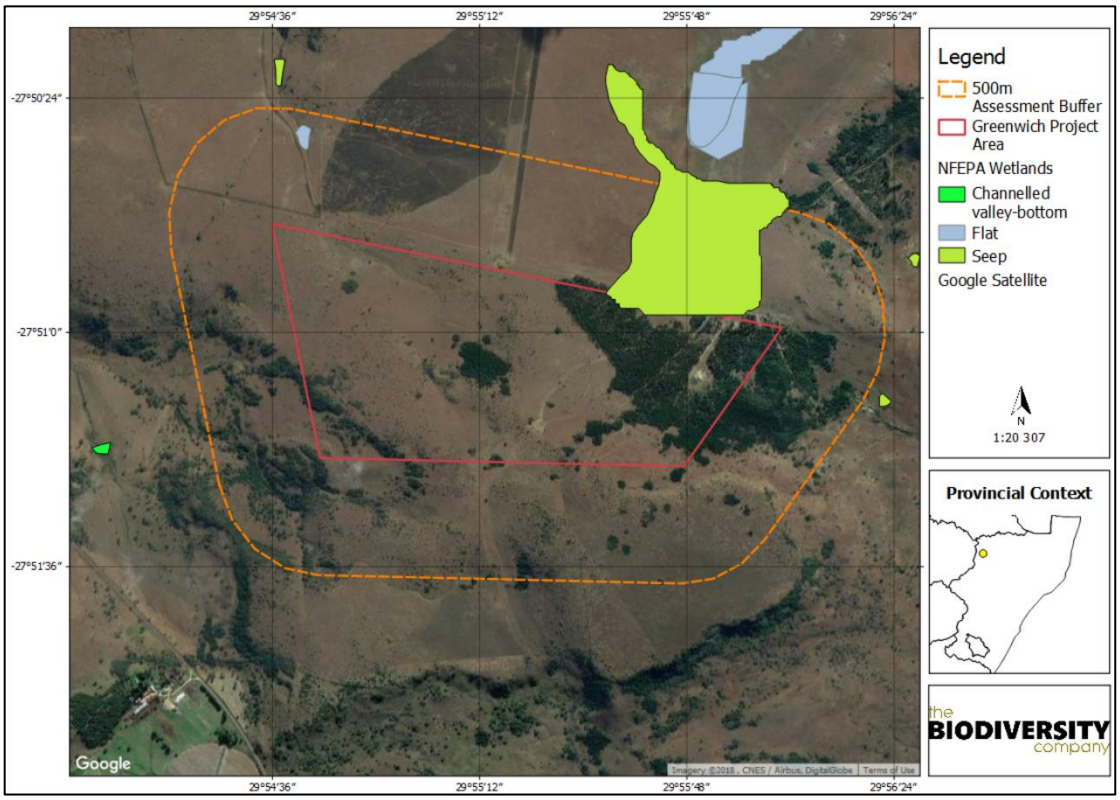


Figure 4-23: FEPA wetlands within 500 m of the proposed landfill site.

Table 4-6: Wetland Classification of the FEPA Wetlands.

FEPA WETLAND	CLASSIFICATION LEVELS				WETLAND VEGETATION CLASS	NATURAL/ ARTIFICIAL	CONDITION	RANK
	L1 (SYSTEM)	L2 (ECOREGION)	L3 (LANDSCAPE POSITION)	L4 (HGM CLASS)				
Seepage	Inland	North Eastern Uplands	Slope	Seep	Sub-Escarpment Grassland Group 4	Natural	AB	5
Flat	Inland	North Eastern Uplands	Bench	Flat	Sub-Escarpment Grassland Group 4	Artificial	Z3	6

4.6.2 On-site Wetland Assessment

The on-site wetland survey included assessing all the wetland indicators as well as assessing the Present Ecological Score (PES) or health of the wetland, the wetland's ability to provide goods and services (Eco-services) and the Ecological Importance and Sensitivity (EIS) of the wetlands.

The wetland delineation based on the on-site survey is shown Figure 4-24. Two (2) Hydrogeomorphic (HGM) units were identified within the 500 m project assessment boundary, namely a Channelled Valley Bottom (HGM 1) and a Wetland Flat (HGM 2). The classified wetland HGM units, as per the SANBI guidelines (Ollis et al., 2013), are presented in Table 4-7.

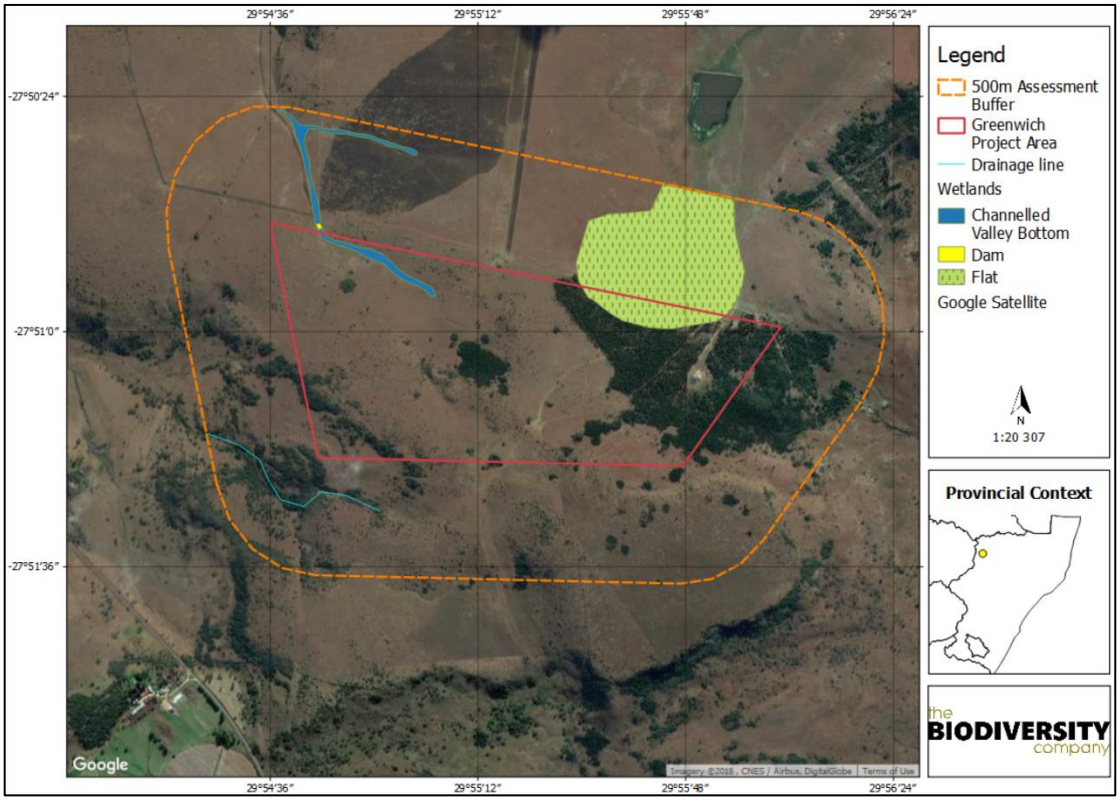


Figure 4-24: The delineated HGM units within 500m of the project area.

Table 4-7: Wetland classification as per SANBI guideline (Ollis et al., 2013).

WETLAND NAME	LEVEL 1	LEVEL 2		LEVEL 3	LEVEL 4		
	SYSTEM	DWS ECOREGION/S	NFEPA WET VEG GROUP/S	LANDSCAPE UNIT	4A (HGM)	4B	4C
HGM 1	Inland	North Eastern Uplands	Sub-Escarpment Grassland Group 4	Valley Bottom	Channelled Valley Bottom	N/A	N/A
HGM 2	Inland	North Eastern Uplands	Sub-Escarpment Grassland Group 4	Bench	Flat	N/A	N/A

Figure 4-25 presents the depictions of the identified HGM units as described in the SANBI Wetland Classification (Ollis *et. al.*, 2012). Table 4-8 presents a summary of the findings for each of the wetland units on site.

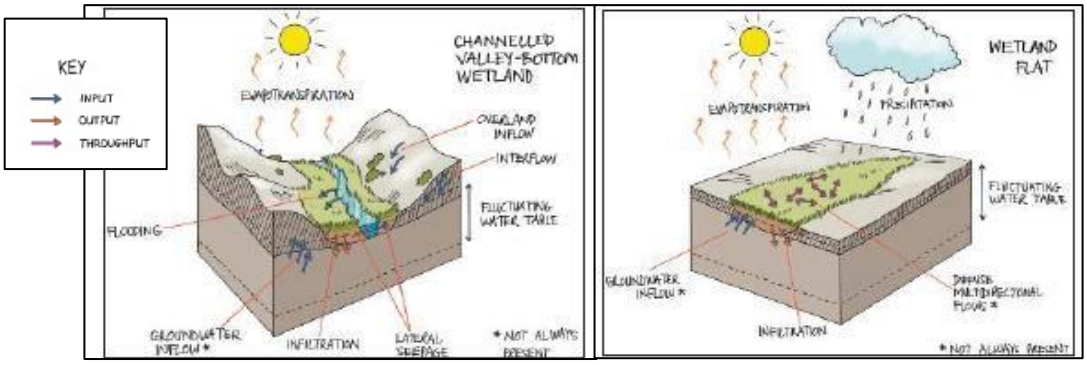


Figure 4-25: Ollis *et al*. depiction of HGM unit settings and flow paths.

Table 4-8: A summary of the results for the HGM units identified on site.

	HGM 1 - CHANNELLED VALLEY BOTTOM	HGM 2 - WETLAND FLAT
Description	The channelled valley bottom wetland was found in the north-western corner of the project area. The wetland was a narrow channel with the slopes comprised of rocky outcrops and shallow soils. The wetland was well vegetated with species of *Aristida*, *Juncus*, *Cyperus* and *Eragrostis*. The Rensburg soil form was identified within the wetland.	The wetland flat was found on the northern border of the project area. The wetland was largely intact with exception of an upstream dammed area. The wetland was well vegetated with species of *Aristida*, *Juncus*, *Cyperus* and *Eragrostis*. The Kroonstad soil form was identified within the wetland area. *Hypocharis radiata* was identified within the wetland which suggested an elevated clay content in the soil.
Photograph		
Overall Present Ecological State	**Moderately Modified (C)**	**Largely Modified**
Hydrology	**Largely Modified (D)**	**Seriously Modified (E)**
Geomorphology	**Largely Natural (B)**	**Moderately Modified**
Vegetation	**Moderately Modified**	**Largely Modified**
WET-EcoServices rated as high	• Toxicant Assimilation • Erosion control	• Sediment trapping • Phosphate assimilation • Nitrate assimilation • Toxicant Assimilation
EIS	**Moderate (C)**	**Moderate**
Hydrological/Functional Benefit	**Moderate**	**High (B)**
Direct Human Benefits	**Low (D)**	**Low**

4.6.2.1 Present Ecological State

The PES for the assessed HGM units are presented in Table 4-9. The overall wetland health for the HGM units was determined to be that of a Moderately Modified (C) for HGM 1 and Largely Modified (D) for HGM 2.

Table 4-9: Summary of the scores for the wetland PES.

WETLAND	HYDROLOGY		GEOMORPHOLOGY		VEGETATION	
	RATING	SCORE	RATING	SCORE	RATING	SCORE
HGM 1	C: Largely Modified	4.0	B: Largely Natural	1.9	C: Moderately Modified	2.4
Overall PES Score	**2.9**		**Overall PES Class**		**C: Moderately Modified**	
HGM 2	E: Seriously Modified	7.5	C: Moderately Modified	2.3	D: Largely Modified	4.2
Overall PES Score	**5.1**		**Overall PES Class**		**D: Largely Modified**	

The most significant impacts to HGM 1 were determined to arise from the increased hard surfaces in the wetland catchment which would increase flows. The extent of alien invasive plants in the upper reaches contributes to decreased water flows into the wetland. The geomorphology of the wetland remained largely intact due to the good vegetation cover and low slope of the wetland. The vegetation was moderately impacted upon by the presence of invasive plant species and shallow soils which did not allow for adequate cover in certain areas.

The hydrology of HGM 2 was most significantly impacted upon by the impoundment which caused prolonged unnatural inundation and decreases downstream flows. The presence of the large Wattle and Eucalyptus reduced the volumes of water into the downstream areas of the wetland. The geomorphology was largely impacted by large bare areas of soil susceptible to loosening and erosion, compaction and exportation. The vegetation was degraded to due to drying out of downstream areas and the presence of invasive trees in the wetland areas.

A summary for the respective modules is as follows:

- Hydrology:
  - HGM 1 – The hydrology of the wetland was altered as a result of the shallow soils and rocky outcrops on the slopes of the wetland which increase flow velocities and decrease the water retention capabilities of the wetland. The wetland flood

peaks have been altered which could result in erosion as seasonal changes could result in reduced vegetation cover in times of high flows.

- HGM 2 – The flows have been altered as a result of a dam/excavation to catch water was erected within the wetland. Large invasive trees further decrease the supply of water to the wetland areas. The downstream areas of the wetland are semi-desiccated which reduces the functional wetland areas.

- Geomorphology:
  - HGM 1 – The geomorphology of the wetland was largely natural, despite the hydrological changes, with a few areas where erosion was evident. The vegetation cover and low slope of the wetland enable the wetland to retain much of the geomorphology. Furthermore; water inputs are reduced as a result of upper catchment water losses to alien trees.
  - HGM 2 – The geomorphology of the wetland was altered due to the hydrological impacts. The geomorphology was altered as a result of the dam, bare areas and livestock trampling within the wetland. The soils showed signs of physical disturbances due to livestock movements. The soils are susceptible to compaction, loosening, erosion and exportation out of the wetland.
- Vegetation:
  - HGM 1 and HGM 2 – The vegetation of the wetlands was modified as a result of the alien invasion encroaching into the wetland areas. Grazing and lack of water has also led to the wetland areas transforming into moist grassland in areas. The wetlands are desiccating as a result of water shortages; this leaves the wetland areas unable to support hydrophytic vegetation which drives the transformation to facultative grass species which are often referred to as moist-grassland species.

The alien invasive plants that were identified within the wetland areas and presented in Figure 4-26. The invasive category is indicated in brackets.

Figure 4-26: Observed alien invasive plants a) *Xanthium spinosum* (1b) b) *Solanuma syssimbrifolium* (1b) c) *Eucalyptus camaldulensis* (1b), and d) *Acacia mearnsii* (1b)

4.6.2.2 Ecosystem Services Assessment

The Ecosystem services provided by the HGM units present on site were assessed and rated using the WET-EcoServices method (Kotze *et al.*, 2009). The summarised results for the HGM units are shown in Table 4-10. The indirect services associated with both HGM units are considerably more beneficial when compared to the direct services. This emphasises the importance and need to conserve these systems to provide effective services which includes water quality enhancement.

Table 4-10: The EcoServices being provided by the wetlands at the project site.

WETLAND UNIT					HGM 1	HGM 2
Ecosystem Services Supplied by Wetlands	Indirect Benefits	Regulating and supporting benefits	Flood attenuation		1,7	1,7
			Streamflow regulation		2,0	2,0
			Water Quality enhancement benefits	Sediment trapping	1,9	2,1
				Phosphate assimilation	2,0	2,6
				Nitrate assimilation	1,9	2,3
				Toxicant assimilation	2,3	2,6
				Erosion control	2,1	2,0
			Carbon storage		2,0	1,3
	Direct Benefits	**Biodiversity maintenance**			1,6	1,8
		Provisioning benefits	Provisioning of water for human use		1,0	1,0
			Provisioning of harvestable resources		0,8	0,8
			Provisioning of cultivated foods		0,4	0,4
		Cultural benefits	Cultural heritage		0,0	0,0
			Tourism and recreation		0,6	0,6
			Education and research		0,8	0,8
Overall					21,0	21,8
Average					1,4	1,5

HGM 1 and HGM 2 had an overall intermediate level of service with the following services showing moderately high or high levels of services:

- Sediment trapping;
- Phosphate assimilation;
- Nitrate assimilation;
- Toxicant Assimilation; and
- Erosion control.

The remaining services for the HGMs unit were scored as intermediate or lower.

HGM 2, despite being altered, showed high levels of service for sediment trapping, phosphate, nitrate and toxicant assimilation as a result of the alterations. The impoundment of water flows in the wetland allowed sediment trapping which may not have been the case without the impoundment. The livestock activities within the wetland produce nitrates and toxicants that the wetland is now assimilating. Figure 4-27 presents the Spider Diagrams for the HGM Ecoservices.

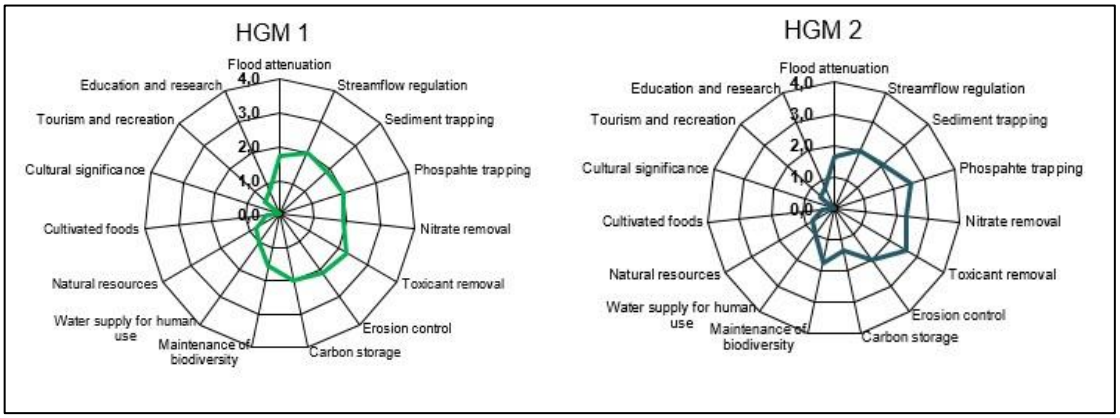


Figure 4-27: The EcoServices Spider Diagrams for HGM 1 and HGM 2.

The indirect benefits had a moderately high level of service for HGM 2 and intermediate level of service for HGM 1. The level of service for the direct benefits was determined to be moderately-low for both HGM units. The findings show that the benefits associated with the maintenance of biodiversity were rated as intermediate for all HGM units (Table 4-11).

Table 4-11: A summary of the indirect and indirect benefits provided by the wetlands.

WETLAND UNIT	HGM 1	HGM 2
Indirect Benefits	2,0	2,2
Direct Benefits	0,6	0,6
Biodiversity Maintenance	1,6	1,8

4.6.2.3 Ecological Importance and Sensitivity

The EIS assessment was applied to the HGM units identified in order to assess the levels of sensitivity and ecological importance of the wetland. HGM 1 and HGM 2 showed a Moderate (C) level of importance for the EIS. The wetlands are located on a crest and have been impacted on by alien invasion. The wetland ecological support is considered low as a result of the modifications and the anthropogenic activities in the local area.

HGM 1 showed a Moderate (C) level of importance for the Hydrological Functional Importance. The wetland is supplied by the upper catchment over the shallow rocks and is largely seasonal. HGM 2 showed a High (B) level of importance for the Hydrological Functional Importance was rated as High (B) owing to the downstream water contribution of the wetland. The wetland catches a large volume of water and directs towards streams and watercourses.

Both the HGM units showed a Low (D) level of importance for the Direct Human Benefits. The wetlands do not provide any direct human uses, although they contribute to greater area through the watercourse network.

The results of the assessment are shown in **Table 4-12**.

Table 4-12: The EIS results for the HGM units within the project area.

HGM UNIT	EIS RESULT	IMPORTANCE
HGM 1	Ecological importance & sensitivity	1,8
	Hydrological/functional importance	2,0
	Direct human benefits	0,6
HGM 2	Ecological importance & sensitivity	1,3
	Hydrological/functional importance	2,1
	Direct human benefits	0,6

4.7 Biodiversity

4.7.1 Vegetation Assessment

4.7.1.1 Desktop Vegetation Assessment

From a desktop assessment, the site is situated in the grassland biome of South Africa. The grassland biome occurs mainly on the highveld, the inland areas of the eastern seaboard, the mountainous areas of KwaZulu-Natal and the central parts of the Eastern Cape (Mucina & Rutherford, 2006). According to Mucina & Rutherford (2006), the proposed landfill site area is situated in the Northern KwaZulu-Natal Moist Grassland vegetation community whilst portions of a 500 m assessment buffer around the project area included Northern KwaZulu-Natal Shrubland.

Ezemvelo KZN Wildlife (Ezemvelo) together with various role players, including government departments and NGOs, developed a new vegetation map for the province (Scott-Shaw & Escott, 2011). Based on the updated vegetation map the entire project area is situated in the Northern KwaZulu-Natal Moist Grassland vegetation community whilst a portion of the

500 m assessment buffer to the north of the project area is classified as Alluvial Wetland: Temperate Alluvial Vegetation. The Northern KwaZulu-Natal Moist Grassland vegetation community occurs in KwaZulu-Natal on gentle to steep upper slopes of mountains formed by hard dolerite dykes dominated by forb-rich tall sour *Themeda triandra* grasslands (Scott-Shaw & Escott, 2011) (Figure 4-28).

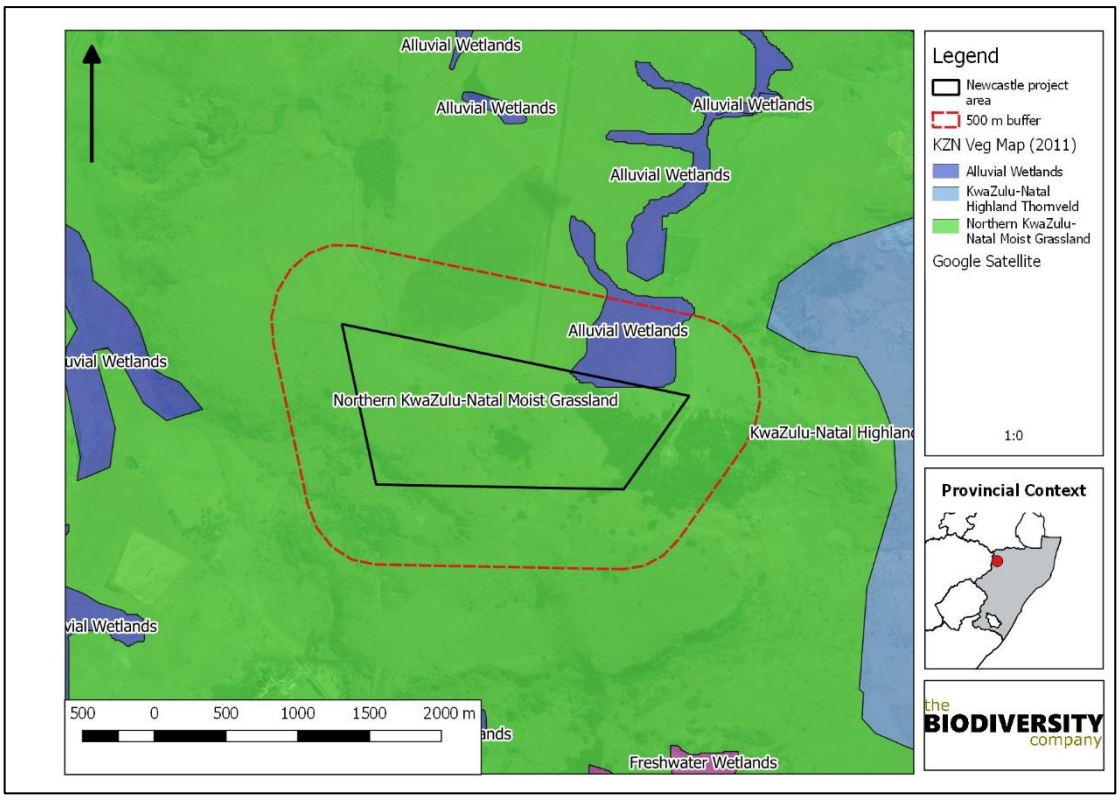


Figure 4-28: Map showing the vegetation types based on the updated KwaZulu-Natal vegetation map (Scott-Shaw & Escott, 2011).

Mucina & Rutherford (2006) classified Northern KwaZulu-Natal Moist Grassland as Vulnerable (VU), with only 2% statutorily conserved. The VU status of this vegetation community was confirmed during the development of the new vegetation map. A conservation status of VU is assigned to vegetation communities of which less than or equal to 60% remain of its original extent.

The process of conservation planning involves extensive mapping of vegetation types, transformation, species data, ecological processes and threats (KZNSCP, 2012). This information is then used to identify different conservation priority areas:

- Critical Biodiversity Areas (CBAs) are the highest priority areas in terms of conservation. These areas need to be maintained in a near natural state in order to

ensure the continuing functioning of ecosystems. The CBAs can be divided into two subcategories, namely:

- Irreplaceable – areas considered critical for meeting biodiversity targets and thresholds and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems; and
- Optimal – areas which represent the best localities out of a potentially larger selection of Planning Units (PUs). These areas should not necessarily be regarded as being of lower biodiversity value, only that there are more alternate options available within which the features located within can be met.

- Ecological Support Areas (ESAs) areas are required to support and sustain the ecological functioning of CBAs. These areas are functional but not necessarily pristine natural areas. The degree or extent of restriction on land use and resource use in these areas may be lower than that recommended for CBAs

The provincial conservation priority areas associated with the Newcastle Greenwich landfill site are shown in Figure 4-29.

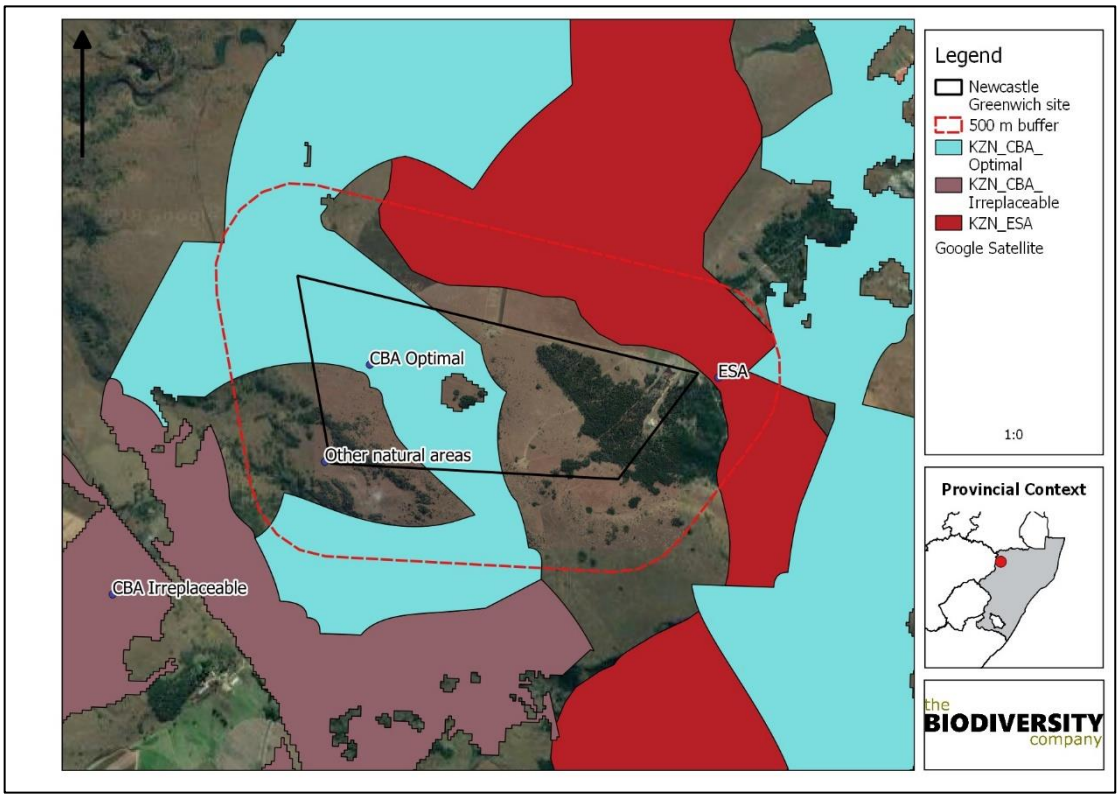


Figure 4-29: Provincial conservation priority areas associated with the proposed site (Ezemvelo KZN Wildlife, 2016).

Based on this desktop assessment, the proposed project area is overlapped by a CBA Optimal. The remainder of the project area is classified as other natural area. The CBA Optimal connects with a CBA Irreplaceable which is situated approximately 600 m south and west of the project area. Based on this the ecosystems within the project area are classified as being of very high biodiversity importance and should be maintained in a near natural state if possible. If this is not possible sensitive natural plant species must be recovered and relocated elsewhere on the Greenwich farm or, if that is not suitable, at an identified biodiversity offset area within the greater region.

4.7.1.2 In-field Vegetation Assessment

Prior to commencement of the field survey 16 vegetation plots were randomly selected throughout the project area. During the survey these plots were sampled, and 4 vegetation communities identified in the project area (**Figure 4-30**) namely:

- Alien Invasive vegetation;
- Indigenous shrub patches;
- Rocky grassland; and
- Grassland.

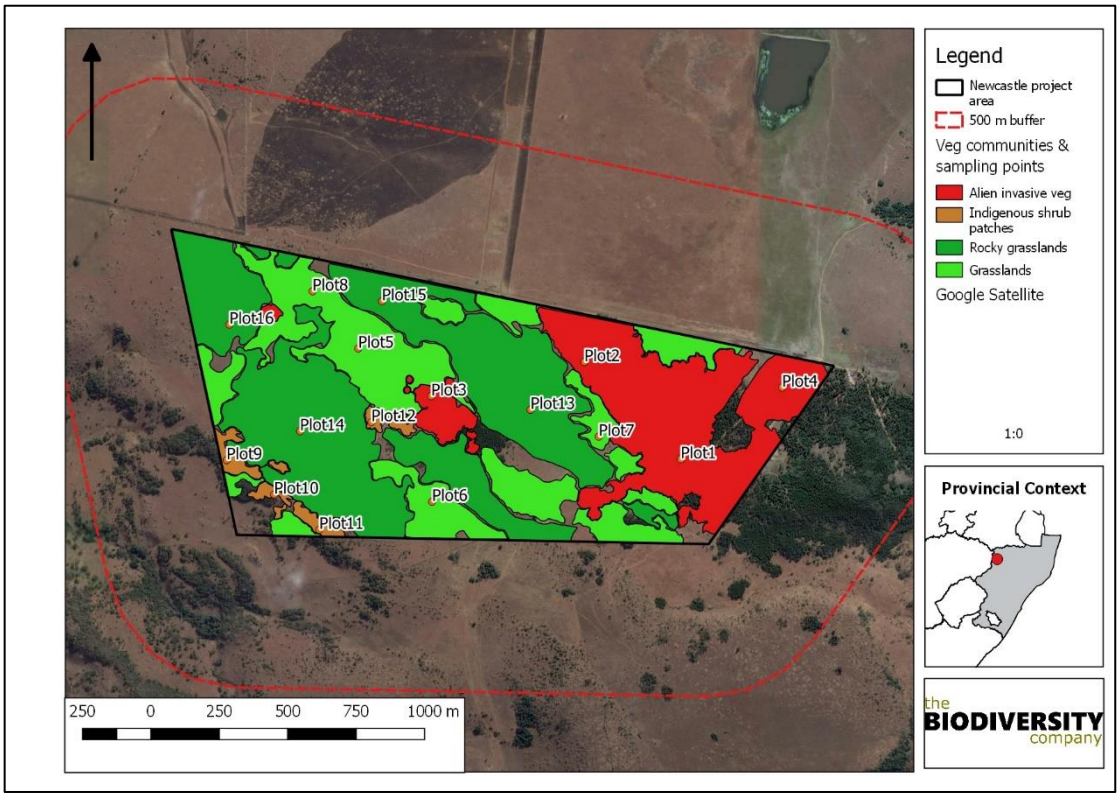


Figure 4-30: Location of vegetation plots and vegetation communities within the project area.

A total of 30 plant species were recorded in the indigenous vegetation communities (Table 4-13), whereas the alien invasive communities were dominated by a handful of invasive species namely *Acacia mearnsii*, *Eucalyptus saligna* and *Datura stramonium*.

Table 4-13: Plants species recorded in grassland, rocky grassland and indigenous shrub vegetation communities during the February 2018 field survey.

SPECIES	SANBI RED LIST (2018)
Acacia sieberiana	LC
Aloe maculata	LC
Aristida congesta	LC
Asparagus densiflorus	LC
Berkheya rehmani	LC
Berkheya speciosa	LC
Centella asiatica	LC
Commelina erecta	LC
Crassula alba	LC
Cucumis zeyheri	LC
Cussonia spicata	LC
Cymbopogon caesius	LC
Datura stramonium	LC
Diheteropogon amplectens	LC
Eragrostis plana	LC
Eragrostis superba	LC
Euclea natalensis	LC
Euphorbia pulvinata	LC
Gerbera ambigua	LC
Gladioli crassifolius	LC
Helichrysum rugulosum	LC
Hypoxis haemarcallidea	**Declining**
Heteropogon contortus	LC
Ipomoea crassipes	LC
Ledebouria ovatifolia	LC
Nuxia congesta	LC
Searsia pyroides	LC
Solanum panduriforme	LC
Themeda triandra	LC
Ziziphus mucronata	LC

The indigenous vegetation communities were found to be largely intact, although evidence of trampling by cattle was noted along with an increase in annual grass species such as

Aristida congesta that dominates the grassland community. The rocky grassland and indigenous shrub vegetation communities were found to be most intact, although even in these areas evidence of overgrazing and trampling was evident.

4.7.2 Faunal Assessment

4.7.2.1 Desktop Faunal Assessment

Avifauna

Based on the South African Bird Atlas Project (SABAP, Version 2) 297 bird species are expected to occur in pentads 2750_2955, 2750_2950, 2745_2950 and 2745_2955. Of the expected bird species, 27 (9.1%) are listed as Species of Conservation Concern (SCC) either on a regional or global scale (Table 4-14). The SCC include the following:

- Three (3) species that are listed as Endangered (EN) on a global basis and six (6) species are listed as EN on a regional basis;
- Six (6) species that is listed as Vulnerable (VU) on a global scale and eleven (11) on a regional scale; and
- Seven (7) species that are listed as Near Threatened (NT) on a global scale and six (6) on a regional scale.

Table 4-14: List of bird species of regional or global conservation importance that are expected to occur in pentads 2750_2955, 2750_2950, 2745_2950 and 2745_2955 (SABAP2, 2018, ESKOM, 2014; IUCN, 2018).

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (BLSA, 2017)
Balearica regulorum	Crane, Grey Crowned	EN	EN
Circus maurus	Harrier, Black	EN	EN
Gyps coprotheres	Vulture, Cape	EN	EN
Anthropoides paradiseus	Crane, Blue	VU	NT
Bucorvus leadbeateri	Ground-hornbill, Southern	VU	EN
Geronticus calvus	Ibis, Southern Bald	VU	VU
Lioptilus nigricapillus	Blackcap, Bush	VU	VU
Polemaetus bellicosus	Eagle, Martial	VU	EN
Sagittarius serpentarius	Secretarybird, Secretarybird	VU	VU
Calidris ferruginea	Sandpiper, Curlew	NT	LC
Eupodotis caerulescens	Korhaan, Blue	NT	LC
Falco vespertinus	Falcon, Red-footed	NT	NT
Geocolaptes olivaceus	Woodpecker, Ground	NT	Unlisted
Monticola explorator	Rock-thrush, Sentinel	NT	Unlisted
Neotis denhami	Bustard, Denham's	NT	VU

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (BLSA, 2017)
Stephanoaetus coronatus	Eagle, African Crowned	NT	VU
Circus ranivorus	Marsh-harrier, African	LC	EN
Aquila verreauxii	Eagle, Verreaux's	LC	VU
Ciconia nigra	Stork, Black	LC	VU
Eupodotis senegalensis	Korhaan, White-bellied	LC	VU
Falco biarmicus	Falcon, Lanner	LC	VU
Sterna caspia	Tern, Caspian	LC	VU
Tyto capensis	Grass-owl, African	LC	VU
Alcedo semitorquata	Kingfisher, Half-collared	LC	NT
Coracias garrulus	Roller, European	LC	NT
Phoenicopterus ruber	Flamingo, Greater	LC	NT
Rostratula benghalensis	Painted-snipe, Greater	LC	NT

Mammals

The IUCN Red List Spatial Data (IUCN, 2018) lists 84 mammal species that could be expected to occur within the project area. Of these species, 8 are medium to large conservation dependant species, such as *Diceros bicornis* (Black rhinoceros), *Ceratotherium simum* (Southern White Rhinoceros) and *Equus quagga* (Plains zebra) that in South Africa are restricted to protected areas such as game reserves. These species are not expected to occur in the project area and were therefore removed from the expected SCC list.

Of the remaining 76 small to medium sized mammal species, 14 (18.4%) are listed as being of conservation concern on a regional or global basis (Table 4-15). The list of potential SCC includes:

- One (1) that is listed as EN on a global scale and two (2) on a regional scale;
- Two (2) that are listed as VU on a global scale and six (6) on a regional scale; and
- Four (4) that are listed as NT on a global scale and five (5) on a regional scale.

Table 4-15: List of mammal species of conservation concern that may occur in the project area as well as their global and regional conservation statuses (IUCN, 2018; SANBI, 2016).

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (SANBI, 2016)
Mystromys albicaudatus	White-tailed rat	EN	VU
Felis nigripes	Black-footed cat	VU	VU
Panthera pardus	Leopard	VU	VU
Aonyx capensis	Cape clawless otter	NT	NT
Eidolon helvum	Straw-coloured fruit bat	NT	LC

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (SANBI, 2016)
Hydrictis maculicollis	Spotted-necked otter	NT	VU
Parahyaena brunnea	Brown hyaena	NT	NT
Crocidura maquassiensis	Maquassie musk shrew	LC	VU
Leptailurus serval	Serval	LC	NT
Ourebia ourebi	Oribi	LC	EN
Pelea capreolus	Grey rhebok	LC	NT
Poecilogale albinucha	African striped weasel	LC	NT
Redunca fulvorufula	Mountain reedbuck	LC	EN
Rhinolophus swinnyi	Swinny's horseshoe bat	LC	VU

Herpetofauna (reptiles and amphibians)

Based on the IUCN Red List Spatial Data (IUCN, 2017) and the ReptileMap database provided by the Animal Demography Unit (ADU, 2017) 13 reptile species are expected to occur in the project area. No species of conservation concern should be present according to the above-mentioned sources within the project area but in situ observations may prove otherwise.

Based on the IUCN Red List Spatial Data (IUCN, 2017) and the AmphibianMap database provided by the Animal Demography Unit (ADU, 2017) 25 amphibian species are expected to occur in the project area. One (1) amphibian species of species of conservation concern, *Hemisus guttatus* (Spotted shovel-nosed frog) is expected to occur in the project area. This species is listed as VU on the IUCN Red List of Threatened Species (IUCN, 2018).

4.7.2.2 In-field Faunal Assessment

Due the proximity of the sites to each other and the similarity of habitats observed on the sites the sites were treated as one for the faunal assessment.

Avifauna

A total of 49 bird species were recorded in the project area during the February 2018 survey (Table 4-16). One (1) bird species of conservation concern, *Geronticus calvus* (Ibis, Southern Bald) was observed flying over the site. This species is listed as VU both at a global and regional scale. The species can be expected to forage on the site. The alien invasive bird species *Acridotheres tristis* (Myna, Common) was observed at several location during the survey.

Table 4-16: Bird species recorded in the project area during the February 2018 field survey.

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (BLSA, 2017)
Bubo africanus	Eagle-owl, Spotted	LC	Unlisted
*Acridotheres tristis**	Myna, Common	LC	Unlisted
Anthus cinnamomeus	Pipit, African	LC	Unlisted
Ardea cinerea	Heron, Grey	LC	Unlisted
Batis molitor	Batis, Chinspot	LC	Unlisted
Bostrychia hagedash	Ibis, Hadeda	LC	Unlisted
Bubulcus ibis	Egret, Cattle	LC	Unlisted
Buteo rufofuscus	Buzzard, Jackal	LC	Unlisted
Caprimulgus pectoralis	Nightjar, Fiery-necked	LC	Unlisted
Cercomela familiaris	Chat, Familiar	LC	Unlisted
Chrysococcyx caprius	Cuckoo, Diderick	LC	Unlisted
Cisticola juncidis	Cisticola, Zitting	LC	Unlisted
Cisticola tinniens	Cisticola, Levaillant's	LC	Unlisted
Colius striatus	Mousebird, Speckled	LC	Unlisted
Columba guinea	Pigeon, Speckled	LC	Unlisted
Corvus albus	Crow, Pied	LC	Unlisted
Cossypha caffra	Robin-chat, Cape	LC	Unlisted
Crithagra atrogularis	Canary, Black-throated	LC	Unlisted
Crithagra mozambicus	Canary, Yellow-fronted	LC	Unlisted
Cuculus solitarius	Cuckoo, Red-chested	LC	Unlisted
Dicrurus adsimilis	Drongo, Fork-tailed	LC	Unlisted
Euplectes orix	Bishop, Southern Red	LC	Unlisted
Falco amurensis	Falcon, Amur	LC	Unlisted
Geronticus calvus	Ibis, Southern Bald	VU	VU
Hirundo cucullata	Swallow, Greater Striped	LC	Unlisted
Hirundo spilodera	Cliff-swallow, South African	LC	Unlisted
Indicator	Honeyguide, Greater	LC	Unlisted
Lamprotornis nitens	Starling, Cape Glossy	LC	Unlisted
Lanius collaris	Fiscal, Common (Southern)	LC	Unlisted
Mirafra africana	Lark, Rufous-naped	LC	Unlisted
Numida meleagris	Guineafowl, Helmeted	LC	Unlisted
Onychognathus morio	Starling, Red-winged	LC	Unlisted
Passer diffusus	Sparrow, Southern Grey-headed	LC	Unlisted
Passer domesticus	Sparrow, House	LC	Unlisted
Passer melanurus	Sparrow, Cape	LC	Unlisted
Ploceus velatus	Masked-weaver, Southern	LC	Unlisted

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (BLSA, 2017)
Pternistis swainsonii	Spurfowl, Swainson's	LC	Unlisted
Saxicola torquatus	Stonechat, African	LC	Unlisted
Streptopelia capicola	Turtle-dove, Cape	LC	Unlisted
Streptopelia semitorquata	Dove, Red-eyed	LC	Unlisted
Streptopelia senegalensis	Dove, Laughing	LC	Unlisted
Terpsiphone viridis	Paradise-flycatcher, African	LC	Unlisted
Trachyphonus vaillantii	Barbet, Crested	LC	Unlisted
Tricholaema leucomelas	Barbet, Acacia Pied	LC	Unlisted
Turdoides jardineii	Babbler, Arrow-marked	LC	Unlisted
Vanellus armatus	Lapwing, Blacksmith	LC	Unlisted
Vanellus senegallus	Lapwing, African Wattled	LC	Unlisted
Vidua macroura	Whydah, Pin-tailed	LC	Unlisted
* *Alien invasive species*			

Mammals

Ten (10) mammal species were observed or recorded in the project area based on visual tracks and signs. This included 5 rodent species, 1 shrew, an Eastern rock sengi and 2 species of antelope (Table 4-17). The species present in the area are all common. No mammal SCC were recorded during the survey.

Table 4-17: Mammal species observed or deduced to be present in the project area based on tracks and signs during the February 2018 survey.

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (SANBI, 2016)
Aethomys namaquensis	Namaqua rock rat	LC	Unlisted
Cryptomys hottentotus	Common mole-rat	LC	LC
Elephantulus myurus	Eastern rock sengi	LC	LC
Mastomys natalensis	Natal multimammate mouse	LC	LC
Pronolagus saundersiae	Hewitt's red rock rabbit	LC	LC
Rhabdomys pumilio	Xeric four-striped mouse	LC	LC
Steatomys pratensis	Fat mouse	LC	LC
Suncus varilla	Lesser dwarf shrew	LC	LC
Sylvicapra grimmia	Common duiker	LC	LC
Tragelaphus strepsiceros	Kudu	LC	LC

Herpetofauna (reptiles and amphibians)

Two (2) reptile species and 1 amphibian species were observed in the project area during the February 2018 survey (Table 4-18). No herpetofauna species of conservation concern were

recorded. Both observed reptile species are near-endemic. The low species diversity was attributed to the short duration of the survey and the timing of the survey during a period of cold and wet weather. During these periods, reptiles and amphibians reduce their activity and seek shelter in burrows and under rocks.

Table 4-18: Herpetofauna species recorded within the project area during the February 2018 survey.

SPECIES	COMMON NAME	GLOBAL (IUCN, 2018)	REGIONAL (BATES, BRANCH ET AL., 2014)
Agama atra	Southern rock agama	LC	Near-endemic
Pachydactylus vansoni	Van Son's thick-toed gecko	LC	Near-endemic
Sclerophrys capensis	Raucous toad	LC	LC

4.8 Hydrology

4.8.1 Drainage and Catchments

The greater region in which the Newcastle Greenwich project site is located is drained by the Ncandu River which is a secondary perennial channel, being fed by non-perennial tertiary streams. Five (5) sub-catchments were delineated at the Greenwich site and these can be seen in **Figure 4-31**.

The hydraulic characteristics of the delineated sub-catchments are presented in Table 4-19. Catchment characterisation was undertaken in order to evaluate catchment parameters which included the catchment area, hydraulic length, distance to catchment centroid and channel slopes. These parameters were useful in calculating associated peak flows for the sub-catchments.

Table 4-19: Characteristics of the delineated catchments.

CATCHMENTS	AREA	HYDRAULICLENGTH (L)	DISTANCE TO CATCHMENT CENTROID (LC)	SLOPE
	km^2	km	km	(m/m)
SC1	1.69	2.41	1.06	0.101
SC2	0.83	1.214	0.582	0.136
SC3	1.16	2.33	1.26	0.069
SC4	0.54	1.061	0.535	0.041
SC5	1.64	1.72	0.93	0.068

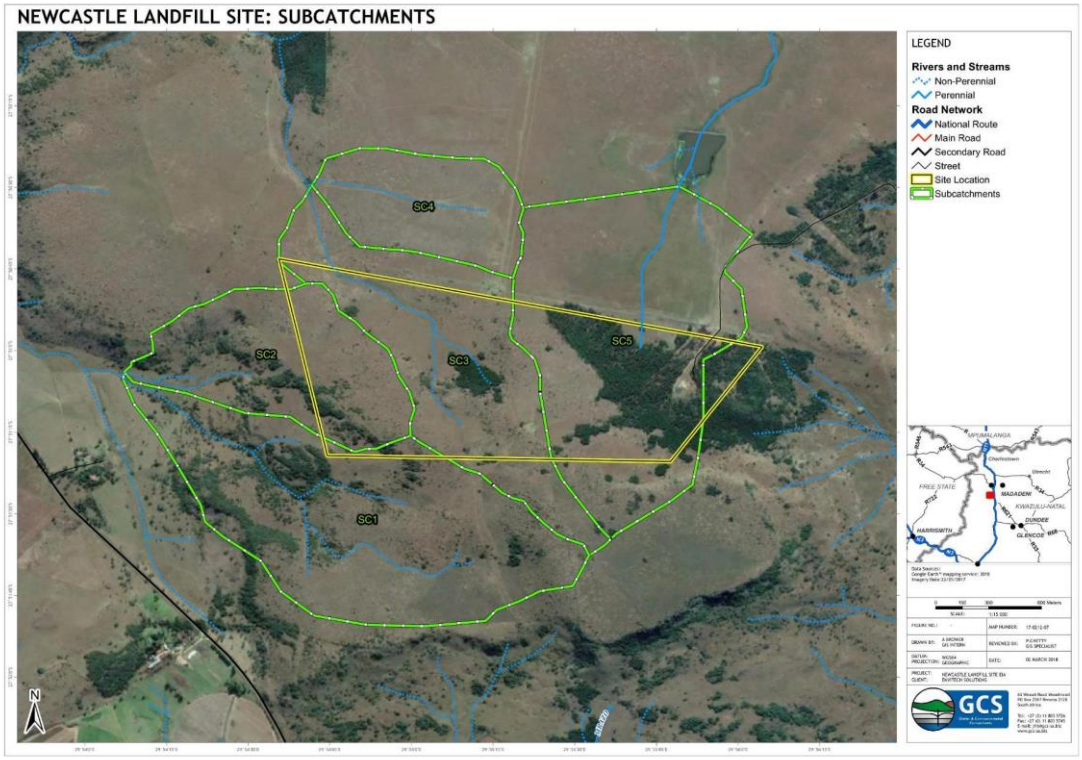


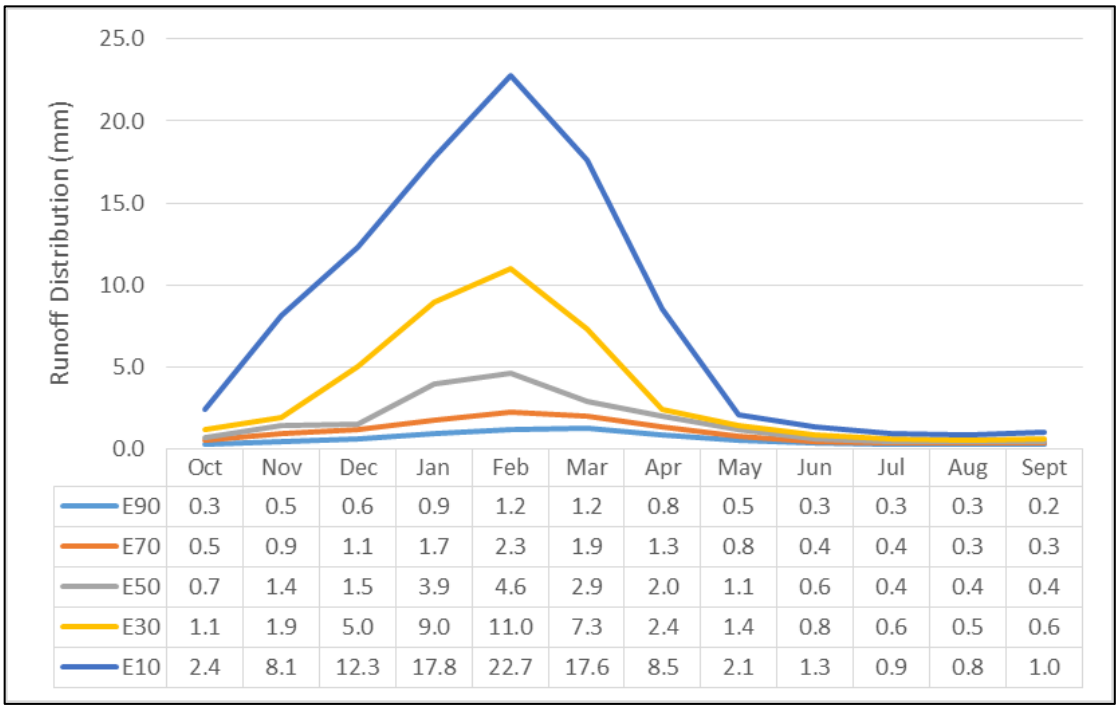
Figure 4-31: Delineated sub-catchments at the site.

4.8.2 Runoff Processes

The combined Mean Annual Runoff (MAR) of quaternaries V31J and V31K where the project site is located is 42.2 mm which accounts for approximately 5% of the MAP. The distribution of this MAR is indicated in Figure 4-32.

4.8.3 Design Rainfall Depths

The design rainfall depths for the proposed Newcastle Greenwich landfill site were calculated using the Design Rainfall software for South Africa (Smithers and Schulze, 2000). The design rainfall depths for the 1:2–year to 1:200-year return periods are presented in **Table 4-20**. These rainfall depths were used as input in calculating flood peak flows for the project site using the Rationale Method Alternative 3 (RM3) as well as for stormwater modelling utilizing the PCSWMM stormwater modelling software.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
E90	0.3	0.5	0.6	0.9	1.2	1.2	0.8	0.5	0.3	0.3	0.3	0.2
E70	0.5	0.9	1.1	1.7	2.3	1.9	1.3	0.8	0.4	0.4	0.3	0.3
E50	0.7	1.4	1.5	3.9	4.6	2.9	2.0	1.1	0.6	0.4	0.4	0.4
E30	1.1	1.9	5.0	9.0	11.0	7.3	2.4	1.4	0.8	0.6	0.5	0.6
E10	2.4	8.1	12.3	17.8	22.7	17.6	8.5	2.1	1.3	0.9	0.8	1.0

Figure 4-32: Runoff distribution for quaternaries V31J and V31K.

Table 4-20: Design rainfall depths for the proposed site.

RETURN PERIOD							
DURATION (minutes/hours)	**2 YEAR**	**5 YEAR**	**10 YEAR**	**20 YEAR**	**50 YEAR**	**100 YEAR**	**200 YEAR**
5 m	12.9	17	19.8	22.7	26.5	29.6	32.7
10 m	17	22.4	26.1	29.9	34.9	38.9	43.1
15 m	20	26.3	30.7	35.1	41.1	45.8	50.6
30 m	25.4	33.4	39	44.6	52.2	58.2	64.3
45 m	29.2	38.5	44.9	51.3	60.1	66.9	74
1 h	32.3	42.5	49.6	56.7	66.3	73.9	81.8
1.5 h	37.1	48.9	57.1	65.2	76.3	85.1	94.1
2 h	41	54	63	72.1	84.3	94	103.9
4 h	48	63.2	73.8	84.3	98.7	110	121.6
6 h	52.6	69.3	80.8	92.4	108.2	120.5	133.3
8 h	56.1	73.9	86.3	98.7	115.4	128.7	142.3
10 h	59	77.8	90.8	103.8	121.4	135.3	149.7
12 h	61.5	81	94.6	108.2	126.6	141	156
16 h	65.7	86.5	101	115.5	135.1	150.5	166.5
20 h	69.1	91	106.2	121.4	142.1	158.4	175.1
24 h	72	94.8	110.7	126.6	148.1	165	182.5

4.8.4 Peak Flows

The flood peak flows for the delineated sub-catchments (**Table 4-21**) were calculated using the RM3, Rational Method Alternative 2 (RM2), Standard Design Flood (SDF) and the Midgley Pitman (MIPI) methods. Generally all 4 methods indicated peak flows of the same order of magnitude which implies these peaks are realistic for the study site. The SDF peak flows were selected for use in Hydrologic Engineering Center's River Analysis System HEC-RAS because they were more conservative than the remaining 3 methods which will ensure infrastructure safety from flood inundation and associated risks.

Table 4-21: Peak flows for sub-catchments at the proposed site.

CATCHMENT	METHOD							
	RM3		RM2		SDF		MIPI	
	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr
	(m^3/s)							
SC1	20.2	27.1	20.3	28.2	36.4	45.8	30.0	37.9
SC2	28.2	37.8	28.9	40.1	25.4	32.0	22.6	28.6
SC3	12.3	16.5	18.8	26.1	23.2	29.2	20.8	26.3
SC4	12.9	17.3	11.4	15.8	13.8	17.3	14.9	18.8
SC5	25.6	34.4	29.8	41.3	37.7	47.4	30.9	39.0

4.8.5 Flood Lines

Flood lines were calculated for 5 non-perennial tributaries of the Ncandu River for flood events of the 1:50-yr and 1:100-year return periods (**Figure 4-33**).

4.8.6 Baseline Surface Water Quality

Two (2) water quality monitoring localities, namely V3H7 and V3R2, were identified for assessment of the baseline surface water quality within the vicinity of the proposed site. Both monitoring localities are situated within the Ncandu River, upstream (V3H7) and downstream (V3R2) of the proposed site. The location of these monitoring points is indicated in **Figure 4-34**.

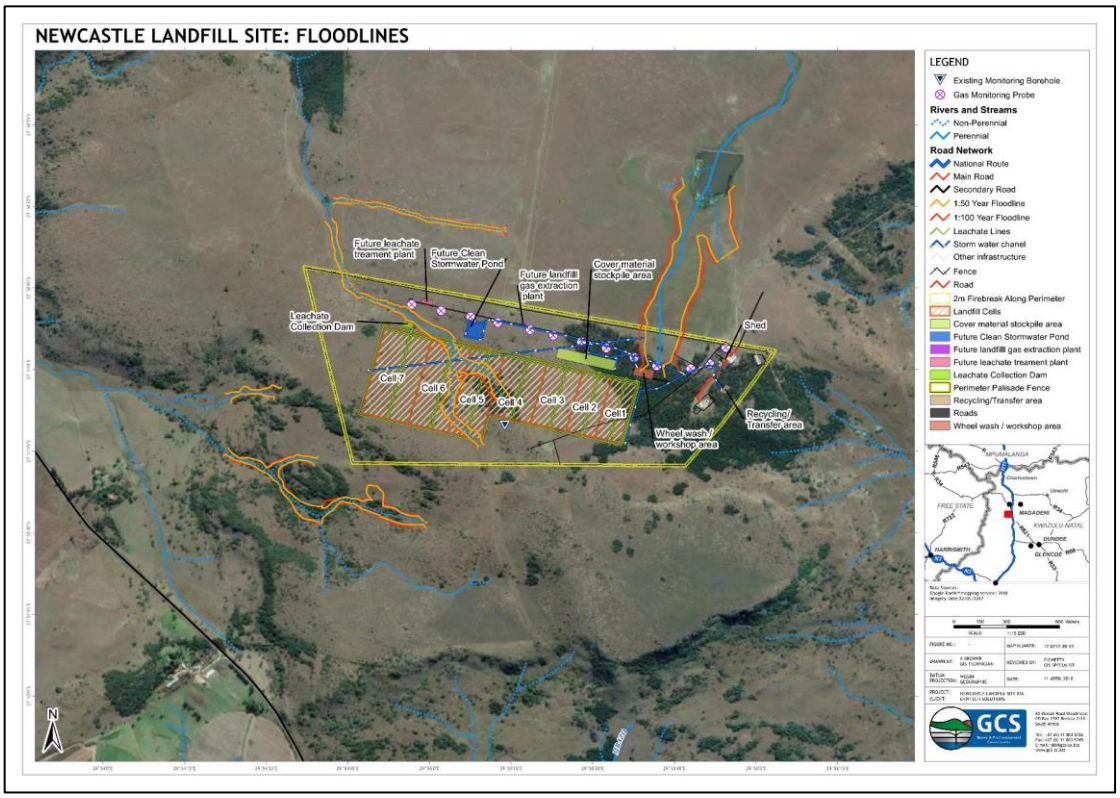


Figure 4-33: 1:50-year and 1:100-year flood lines for the proposed site.

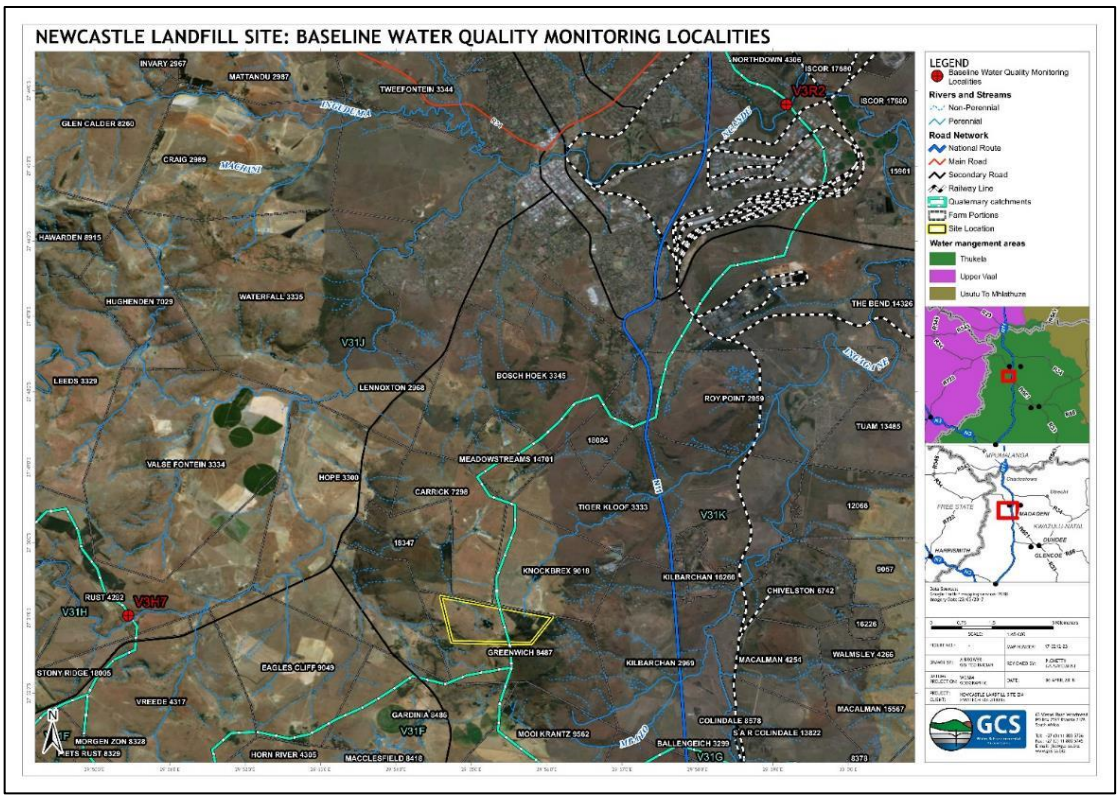


Figure 4-34: Baseline water quality monitoring localities.

Monitoring locality V3H7 indicates satisfactory water quality with neutral pH (average 7.25 pH units) and low Electrical Conductivity (EC) (average 8.58 milliSiemens per metre (mS/m)) values. Low Sulphate (SO_4), low Nitrate (NO_3) and Nitrite (as N) concentrations are also present throughout the monitoring period (1966 - 2017).

Monitoring locality V3R2 also indicates satisfactory water quality with neutral pH (average 7.54 pH units) and low EC (average 20.97 mS/m) values. Low SO_4, low NO_3 and Nitrate (as N) concentrations are also present throughout the monitoring period (1980 - 2017).

When comparing the upstream (V3H7) and downstream (V3R2) monitoring localities the downstream locality does indicate a slight increase in most analysed parameters.

4.9 Geohydrology

4.9.1 Hydrogeological Setting

According to the 1:500 000 hydrogeological map series 2726 Kroonstad (Baran and Jonck, 2000), the underlying aquifer for the proposed site is classified as an intergranular and fractured aquifer with average borehole yields between 0.5 – 2 litres per second (l/s). The aquifer vulnerability and classification maps of South Africa classify the underlying aquifer as a minor aquifer which is considered a moderately vulnerable aquifer system. According to Parsons and Conrad (1998), a minor aquifer system can be defined as fractured or potentially fractured rocks which do not have a high permeability, or other formations of variable permeability. The aquifer extent may be limited and seldom produce large quantities of water. There are no National Groundwater Archive (NGA) boreholes located within a 1 km radius of the site.

4.9.2 Hydrocensus

A hydrocensus was conducted on 16 February 2018. The details of the owners of the properties visited are presented in **Table 4-22**. Six (6) boreholes (HBH1 - HBH6) as well as a spring were identified during the hydrocensus. The locations of these boreholes are presented in **Figure 4-35**. **Table 4-23** and **Table 4-24** provide details on the identified boreholes. Measured groundwater levels ranged from 4.75 - 25.9 meters below ground level (mbgl). HBH5 was in use during the assessment hence the deeper groundwater level.

Table 4-22: Hydrocensus Property Owners.

BOREHOLE ID	CONTACT PERSON	ADDRESS	COMMENT
HBH1	Craig Peterson	RE 1 of Hope 3300	Owners in the area are concerned about the potential contamination that can arise from the landfill as the water source within the area is mainly groundwater.
HBH2	Craig Peterson		
HBH3	Kobus	Portion 4 of Hope 3300	-
HBH4	Kobus		-
HBH5	Lloyd Phillips	Gardinia 8486	Owners in the area are concerned about the potential contamination that can arise from the landfill as the water source within the area is mainly groundwater.
HBH6	Site Manager: Lloyd Phillips	Portion 10 of Hope 3300	

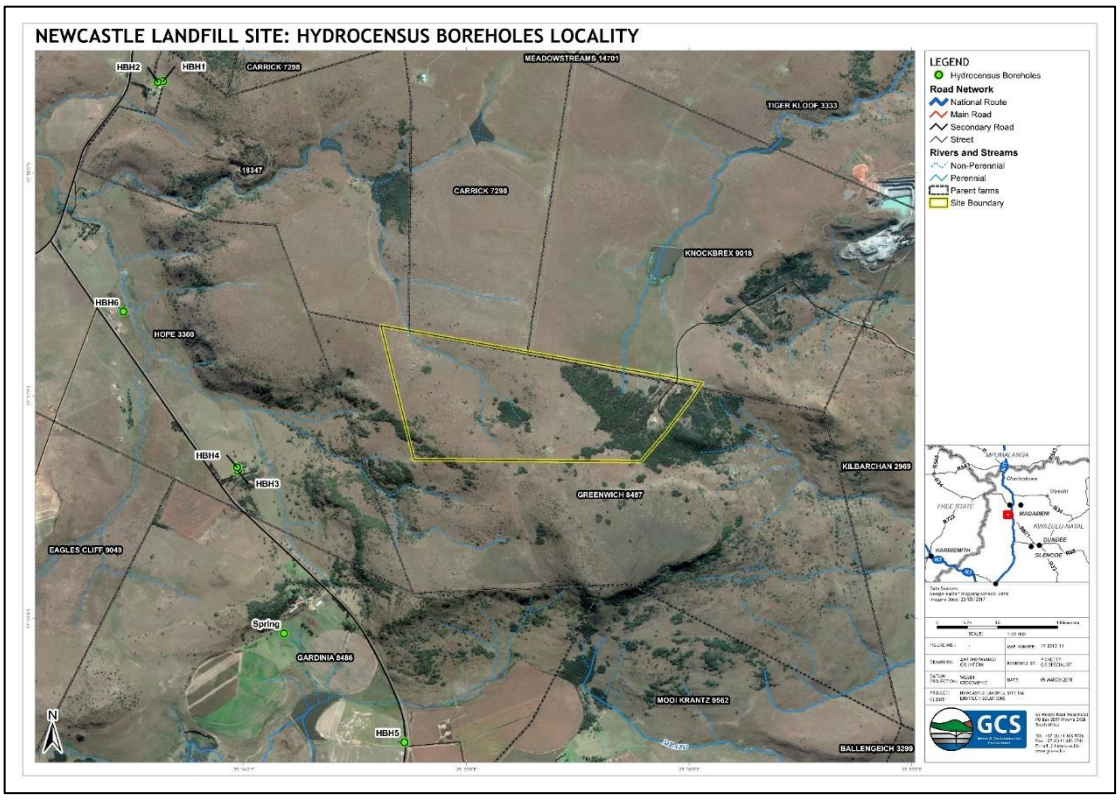


Figure 4-35: Hydrocensus Borehole Locality.

Table 4-23: Hydrocensus Borehole Identification.

ID	LATITUDE	LONGITUDE	COLLAR HEIGHT (m)	WATER LEVEL (mbgl)	DEPTH (m)	COMMENTS
HBH1	-27.826461	29.893983	0.3	4.75	17	Not in use.
HBH2	-27.826531	29.893563	0.1	15.9	Unknown	Sulphur smell and taste.
HBH3	-27.855622	29.899557	0.2	8.2	Unknown	Not in use. Water supplied by Municipality.
HBH4	-27.855353	29.899503	0.2	-	-	Welded closed.
HBH5	-27.875921	29.912022	0.1	25.9	40	Pumping during visit.
HBH6	-27.843702	29.890985	0.1	4.9	30	Slight sulphur smell and taste.
Spring	-27.867783	29.903021	-	0	-	Water flowing from spring is diverted to dam.

Table 4-24: Hydrocensus Borehole Details.

ID	KNOWN YIELD (l/hr)	PUMP TYPE	POWERED BY	RESERVOIR	VOLUME ABSTRACTED (l/day)	APPROXIMATE POPULATION	WATER USED FOR	TASTE AND SMELL
HBH1	<1 000	None	N/A	N/A	N/A	N/A	N/A	N/A
HBH2	5 000	Submersible	Electricity	5 kl JoJo tank	15 000	5	Domestic	Sulphur smell and taste
HBH3	Unknown	Submersible	Electricity	None	N/A	N/A	N/A	N/A
HBH4	Unknown	Mono	Electricity	None	N/A	N/A	N/A	N/A
HBH5	10 000	Submersible	Electricity	10kl JoJo tank	25 000	10	Domestic, cattle watering, crop spraying	Good
HBH6	3 000	Submersible	Electricity	5 kl JoJo tank	5 000	1	Domestic and cattle watering	Slight sulphur smell and taste
Spring	-	-	-	-	-	-	Stock watering	Good

4.9.3 Aquifer Testing

A short duration Constant Rate (CR) test including a recovery test was conducted for BH1, BH2 and BH3. A CR test is a field experiment in which a well is pumped at a controlled rate and water-level response (drawdown) is measured in the pumped well. The response data from the pumping tests are used to estimate the hydraulic properties of aquifers. The aquifer test data was analysed with using Aqtesolv v4.5 (AQuifer TEst SOLVer) software and the Cooper-Jacob method was used to determine the Transmissivity (T) based on the drawdown and recovery data. The results of the tests are presented in **Table 4-25**.

Table 4-25: Aquifer Test Details.

ID	TEST DURATION (hr)	RECOVERY DURATION (hr)	RECOVERY %	EARLY T (m^2/d)	LATE T (m^2/d)	RECOVERY T (m^2/d)
BH1	1.5	1	100	0.236	0.9078	0.06188
BH2	1.9	1.5	97	1.504	0.1065	0.1642
BH3	2.1	2	97	1.944	0.7113	0.3838

Transmissivity (T) is defined as the measure of the ease with which water will pass through the earth's material, expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer. It therefore indicates the ease with which water moves through the subsurface and is used to calculate rates of groundwater movement.

The recovery transmissivity in the tested boreholes was calculated to be between 0.06188 - 0.3838 square metres per day (m^2/day). These are considered low transmissivity values representing fine sand to silt and would impede the flow and dispersion of contamination if it were present.

4.9.4 Groundwater Flow Direction

A groundwater flow direction map was constructed using data obtained during the hydrocensus and monitoring borehole installation. The groundwater flow within the study area is in a general north westerly and north easterly direction (Figure 4-36).

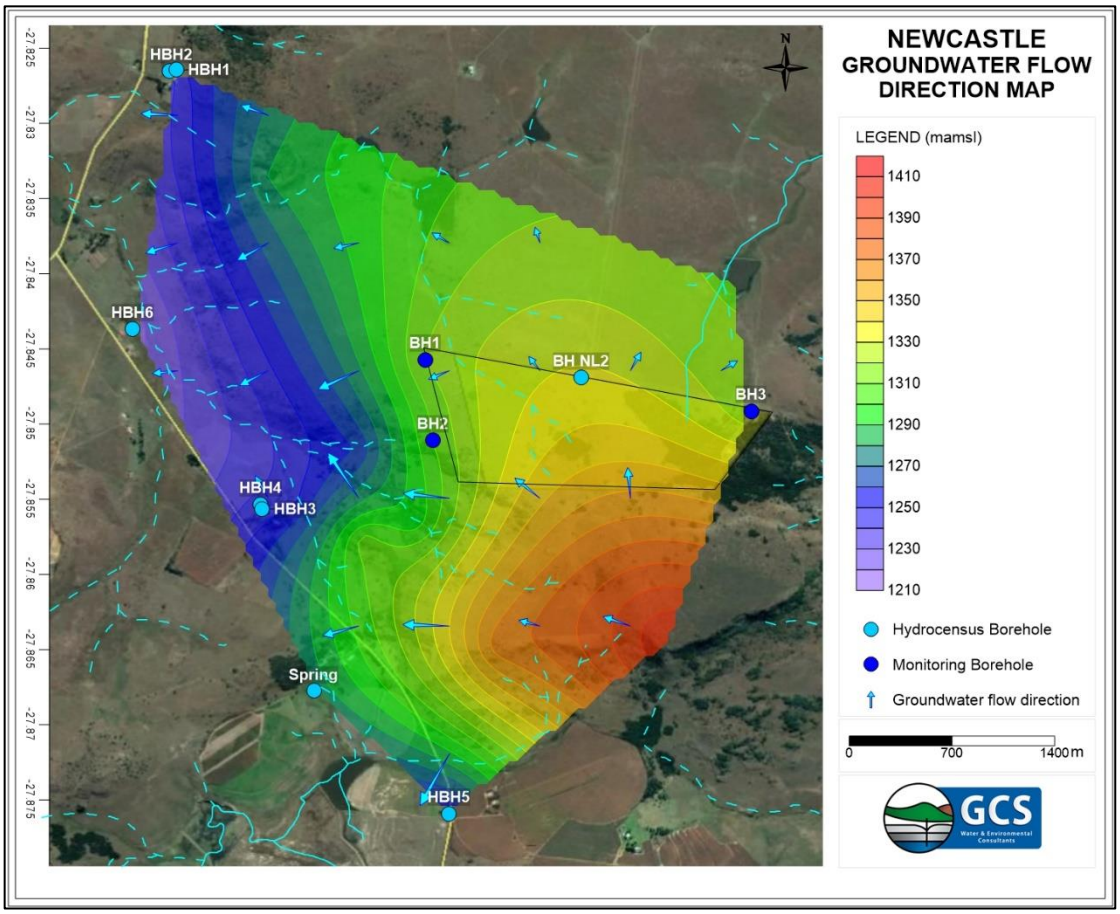


Figure 4-36: Groundwater Flow Direction.

4.9.5 Baseline Groundwater Quality

One existing (BH NL2) and the three (3) newly installed boreholes (BH1, BH2 and BH3) were inspected (**Figure 4-37**). BH NL1 was inaccessible. Static groundwater levels ranged from 0.49 - 14.35 mbgl and well depth was measured between 19 - 59.66 mbgl as presented in **Table 4-26**. Clear and odourless water was noted at BH1, BH2 and BH3, whilst water from BH LN2 was observed to have an oily substance present.

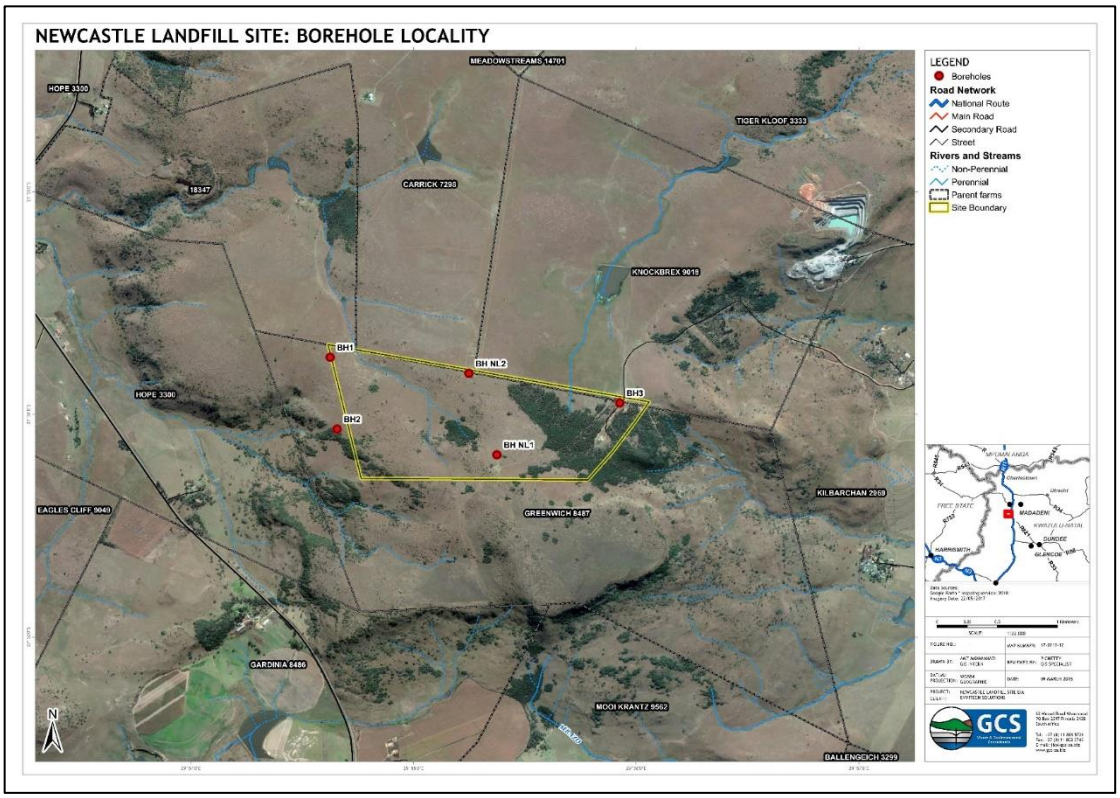


Figure 4-37: Borehole Locality.

Table 4-26: Monitoring Borehole Details.

ID	LATITUDE	LONGITUDE	DEPTH (m)	COLLAR HEIGHT (m)	WATER LEVEL (mbgl)	ELEVATION (mamsl)	WATER ELEVATION (mamsl)
BH1	-27.845718	29.910433	19	1.01	0.49	1342.135	1341.645
BH2	-27.851088	29.910946	25.4	0.6	12.9	1343.475	1330.575
BH3	-27.849137	29.932111	31	0.6	14.35	1357.217	1342.867
BH NL2	-27.846924	29.920811	59.66	0.6	10.22	1372.494	1362.274

Groundwater samples were collected from BH1, BH2, BH3 and BH NL2 and were submitted to an accredited laboratory services for analysis. The laboratory results, compared to South African National Standard (SANS) for Drinking Water Purposes (SANS 241-1:2015) (SABS, 2015), are presented in **Table 4-27**.

Table 4-27: Laboratory Analysis Results.

ANALYSES (mg/l) UNLESS SPECIFIED OTHERWISE	SANS 241-1:2015	SAMPLE IDENTIFICATION			
		BH1	BH2	BH3	BH NL 2
General Parameters					
pH - Value at 25°C	≥ 5 to ≤ 9.7	6.15	8.04	7.27	7.26
Electrical Conductivity in mS/cm	≤ 1 700	57.4	120.1	186.3	476
Total Dissolved Solids	≤ 1 200	50	60	160	201
Bicarbonate, HCO3	NS	20	72	82	96
P-Alk as CaCO3	NS	<0.6	<0.6	<0.6	<0.6
M-Alk as CaCO3	NS	16	59	67	78
Colour in PtCo Units *	≤ 15	26	836	209	24
Turbidity in N.T.U	Operational ≤ 1 Aesthetic ≤ 5	20.4	1320	3920	10.57
Anions					
Fluoride as F	≤ 1.5	<0.4	<0.4	<0.4	<0.4
Chloride as Cl	≤ 300	<1	<1	7.9	117.7
Nitrite, NO2	≤ 0.9	<2	<2	<2	<2
Nitrate, NO3	≤ 11	<2	<2	8.3	5.6
Combined NO3 and NO2	≤ 1	>0.45	<0.45	1.9	1.3
Sulphate as SO_4	Acute health ≤ 500 Aesthetic ≤ 250	<4	<4	7.3	7.5
Cations and metals					
Aluminium as Al	≤ 0.3	0.16	2.41	1.69	0.06
Arsenic as	≤ 0.01	<1	<1	<1	<1
Boron as B	≤ 2.4	0.27	0.23	0.21	0.2
Barium as Ba	≤ 0.7	<0.05	<0.05	<0.05	<0.05
Calcium as Ca	NS	3.2	13.1	16.2	19.8
Cadmium as Cd	≤ 0.003	<0.05	<0.05	<0.05	<0.05
Total Chromium as Cr	≤ 0.05	<0.05	<0.05	<0.05	<0.05
Copper as Cu	≤ 2	<0.05	<0.05	<0.05	0.06
Iron as Fe	Chronic health ≤ 2 Aesthetic ≤ 0.3	0.37	4.74	0.89	0.05
Potassium as K	NS	0.1	1.1	1.9	1.7
Magnesium as Mg	NS	1.5	8	8	7.3
Manganese as Mn	Chronic health ≤ 0.4 Aesthetic ≤ 0.1	<0.05	0.14	0.06	<0.05
Sodium as Na	≤ 200	1.9	3.9	10.8	61.9

ANALYSES (mg/l) UNLESS SPECIFIED OTHERWISE	SANS 241-1:2015	SAMPLE IDENTIFICATION			
		BH1	BH2	BH3	BH NL 2
Nickel as Ni	**≤ 0.07**	<0.05	<0.05	<0.05	<0.05
Lead as Pb	**≤ 0.01**	<1	<1	<1	<1
Antimony as Sb	**≤ 0.02**	<1	<1	<1	<1
Selenium as Se	**≤ 0.04**	<1	<1	<1	<1
Zinc as Zn	**≤ 5**	<0.05	<0.05	<0.05	<0.05
*Exceeds SANS 241-1:2015 drinking water quality standard					

4.9.5.1 General Parameters

Colour and turbidity detected in all boreholes exceeded the SANS standards. Turbidity is a measure of the light-scattering ability of water and is indicative of the concentration of suspended matter (inorganic matter, such as clay and soil particles, and organic matter) in water (DWAF, 1996). The elevated turbidity in the newly installed boreholes are most likely associated with disturbance during drilling and is not representative of groundwater conditions.

4.9.5.2 Anions

Combined Nitrate (NO_3) and Nitrite (NO_2) detected in BH3 and BH NL2 marginally exceeded the SANS standard of 1 milligram per litre (mg/l). The remaining anions were compliant with the SANS standards.

4.9.5.3 Cations and Metals

The Aluminium (Al) concentration of 2.41 mg/l and 1.69 mg/l detected in BH2 and BH3, respectively, exceeded the SANS standard of 0.3 mg/l. The Iron (Fe) concentrations of 0.37 mg/l and 0.89 mg/l detected in BH1 and BH3 exceeded the aesthetic SANS standard, however were below the chorionic health SANS standard of 2 mg/l. Fe detected in BH2 however exceeded the chronic health standard. A Manganese (Mn) concentration of 0.14 mg/l was detected in BH2 and exceeded the aesthetic standard of 0.1 mg/l, however was below the chronic standard of 0.4 mg/l.

4.10 Heritage

The cultural heritage baseline description considers the predominant landscape based on the identified heritage resources within the regional and local study area. Table 4-28 presents the broad timeframes for the major periods of the past in South Africa.

Table 4-28: Archaeological periods in South Africa (adapted from Esterhuysen & Smith, 2007).

The Stone Age	Early Stone Age (ESA)	2 million years ago (mya) to 250 thousand years ago (kya)
	Middle Stone Age (MSA)	250 kya to 20 kya
	Later Stone Age (LSA)	20 kya to 500 Common Era[1] (CE)
Farming Communities	Early Farming communities (EFC)	500 to 1400 CE
	Late Farming Communities (LFC)	1100 to 1800 CE
Historical Period	-	1500 CE to 1994 (Behrens & Swanepoel, 2008)

In southern Africa, the last 500 years represents a formative period that is marked by enormous internal economic invention and political experimentation that shaped the cultural contours and categories of modern identities outside of European contact. This period is currently not well documented, but is being explored through the 500 year initiative (Swanepoel, Esterhuysen, & Bonner, 2008).

4.10.1 Geological context and palaeontological sensitivity

KwaZulu-Natal is underlain by the Main Karoo Basin and lithostratigraphic units associated with the Karoo Supergroup (Table 4-29). The Main Karoo Basin dates to the Late Carboniferous to Middle Jurassic periods (approximately 320 to 145 mya) and constitutes a retro-arc foreland basin. As described by Johnson *et al* (Sedimentary Rocks of the Karoo Supergroup, 2006), this is because of:

- The thick flysch-molasse succession which wedges out northwards over the adjacent craton;
- The Main Karoo Basin's position behind an inferred magmatic arc; and
- The associated fold thrust belt produced by the northward subduction of oceanic lithosphere located south of the arc.

[1] Common Era (CE) refers to the same period as *Anno Domini* ("In the year of our Lord", referred to as AD): i.e. the time after the accepted year of the birth of Jesus Christ and which forms the basis of the Julian and Gregorian calendars. Years before this time are referred to as 'Before Christ' (BC) or, here, BCE (Before Common Era).

Table 4-29: Geological setting and fossil heritage of the site-specific study area within the regional study area.

EON	ERA	PERIOD	MYA	LITHOSTRATIGRAPHIC UNITS			SIGNIFICANCE	FOSSILS
				SUPERGROUP	GROUP	FORMATION		
Phanerozoic	Mesozoic	Jurassic	145			Karoo dolerites	Negligible	None
	Palaeozoic	Permian	300	Karoo	Ecca	Vryheid	Very High	Abundant fossils of Glossopteris and other plants, including lycopods, rare ferns and horsetails, abundant glossopterids, cordaitaleans, conifers and ginkgoaleans. Fossil wood is rare, but does occur. Diverse palynomorphs. Abundant, low-diversity trace fossils, rare insects, possible conchostracans, non-marine bivalves and fish scales also occur. The reptile Mesosaurus has been found in the southern part of the Karoo Basin.

The basin was subsequently sedimented, forming what is collectively known as the Karoo Supergroup (Johnson, et al., 2006). These sediments cover approximately 700 000 km^2, including the site-specific study area. The Karoo Supergroup is known for its extensive dolerite dykes and sills among the sediments, which include terrestrial vertebrate fossils, distinctive plant fossil assemblages and thick glacial deposits (Johnson, Van Vuuren, Hegenberger, Key, & Shoko, 1996; Sedimentary Rocks of the Karoo Supergroup, 2006). Figure 4-38 illustrates the extent of the Karoo basins and the envisaged plate tectonic setting of the basin in the Late Triassic.

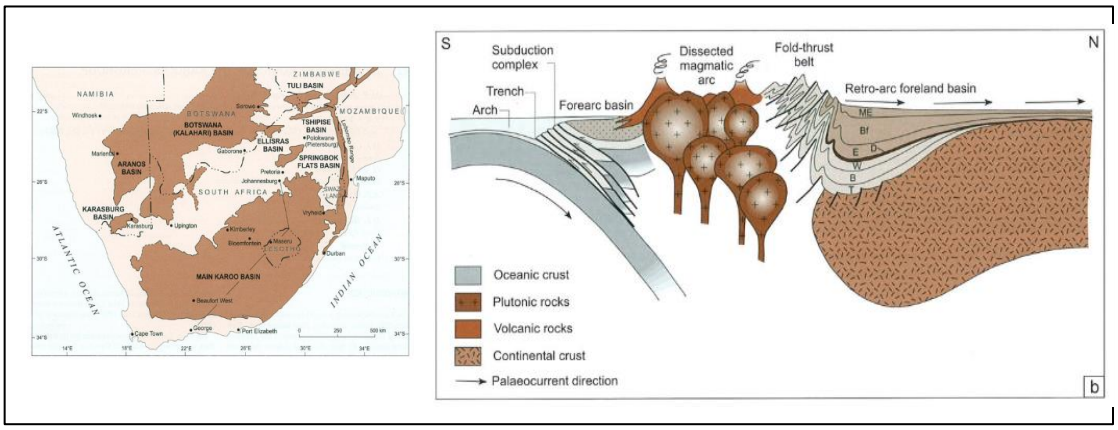


Figure 4-38: Location and envisaged plate tectonic setting of the Main Karoo Basin during the Late Triassic. E = Ecca Group (adapted from Johanson, *et al*., 2006)

The Karoo Supergroup includes the Dwyka, Ecca and Beaufort Groups. Of relevance to this region is the Ecca Group which dates to the Permian Period. The Ecca Group overlies the Dwyka Group and is the most palaeontologically-sensitive layer of the Karoo Supergroup.

The Ecca Group is represented within the regional study area by the Vryheid Formation. These layers feature shales, sandstones and mudstones as well as coal and were deposited approximately 180 mya in a deltic environment (Bamford, 2016). Coal is formed through the compression and alteration by heat of plant matter; alteration happens to such an extent that potential plant fossil remains are no longer recognisable. The potential for the preservation of plant fossils lies in the shales between the coal horizons, were very good examples of these fossils may occur (Bamford, 2014; 2016). The sandstone surface outcrops may also preserve fossil plants, to a lesser extent. Common fossil plants that could be expected within the Vryheid Formation include *Glossopteris* leaves, roots and inflorescences; and *Calamites* stems. Coal deposits can potentially also include fossils of mammal-like reptiles and mammals but these are however, rarely, if ever, preserved with plant fossils (Bamford, 2012; 2016).

The Karoo dolerites are also represented within the regional study area. These are intrusive diatremes classified as plutonic igneous rocks. These features include no fossiliferous material and their palaeo-sensitivity is negligible (Rubidge, 2013a; 2013b; SAHRA, 2013; 2017).

4.10.1.1 Regional Cultural Heritage Resources

The potential palaeontological sensitivity of the *Vryheid Formation* notwithstanding, the cultural heritage baseline description considers the predominant landscape based on the identified heritage resources within the greater study area. A total of 44 heritage resources were recorded within the regional, local and site-specific study areas. These resources comprised resources associated with the Farming Community period, the Historical Period and a single rock art site associated with the Late Stone Age Period. Burial grounds and graves comprise the dominant category of tangible resources recorded in the regional study area (75% of the recorded heritage resources).

To provide the reader with context and assist in identifying preliminary risks and impacts to the heritage resources, this section presents a cultural heritage baseline description that describes the archaeological periods relevant to the regional study area.

The Stone Age Period

The Stone Age in South Africa comprises three broad periods, which are determined according to the lithic tools and material culture produced by the various hominid species through times. These periods are:

- The Early Stone Age (ESA);
- The Middle Stone Age (MSA); and
- The Late Stone Age (LSA).

The ESA dates between approximately 2 mya and 250 kya and is comprised predominantly of large hand axes and cleavers made of coarse-grained material (Esterhuysen & Smith, 2007). The hominids associated with the ESA include *Australopithecus* and early *Homo* species.

The MSA dates between approximately 250 to 20 kya. Early MSA stone tool industries include high proportions of blades which have been minimally modified and which have been made using the Levallois technique (Clark, 1982; Deacon & Deacon, 1999). Bone tools, ochre, beads and pendants appear in the archaeological record at this time and lithics are generally made using good quality raw materials. Archaic *H. sapiens* and early anatomically-modern *H. sapiens* are generally associated with the MSA.

Stone tools in the LSA are specialised (specific tools have been created for specific functions) (Mitchell, 2002). LSA assemblages include diagnostic tools such as microlithic scrapers and segments and bone points are also included in these collections. This period dates between 20 kya and 500 CE (i.e. the historical period). The LSA is associated with anatomically and behaviourally modern *H. sapiens sapiens*. LSA sites are usually open and are poorly preserved; this speaks to the nomadic nature of hunter-gatherers. In southern Africa, the LSA is specifically associated with hunter-gatherer groups such as the San (Mitchell, 2002; Makhura, 2007). The LSA is further defined by evidence of ritual practices and complex societies, including rock art (Deacon & Deacon, 1999).

The Farming Community Period

In southern Africa, the Stone Age is followed by the Farming Community period. The farming community period correlates to the movements of Bantu-speaking agro-pastoralists moving into southern Africa (Makhura, 2007). The period is divided into two phases:

- The Early Farming Community (EFC), between 200 and 1000 CE; and
- The Late Farming Community (LFC) between 1000 and 1840 CE.

No EFC material was identified in the available literature so this phase will not be considered further in this report. The LFC resources accounted for 13.6% (six records) within the regional study area.

Stonewalling is the most visible indicator of LFC settlements and attests to the complex processes of development and decline over several years (Delius, Maggs, & Schoeman, 2014). Stonewalled settlements are classified into various groups according to their construction technique, coursing height, shape and the internal division of the settlement and the walling (Huffman, 2007). Of relevance to this study are two stonewalled settlement clusters: the *Moor Park* and the *Ntsuanatstsi*. In KwaZulu-Natal, the *Moor Park* settlements are associated with Nguni-speaking people and are characterised by the presence of low hut platforms. These platforms would have supported beehive huts, which would have been located in the residential area behind the cattle kraals, between the 14th and 16 centuries.

Within the site-specific study area, the LFC was represented as:

- Stonewalling (Becker 2008; Prins, 2013; Van Schalkwyk, L. 2015); and
- Sites of low complexity (Becker 2008; Digby Wells 2016).

The Historical Period

The historical period[2] is commonly regarded as the period characterised by contact between Europeans and Bantu-speaking African groups and the written records associated with this interaction. The distinction between these two periods is largely artificial and within the regional study area, there is a large amount of overlap. This section will however consider the historical landscape from the beginning of the 19th Century, as the pre-European history has already been discussed in the preceding sections.

Named after the Duke of Newcastle, the town of Newcastle was established in 1864 and was the fourth town of the Natal Colony (Derwent, 2006). The economy centred on the washing and spinning of wool produced by sheep farmers in the region (Amajuba District Municipality, 2014).

The Transvaal War (*also known as the First Anglo Boer War*) occurred between 1880 and 1881 (South African History, 2014). War erupted in Potchefstroom through tensions caused by Boers who refused to fall under British rule and the British, who were endeavouring to expand their territory. Within the greater study area, Fort Amiel is linked to this event. The fort was built in 1879 by the British. Several battles occurred in the regional study area, including:

- The Battle of Laing's Nek (28 January 1881);
- The Battle of Ingogo (8 February 1881); and
- The Battle of Majuba (27 February 1881).

Coal was discovered in the Newcastle area and, by 1885, coal mining on the farm Kilbarchen and surrounding areas were hosting coal mining activities. Railways and trains were introduced to the area in 1890, in response to the infrastructure requirements of the new coal industry (Amajuba District Municipality, 2014).

Today, many of the places and features associated with historical Newcastle and the surrounding areas have been declared protected heritage resources (AMAFA, 2017). These resources include historical built environment resources and resources associated with the above-mentioned Transvaal War.

Within the site-specific study area, the historical period includes three resources and burial grounds and graves, which accounts for 33 records, or 75% of the identified heritage resources. The historical period is represented by:

[2] In southern Africa, the last 500 years represents a formative period that is marked by enormous internal economic invention and political experimentation that shaped the cultural contours and categories of modern identities outside of European contact. This period is currently not well documented, but is being explored through the 500 year initiative (Swanepoel, et al., 2008).

- Historical built environment (Digby Wells 2016);
- Resources associated with battlefields, in this case a Boer campsite (Becker 2008); and
- Burial grounds of graves, from single graves to burial grounds including less than one hundred graves (Becker 2008; Prins 2013; Digby Wells 2016). The size of most of the burial grounds (i.e. number of graves) was not recorded.

4.10.1.2 In-field Cultural Heritage Assessment

Table 4-30 describes the heritage resources that were identified during the survey. These resources are illustrated in Figure 4-39. No historical structures or graves were recorded.

Table 4-30: Heritage Resources identified through the pre-disturbance survey.

SITE NAME	LATITUDE	LONGITUDE	DESCRIPTION
7654/LFC-001	27°51'19.73" S	29°55'32.4" E	Stonewalling in a circle of approximately 9 to 10 m in diameter. The wall is approximately 0.5 m at its tallest. While there is very little vegetation growing inside the stonewalled circle, trees are growing amongst the walls and the vegetation outside the circle is tall and overgrown. This feature is positioned at the base of a small slope.
7654/LFC-002	27°51'17.72" S	29°55'26.99" E	A collection of stones that could represent collapsed stone walling and/or a stone terrace. This stone feature is poorly defined, but does appear to be associated with the LFC. The site extends up to point LFC-002a in loosely concentric arcs up the slope.
	27°51'18.55" S	29°55'27.33" E	

Figure 4-39: Examples of identified heritage resources (A: LFC-001; B and C: LFC-002).

Two buildings which may potentially be afforded general protection under Section 34 of the NHRA and Section 33 under the KZNHA (i.e. buildings which may potentially be older than sixty years) were identified on the historical imagery. Figure 4-40 shows these two buildings as well as the identified heritage resources on the historical layering. These two potential historical buildings were not verified during the pre-disturbance survey and they appear to have been demolished at some point. A sheep and goat pen and two smaller, more recent houses now stand at the GPS co-ordinates indicated in the historical layering. Therefore no historical buildings were identified during the survey.

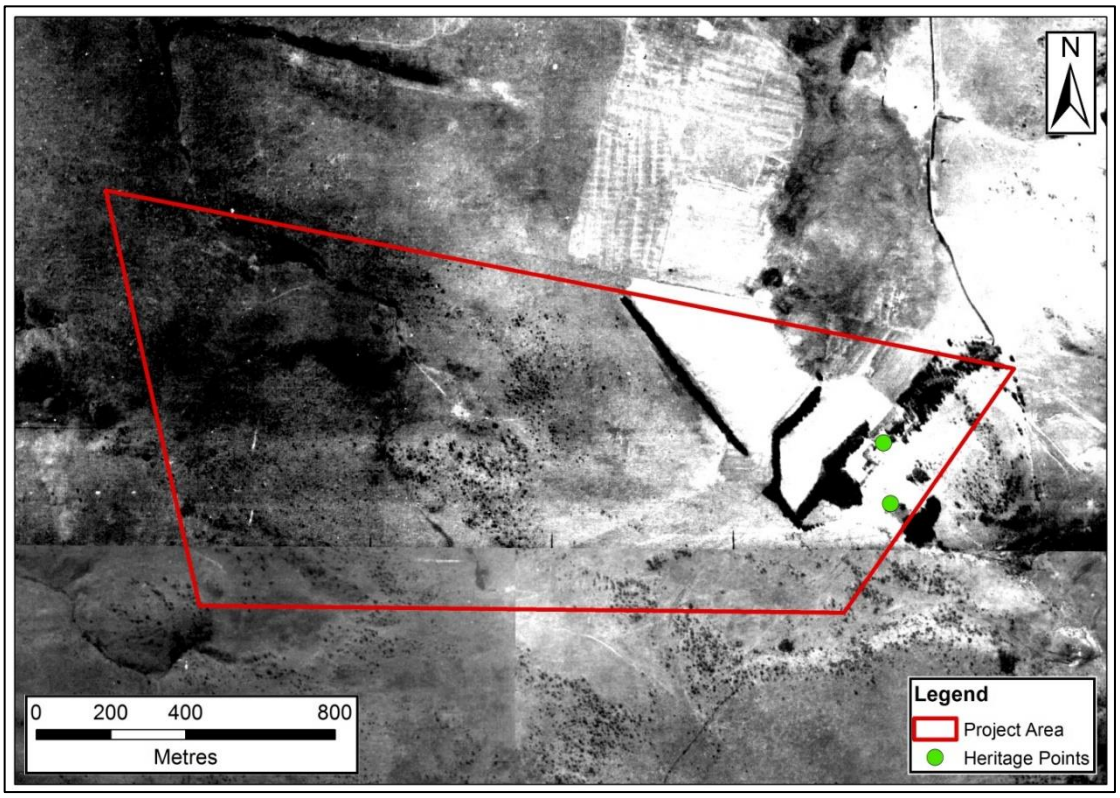


Figure 4-40: Historical imagery of the site-specific study area (demarcated in red).

4.11 Traffic

A site visit was conducted on Tuesday, 20 February 2018. The site visit focused on observing the general road network layout, road conditions, modes of transport available in the area, traffic safety and some land use aspects that were relevant to this study.

4.11.1 Baseline Assessment

Traffic Conditions

A smooth flow of traffic was observed on the road network that is within close proximity of the proposed development. At the time of the site visit, the possibly affected major roads; the N11 and the R34 were observed to have relatively low traffic volumes. On the proposed access route, however, no vehicles were observed.

Non-motorised Transport and Public Transport

The land-use around the proposed development is mainly a sparsely populated residential area called Kilbarchan and a mine located approximately 1 km north of the proposed landfill site. On the section of the N11 close to the proposed landfill and along the access route, there were no public transport or Non-motorised Transport (NMT) facilities observed

Road Condition and Road Safety

Most of the road network surrounding the proposed landfill was in a good condition – with visibly clear the road marking, road signs and a good pavement surface. At the access intersection (Road A/N11), Road A is also in a fairly good condition – paved with two lanes (3 meters wide) –One lane per direction. At approximately 0.3 km away from the access intersection, the road is deteriorated and the road-width keeps decreasing. On Road A, approximately 1.8 km before the access point of the proposed landfill site, the road passes through a small residential area. At that point, the road is only one lane – serving traffic from the eastbound and westbound directions. Table 4-31 shows the condition of the access road (Road A).

Table 4-31: Condition of Road A.

DESCRIPTION	PHOTOGRAPH
The condition of the Road A closer to the N11	
The condition of the Road A approximately 1 km west of the N11	
The condition of the Road A approximately 1.5 km west of the N11	

DESCRIPTION	PHOTOGRAPH
The condition of the Road A at the access gate to the property to be developed.	
Road A going through a residential area	
The condition of Road A between the residential area	

4.11.2 In-Field Traffic Survey

On Thursday, 22 February 2018, a traffic survey was conducted at the selected intersections surrounding the proposed site to determine the existing traffic volumes. The light vehicles, heavy vehicles (typically 2-4 axels) and very heavy vehicles (typically 5 and more axels) were all counted. The weekday morning (AM) and evening (PM) peak hour were determined based on the highest traffic volumes registered during the morning and afternoon periods respectively.

Existing External Road Network

The existing surrounding roads that might be impacted by the traffic generated by the proposed Newcastle Landfill site, are described herewith.

- N11
  N11 is a Class 1 paved road with two lanes – one lane per direction. The road has mainly mobility function and a low accessibility function. In the vicinity of the proposed development, this road carries traffic volumes, in order of 700 vehicles (both directions) during the weekday AM and PM peak hours respectively. This road will be used by most of the vehicles transporting the waste materials from Newcastle to the landfill. Access (Road A) to the proposed Newcastle Landfill will also be provided off the N11 approximately 7 km from the N11/R34 intersection.
- R34
  R34 is a Class 2 paved road with two lanes per direction. The road performs a mobility function with some accessibility function. The road is located to the north of the proposed development. The road generally carries low traffic volumes (approximately 250 vehicles during the most critical peak hour).
- Road A (Access to the proposed Newcastle Landfill site)
  Road A is an unnamed class 4 road with two lanes – one lane per direction. The road performs an accessibility function only. The road is located to the east of the proposed Newcastle Landfill. Currently, the road carries very low traffic volumes (Less than 5 vehicles during the most critical peak hour).
- Other
  Two other unnamed roads will be affected by the traffic from the development. For the purpose of this report, these roads were labelled as Road B and Road C.

Figure 4-41 shows the surface condition along the N11, Figure 4-42 shows the surface condition of the R34, and Figure 4-43 shows the surface condition of the Road A.

Figure 4-41: The N11.

Figure 4-42: The R34.

Figure 4-43: The Access Road (Road A).

In order to assess the transportation aspects related to the proposed Newcastle Landfill activities an evaluation of the worst traffic scenarios was undertaken. The scenarios considered are defined as follows:

- **Scenario 1: No-Go Option (2018 Existing AM and PM Peak Hour Traffic Volumes)**
  This refers to the assessment of the existing traffic on the surrounding road network, i.e. the 2018 AM and PM peak hour base year traffic volumes and analysis results. This scenario determined existing intersection operating conditions and road upgrade requirements for the year 2018 AM and PM peak hour traffic volumes based on the existing geometry and intersection control.
- **Scenario 2 – Construction Phase (1 year, 2019 Projected AM and PM Peak Hour Traffic Volumes with development traffic during the construction phase)**
  This refers to the assessment of traffic generated during the construction phase. The construction phase will generate traffic to the surrounding road network through the

construction workforce, and delivery of materials and equipment to site. The developer of the proposed Newcastle Landfill anticipates that the construction phase and its associated provision of the will take place over a period of 12 months (January 2019 to December 2019). A growth rate of 1.5% per annum was applied to the 2018 existing traffic to determine the projected 2019 traffic volumes.

- **Scenario 3 – Operational Phase (2020 – 2026 and beyond, Projected AM and PM Peak Hour Traffic Volumes with development traffic**
  This refers to the assessment of the traffic generated during the first phase of operation of the landfill. It was anticipated that operations of the landfill will commence in 2020 and operate for a period of 6 years per phase. A growth rate of 1.5% per annum was applied to the 2018 existing traffic in order to determine the projected 2026 traffic volumes.

Following the assessment of the scenarios, together with the proposed landfill transport requirements, it was determined that 10 vehicle trips are expected to be generated during a typical weekday AM and PM peak hour of the construction phase and 64 vehicle trips are expected to be generated during a weekday AM and PM peak hour during the operational phase.

The capacity analysis results show that the intersections under investigation as well as the affected external road link are anticipated to operate at acceptable level of service, i.e. the surrounding road network has sufficient capacity to accommodate the future traffic demand generated by the proposed development.

Access to the proposed development will be off the N11 and the following upgrades at the access point and intersection thereof with the access road (Road A) need to be considered:

- The section of the access road (Road A) at the Road A/N11 intersection should be expanded to accommodate the size of the trucks and construction vehicles;
- The access road (Road A) should be upgraded to a 2-lane road, 1-lane per traffic direction, to allow for vehicles going to and from the site; and
- Appropriate road markings and warning signs should be implemented during construction and the operational phases for safety purposes.

4.12 Noise

A noise assessment was carried out on 12 March 2018 during the day and night time periods. The area assessed covered the roads and residential areas in the vicinity of the proposed landfill operations. The residents in the vicinity of the proposed landfill site are exposed to traffic noise, distant traffic noise, and agricultural activity noises, domestic and natural

noises such as insects, wind and animal noises. These existing noise sources forms part of the prevailing environmental ambient noise level for the study area.

Noise or sound is part of our daily exposure to different sources which is part of daily living and some of the sounds which are intrusive such as traffic noise forms part of the ambient noise that people get accustomed to without noticing the higher sound levels. Any person in the workplace or at home is exposed to the noise levels as presented in Table 4-32. These are the average noise levels in the workplace and at home that will mask noise from a source introduced into an area.

Table 4-32: Different noise levels in and around the house and/or workplace.

TYPE OF NOISE	ACTIVITY	DBA
Communication	Whisper	30.0
Communication	Normal Conversation	55.0-65.0
Communication	Shouted Conversation	90.0
Communication	Baby Crying	80.0
Communication	Computer	37.0-45.0
Home/Office	Refrigerator	40.0-43.0
Home/Office	Radio Playing in Background	45.0-50.0
Home/Office	Background Music	50.0
Home/Office	Washing Machine	50.0-75.0
Home/Office	Microwave	55.0-59.0
Home/Office	Clothes Dryer	56.0-58.0
Home/Office	Alarm Clock	60.0-80.0
Home/Office	Vacuum Cleaner	70.0
Home/Office	TV Audio	70.0
Home/Office	Flush Toilet	75.0-85.0
Industry	Industrial activities	85.0-95.0
Home/Office	Ringing Telephone	80.0
Home/Office	Hairdryer	80.0-95.0
Home/Office	Maximum Output of Stereo	100.0-110.0

The time-varying characteristics of environmental noise are described using statistical noise descriptors:

- L_{eq}: The Leq is the constant sound level that would contain the same acoustic energy as the varying sound level, during the same period of time;
- L_{Max}: The instantaneous maximum noise level for a specified period of time; and
- L_{Min}: The instantaneous minimum noise level for a specified period of time.

The World Bank, in the Environmental Health and Safety Regulations, has laid down the following noise level guidelines:

- Residential area – 55.0 A-weighted decibels (dBA) for the daytime and 45.0 dBA for the night time period; and
- Industrial area – 70.0 dBA for the day and night-time periods.

The difference between the actual noise and the ambient noise level and the time of the day and the duration of the activity, will determine how people will respond to sound and what the noise impact will be. In order to evaluate such, there must be uniform guidelines to evaluate each scenario. SANS 10103 of 2008 has laid down sound pressure levels for specific districts and has provided the continuous noise levels per district as given in Table 4-33.

Table 4-33: Recommended noise levels for different districts.

TYPE OF DISTRICT	EQUIVALENT CONTINUOUS RATING LEVEL ($L_{REQ.T}$) FOR AMBIENT NOISE - DBA					
	OUTDOORS			INDOORS, WITH OPEN WINDOWS		
	DAY-NIGHT LRdn	DAYTIME LReqd	NIGHTTIME LReqn	DAY-NIGHT LR.dn	DAYTIME LReq.d	NIGHTTIME LReq.n
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	30
d) Urban districts with some workshops, with business premises and with main roads	60	60	50	50	50	40
e) Central business district	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50
For industrial districts, the $L_{R.dn}$ concept does not necessarily hold. For industries legitimately operating in an industrial district during the entire 24h day/night cycle, $L_{Req.d} = L_{Req.n} = 70$dBA can be considered as typical and normal.						

The response to noise can be classified as follows:

- An increase of 1.0 - 3.0 dBA above ambient noise level will cause no response from the affected community. For a person with normal hearing an increase of 0 - 3.0 dBA will not be noticeable;

- An increase between 1.0 - 10.0 dBA will elicit little to sporadic response. When the difference is more than 5.0 dBA above the ambient noise level a person with normal hearing will start to hear the difference;
- An increase between 5.0 - 15.0 dBA will elicit medium response from the affected community; and
- An increase between 10.0 - 20.0 dBA will elicit strong community reaction.

The noise survey was conducted in terms of the provisions of the Noise Control Regulations, 1994 and SANS 10103 of 2008.

4.12.1 In-field Noise Assessment

The measuring points for the study area were selected to be representative of the prevailing ambient noise levels for the study area and include all the noise sources such as distant traffic and domestic noise. The measuring points and noise receptors are illustrated in Figure 4-44, whilst the physical attributes of each measuring point is provided in Table 4-34.

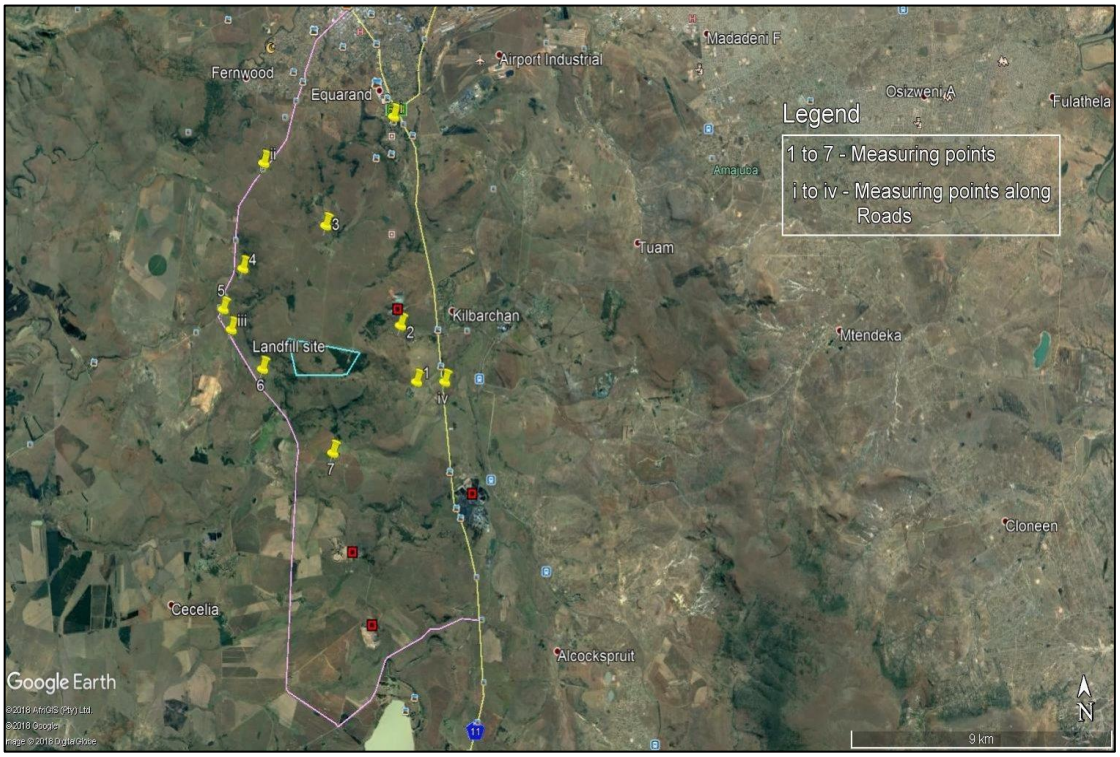


Figure 4-44: Measuring points for the noise survey.

Table 4-34: Measuring points and co-ordinates for the Greenwich tip site study area.

POSITION	LATITUDE	LONGITUDE	REMARKS
1	27° 51.675'	29° 57.157'	Entrance to the residential area some distance from the N11 road. Distant traffic noise.
2	27° 50.744'	29° 56.858'	Along a gravel road in the vicinity of a processing plant and some distance from the N11. Distant mine and traffic noise.
3	27° 49.069'	29° 55.375'	On the plateau in the vicinity of agricultural holdings/residential properties. Distant traffic noise.
4	27° 49.718'	29° 53.613'	At Norseland farm. Distant traffic noise.
5	27° 50.373'	29° 53.168'	At the boundary of the property. Distant traffic noise.
6	27° 51.376'	29° 53.962'	At the boundary of the property. Distant traffic noise.
7	27° 52.789'	29° 55.380'	In the vicinity of the farm house some distance from the feeder road. Far distant traffic noise.
i	27° 47.317'	29° 56.838'	Along the access road to MP3. Traffic noise.
ii	27° 47.999'	29° 54.104'	Along the feeder road. Traffic noise.
iii	27° 50.710'	29° 53.326'	Along the feeder road. Traffic noise.
iv	27° 51.692'	29° 57.741'	Along the feeder road. Traffic noise.

The following is of relevance to the ambient noise measurements:

- The L_{Aeq} was measured over a representative sampling period exceeding 10 minutes at each measuring point;
- The noise survey was carried out during the day (06h00 – 22h00) and night (22h00 – 06h00) periods.

The prevailing ambient noise levels at the different measuring points are given for the day in Table 4-35 and for the night in Table 4-36. These noise levels include all the noise sources currently in the area such as domestic, traffic noise, distant mine noise and natural noise sources. The L_{Eq} is the average noise level for the specific measuring point over a period of time, the L_{Max} is the maximum noise level and the L_{Min} is the minimum noise level in dBA registered during the noise survey for the area.

Table 4-35: Noise levels for the day at the study area.

POSITION	DAY TIME			
	Leq dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	REMARKS
1	42.9	65.3	33.7	Distant traffic noise.
2	39.0	64.6	30.8	Distant traffic noise.

POSITION	DAY TIME			
	Leq dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	REMARKS
3	32.6	64.8	22.0	Natural noises.
4	36.6	57.5	23.7	Distant traffic noise.
5	39.2	65.0	23.8	Distant traffic noise.
6	35.8	55.9	22.2	Distant traffic noise.
7	44.2	64.4	26.2	Distant traffic noise.
i	44.7	64.2	38.7	Distant traffic noise.
ii	52.7	73.9	27.5	Intermittent traffic noise.
iii	42.3	64.0	23.0	Intermittent traffic noise.
iv	61.3	75.2	39.3	Traffic noise.

Table 4-36: Noise levels for the night at the study area.

POSITION	NIGHT TIME			
	Leq dBA	Lmax (Fast) - dBA	Lmin (Fast) - dBA	REMARKS
1	44.2	59.2	36.2	Distant traffic and insect noises.
2	44.2	59.2	36.2	Distant traffic and insect noises.
3	33.9	59.7	28.2	Distant traffic and insect noises.
4	41.7	56.5	34.9	Distant insect noises.
5	44.6	52.5	39.3	Distant insect noises.
6	36.0	64.0	29.0	Distant insect noises.
7	37.5	65.4	30.3	Distant insect noises.
i	42.3	64.3	31.9	Distant insect noises.
ii	41.7	56.5	34.9	Distant insect noises.
iii	34.3	57.3	22.0	Distant insect noises.
iv	58.1	73.5	48.6	Distant insect noises.

The noise reduction can be calculated for direct line of sight and medium ground conditions. Engineering control measures and topography can have an influence on how the noise level is perceived by the occupants of nearby noise sensitive areas.

4.13 Visual

In terms of the Newcastle Municipality IDP (2017-2018), the overarching principles that have been identified include:

- Sustainability;

- Integrated development;
- Equitable access to basic services and public facilities; and
- Efficient and effective delivery of services.

One of the key development areas identified as part of the IDP includes improved access to basic service delivery, which includes water, sanitation, electricity, housing and waste removal and disposal. The proposed development of the landfill site is therefore in-line with the municipalities infrastructural requirements, as the need for the landfill site has already been established and motivated.

Given the hilly and rolling landscapes, with relatively undisturbed surrounding environments, the sense of place for the project area is defined as an area of medium scenic, cultural or historical significance. Figure 4-45 - Figure 4-48 illustrate the sense of place description and provide in-field perspectives of the land use in the region.

Figure 4-45: Taken from Ballengeich train station, 5.7km away, looking towards project site.

Figure 4-46: Taken from Fairleigh (Newcastle Central) 6.3km away looking towards the project site.

Figure 4-47: Taken from corner of boundary road and unnamed road running closest to the site, 2.7km away.

Figure 4-48: Taken from Cecelia settlement AH 6.7km away, looking towards project site.

4.13.1 Sensitive/Critical Receptors

Viewer groups are a collection of viewers that are involved with similar activities and experience similar views of the proposed development. Within the receiving environment, specific visual receptors experience different views of the proposed development. They will be affected due to the alteration of their views and are therefore identified as part of the receiving and affected environment. The visual receptors are grouped according to the similarities in views. The visual receptors included in this study, and which may be affected because of alterations of their views due to the proposed project, are:

- Residents;
- Adjacent Mines/Quarries; and
- Motorists.

4.13.1.1 Residents

In the case of static views, such as views from buildings, the visual relationship between an activity and the landscape will not change. The cone of vision is relatively wide and the viewer tends to scan back and forth across the landscape. Residents of the affected environment are therefore classified as visual receptors of high sensitivity owing to their sustained visual exposure to the proposed development as well as their attentive interest towards their living environment.

4.13.1.2 Motorists

Motorists are generally classified as visual receptors of low sensitivity due to their momentary views and experience of the proposed development. Under normal conditions, views from a moving vehicle are dynamic as the visual relationship between the activities is constantly changing as well as the visual relationship between the activity and the landscape in which they are seen. The view cone for motorists, particularly drivers, is generally narrower than for static viewers. Motorists will therefore show low levels of sensitivity as their attention is focused on the road and their exposure to roadside objects is brief.

For this particular project, tourists would be travelling as motorists and have therefore been included in the motorist receptor categorisation. Tourists are regarded as visual receptors of exceptionally high sensitivity. Their attention is focused towards the landscape which they essentially utilise for enjoyment purposes and appreciation of the quality of the landscape. While there may not be any tourist attractions in proximity to the project area, tourists may use the N11 and boundary street to travel to their destinations.

4.13.1.3 Neighbouring Mines/Quarries

3 significant mines/quarries were identified within a 10 km radius of influence. Afrisam Aggregate Newcastle is situated approximately 2 km to the North East of the propose landfill site, whilst SA Calcium Carbide is an opencast operation, approximately 6.2 km to the South East. An additional quarry was also identified to the south of the proposed landfill site, approximately 5.5 km away.

The critical receptors identified for the proposed Landfill project includes residents (urban settlements and sparsely located homesteads) and motorists. Any tourists have been included under motorists as their interaction with the environment is limited primarily to driving past the proposed landfill en route to tourist attractions in the Kwazulu Natal and Mpumalanga region which includes the Chelmsford Nature Reserve, the Nacandu Nature Reserve, the Vulintaba Country Estate and various accommodation holdings in the Newcastle Urban area.

Using ArcGIS, a buffer operation was conducted across the major infrastructure development features which include the Landfill Cells, Cover Material Stockpile, Stockpiles, the Gas Extraction Plant, the Leachate Treatment Plant and Collection Dam. The output of the buffer operation is used to identify a zone where varying degrees of influence are anticipated based on the description of the generalised topography in the region. The site specific topographical features combined with the proposed projects development plan then refined the Zones of Influence to form segmented areas with varying amounts of visual exposure.

Figure 4-49 shows the identification of receptors based on the categorisation criteria discussed previously. The national landcover dataset distributed from the Department of Environmental Affairs was used to identify the areas described above, along with the additional of points of interest for potential tourism destinations.

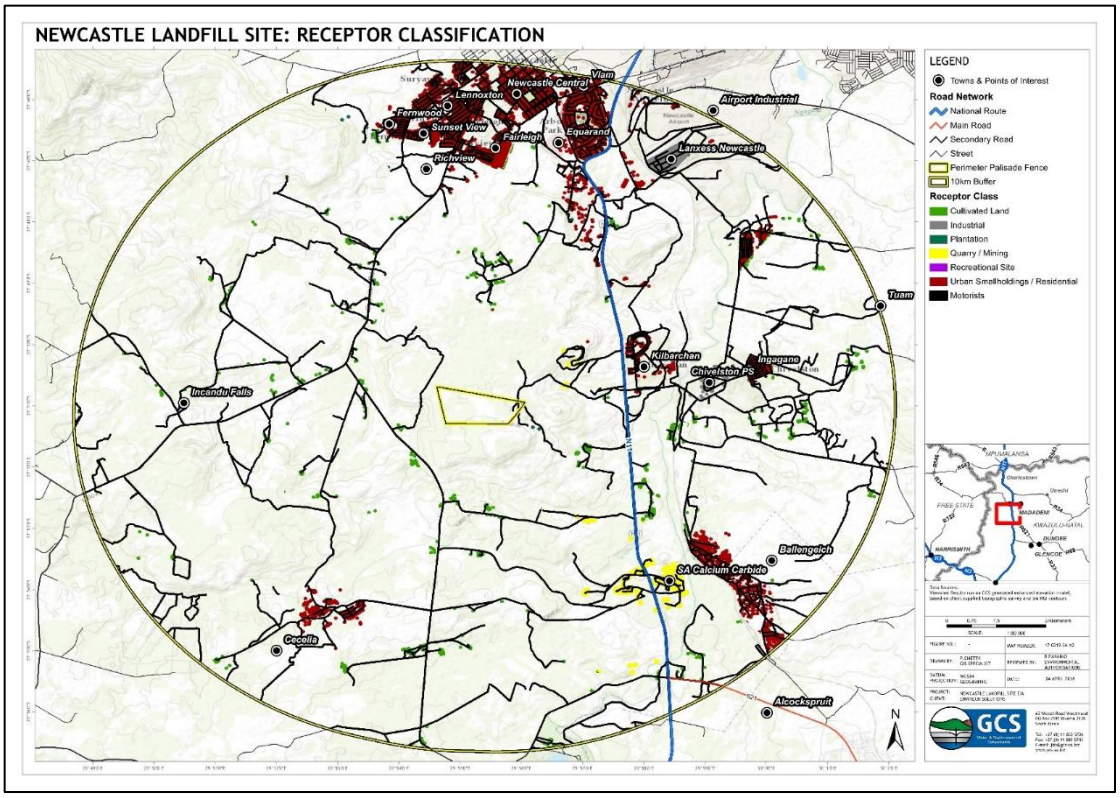


Figure 4-49: Identified Receptors.

Sensitive receptors were identified (towns and regional roads) within a 10 km Potential Zone of Influence (PZI) of the proposed landfill site and are listed in **Table 4-37**.

Table 4-37: List of Potential Sensitive Receptors.

RECEPTOR	RECEPTOR CATEGORY	CLOSEST INFRASTRUCTURE	DISTANCE FROM CLOSEST INFRASTRUCTURE
Dispersed Settlements - Agriculture	Settlement	Landfill Cells	1.1 km
Dispersed Settlements - Agriculture	Settlement	Landfill Cells	1.4 km
Dispersed Settlements - Agriculture	Settlement	Admin Offices, Parking Areas, Weighbridges	2.04 km

RECEPTOR	RECEPTOR CATEGORY	CLOSEST INFRASTRUCTURE	DISTANCE FROM CLOSEST INFRASTRUCTURE
Afrisam Aggregate	Quarry	Admin Offices, Parking Areas, Weighbridges	2.08 km
Dispersed Settlements - Agriculture	Settlement	Landfill Cells	3.11 km
Kibarchan Settlement and Golf Course	Urban Settlement	Admin Offices, Parking Areas, Weighbridges	3.31 km
Chivelston Powerstation	Industrial	Admin Offices, Parking Areas, Weighbridges	4.83 km
Equarand Settlement	Urban Settlement	Cover Material Stockpile Area	6.0 km
Ingagane Settlement	Urban Settlement	Admin Offices, Parking Areas, Weighbridges	6.3 km
Cecelia Settlement	Urban Settlement	Landfill Cells	6.5 km
Incandu Falls	Recreational Facility	Landfill Cells	7.0 km
Fairleigh Settlement	Urban Settlement	Future Leachate Treatment Plant	7.06 km
Sunset View	Urban Settlement	Future Leachate Treatment Plant	7.53 km
Fernwood	Urban Settlement	Future Leachate Treatment Plant	8.0 km
Lennoxton	Urban Settlement	Future Leachate Treatment Plant	8.75 km
Lanxess Newcastle	Industrial	Admin Offices, Parking Areas, Weighbridges	9.01 km
Newcastle Central	Urban Settlement	Future Landfill Gas Extraction Plant	9.29 km

4.14 Social and Economic

4.14.1 Description of the Baseline Environment

Each community is unique as it is shaped by its social networks, cultural influences, values and norms, politics and the infrastructure in the area. The report therefore provides an

overview of the social characteristics of the area in order to determine its current capacity and its ability to manage change.

4.14.1.1 Receiving Environment

Amajuba District Municipality

The Amajuba District Municipality includes three local municipalities, namely the Newcastle, eMadlangeni and Dannhauser Local Municipalities. This Category C municipality is located in the north-western corner of KwaZulu-Natal, bordering on the Free State Province and Limpopo. It is one of the smallest districts in the province, making up only 8% of its geographical area. The main economic sectors are manufacturing (35.0%), community services (22.2%), financial and business services (15.2%), as well as trade (8.6%). The N11 and R34 are the main routes through the area.

Newcastle Local Municipality

The Newcastle Local Municipality is a Category B municipality situated within the Amajuba District. It is located in the inland region on the north-west corner of KwaZulu-Natal, a few kilometres south of the Free State, Mpumalanga and Gauteng Province borders. Newcastle is the third-largest urban centre in KwaZulu-Natal and is categorised as a secondary city. The main economic sectors are manufacturing (27%), general government (17.6%), wholesale and retail trade (14%), business services (10.2%), finance and insurance (6.9%). The proposed Greenwich Landfill site on the farm Greenwich falls within Ward 21 of the NLM (Figure 4-50).

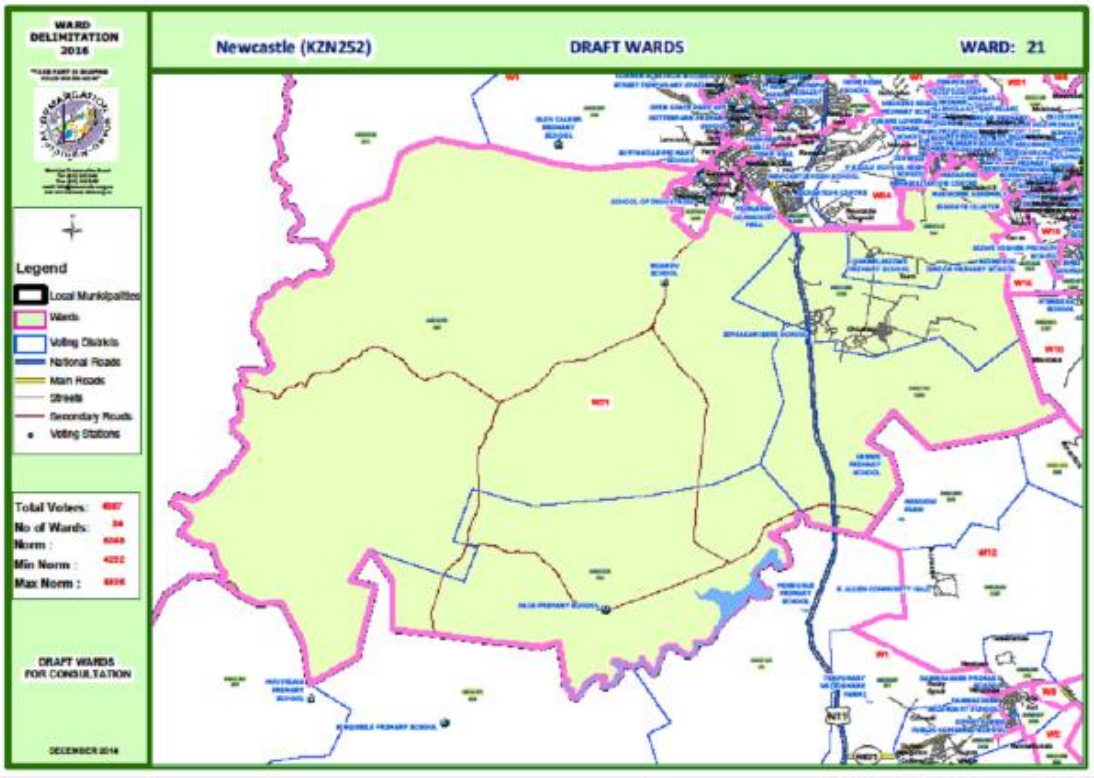


Figure 4-50: Ward 21 of the Newcastle Local Municipality

Socio-Economic Sensitive Areas within the Influence Zone of the Landfill

Socio-economic sensitive areas within a 5 km radius of the proposed landfill site include:

- Hilldrop smallholdings (north of the site);
- A poultry and game farm (Carrick/Hofina) (north of the proposed site);
- Ncandu Combined School (north west of the proposed site);
- A pecan and cattle farm (Norseland) (west of the proposed site);
- Newcastle Boere Vereening hall (south west of the proposed site);
- A dairy farm (Gardenia) (south west of the proposed site);
- A cattle farm (Mooikrans -neighbouring Gardenia to east) (south of the proposed site);
- Lenteson farm (east of the proposed site);
- Indian village (northeast of the proposed site) consisting of approximately 21 families living in houses formerly owned by Eskom; and
- Afrisam aggregate quarry (northeast of the proposed site).

4.14.1.2 Demographic and Socio-Economic Profile

Population and Household Figures

According to the recent Community Survey (2016) conducted by Statistics SA, the population of Newcastle totalled 389 117 people. This indicated a 7.1 % increase (25 881 people) over a 5-year period from the year 2011 (363 236 people). The NLM thus remains the fastest growing municipality within the Amajuba District Municipality and accounts for 73% of the district population.

This means that on average, Newcastle has experienced a 1.42% annual growth rate, which translates to an increase of 5 176 people per year. Newcastle has also experienced a significant increase in the total youth proportion of the population. The growth is mainly occurring mainly in the eastern areas, such as around the Madadeni and Osizweni Townships.

The population growth can be attributed to urbanisation, the natural growth rate, a breakdown in extended families and the in-migration of outsiders to the area due to the decline in employment opportunities within the agricultural sector.

The population of Newcastle is spread unevenly over 34 wards. A high majority of the people (80%) within Newcastle resides within the Newcastle East area, which is predominantly township and semi-rural areas characterised by a general lack of adequate infrastructure.

Furthermore, there has been a 7% increase (6 075) in the number of households within Newcastle from 84 272 in 2011 to 90 347 in 2016, with the average household size remaining constant at 4.3 people per dwelling unit.

In 2011, Ward 21 had 13 865 individual residents with 3 099 households. The average household size is 4.4 which are similar to that of the rest of the NLM area.

Age Structure and Gender

Newcastle's population is relatively young with 46% of the population being younger than 19 years of age, while the age group between 20 and 34 years accounting for 27% of the population (Table 4-38). A similar situation is found in Ward 21 with the majority of the population under the age of 34 years. Collectively the youth in Newcastle (0 – 34 years) makes up 71% of the total population.

Table 4-38: Age structure (2011).

AREA	POPULATION (YEARS)					
	0 - 19	20 - 34	35 - 44	45 - 54	55 - 64	OVER 65
NLM	46%	27%	10%	8%	5%	4%
Ward 21	40%	29%	12%	8%	6%	4%

The large young population profile puts severe pressure on educational facilities, job creation, as well as infrastructure and services. Due to the rapid growth and in-migration into the Newcastle area, this pressure is intensified.

As indicated in Table 4-39, there are slightly more females in the area than males. This gender distribution in the NLM and Ward 21 conforms to the National norm.

Table 4-39: Gender profile (2011).

AREA	MALE	FEMALE
NLM	48%	52%
Ward 21	48%	52%

Population Stability

The majority of the individuals residing in Newcastle are originally from the KwaZulu-Natal Province. The majority of immigrants into Newcastle emanate from the Gauteng Province with the second largest group coming from the Mpumalanga Province and subsequently the Free State. The cause for immigration into Newcastle may largely be attributed to the rapid development of the town as a regional services centre within the Northern KwaZulu-Natal region possibly providing employment opportunities.

Due to the growth rate of the population within Newcastle, one can conclude that the population instability raises various challenges in terms of the provision of infrastructure and services. In this regard it is anticipated that there would be some movement from the Newcastle west and Newcastle east areas towards the southern boundary of Newcastle, just before Kilbarchan. This is based on the proximity of this area to economic opportunities in the form of the surrounding Industrial Area and the Newcastle CBD.

Education and Skills Levels

The NLM has approximately 118 schools including both primary and secondary schools. These include:

- 10 combined schools;
- 12 junior primary schools;

- 7 senior primary schools;
- 55 primary schools; and
- 34 secondary schools.

According to planning standards, the NLM should have between 90 - 120 primary schools to accommodate the population size. There is thus a definite need for additional primary schools. Tertiary education facilities include the former Madadeni College of Education (now used as a College for Further Education and Training), the Majuba FET (Newtech Campus), Majuba College FET, and Majuba FETC (MTC Campus).

As indicated in Table 4-40, progress has been made in terms of education levels in the municipality in general since 2011 as the number of those without schooling has declined from 7.1% in 2011 to 5.8% in 2016. Similar improvements can be seen with regards to those that completed school. Unfortunately less have obtained a tertiary level in 2016 compared to those in 2011.

Table 4-40: Education levels within the NLM (Aged 20+).

YEAR	NO SCHOOLING	COMPLETED SECONDARY	HIGHER EDUCATION
2011	7.1%	33.1%	11.2%
2016	5.8%	38.7%	10.2%

Employment and Poverty

Table 4-41 shows that although the official unemployment rate in Newcastle and local ward 21 declined significantly between 2001 and 2011, the official unemployment rates in these areas were still significantly above the national average in 2011 at 37% and 36% of the labour force respectively. If discouraged job seekers are taken into consideration, local unemployment rates as measured by the expanded definition remained very high in 2011 at close to 50% and above.

Table 4-41: The unemployment rate in the local area, NLM and South Africa.

AREA	OFFICIAL UNEMPLOYMENT			EXPANDED UNEMPLOYMENT		
	2001	2011	2017 Q1	2001	2011	2017 Q1
Ward 21	54%	36%	N/A	56%	50%	N/A
NLM	54%	37%	N/A	57%	51%	N/A
Kwazulu Natal	49%	33%	26%	54%	48%	41%
South Africa	42%	30%	28%	47%	40%	36%

In Kwazulu Natal in general the trends in unemployment (narrow and expanded) declined between 2011 and 2017. The relatively lower output growth rates in NLM after 2011 suggests that this might not have been the case in the local municipal area but that unemployment rates might have remained unchanged between 2011 and 2017.

As could be expected in an area with high unemployment rates, income poverty rates in the NLM are also very high. The percentage of households under the income poverty line (low threshold) remained high at high levels of between 42% and 41% between 2011 and 2016.

Basic Services

In the NLM there are huge backlogs in the delivery of basic services (electricity, water, sanitation), especially within the Newcastle-East area, including Johnstown, Blauuwbosch and Cavan, Madadeni and Osizweni townships as well as the surrounding rural settlements located within the vicinity of the Ubuhlebomzinyathi area.

The municipality, with the assistance of Eskom, has made substantial progress with the provision of electricity throughout its area of jurisdiction. The majority of households within the NLM are using electricity for cooking (94.8% in 2016) and lighting. In 2011, in Ward 21, this figure was lower as 72% of the households used electricity for cooking and 74% for lighting purposes. However, there are few areas where electricity services are lacking such as newly established informal settlements.

In respect of the water and sanitation service, this service is rendered through a water services provider (uThukela Water Pty Ltd) with the Municipality serving as the Water Services Authority. Access to water in the NLM, where households had access to piped water inside their dwellings increased from 2001 to 2011. Since 2011, however, fewer households had access to piped water inside their dwellings (50% as opposed to 43.4% in 2016). Within Ward 21 only 52% of the residents had access to piped water inside their dwellings even though the majority of the residents live in formal dwellings.

Critical water related issues that require attention include:

- Developing a Water and Sanitation Master Plan;
- Annual review of the web-based Water Service Delivery Plan (WSDP) for long term planning to guide investment in water infrastructure in the short to long term;
- Maintenance of the existing infrastructure; and
- Funding for maintenance and new water infrastructure projects.

Road and storm water infrastructure also require upgrades in terms of the Roads and Storm Water Master Plan. Access to public facilities should be upgraded through refurbishment of the related infrastructure.

In 2016, 62.7% of households had a flush toilet connected to sewerage as opposed to 55.8% households in 2011. In Ward 21, this figure is at 63.6%. Progress has thus been made to provide efficient sanitation to households. However, some of the peri-urban and rural areas, as well as rural settlements are still characterised by high sanitation backlogs, with some not even having a sewerage reticulation in place.

In terms of waste management, the weekly refuse removal could not keep up with the increased population figures and households. In 2011, 71% of households had a weekly service, whereas only 65.5% of households were serviced weekly in 2016. Within Ward 21, 72% of residents had their refuse removed by the NLM once weekly. It should also be noted that 23% of the residents in Ward 21, as well as in the NLM used their own refuse dump.

The Newcastle Waste Disposal Site (WDS), which was established in 1971, is nearing the end of its lifespan and the process for developing a new disposal site (this project) is underway. Currently the waste site receives domestic waste, garden waste, construction waste, and commercial waste. In 2011 it was projected that waste generation will increase to 123.9 tons per day in the Newcastle West area and 97 tons in the Newcastle East area in 2015. The projected growth is linked to the projected population growth, and emphasized a need for environmentally friendly waste management practices.

It should also be noted that the standard and level of service differs significantly among the different areas where some settlements are characterised by severe service backlogs and underdevelopment.

In terms of housing, the NLM has to attend to the huge housing backlog, mainly due to the rapid urbanisation taking place in the area. Various households reside in informal settlements, backyard shacks and poorly developed traditional housing structures (mainly concentrated in Newcastle East area). Within Ward 21, the majority of the residents live in formal dwellings (89%). The low cost housing need in Newcastle is currently estimated at 74 991 units.

It is further anticipated that in-migration will take place in the southern areas of Newcastle which is in close proximity to the industrial are and the Newcastle CBD. This would place additional pressure on the municipality to provide a variety of housing typologies such as

social housing, Community Residential Units (CRUs), and rental housing stock around the Newcastle CBD.

Newcastle serves as an administrative and economic hub for the North-Western part of KwaZulu-Natal, including the Amajuba District and some of the surrounding areas in the Ubuhlebomzinyathi District and the Mpumalanga Province. It is thus critical to ensure adequate infrastructure and services to be able to continue to play its role as sub-regional economic hub.

Health Care

The majority of the population within the NLM is reliant on the state to provide health care support. This just highlights the need to provide an integrated and efficient public health system across the spheres of government. Although the most vulnerable and under-serviced wards were located in the eastern area of the NLM, Ward 21 is also likely to require such basic health care services.

There are approximately 12 mobile clinics that serve the municipality and 10 permanent clinics. The backlog is mainly in the Newcastle East area where the majority of the population lives. The two hospitals in the NLM are situated in Newcastle and in Madadeni. The latter serves a district function, while Newcastle Hospital is classified as a Provincial Hospital and provides service to the whole of Amajuba District and the surrounding areas. A private hospital is also situated within Newcastle.

The prevalence of HIV/Aids remains a huge concern which requires various interventions to combat the challenge. It will remain one of the key factors that will continue to influence development over the next few decades.

Safety and Security

There are seven permanent police stations in NLM and one satellite station providing safety and security services. Criminal activities, especially house burglaries seem to be on the rise in the Newcastle area. Policing forums are present, and the NLM is in the process of installing the CCTV cameras in the CBD, industrial areas, suburbs, and in the townships of Madadeni and Osizweni. Special attention is given to hot spot crime zones identified by the SAPS through the installation of high mast lights.

Local Municipal Governance

Financial Management: NLM experience funding challenges as evidenced in the deterioration of capital expenses as a percentage of the capital budget. The ratio deteriorated from 95%

in 2013/14 to 78% in 2015/16 due to some of projects that were suspended before the end of the financial year due to funding challenges. In addition, the NLM experienced major expenditure drivers in 2016 resulting in a large fiscal deficit of close to R900m in 2016 compared to surpluses in the 2014 and 2015 financial years. Municipal debts in excess of R360 million due to non-payment for services were written off during 2016. Problem areas that are identified includes the insufficient financial surplus (the large deficit); limited access to funding in relation to need; over-committed reserves to the funding of capital expenditure and the inadequate provision for repairs and maintenance in relation to the value of assets.

The audit opinion results of the local municipality improved from qualified audit opinions (second best to clean audit status) from the Auditor General of South Africa (AGSA) for the last two financial years (2016 – 2017). Problem areas emphasised by AGSA were the writing-off of high amounts of debt, irregular/wasteful expenditure and procurement irregularities. There are local concerns that the issue of fruitless and wasteful expenditure is not adequately addressed.

Civic Protests: As is the case across South Africa, NLM also experienced a series of service delivery protests, the latest organised by the South African National Civic Organisation (SANCO) at the end of 2016. The central issue were slow service delivery with too many unfinished projects and development issues in the townships.

Environmental Management: A recent research project related to waste management in NLM highlights the following challenges in terms of the effective implementation of policies on environmental management, especially waste management in NLM:

- As a developing area, the NLM does not have comprehensive legislation dedicated to waste management and minimisation of waste;
- There is a need for law enforcement, especially regarding illegal dumping sites which cause a whole place to look unattractive;
- The NLM experiences uncontrolled discharges of effluent in the area, air pollution associated with industrial development, and solid waste disposal challenges which produce harmful materials which are known to be toxic to human beings or destructive to the environment;
- There is little compliance regarding implementation of waste management plans, indicating weak policy enforcement;
- Landfills are inappropriately sited, designed, managed and operated; and
- The municipality does not have the funding to maintain a healthy and disease free environment and knowledge is a serious challenge.

4.14.1.3 The Local Economy

NLM dominates the Amajuba District Municipality, providing more than 70% of jobs within the district municipality. NLM is strategically located within the province in terms of major tourism routes, logistics, farming and industrial activity. As indicated in Figure 4-51, the Newcastle local economy is currently dominated by the services sector (including the public sector) in terms of output and employment.

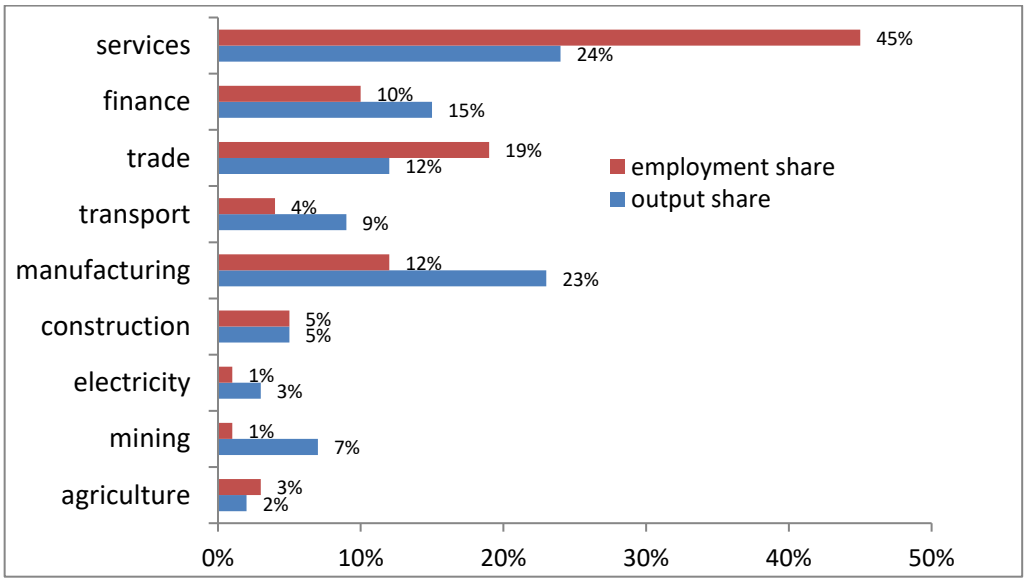


Figure 4-51: The economic structure of NLM, 2015.

The contribution of the manufacturing sector is large in terms of output but significantly lower in terms of employment, indicating to the capital intensity of the sub-sectors that dominate in the Newcastle economy, i.e. steel, rubber manufacturing, heavy engineering, slagment cement, chemicals, textiles etc.). Major manufacturers such as ArcelorMittal Steel, Lanxess and Karbochem synthetic rubber plant are located in the local area. A large number of Chinese and Taiwanese owned textiles factories are also located into the region. Since 2009 the growth in the manufacturing sector came under pressure mainly due to lower global economic growth and a lack of competitiveness.

The relatively large role that the finance and trade sectors play in the local economy underscores the importance of Newcastle as a service and trade hub in the larger region. Examples of larger trade and entertainment facilities include the Blackrock Casino and Entertainment Hotel and recently completed the Newcastle Mall.

The tourism sector is currently a small contributor to the region's economy. The main potential related the development of the tourism sector within Newcastle is business, sports and events-related tourism.

Over the past few decades coal mining activities within the Newcastle area has declined significantly and currently the mining sector only contributes 1% towards local employment.

While the agricultural sector is also continuing to shed jobs, the sector is still highly organised and linked into agro-processing manufacturing expansion. The high potential agricultural sub-sectors with related agro-processing activities are identified as:

- Agronomic crops (soya, maize and wheat);
- Dairy based agro-processing opportunities for yoghurt, ice-cream, powdered milks, and custard production. The number of dairy farmers has declined to three active dairy farmers in the area ;
- Floriculture including traditional (roses, carnations) as well as indigenous (proteas, fynbos and bulbs) flowers;
- Meat processing (game and cattle);
- Aquaculture;
- Poultry – broiler and layer production;
- Expanded production in fruits, vegetable and nuts;
- Pressing, distillation of essential oils;
- Hot processing of citrus (jams and spreads); and
- Wool and mutton in some regions, although this is on the decline.

As illustrated in Figure 4-52 the growth rates of the NLM are significantly lower since 2008 with most of the sectors discussed above being under pressure. Economic activities that experience higher growth rates include public service infrastructure, retail and residential developments (e.g. Victoria Mall, Meadowlands Estate, Vulintaba Estate) and transport related developments (Heartlands Dry Port) and the finance and insurance sector.

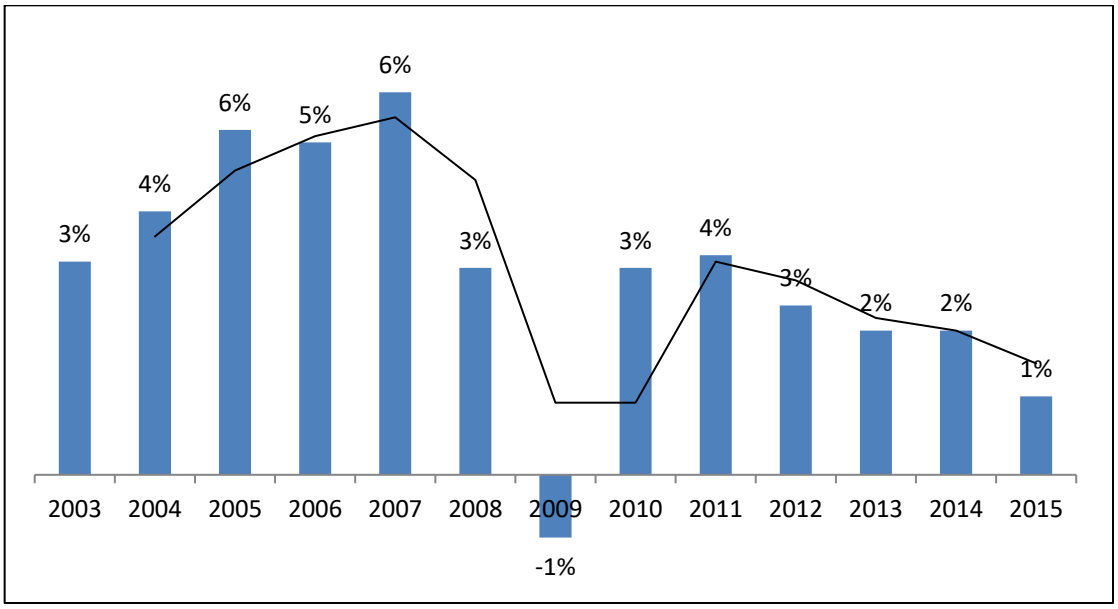


Figure 4-52: Annual growth in real output, NLM economy (2003-2015).

The main economic activities directly adjacent to the landfill site include:

- Carrick/Hofina poultry: A poultry and game farm (north of the site) employing around 100 mainly unskilled workers;
- Norseland: A pecan and cattle farm (west of the site) employing around 5 permanent workers and 50 seasonal workers;
- Gardenia: A dairy farm (south west of the site);
- Mooikrans: A cattle farm (neighbouring Gardenia to east) (south of the site) employing around 20 mainly unskilled people; and
- Afrisam aggregate quarry (northeast of the proposed site).

4.14.1.4 Identification of Local Community Priorities

The NLM IDP highlights the following development objectives for the local area:

- Sound Municipal Financial Management/Viability;
- Improved access to basic service delivery (i.e. water, sanitation, electricity, housing, waste removal);
- Local Economic Development (eradication of poverty and unemployment):
    - Develop Newcastle as a service and industrial hub;
    - Conservation of agriculturally valuable land;
    - Expansion and diversification of the agricultural sector;
    - Expansion and diversification of the manufacturing sector;
    - Development and support for the tourism sector;

  - Effective support to the informal economic and development small enterprises; and
  - Skills training and development.
- Improved quality of roads and stormwater infrastructure (including sidewalks);
- Environmental sustainability (environmental conservation/management);
- Accelerated Municipal Transformation and Corporate Development;
- Improved access to public facilities;
- Improved community safety;
- Improved access to basic health services; and
- Improved access to land (including Land Reform).

In terms of the proposed landfill, the emphasis on the conservation of agricultural land and the expansion of the agricultural sector is worth noting. Environmental management is also a relevant local development priority to be noted for this specific project.

5 PUBLIC PARTICIPATION PROCESS

5.1 Purpose of Public Participation

The Public Participation Process (PPP) is a requirement of the environmental authorisation process and ensures that all relevant I&APs are consulted and involved. The process ensures that all stakeholders have an opportunity to raise their comments as part of an open and transparent process, which in turn ensures for a complete comprehensive environmental study.

The purpose of PPP and the engagement process is to:

- Introduce the proposed project;
- Explain the EIA/EMP and PPP processes to be undertaken;
- Determine and record public issues and concerns;
- Provide opportunities for public input and gathering of local knowledge;
- Inform a broad range of stakeholders about the project and the environmental process to be followed;
- Establish lines of communication between stakeholders and the project team;
- Identify all the significant issues in the project; and
- Identify possible mitigation measures or environmental management plans to minimise and/or prevent environmental impacts, associated with the project.

Once the concerns of I&APs have been established, the EIA phase of the project will aim to address these concerns.

5.2 Authority Consultation

A comprehensive list of authorities was developed during the Scoping Phase of the project. This list has been used to establish communication with the relevant authorities who are required to contribute to the environmental authorisation process.

5.3 Interested and Affected Party Consultation Conducted by the previous EAP

5.3.1 Identification of I&APs

Site notices were placed around site and advertisements were placed in the Daily News dated 21 October 2014, Isolezwe dated 21 October 2014 as well the Newcastle Advertiser dated 24 October 2014 giving rise to a list of I&APs. The Background Information Document (BID) was distributed to the landowners in the proximity of the site as well as the authorities.

A complete list of all of the registered I&APs and their contact details, is contained in Appendix B.

5.3.2 Background Information Document

A BID (Appendix B) was compiled in IsiZulu as well as English and sent to the relevant authorities and stakeholders, including Department of Water and Sanitation, the Department of Health, Amajuba District Municipality, Ezemvelo KZN Wildlife, Department of Economic Development, Tourism and Environmental Affairs, Department of Transport and the Department of Agriculture, Forestry and Fisheries.

The BID was also hand delivered to the landowners within the Greenwich Farm. Due to the unclear access to the adjacent farms copies of the BID were left with one of the landowners to share with the farmers. The BIDs were also emailed to the individuals that requested to be registered as I&APs for the proposed development.

The BID was posted via registered mail I&APs where no email addresses were available. Proof of the letters posted is attached in Appendix B.

5.3.3 Notification of Stakeholders

5.3.3.1 Site Notices

Site notices were placed at the Greenwich Farm entrance on the 21st October 2014 (Appendix B).

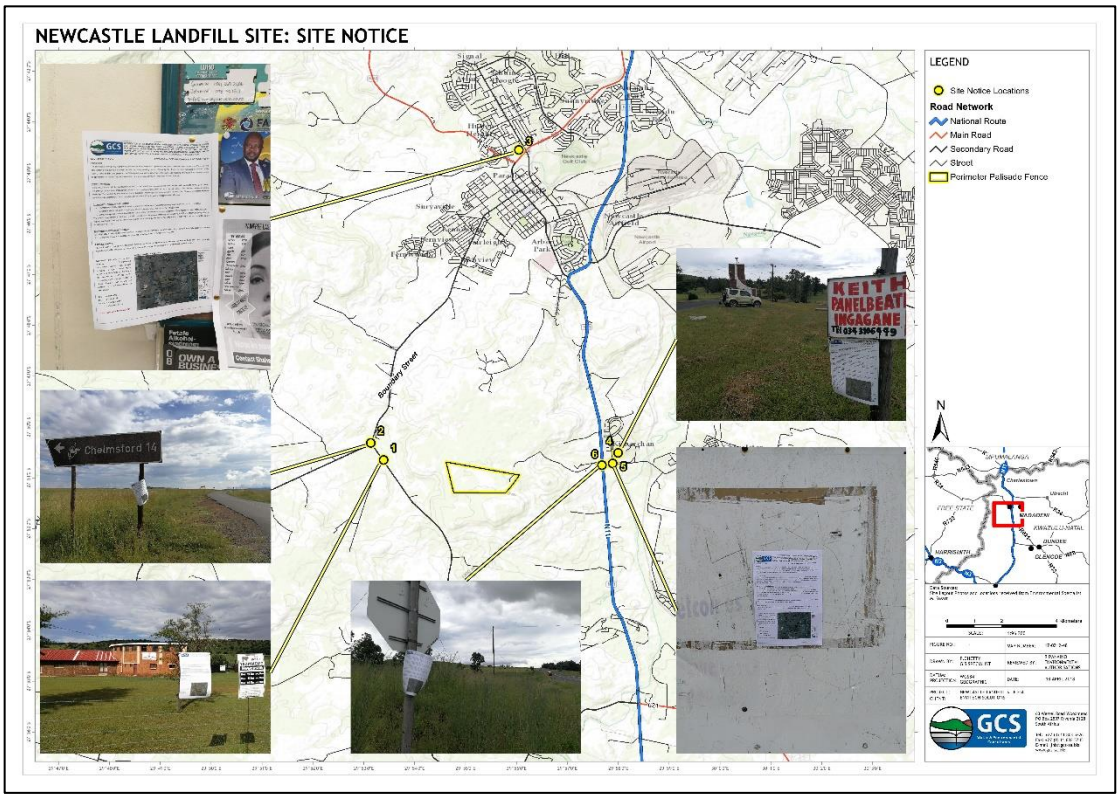


Figure 5-1: Site notice Placement

5.3.3.2 Media Advertisements

Advertisements were placed in the Daily News dated 21 October 2014, Isolezwe dated 21 October 2014 as well as the Newcastle Advertiser newspaper dated 24 October 2014 (Appendix B).

5.3.4 Public Meeting

A public meeting for the proposed development was held on the 25th November 2014 at the Newcastle Town Hall (Scott Street) where all stakeholders and registered I&APs were invited to attend. The EAP prepared a PowerPoint presentation in order to:

- Give an overview of the proposed development;
- Describe the need of the proposed landfill;
- Give I&APs an opportunity to raise their concerns/comments; and
- Describe the Scoping and EIA process.

A copy of the PowerPoint presentation, meeting minutes as well as the signed copy of the attendance register is provided in Appendix B.

5.3.5 Issues and Comments Raised

Requests for registration as I&APs were received from the I&APs. The requests were accompanied by concerns and comments that the I&APs identified to be potentially possible with the development of the landfill. Comments included some of the following:

- Contamination of the surface water resources;
- Odour impacts;
- Scattering of waste disposed;
- Negative health impacts on the community;
- Decrease in property values;
- Traffic impacts; and
- Exposure of local people to methane gas.

During the public meeting held, a number of issues/concerns were raised by the I&APs for further discussion in the Scoping Report, including;

- Development of firebreaks to deal with fires during the operation of the landfill;
- Alternatives sites considered for the development of the landfill;
- Elevation of the proposed landfill site;
- Wind pollution and odour impacts;
- Rehabilitation of existing landfill sites at Osizweni and Madadeni rather than establishing a new landfill site;
- Daily covering of landfilled waste; and
- Access road to the landfill.

During the public meeting, a major issue relating to the purchase of the Greenwich site to which the landfill is being proposed was raised, however the EAP mentioned that land purchase is not directly related to the EIA process and recommended that it is taken up directly between the community and the NLM.

Copies of the registration and comment sheets, the meeting minutes as well as the responses to the comments raised are included in Appendix B.

5.3.6 Circulation of the Draft Scoping Report

The Draft Scoping Report was circulated to all registered I&APs electronically. Hardcopies were also available at the Newcastle Library as well as the Ingagane Library. Authorities listed below were also given an opportunity to review and comment on the report:

- Department of Water and Sanitation (DWS);
- Department of Economic Development, Tourism and Environmental Affairs;

- Department of Transport;
- Department of Health;
- Department of Agriculture, Forestry and Fisheries;
- Amajuba District Municipality;
- Ezemvelo KZN Wildlife; and
- AMAFA.

Appendix B, the Public Participation Documentation, provides full copies of comments received and responses to the comments which have been incorporated into the comments and responses table.

5.3.7 Circulation of Amended Scoping Report

From the submission of the Final Scoping Report to EDTEA for review in August 2015, the Department requested that the report be amended to include information relating to the following:

- Need and desirability of the development;
- Information relating to the other 17 candidate sites investigated;
- Motivation for having Greenwich Site as the only alternative site for the development;
- Information on the leachate collection system;
- Access road alternative considered;
- Information relating to the proposed access road;
- Preliminary layout plan showing location of proposed infrastructure;
- Detailed methodology of proposed specialist studies;
- Newspaper advert indicating dates of publication;
- Clarification regarding project reference number; and
- Size and map indicating the site of the Greenwich Farm.

The amended report was compiled and circulated to the authorities as well I&APs for comments. The Department of Water and Sanitation, Ezemvelo KZN Wildlife and Amajuba District Municipality provided comments on the Amended Report (Appendix B).

5.4 Interested and Affected Party Consultation Conducted by the Current EAP

To be populated after EIA phase public meeting and Draft report Review.

6 IDENTIFICATION OF IMPACTS AND CONCERNS WITH MANAGEMENT MEASURES AND ACTON PLANS

6.1 Environmental Impact Assessment Methodology

To ensure uniformity, the assessment of potential impacts was addressed in a standard manner so that a wide range of impacts is comparable. The ranking criteria and rating scales was applied to all specialist studies for this project.

The following methodology was used to rank these impacts. Clearly defined rating and rankings scales (**Table 6-1** - Table 6-7) were used to assess the impacts associated with the proposed activities. The impacts identified by each specialist study and through public participation were combined into a single impact rating table for ease of assessment.

Table 6-1: Severity.

Insignificant/non-harmful	1
Small/potentially harmful	2
Significant/slightly harmful	3
Great/harmful	4
Disastrous/extremely harmful/within a regulated sensitive area	5

Table 6-2: Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional/neighboring areas (5km to 50km)	4
National	5

Table 6-3: Duration.

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5

Table 6-4: Frequency of the activity - How often do you do the specific activity?

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

Table 6-5: Frequency of the incident/impact - How often does the activity impact on the environment?

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

Table 6-6: Legal Issues - How is the activity governed by legislation?

No legislation	1
Fully covered by legislation	5

Table 6-7: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

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

Each impact identified was rated according the expected magnitude, duration, scale and probability of the impact. Each impact identified will be assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in **Table 6-8**.

Table 6-8: Impact Ratings.

SIGNIFICANCE RATING	CLASS (NEGATIVE IMPACT)	CLASS (POSITIVE IMPACT)
1 – 55	(L) Low Significance	(L) Low Significance
56 – 169	(M) Moderate Significance	(M) Moderate Significance
170 – 600	(H) High Significance	(H) High Significance

The findings of the specialist assessments (Appendix E) have been used to determine and potential impacts associated with the proposed landfill site development. The EAP has, where required, consolidated potential impacts associated with each phase and each specialist assessment in order to remove duplication.

6.2 Pre-Construction Phase

No impact assessment is undertaken for the pre-construction phase as the activities assessed are all process related.

6.3 Construction Phase

During the construction phase the following activities will take place on site:

- Site clearing/preparation;
- Heavy machinery and vehicle movement;
- Hydrocarbon spills;
- Chemical spills;
- Infrastructure establishment; and
- Earth Excavation.

The construction phase impacts that were identified are presented in Table 6-9.

Table 6-9: Anticipated Construction Phase Impacts.

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Visual	Landscape visual change	-
Geohydrology	Groundwater contamination	-

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Social	Temporary job creation	+
	Decline in local safety	-
	Nuisance/decline in human health (dust and noise)	-
Soils, Land Use and Land Capability	Soil exposure	-
	Soil compaction	-
	Temp job creation	-
	Decline in local safety	-
	Nuisance/decline in human health (dust and noise)	-
Ecology	Loss of floral species and habitat	-
	Loss of faunal species and habitat	-
	Loss of high biodiversity importance CBA	-
	Loss of habitat functionality and connectivity including servicing of Irreplaceable CBA situated to the south of the site	-
Wetlands	Loss of wetland plants and decrease surface roughness	-
	Sedimentation of wetland areas	-
	Erosion from increased flow velocities into wetland areas	-
	Loss of wetland area and soils	-
	Sedimentation of wetland areas	-
	Erosion, Sedimentation and Desiccation of wetland areas	-
	Water quality impairment and habitat loss/alteration	-
	Water quality impairment	-
Air Quality	Exceedance of daily dust fallout levels	-
	Exceedance of daily PM10 levels	-
	Exceedance of annual PM10 levels	-
	Exceedance of daily PM2.5 levels	-
	Exceedance of annual PM2.5 levels	-
Heritage	Damage to or destruction of fossils	-
	Damage to or destruction of cultural heritage resources	-
Hydrology	Pollution of nearby watercourses	-
	Sedimentation/siltation of nearby watercourses	-
	Reduction of runoff at downstream reaches by approximately 0.5 % of MAR.	-
	Reduced biodiversity	-

6.3.1 Air Quality Modelling Results

Dust and gaseous emissions are identified for proposed onsite operations will be emitted from the following key sources:

- Dust and particulate emissions

- Heavy construction activities.

To investigate the potential impacts of operations associated with the proposed landfill on local ambient air quality, the following air pollutants were chosen in the quantification of emissions associated with the construction phase:

- Dust fallout as Total Suspended Particles (TSP); and
- Particulate Matter (PM_{10} and $PM_{2.5}$).

In the quantification of emissions for the construction phase of the proposed landfill, use was made of published predictive emission factor equations given in the United States Environmental Protection Agency (USEPA) AP-42 documents. The South African Regulations regarding Air Dispersion Modelling recommends the use of published emission factors for national consistency, such as the USEPA AP42 emissions factors.

The USEPA provides an emissions equation for general heavy construction operations. Dust is the main pollutant of concern emitted during heavy construction activities. The impact of dust emissions associated with heavy construction is generally limited to the period of construction where the impact is significantly reduced once construction activities have stopped. Dust emissions from construction activities is associated with land clearing, ground excavation, drilling and blasting, cut and fill operations, vehicle dust entrainment from trucks and the construction of infrastructure. Dust emissions from construction activities will vary depending on the level of activity and prevailing meteorological conditions (USEPA, 1995).

The emission factor and equation used to estimate emissions from construction activities were obtained from the USEPA AP-42 document, Section 13.2.3 Heavy Construction Operations (USEPA, 1995). The value is most applicable to construction operations with medium activity level, moderate silt contents and semi-arid climate. Construction was assumed to occur for 10 hours a day for 5 days a week. In addition, it was assumed that no dust suppression measures would be implemented during construction activities. Input parameters for construction activities are summarised in Table 6-10.

Table 6-10: Input parameters for heavy construction activities.

SOURCE	EMISSION RATE (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Cell 1	13,9415	6,9707	0,6971
Cell 2	15,2315	7,6158	0,7616
Cell 3	18,7873	9,3936	0,9394
Cell 4	22,765	11,3825	1,1383
Cell 5	25,1817	12,5908	1,2591

SOURCE	EMISSION RATE (g/s)		
	TSP	PM_{10}	$PM_{2.5}$
Cell 6	30,5735	15,2868	1,5287
Cell 7	36,2064	18,1032	1,8103

Notes:

- *Area dimensions and footprint based on Google Earth files provided*
- *No dust suppression considered*
- *Construction hours assumed to occur 10 hours/day for 5 days per week*

Dispersion simulations were undertaken to determine predicted ground-level impacts from all key sources for TSP (as dust fallout), PM_{10} and $PM_{2.5}$ for proposed construction activities associated with the proposed site.

6.3.1.1 Dust Fallout

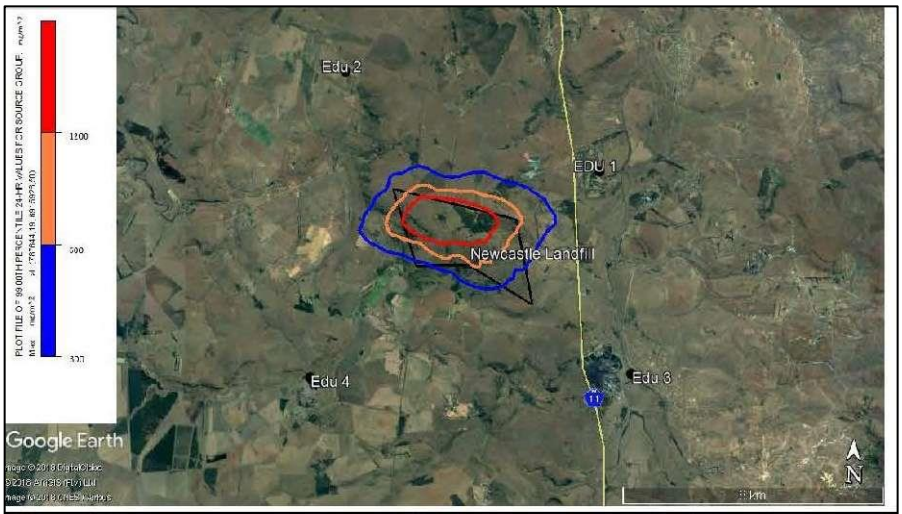
Predicted incremental dust fallout rates associated with construction activities at the proposed landfill sites are presented in **Figure 6-1**. Predicted incremental dust fallout rates:

- Comply with the non-residential standard of 1 200 milligrams per square metre per day ($mg/m^2/day$) beyond the site boundary;
- Exceed the residential standard of 600 $mg/m^2/day$ beyond the western and northern boundaries, however these occur within 1 km of the boundary line; and
- No exceedances of the dust fallout limits are observed at surrounding sensitive receptors.

6.3.1.2 PM_{10} Concentrations

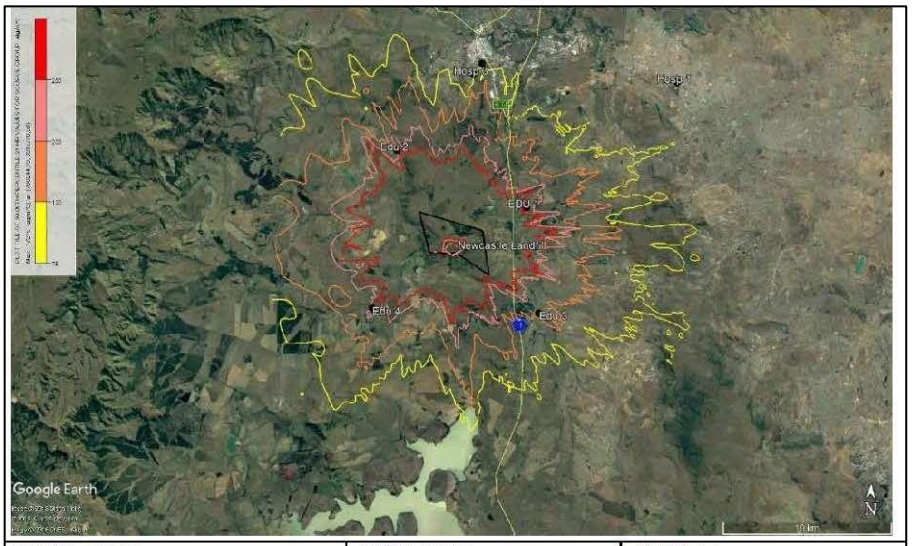
Predicted incremental PM_{10} concentrations associated with construction activities at the proposed landfill site are presented in Figure 6-2 and Figure 6-3. Predicted incremental PM_{10} concentrations:

- Under the worst-case scenario are shown to be relatively high, with exceedances of the daily limit of 75 micrograms per cubic metre ($\mu g/m^3$) observed over most of the project area (Figure 6-2);
- Comply with the annual limit of 40 $\mu g/m^3$ beyond 3 km from the landfill boundary line (Figure 6-3); and
- Predicted incremental annual average concentrations comply with the annual average limit at identified nearby sensitive receptors, however, the predicted daily average concentrations exceed the daily limit at eight (8) of the nearby sensitive receptors (Table 6-11).



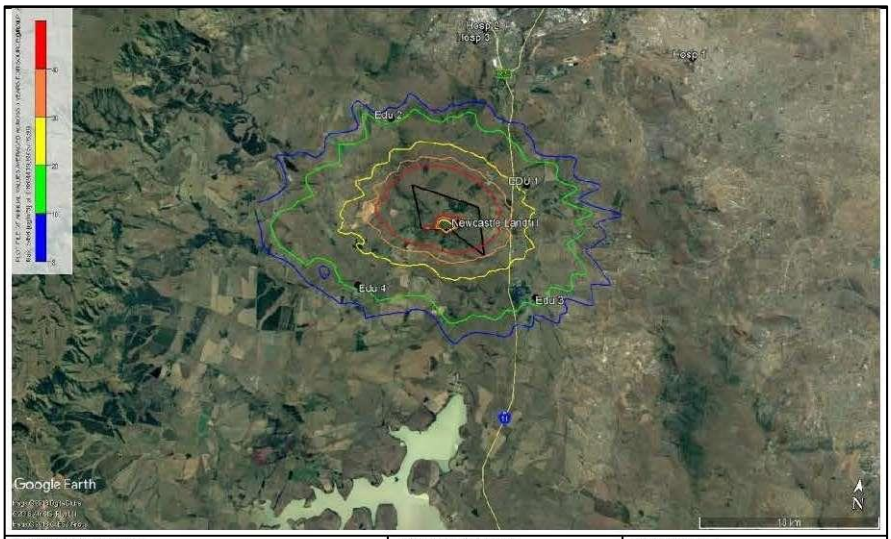
COMMENTS: Orange band - exceedances of the residential area standard of 600 mg/m^2/day. Red band - exceedances of the non-residential area standard of 600 mg/m^2/day.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 2 tiers	**OUTPUT TYPE:** 99th Percentile Deposition Rates
	NUMBER OF SOURCES: X 7 area	**ASSUMPTIONS:** No dust suppression
	DUST FALLOUT STANDARD: 1200 mg/m^2/day (non-residential areas) 600 mg/m^2/day (residential areas) **DATE:** 09/04/2018	

Figure 6-1: Predicted incremental dust fallout (TSP) rates for the proposed site (construction phase).



COMMENTS: All band - exceedances of the SA-daily PM10 standard of 75 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 7 area	**ASSUMPTIONS:** No dust suppression
	AMBIENT STANDARD: 75 µg/m^3 (SA 24-Hour standard) **DATE:** 09/04/2018	

Figure 6-2: Predicted incremental daily average PM_{10} concentrations for the proposed site (construction phase).



COMMENTS: Red band - exceedances of the SA-annual PM10 standard of 40 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** Ground Level Concentrations
	NUMBER OF SOURCES: X 7 area	**ASSUMPTIONS:** No dust suppression
	AMBIENT STANDARD: 40 µg/m^3 (SA annual standard) **DATE:** 09/04/2018	

Figure 6-3: Predicted incremental annual average PM_{10} concentrations for the proposed site (construction phase).

Table 6-11: Maximum predicted incremental PM_{10} and $PM_{2.5}$ concentrations as well as dust fallout rates at nearby sensitive receptors (construction phase).

SENSITIVE RECEPTOR	CO-ORDINATES		PM2.5		PM10		DUST FALLOUT ($mg/m^2/day$)
			DAILY AVERAGE	ANNUAL AVERAGE	DAILY AVERAGE	ANNUAL AVERAGE	
STANDARD ($\mu g/m^3$)	X	Y	40	20	75	40	RESIDENTIAL: 600; NON-RESIDENTIAL: 1200
Edu1	784754,95	6919647,35	22.94	1.16	229.39	11.65	67.44
Area 1	799824,22	6927465,59	3.10	0.16	30.99	1.58	8.89
Edu 2	788134,43	6925776,81	5.96	0.28	59.57	2.83	15.22
Edu 3	792301,86	6917298,25	26.19	1.71	261.88	17.06	122.56
Edu 4	783679,59	6910184,88	14.72	0.86	147.18	8.55	37.12
Edu 5	791870,75	6910113,03	10.02	0.97	100.23	9.73	64.93
Edu 6	794457,43	6911047,11	13.29	0.94	132.86	9.39	43.44
Edu 7	789212,21	6905801,89	9.37	0.48	93.66	4.76	17.97
Health 1	799871,71	6925607,77	4.36	0.19	43.57	1.90	10.97
Health 2	800717,04	6925269,64	2.83	0.17	28.31	1.73	10.35
Area 1	795306,97	6928059,21	3.27	0.17	32.66	1.67	7.81
Area 3	801562,36	6922902,74	3.58	0.21	35.82	2.12	18.59
Fernwood	785681,26	6924407,02	8.24	0.37	82.43	3.67	20.98
Arbor Park	790850,32	6924504,92	7.71	0.36	77.09	3.36	12.78

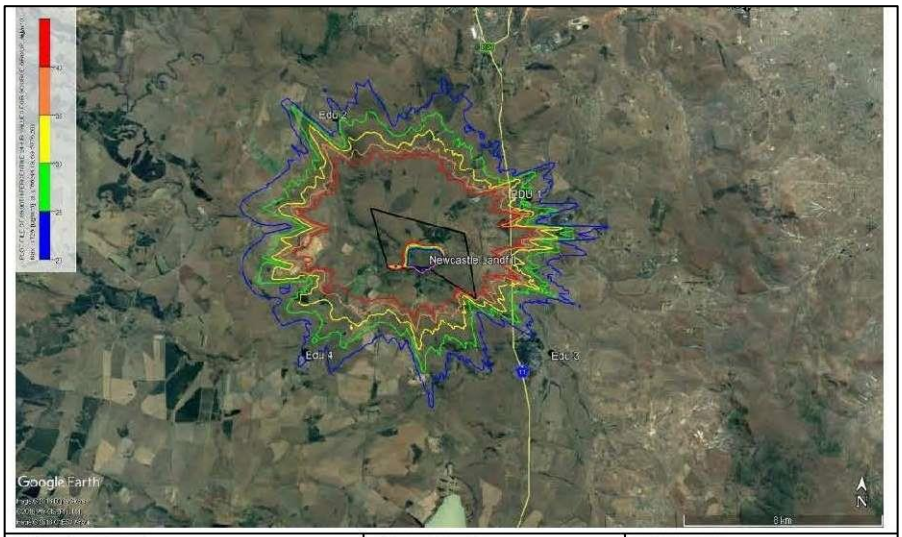
Notes:

- *Edu = educational facility/school/training centre*
- *Old = old age home*
- *Hosp = hospital/clinic/health care facility*
- *+ = and*
- *Area = unknown name area identified as a nearby receptor*

6.3.1.3 $PM_{2.5}$ Concentrations

Predicted incremental $PM_{2.5}$ concentrations associated with construction activities at the proposed landfill site are presented in Figure 6-4 and Figure 6-5. Predicted incremental $PM_{2.5}$ concentrations:

- Comply with the daily average standard of 40 µg/m3 beyond 3km from the site boundary line (Figure 6-4).
- Comply with the annual average standard of 20 µg/m3 beyond all site boundaries, however, exceedances of the standards are observed within 500m of the western and northern boundaries (Figure 6-5).
- Predicted incremental daily and annual concentrations at the identified nearby sensitive receptors comply with the applicable limits (Table 6-11).



COMMENTS: Red band - exceedances of the SA-24H PM2.5 standard of 40 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 7 area	**ASSUMPTIONS:** No dust suppression
	AMBIENT STANDARD: 40 µg/m^3 (SA 24-Hour standard) (current) 25 µg/m^3 (SA 24-Hour standard) (By 1 Jan 2030) **DATE:** 09/04/2018	

Figure 6-4: Predicted incremental daily average $PM_{2.5}$ concentrations for the proposed site (construction phase).

COMMENTS: Red band - exceedances of the SA PM2.5 annual standard of 20 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** Ground Level Concentrations
	NUMBER OF SOURCES: X 7 area	**ASSUMPTIONS:** No dust suppression
	AMBIENT STANDARD: 20 µg/m^3 (SA annual standard) (Current) 15 µg/m^3 (SA annual standard) (By 1 Jan 2030) **DATE:** 09/04/2018	

Figure 6-5: Predicted incremental annual average $PM_{2.5}$ concentrations for the proposed site (construction phase).

6.3.2 Wetland Buffer Zones

The DWS buffer tool recommends, at a desktop level, that the required buffer for the development of a landfill site be 180 m. The scenario used to determine the buffer requirements was the Disposal of Hazardous Waste which will cater for the worst possible impacts/risks. Furthermore, a minimum buffer zone of 175 m is recommended for wetlands for activities related to mining (Macfarlane *et al*. 2009). These minimum buffer widths are designed to protect core wetland habitat and aquatic functioning and are calculated based on a simple classification of wetland types and land use categories. This is relevant for the landfill development as activities are similar to mining and the risk of water contamination is high.

When assessing the proposed landfill site it is shown that the largest risks (Very High) posed by the project during the construction phase is that of increased sediment inputs and turbidity. This impact would arise due to excavation and vehicular movements in proximity to or within wetland areas. These risks are calculated with no prescribed mitigation and the

calculated buffer requirement for the construction phase (pre-mitigation) is determined to be 57 m around each identified wetland.

According to the buffer guideline (Macfarlane *et al*. 2014) a high risk activity would require a buffer that is 95% effective to adequately reduce the risk of the impact to a low level threat. Through implementation of the proposed mitigation measures for the construction phase, the risks for some aspects are reduced and the required buffer (post mitigation) is then calculated to be 17 m (Figure 6-6).

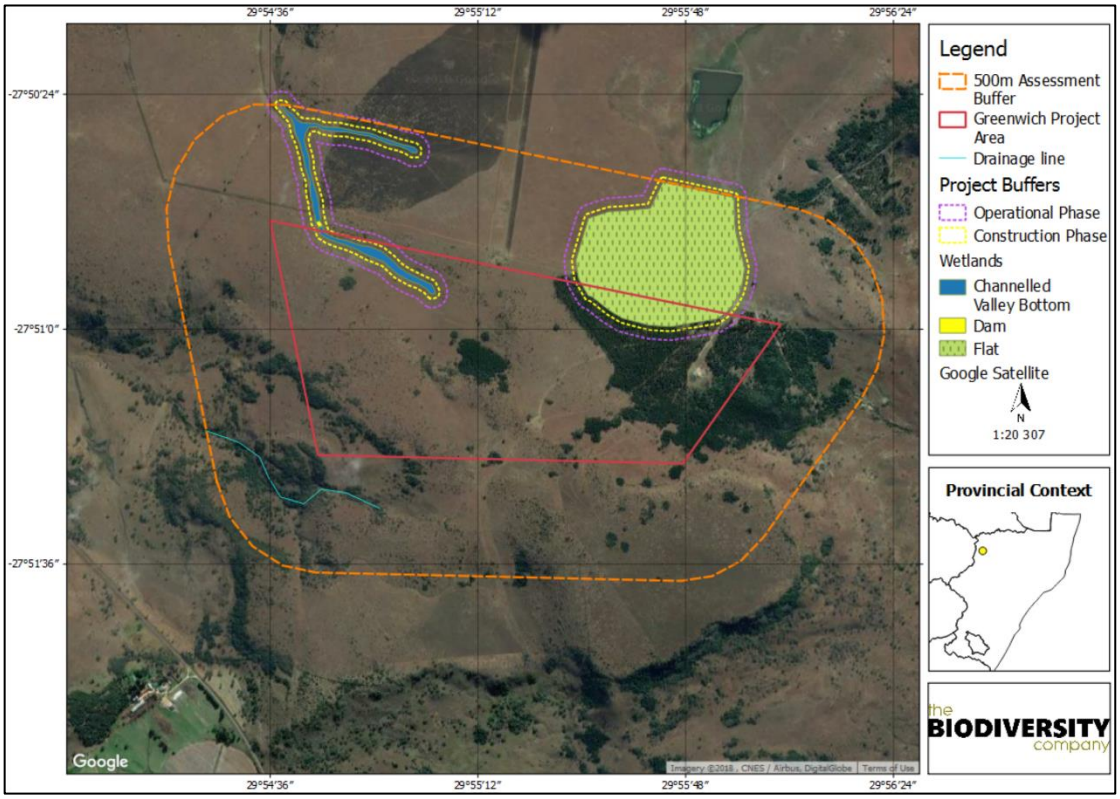


Figure 6-6: The Construction and Operational Phase buffer zones for the proposed project.

The mitigation measures applied included the assumption that there will be no working within wetland areas. All excavation, dumping and roads would be beyond the wetland and buffer zone. The highest risks after mitigations measures were applied were determined to be medium risks.

The 28m buffer zone and the wetland areas within the proposed site development must be treated as no areas (Figure 6-7). Any impact to these wetlands would result in regional water loss and contamination.

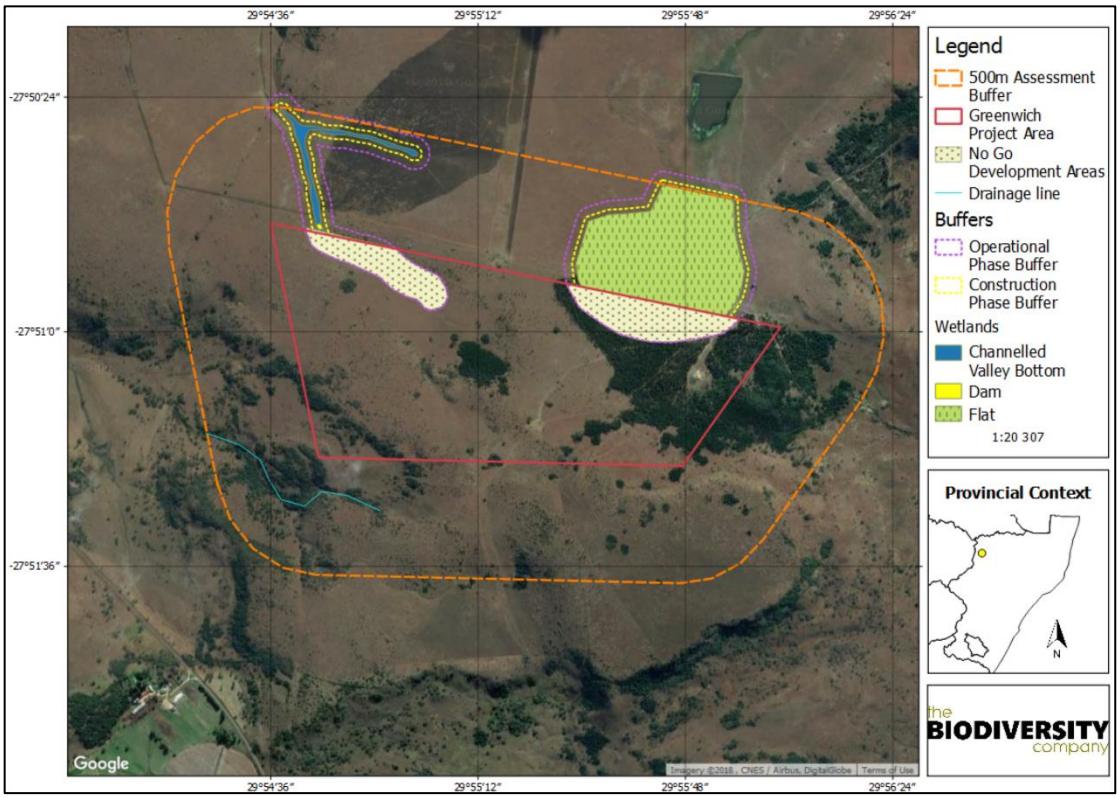


Figure 6-7: Identified wetland no-go areas within the proposed site.

6.3.3 Cultural Significance of Identified Heritage Resources

Through an understanding of the distribution of the various heritage resources within the site-specific study area, a statement of Cultural Significance (CS) as presented in **Table 6-12** demonstrates a generally negligible significance rating for the defined cultural landscape, the very high CS of the palaeontological features underlying the site-specific study area notwithstanding.

Table 6-12: Statement of Cultural Significance (CS).

RESOURCE ID	DESCRIPTION	INTEGRITY	CS VALUE	CS
Vryheid Formation	Geological strata with palaeontological sensitivity	4	20	Very High
LFC-001	Late Farming Community (LFC) stonewalled site (1)	2	3	Negligible
LFC-002	LFC stonewalled site (2)	1	1	Negligible

The two LFC stonewalled sites are of negligible CS. According to the South African Heritage Resources Authority (SAHRA) Minimum Standards, heritage resources of negligible CS require

no further mitigation beyond their inclusion into a specialist report. The stonewalled sites have been included in the Heritage Impact Assessment (Appendix E) and this is considered sufficient to meet the SAHRA Minimum Requirements. This notwithstanding, it is recommended that a buffer zone be created between these heritage resources and the proposed infrastructure associated with the landfill, where possible.

The geological setting of the site-specific study area includes the palaeontologically-sensitive layers of the Ecca Group of the Karoo Supergroup, represented by the *Vryheid Formation*. This feature is known for its fossil potential and has been assigned a very high CS. Since the presence of palaeontological resources can only be confirmed as and when/if they are unearthed by construction activities, it is recommended that a Chance Finds Procedure and a Fossil Chance Finds Procedure be developed and implemented prior to the commencement of the construction phase. If deemed necessary by the Competent Authority, a qualified palaeontologist must be employed to oversee excavation activities associated with the proposed construction phases.

6.3.4 Calculated Noise Impacts

6.3.4.1 Receiving Environment

The prevailing ambient noise levels in the study area were created by domestic activities, distant traffic, wind and natural conditions. Some of the residential areas (Figure 6-8) are located close to or in the vicinity of the feeder roads with the result that the prevailing ambient noise levels will be higher due to the traffic during the day and the night respectively. The proposed tip site will be higher than the residential areas with vertical barriers (hills) between the residential area and the proposed tip site. The distance (m) and difference in meters above the sea-level (mamsl) between the middle of the proposed tip site and the abutting residential is illustrated in Table 6-13.

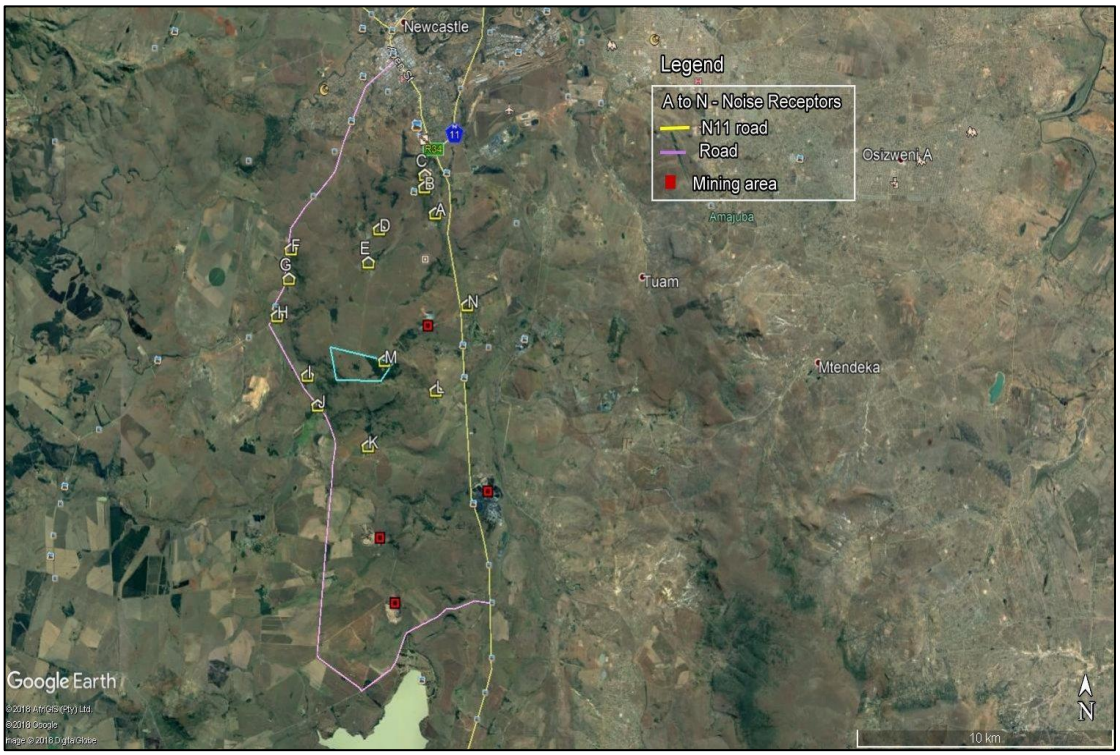


Figure 6-8: Identified noise receptors.

Table 6-13: Distance (m) and difference in mamsl between the noise receptors and the middle of the landfill site.

RESIDENTIAL AREAS	METRES ABOVE MEAN SEA LEVEL	DISTANCE FROM CENTRE OF LANDFILL SITE
A	1299	6070
B	1293	6708
C	1284	7086
D	1345	4772
E	1335	3681
F	1288	4886
G	1261	4100
H	1229	3664
I	1266	2006
J	1322	2051
K	1297	2906
L	1234	3068
M	1354	948
N	1237	4601

The proposed route to and from the Landfill site is illustrated in Figure 6-9.

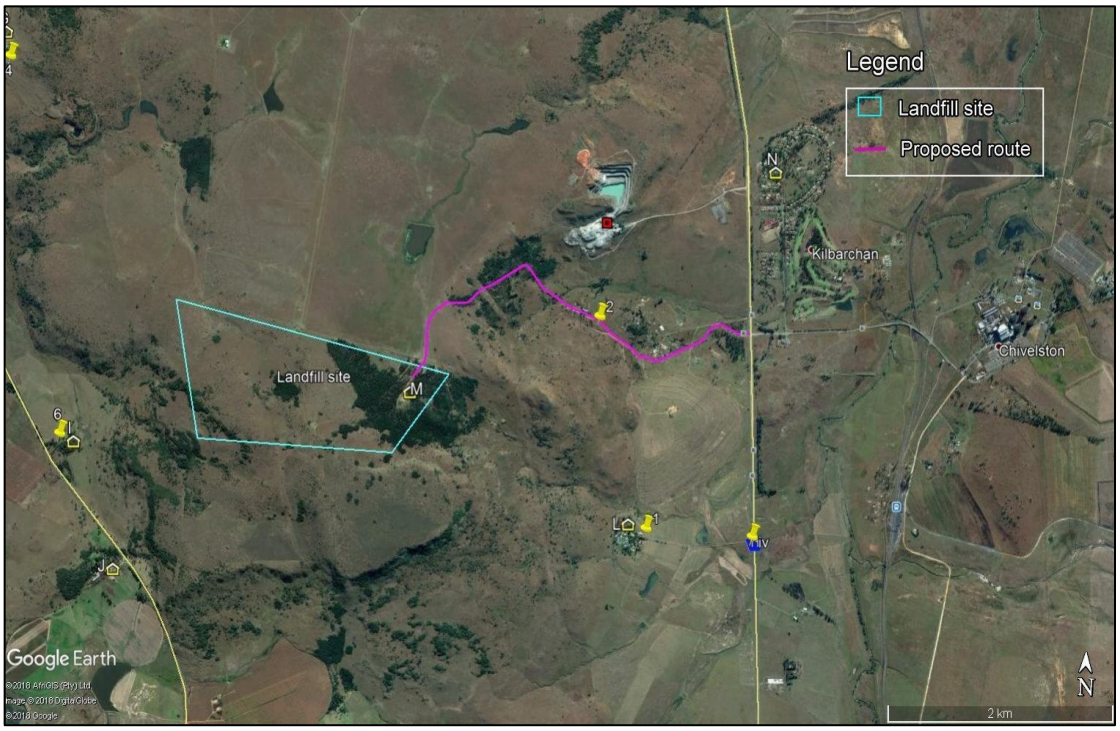


Figure 6-9: Access road to proposed landfill site.

The traffic along the road consists out of heavy-duty trucks and other motor-vehicles. The prevailing ambient noise level along the feeder roads and at the nearest noise receptors were determined to be as follows:

- Along the N11 – 61.3 dBA during the day and 58.1 dBA during the night;
- Gravel road (Road A) to the site – 39.0 dBA during the day and 44.2 dBA during the night;
- At noise receptor E – 32.6 dBA during the day and 33.9 dBA during the night;
- At noise receptor L – 42.9 dBA during the day and 44.2 dBA during the night; and
- At noise receptor M – 39.0 dBA during the day and 44.2 dBA during the night.

The following sound levels were used in determining the noise level at identified receptor areas:

- Construction Phase:
    - Site clearing and grubbing of the footprint areas – 90.5 dBA
    - Construction of landfill liner - 90.5 dBA;
    - Civil construction and construction activities of pipeline, service road, wash bays, workshop and a powerline - 85.5 dBA; and
    - Building material and equipment deliveries at the site – 85.5 dBA.

6.3.4.2 Noise Intrusion Levels

The criteria for assessing the magnitude of a noise impact are illustrated in Table 6-14.

Table 6-14: Noise intrusion level criteria.

INCREASE Δ-DBA	ASSESSMENT OF MAGNITUDE AND COLOUR CODE
0< Δ ≤1	Not audible
1< Δ ≤3	Very Low
3< Δ ≤5	Low
5< Δ ≤10	Medium
10< Δ ≤15	High
15< Δ	Very High

The environmental noise impact assessment in terms of the magnitude of a noise impact during the construction phase of the landfill site at the residential areas is illustrated in Table 6-15. The day and night time noise intrusion will be Not Audible to Very Low for all receptors.

The calculated noise levels along the roads during the construction phase will be as follows:

- Along the N11 – 49.2 dBA;
- Along the upgraded access road – 49.2 dBA;
- In the vicinity of noise receptor E – 12.8 dBA;
- In the vicinity of noise receptor L – 21.3 dBA; and
- In the vicinity of noise receptor M – 36.3 dBA.

Table 6-15: Calculated noise intrusion levels (dBA) during the Construction Phase.

RESIDENTIAL PROPERTY	SITE CLEARING AND GRUBBING OF FOOTPRINT	CONSTRUCTION OF LANDFILL LINER	CIVIL CONSTRUCTION ACTIVITIES WASH BAYS AND WORKSHOP	CIVIL CONSTRUCTION SERVICE ROAD	CIVIL CONSTRUCTION POWER LINE	BUILDING MATERIAL AND EQUIPMENT DELIVERIES AT THE SITE	CUMULATIVE LEVELS	CUMULATIVE NOISE LEVEL - DAYTIME	CUMULATIVE NOISE LEVEL - NIGHT TIME	INTRUSION NOISE LEVEL - DAYTIME	INTRUSION NOISE LEVEL - NIGHT TIME
A	9.8	4.8	6.8	6.8	6.8	-0.2	14.5	39.0	41.7	**0.0**	**0.0**
B	8.9	3.9	5.9	5.9	5.9	8.9	14.7	39.0	41.7	**0.0**	**0.0**
C	8.5	3.5	5.5	5.5	5.5	8.5	14.3	39.0	41.7	**0.0**	**0.0**
D	11.9	6.9	8.9	8.9	8.9	11.9	17.7	32.7	34.0	**0.1**	**0.1**
E	14.2	14.2	14.2	14.2	14.2	14.2	22.0	33.0	34.2	**0.4**	**0.3**
F	11.7	11.7	11.7	11.7	11.7	11.7	19.5	36.7	41.7	**0.1**	**0.0**
G	13.2	13.2	13.2	13.2	13.2	13.2	21.0	36.7	41.7	**0.1**	**0.0**
H	14.2	14.2	14.2	14.2	14.2	14.2	22.0	36.0	36.2	**0.2**	**0.2**
I	19.5	19.5	19.5	19.5	19.5	19.5	27.2	36.4	36.5	**0.6**	**0.5**
J	19.3	19.3	19.3	19.3	19.3	19.3	27.0	36.3	36.5	**0.5**	**0.5**
K	16.2	16.2	16.2	16.2	16.2	16.2	24.0	44.2	37.7	**0.0**	**0.2**
L	15.8	15.8	15.8	15.8	15.8	15.8	23.5	43.0	41.8	**0.1**	**0.1**
M	26.0	26.0	26.0	26.0	26.0	26.0	33.7	40.1	36.8	**1.1**	**2.9**
N	12.2	12.2	12.2	12.2	12.2	12.2	20.0	61.3	58.1	**0.0**	**0.0**

6.4 Operational Phase

The operational phase of this application will entail landfill activities. The main operational activities anticipated to have an impact on the bio-physical environment will be:

- Waste site operation;
- Septic tank operation;
- Heavy machinery and vehicle movement;
- Hydrocarbon spills;
- Chemical spills;
- Site clearing/preparation;
- Earth Excavation;
- Infrastructure establishment; and
- Revegetation.

The operational phase impacts that were identified are presented in Table 6-16.

Table 6-16: Anticipated Operational Phase Impacts.

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Visual	Change of Visual Character	-
	Change in sense of place	-
Geohydrology	Groundwater contamination	-
Soils, Land Use and Land Capability	Pollution of soil	-
	Erosion	-
	Loss of soil	-
Social	Additional job creation	+
	Decline in local safety	-
	Decline in human and animal health	-
	Economic costs of water pollution	-
	Disinvestment in local economy	-
	Devaluation of adjacent properties	-
	Increased noise	-
	Impacted sense of place	-
	Impact on tourism activities	-
Ecology	Disturbance of faunal species due to vehicle impacts & noise	-
	Loss of biodiversity from peripheral areas due to increased human presence resulting in increased resource extraction, hunting, harvesting of medicinal plants	-
	Increased presence of alien invasive species due to increased vehicle traffic, dumping of garden refuge	-
Wetlands	Compaction, erosion and sedimentation of wetland areas	-
	Water quality impairment	-
	Erosion, Sedimentation and Desiccation of wetland areas	-

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
	Water quality impairment and habitat loss/alteration	-
Air Quality	Exceedance of annual Benzene levels	-
	Exceedance of hourly Toluene levels	-
	Exceedance of daily Toluene levels	-
	Exceedance of hourly Ethylbenzene levels	-
	Exceedance of hourly Xylene levels	-
	Exceedance of daily Xylene levels	-
	Exceedance of hourly Hydrogen Sulphide levels	-
	Exceedance of daily Hydrogen Sulphide levels	-
Hydrology	Pollution of nearby watercourses	-
	Increased probability of flooding	-

6.4.1 Air Quality Modelling Results

Dust and gaseous emissions are identified for proposed onsite operations will be emitted from the following key sources:

- Gaseous emissions:
    - Waste reception;
    - Waste processing;
    - Waste deposition;
    - Waste compaction; and
    - Waste recovery.

To investigate the potential impacts of operations associated with the proposed landfill on local ambient air quality, the following air pollutants were chosen in the quantification of emissions associated with the operation phases:

- Hydrogen Sulphide (H_2S); and
- Benzene, Toluene, Ethylbenzene, Xylene (BTEX).

In the quantification of emissions for the operational phase of the landfill use was made of the LandGEM-Landfill Gas Emissions Model (Version 3.02). The LandGEM-Landfill Gas Emissions Model (Version 3.02) developed by the U.S Environmental Protection agency was used to quantify emissions from the decomposition of landfilled waste at the proposed Newcastle Landfill Site based on waste acceptance rates. LandGEM is based on the gas generated from anaerobic decomposition of landfilled waste which has a Methane (CH_4) content between 40 – 60%. The emissions were calculated based on the following landfill characteristics:

- Landfill open year: 2019;

- Landfill closure year: 2056;
- Waste design capacity: 375 tons/day; and
- Operational hours: 260 days/annum.

The average emissions for all seven cells over the lifespan of the landfill are shown in Table 6-17.

Table 6-17: Landfilling activities from the proposed Newcastle Landfill Site.

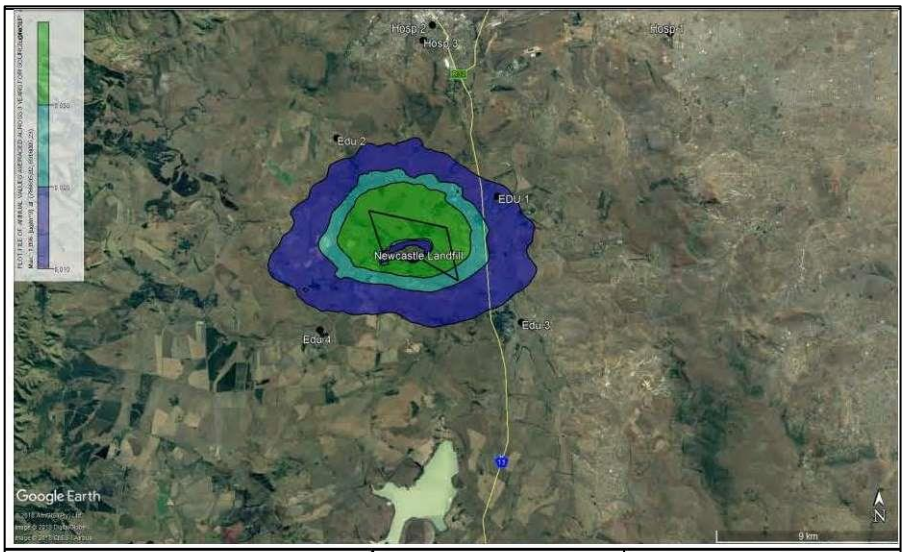
SOURCE	SIZE OF LANDFILL AREA	EMISSION RATE (g/s)				
		H_2S	Benzene	Toluene	Ethylbenzene	Xylene
Operation Phase						
Decomposition of landfill waste	1 855 m^2	0,07793	0,05458	0,9949	0,03102	80,9193
Notes: • *Area size provided by client.*						

Dispersion simulations were undertaken to determine predicted ground-level impacts from all key sources of H_2S and BTEX for the operational activities associated with the proposed site.

6.4.1.1 Benzene

Predicted incremental benzene concentrations associated with proposed operational activities at the proposed landfill sites are presented in **Figure 6-10**. Predicted incremental benzene concentrations:

- Comply with the South African annual average standard of 5 µg/m^3, with no exceedances observed. A maximum predicted incremental concentration of 1 µg/m^3 was recorded (**Figure 6-10**); and
- Predicted incremental concentrations at identified surrounding receptors are shown to be very low (**Table 6-18**).



COMMENTS: No exceedances of the SA Benzene annual standard of 5 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Deposition Rates
	NUMBER OF SOURCES: X1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	BENZENE STANDARD: SA annual standard 5 µg/m^3. **DATE:** 12/04/2017	

Figure 6-10: Predicted incremental annual benzene concentrations for the proposed site (operational phase).

Table 6-18: Maximum predicted incremental BTEX and H_2S concentrations at nearby sensitive receptors (operational phase).

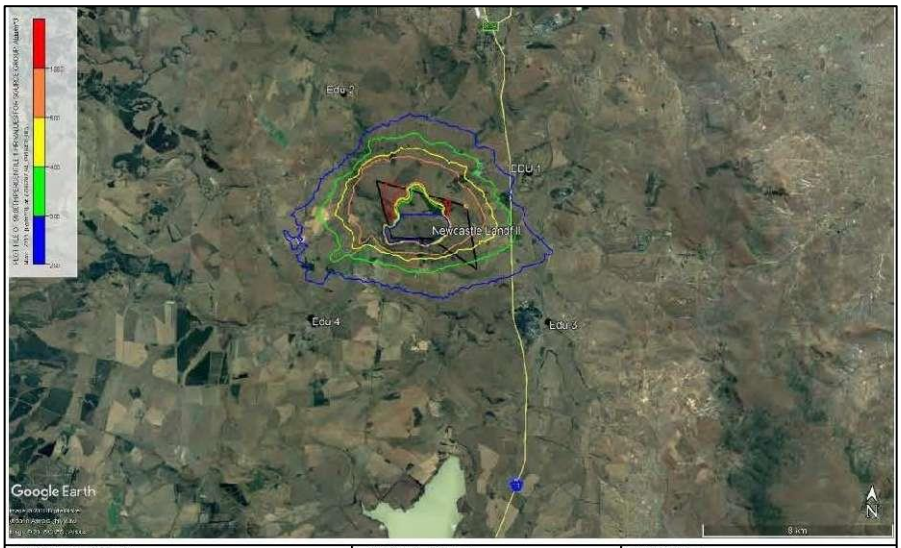
SENSITIVE RECEPTOR	CO-ORDINATES		BENZENE	TOLUENE		ETHYLBENZENE	XYLENE		HYDROGEN SULPHIDE	
			ANNUAL	1-HOUR	24-HOUR	1-HOUR	1-HOUR	24-HOUR	1-HOUR	24-HOUR
STANDARD ($\mu g/m^3$)	X	Y	5	1880	400	2000	2300	700	14	4
Edu1	784754,95	6919647,35	0.009	81.30	78.09	2.53	6.37	6.12	0.22	0.2
Area 1	799824,22	6927465,59	0.001	10.05	10.21	0.31	0.79	0.8	0.027	0.03
Edu 2	788134,43	6925776,81	0.002	14.13	25.80	0.44	1.11	2.02	0.039	0.07
Edu 3	792301,86	6917298,25	0.01	160.95	78.06	5.02	12.61	6.11	0.44	0.2
Edu 4	783679,59	6910184,88	0.006	72.64	49.37	2.26	5.69	3.87	0.2	0.13
Edu 5	791870,75	6910113,03	0.007	87.70	40.03	2.73	6.87	3.14	0.2	0.1
Edu 6	794457,43	6911047,11	0.006	70.50	39.21	2.20	5.52	3.07	0.19	0.1
Edu 7	789212,21	6905801,89	0.003	29.68	34.58	0.93	2.33	2.71	0.08	0.09
Health 1	799871,71	6925607,77	0.001	9.80	13.38	0.31	0.77	1.05	0.03	0.04
Health 2	800717,04	6925269,64	0.001	9.62	10.29	0.30	0.75	0.81	0.03	0.03
Area 1	795306,97	6928059,21	0.001	7.87	9.97	0.25	0.62	0.78	0.02	0.03
Area 3	801562,36	6922902,74	0.001	13.30	14.14	0.41	1.04	1.11	0.04	0.04
Fernwood	785681,26	6924407,02	0.003	20.12	29.91	0.63	1.58	2.34	0.05	0.08
Arbor Park	790850,32	6924504,92	0.002	15.63	31.72	0.49	1.22	2.48	0.04	0.09

Notes:
- *Edu = educational facility/school/training centre*
- *Old = old age home*
- *Hosp = hospital/clinic/health care facility*
- *+ = and*
- *Area = unknown name area identified as a nearby receptor*

6.4.1.2 Toluene Concentrations

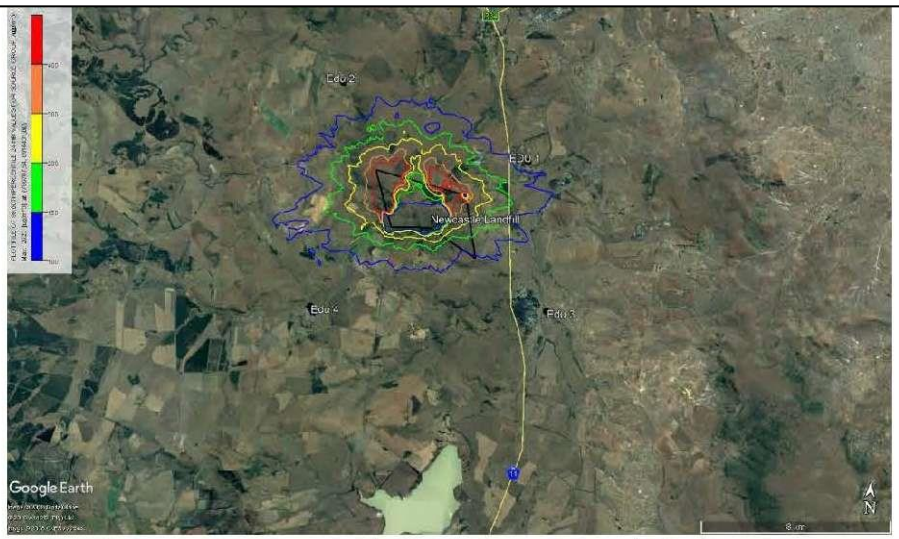
Predicted incremental toluene concentrations associated with operational activities at the proposed landfill site are presented in **Figure 6-11** and **Figure 6-12**. Predicted incremental toluene concentrations:

- Comply with the Alberta Canadian hourly guideline of 1 880 µg/m^3 beyond the landfill site boundary (**Figure 6-11**);
- Comply with the Alberta Canadian daily guideline of 400 µg/m^3 beyond the southern and eastern site boundaries. Exceedances of the guideline occur near to the site, within 800 m of the boundary line (**Figure 6-12**); and
- No exceedances of the hourly and daily guidelines occur at identified surrounding receptors (**Table 6-18**).



COMMENTS: Red band - exceedances of the Alberta Canada hourly guideline of 1880 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: Alberta Ambient Air Quality Guideline of 1 880 µg/m^3 **DATE:** 12/04/2017	

Figure 6-11: Predicted incremental hourly toluene concentrations for the proposed site (operational phase).



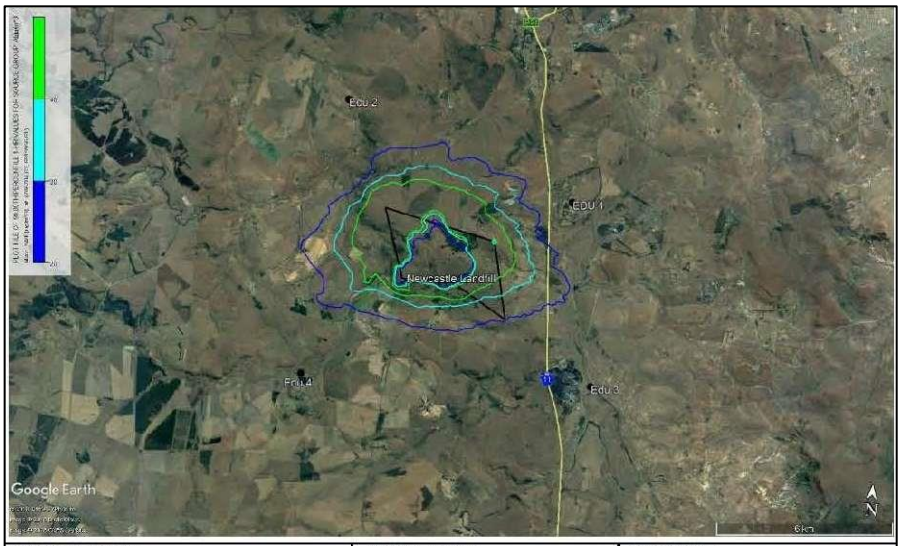
COMMENTS: Red band - exceedances of the Alberta Canada daily guideline of 400 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 400 µg/m^3 (Alberta Canada annual guideline) **DATE:** 12/04/2017	

Figure 6-12: Predicted daily average toluene concentrations for the proposed site (operational phase).

6.4.1.3 Xylene Concentrations

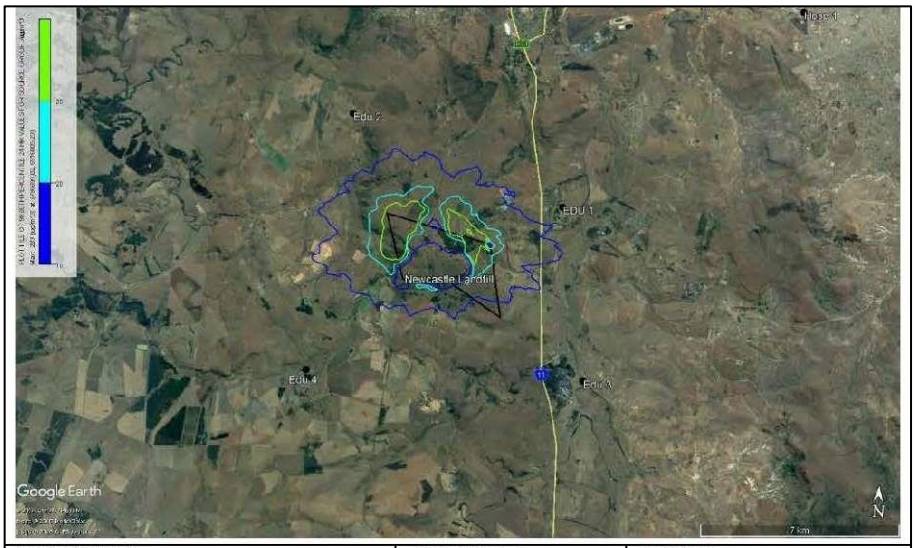
Predicted incremental xylene concentrations associated with operational activities at the proposed landfill site are presented in **Figure 6-13** and **Figure 6-14**. Predicted incremental xylene concentrations:

- No exceedances of the Alberta Canadian hourly guideline of 2 300 µg/m^3 and daily guideline of 700 µg/m^3 were observed (**Figure 6-13** and **Figure 6-14**); and
- A maximum hourly average modelled concentration of 539 µg/m^3 and daily concentration of 202 µg/m^3 were recorded (**Table 6-18**).



COMMENTS: No exceedances of the Alberta Canada 1-hour guideline of 2300 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 2300 µg/m^3 (Alberta Canada 1-Hour standard) **DATE:** 12/04/2018	

Figure 6-13: Predicted hourly average xylene concentrations for the proposed site (operational phase).



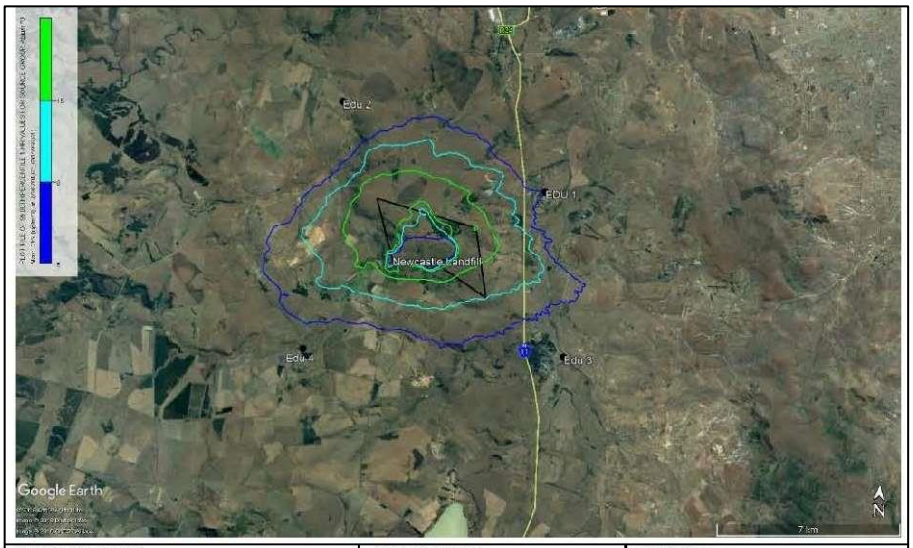
COMMENTS: No exceedances of the Alberta Canada guideline of 700 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 700 µg/m^3 (Alberta Canada 24H Guideline) **DATE:** 12/04/2018	

Figure 6-14: Predicted daily average xylene concentrations for the proposed site (operational phase).

6.4.1.4 Ethylbenzene Concentrations

Predicted incremental ethylbenzene concentrations associated with operational activities at the proposed landfill site are presented in **Figure 6-15**. Predicted incremental xylene concentrations:

- No exceedances of the Alberta Canadian hourly guideline of 2 000 µg/m^3 were observed (**Figure 6-15**); and
- A maximum modelled concentration of 215 µg/m^3 was recorded (**Table 6-18**).



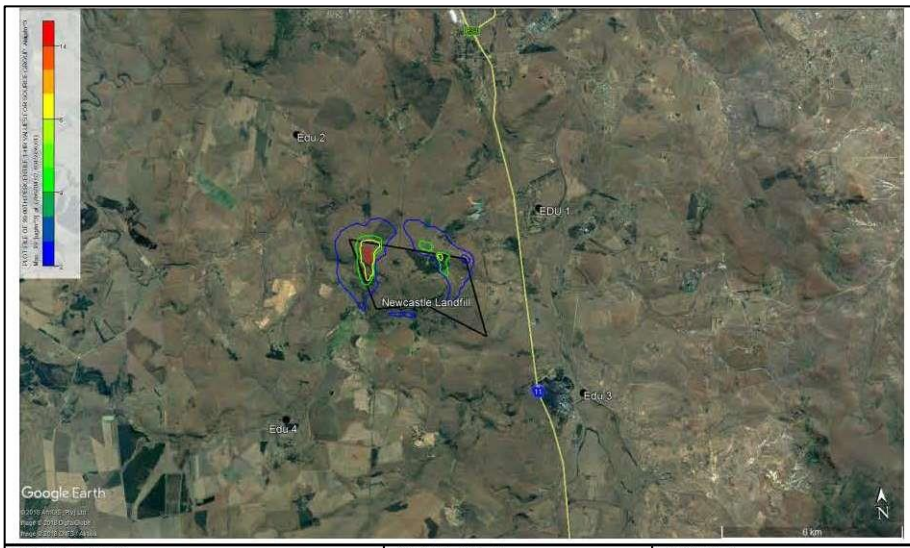
COMMENTS: No exceedances of the Alberta Canada 1-hour guideline of 2000 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 2 000 µg/m^3 (Alberta Canada 1-Hour guideline) **DATE:** 12/04/2018	

Figure 6-15: Predicted hourly average ethylbenzene concentrations for the proposed site (operational phase).

6.4.1.5 Hydrogen Sulphide Concentrations

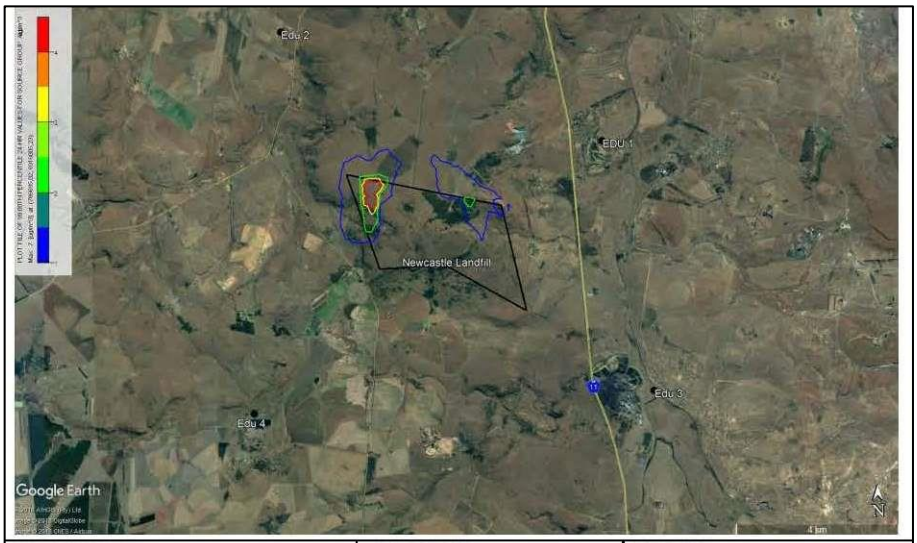
Predicted incremental H_2S concentrations associated with operational activities at the proposed landfill site are presented in **Figure 6-16** and **Figure 6-17**. Predicted incremental H_2S concentrations:

- Comply with the Alberta Canadian hourly and average guidelines of 14 µg/m^3 and 4 µg/m^3 respectively (**Figure 6-13** and **Figure 6-14**); and
- Predicted incremental concentrations at surrounding sensitive receptors comply with the above-mentioned guidelines (**Table 6-18**).



COMMENTS: Red band - exceedances of the Alberta Canada guideline of 14 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 14 µg/m^3 (Alberta Canada 1H Guideline) **DATE:** 12/04/2018	

Figure 6-16: Predicted hourly average H_2S concentrations for the proposed site (operational phase).



COMMENTS: All band - exceedances of the Alberta Canada 24-hour guideline of 4 µg/m^3.	**GRID SIZE:** 15 x 15 km	**MODEL:** AERMOD View
	GRID: Multi-tier – 3 tiers	**OUTPUT TYPE:** 99th Percentile Ground Level Concentrations
	NUMBER OF SOURCES: X 1 area	**ASSUMPTIONS:** Modelled last cell as if operating at end of life of landfill.
	AMBIENT STANDARD: 4 µg/m^3 (Alberta Canada 24 Hour standard) **DATE:** 12/04/2018	

Figure 6-17: Predicted daily average H_2S concentrations for the proposed site (operational phase).

6.4.2 Wetland Buffer Zones

As detailed in Section 6.3.2, for the construction phase, the DWS buffer tool recommends, at a desktop level, that the required buffer for the development of a landfill site be 180 m whilst a minimum buffer zone of 175 m is recommended for wetlands for activities related to mining (Macfarlane *et al*. 2009). These minimum buffer widths are designed to protect core wetland habitat and aquatic functioning and are calculated based on a simple classification of wetland types and land use categories. This is relevant for the landfill development as activities are similar to mining and the risk of water contamination is high.

When assessing the proposed landfill site it is shown that the largest risks (Very High) posed by the project during the operational phase are that of alteration of patterns of flows (increased flood peaks) and inputs of toxic organic contaminants. These impact would arise due to the operation of the landfill site and the potential for pollution as a result of insufficient stormwater management planning and/or water management on site. These risks

are calculated with no prescribed mitigation and the calculated buffer requirement for the operational phase (pre-mitigation) is determined to be 100 m around each identified wetland.

According to the buffer guideline (Macfarlane *et al*. 2014) a high risk activity would require a buffer that is 95% effective to adequately reduce the risk of the impact to a low level threat. Through implementation of the proposed mitigation measures for the operational phase, the risks for some aspects are reduced and the required buffer (post mitigation) is then calculated to be 28 m (Figure 6-6).

The mitigation measures applied included the assumption that there will be no working within wetland areas. All excavation, dumping and roads would be beyond the wetland and buffer zone. The highest risks after mitigations measures were applied were determined to be medium risks.

6.4.3 Calculated Noise Impacts

The following sound levels were used in determining the noise level at identified receptor areas:

- Operational Phase:
    - Traffic to the landfill site – 80.0 dBA;
    - Off-loading of waste – 90.5 dBA;
    - Compaction activities – 95.0 dBA;
    - Maintenance activities – 85.0 dBA;
    - Emergency signal on landfill machinery – 90.0 dBA; and
    - Emergency generator – 90.0 dBA.

6.4.3.1 Noise Intrusion Levels

The criteria for assessing the magnitude of a noise impact are illustrated in Table 6-14.

The environmental noise impact assessment in terms of the magnitude of a noise impact during the operational phase of the landfill site at the residential areas is illustrated in Table 6-19. The day and night time noise intrusion will be Not Audible for all except one receptor. Receptor M will experience Very Low noise intrusion during the day time and Low noise intrusion during the night time.

Table 6-19: Calculated noise intrusion levels (dBA) during the Operational Phase.

RESIDENTIAL PROPERTY	TRAFFIC TO AND FROM THE LANDFILL SITE	OFFLOADING OF WASTE	COMPACTION ACTIVITIES	MAINTENANCE ACTIVITIES	EMERGENCY SIGNAL ON LAND AND MACHINERY	EMERGENCY GENERATOR	CUMULATIVE LEVELS	CUMULATIVE NOISE LEVEL - DAYTIME	CUMULATIVE NOISE LEVEL - NIGHT TIME	INTRUSION NOISE LEVEL - DAYTIME	INTRUSION NOISE LEVEL - NIGHT TIME
A	6.8	9.8	14.8	6.8	9.8	9.8	18.4	39.0	41.7	**0.0**	**0.0**
B	5.9	8.9	13.9	5.9	8.9	8.9	17.4	39.0	41.7	**0.0**	**0.0**
C	5.5	8.5	13.5	5.5	8.5	8.5	17.0	39.0	41.7	**0.0**	**0.0**
D	8.9	11.9	16.9	8.9	11.9	11.9	20.5	32.9	34.1	**0.1**	**0.1**
E	11.2	14.2	19.2	11.2	14.2	14.2	22.7	33.0	34.2	**0.4**	**0.3**
F	8.7	11.7	16.7	8.7	11.7	11.7	20.3	36.7	41.7	**0.1**	**0.0**
G	10.2	13.2	18.2	10.2	13.2	13.2	21.8	36.7	41.7	**0.1**	**0.0**
H	11.2	14.2	19.2	11.2	14.2	14.2	22.8	36.0	36.2	**0.2**	**0.2**
I	16.5	19.5	24.5	16.5	19.5	19.5	28.0	36.5	36.6	**0.6**	**0.5**
J	16.3	19.3	24.3	16.3	19.3	19.3	27.8	36.4	36.6	**0.5**	**0.5**
K	13.2	16.2	21.2	13.2	16.2	16.2	24.8	44.2	37.7	**0.0**	**0.2**
L	12.8	15.8	20.8	12.8	15.8	15.8	24.3	43.0	41.8	**0.1**	**0.1**
M	23.0	26.0	31.0	23.0	26.0	26.0	34.5	40.3	37.2	**1.1**	**2.9**
N	9.2	12.2	17.2	9.2	12.2	12.2	20.8	61.3	58.1	**0.0**	**0.0**

The calculated noise levels along the roads during the operational phase will be as follows:

- Along the N11 – 52.6 dBA;
- Along the upgraded access road – 52.6 dBA;
- In the vicinity of noise receptor E – 16.2 dBA;
- In the vicinity of noise receptor L – 24.7 dBA; and
- In the vicinity of noise receptor M – 40.3 dBA.

The calculated noise levels along the roads during the operational phase will be as follows:

- Along the N11 – 52.6 dBA;
- Along the upgraded access road – 52.6 dBA;
- In the vicinity of noise receptor E – 16.2 dBA;
- In the vicinity of noise receptor L – 24.7 dBA; and
- In the vicinity of noise receptor M – 40.3 dBA.

6.4.4 Visual Viewshed Analysis

To identify and quantify the potential magnitude of visual impacts on identified receptors, individual viewshed analysis (areas which have direct visibility to proposed infrastructure) scenarios were run for key proposed infrastructure and the infrastructure elements identified as being sensitive to a visual impact were identified as follows:

- Landfill cells (vertical footprint: ±5 m);
- Cover material stockpile (vertical footprint: ± m);
- Gas extraction plant (vertical footprint: ±3 m);
- Leachate treatment plant (vertical footprint: ±6 m); and
- Collection dam (vertical footprint: ±3 m).

The viewshed exposure classes are detailed in Table 6-20 and are presented visually on all viewshed analysis maps.

Table 6-20: Viewshed Exposure Classes.

VIEWSHED EXPOSURE CLASS	GRADING (%)
Low	5 - 20
Low - Medium	20 - 40
Medium	40 - 60
Medium - High	60 -80
High	80 - 100

The results of the individual viewshed analyses indicates that the visibility of the proposed surface infrastructure will be largely contained to the Eastern and Western regions of the 10 km buffer extent. The changes in topographic ranges in the region act as a screen for the regions to the south and north. The key results and findings from the viewshed analyses for each modelled site are presented in the sections that follow.

6.4.4.1 Landfill Cells Viewshed Results

The landfill cells were modelled with a 5 m vertical offset to cater for the maximum elevation at any point of the landfill sites operation. The results of the viewshed analysis indicate that areas to the West and areas to the east will experience medium – low degrees of exposure to the proposed infrastructure (Figure 6-18). The highest visual exposure will be constricted within the immediate plateau of the development site, extending to the south west. The affected receptors identified include disperse agricultural settlements, parts of the boundary street route and low exposure to the Incandu falls recreational site. Importantly, the viewshed model indicates that the landfill cells will have no exposure along the N11 route.

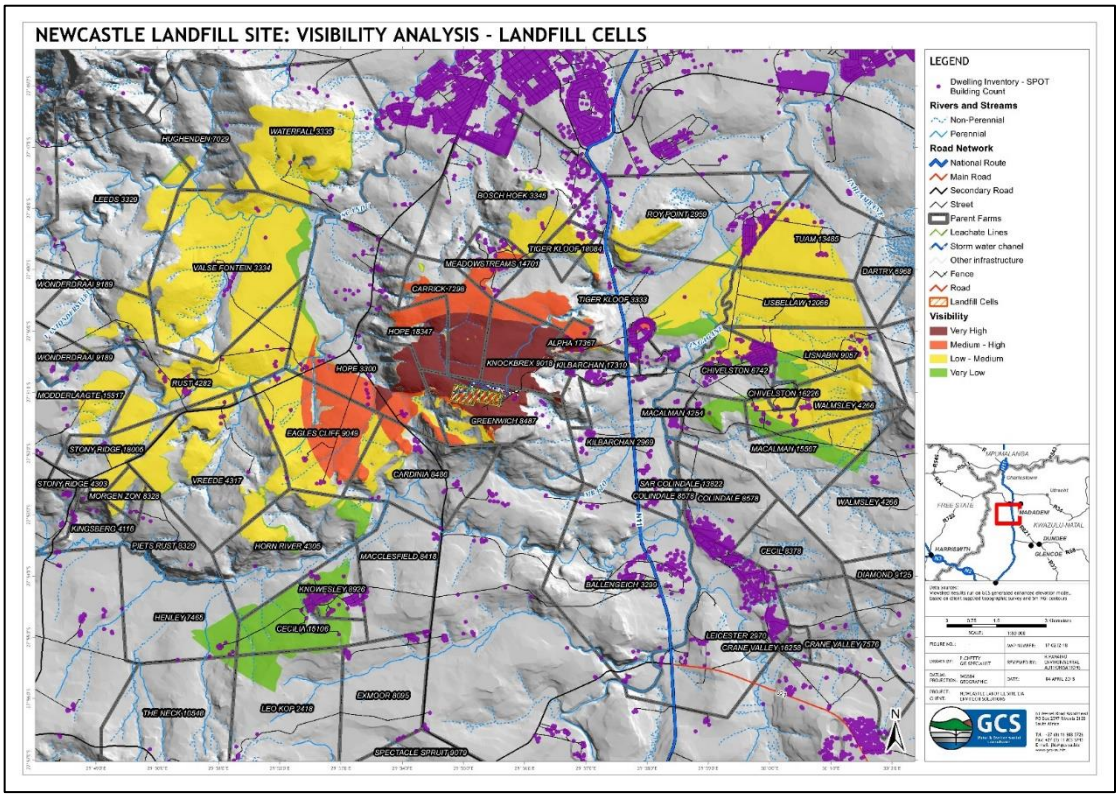


Figure 6-18: Viewshed Analysis for the Landfill Cells.

6.4.4.2 Cover Material Stockpile Viewshed Results

The cover material stockpile region was modelled at a 6 m vertical offset. The viewshed results for the stockpile indicate that the highest degrees of visibility will be limited to the immediate plateau region, with medium – low degrees of exposure to the western sectors of the potential zone of influence (Figure 6-19).

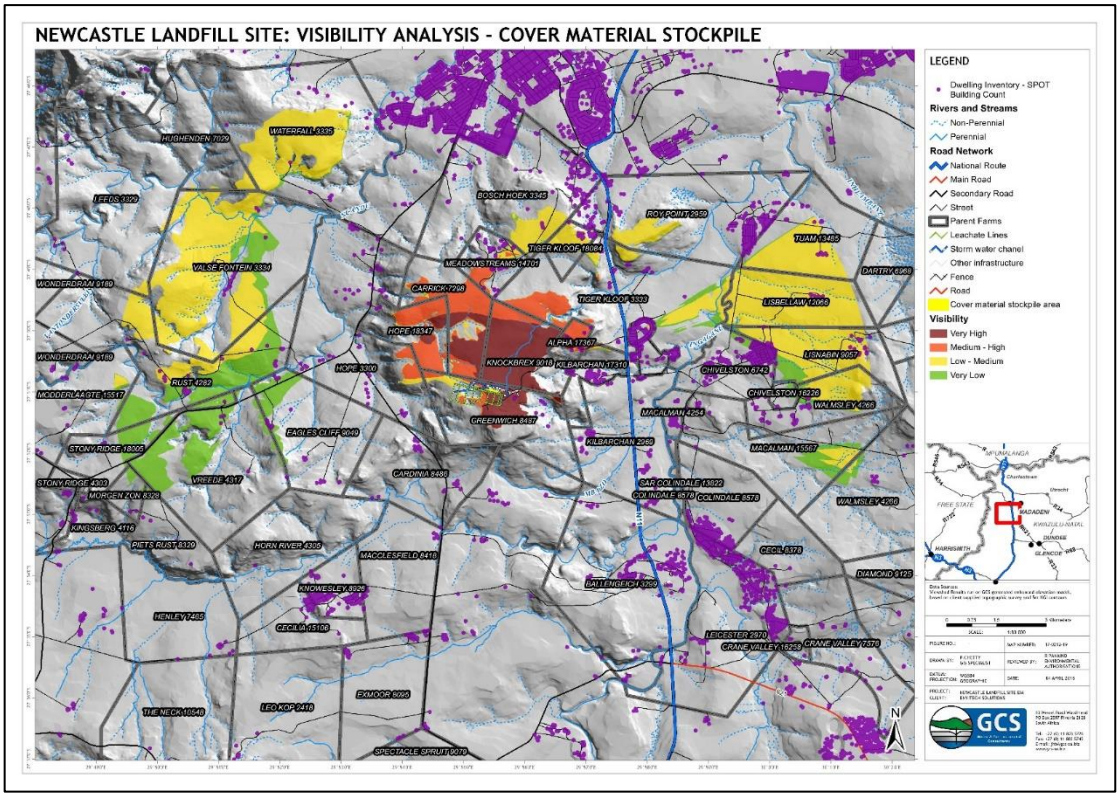


Figure 6-19: Viewshed Analysis for the Cover Material Stockpile.

6.4.4.3 Gas Extraction Plant Viewshed Results

The gas extraction plant was modelled with a 3 m vertical offset across the footprint of the proposed gas extraction plant. The viewshed results indicate that the gas extraction plants' high visual exposure is limited to the western side of the plateau, with lesser degrees to the far western regions of the potential zone of influence (Figure 6-20).

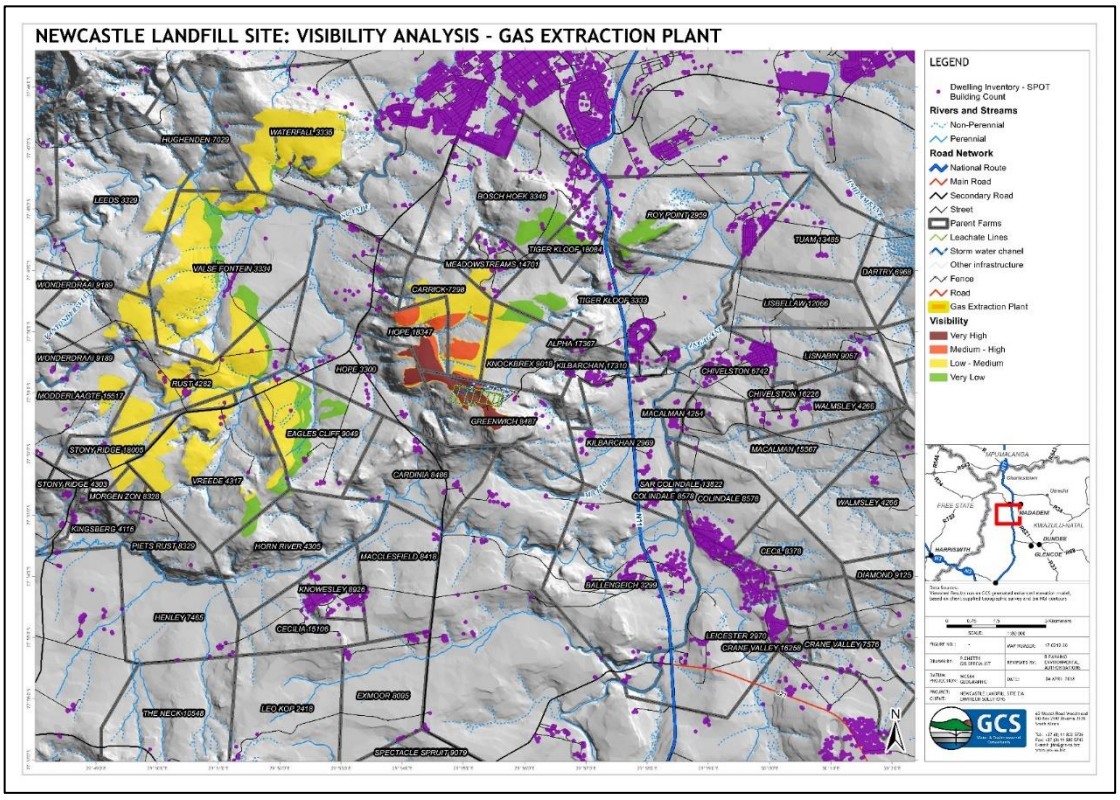


Figure 6-20: Viewshed Analysis for the Gas Extraction Plant.

6.4.5 Leachate Treatment Plant and Collection Dam Viewshed Results

The leachate treatment plant and collection dam were modelled simultaneously, due to the proximity of the proposed footprints. The leachate treatment plant was modelled with a vertical offset of 6 m, while the collection dam was modelled with an offset of 3 m. The viewshed outputs for the leachate treatment plant and collection dams resemble the outputs for the gas treatment plant, with the highest degrees of visual exposure along the western plateau, and medium to low degrees of exposure in the distant western region of the zone of influence (Figure 6-21).

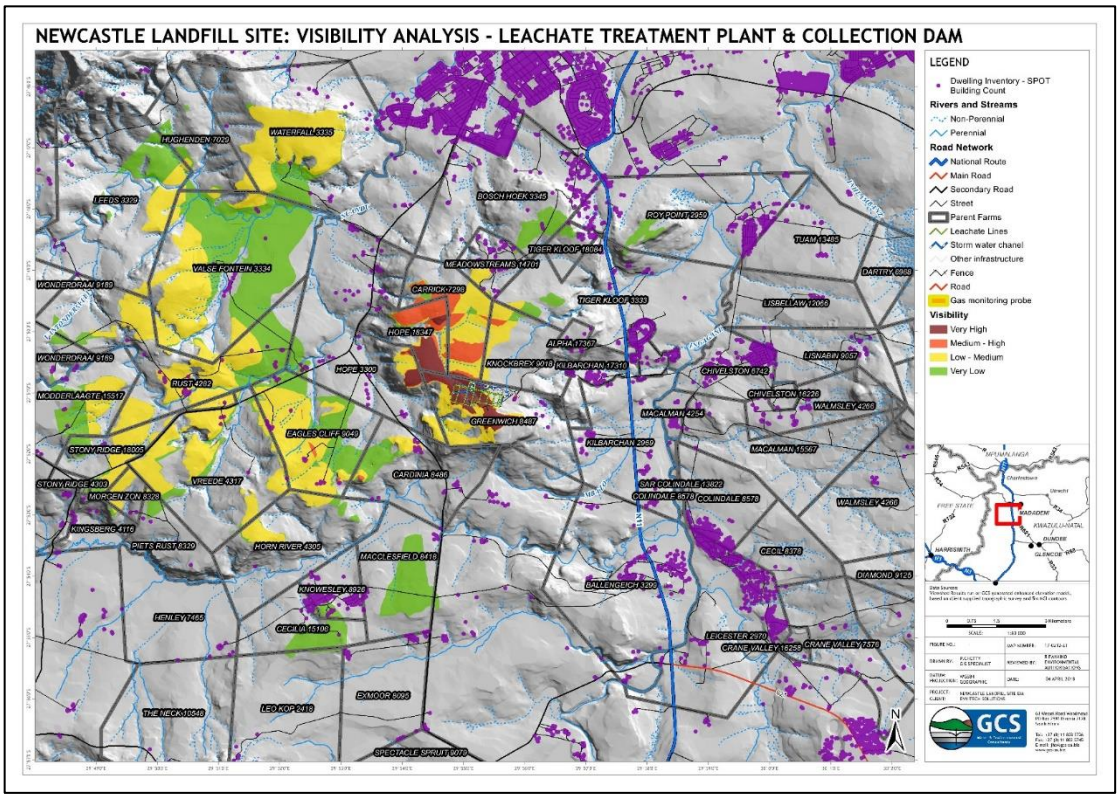


Figure 6-21: Viewshed Analysis for the Leachate Treatment Plant and Collection Dam.

A cumulative view of all viewshed modelling results is presented in Figure 6-22.

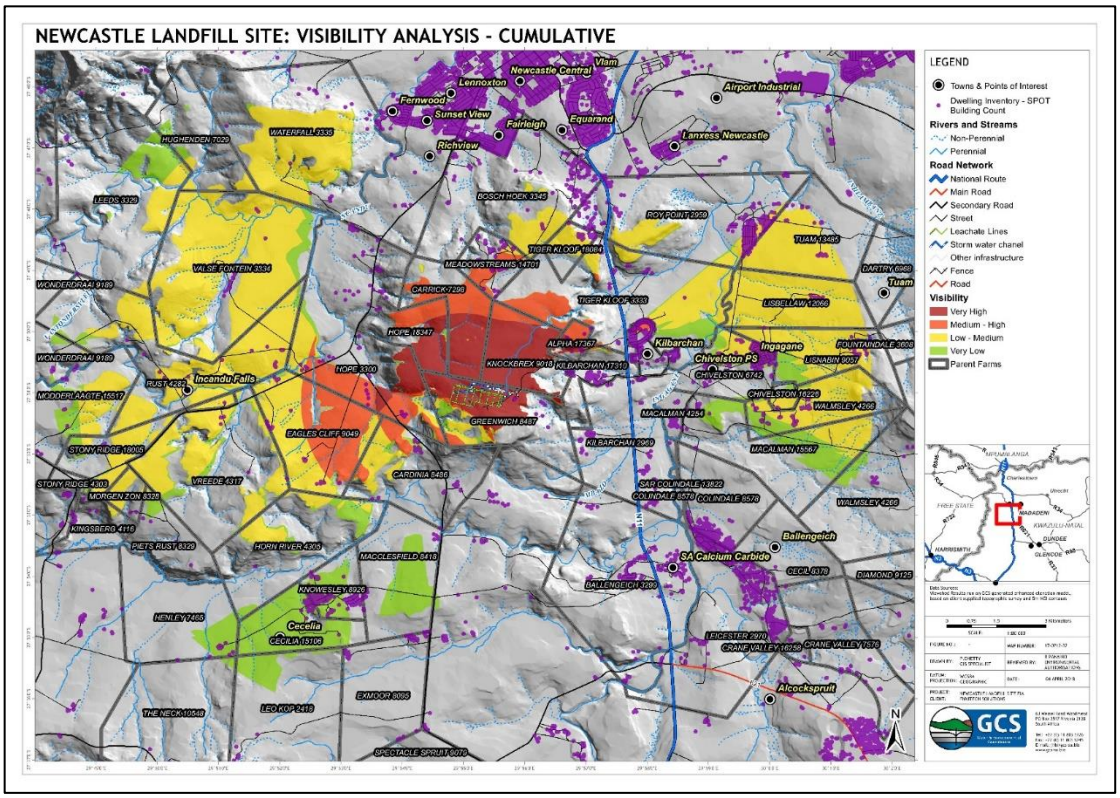


Figure 6-22: Viewshed Analysis for the Cumulative Effects of all Infrastructure Components.

6.5 Decommissioning and Closure Phase

Closure for landfill activities is highly important as far as the environmental factors are concerned. If mitigation measures are not followed properly it could have devastating environmental impacts, as closure without mitigation factors could have a permanent effect on the area and its surrounds. The main decommissioning and closure activities anticipated to have an impact on the bio-physical environment will be:

- Site clearing/preparation;
- Heavy machinery and vehicle movement;
- Hydrocarbon spills;
- Chemical spills;
- Earth Excavation;
- Revegetation;
- Infrastructure removal; and
- After closure rehabilitation.

The decommissioning and closure phase impacts that were identified are presented in Table 6-21.

Table 6-21: Anticipated Decommissioning and Closure Phase Impacts.

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Visual	Landscape visual Change	+
Soil, Land Use and Land Capability	Pollution of soil	+
Social	Nuisance/decline in human health (dust and noise)	-
	Temporary job creation	+
	Permanent job losses	-
	Increase value of adjacent properties	+
	Improvement of sense of place	+
	Positive impact of suitable end-use	+
Ecology	Decommissioning is likely to result in altered topography of the project area, decreased faunal and floral diversity	-
Wetlands	Sedimentation of wetland areas	-
	Loss of wetland plant diversity and increased surface roughness	-
Hydrology	Pollution of nearby watercourses	-
	Siltation of watercourses due to deposition of eroded soils	-

6.5.1 Calculated Noise Impact

6.5.1.1 Noise Intrusion Levels

The following sound levels were used in determining the noise level at identified receptor areas:

Decommissioning and closure phase

- Demolition of surface infrastructure – 90.5 dBA; and
- Rehabilitation of landfill site – 85.0 dBA.

The criteria for assessing the magnitude of a noise impact are illustrated in Table 6-14.

The environmental noise impact assessment in terms of the magnitude of a noise impact during the decommissioning and closure phase of the landfill site at the residential areas is illustrated in Table 6-22. The day and night time noise intrusion will be Not Audible for all receptors.

Table 6-22: Calculated noise intrusion levels (dBA) during the Decommissioning and Closure Phase.

RESIDENTIAL PROPERTY	DEMOLITION OF ALL SURFACE INFRASTRUCTURE	REHABILITATION OF ALL DISTURBED AREAS	CUMULATIVE LEVELS	CUMULATIVE NOISE LEVEL - DAYTIME	CUMULATIVE NOISE LEVEL - NIGHT TIME	INTRUSION NOISE LEVEL - DAYTIME	INTRUSION NOISE LEVEL - NIGHT TIME
A	9.8	6.8	11.6	39.0	41.7	**0.0**	**0.0**
B	8.9	5.9	10.6	39.0	41.7	**0.0**	**0.0**
C	8.5	5.5	10.3	39.0	41.7	**0.0**	**0.0**
D	11.9	8.9	13.7	32.7	33.9	**0.1**	**0.0**
E	14.2	11.2	15.9	32.7	34.0	**0.1**	**0.1**
F	11.7	8.7	13.5	36.6	41.7	**0.0**	**0.0**
G	13.2	10.2	15.0	36.6	41.7	**0.0**	**0.0**
H	14.2	11.2	16.0	35.8	36.0	**0.0**	**0.0**
I	19.5	16.5	21.2	35.9	36.1	**0.1**	**0.1**
J	19.3	16.3	21.0	35.9	36.1	**0.1**	**0.1**
K	16.2	13.2	18.0	44.2	37.5	**0.0**	**0.0**
L	15.8	12.8	17.5	42.9	41.7	**0.0**	**0.0**
M	26.0	23.0	27.7	39.3	34.8	**0.3**	**0.9**
N	12.2	9.2	14.0	61.3	58.1	**0.0**	**0.0**

The landfill site will be required to apply for a Closure Certificate in accordance with NEMA once the end of the life of the landfill site is reached.

6.6 Residual Impacts Post Closure

Although it is assumed that all impacts will be managed, mitigated and rehabilitated by the proposed closure objectives, some residual impacts may however still be present. The main residual impacts post closure anticipated to have an impact on the bio-physical environment will be:

- After closure rehabilitation.

The residual impacts post closure that were identified are presented in Table 6-23.

Table 6-23: Anticipated Residual Impacts Post Closure.

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Visual	Artificial Hills - change in immediate relief	-
Wetlands	Wetland health improvement	+

6.7 Cumulative Impacts

Section 2 of the NEMA requires the consideration of cumulative impacts as part of any environmental assessment process. Furthermore this is carried forward into Regulation 543 which requires assessment of cumulative impacts in an EIR. EIRs have traditionally, however, failed to come to terms with such impacts, largely as a result of the following considerations:

- Cumulative effects may be local, regional or global in scale and dealing with such impacts requires co-ordinated institutional arrangements; and
- Impact assessments are typically carried out on specific developments, whereas cumulative impacts result from broader biophysical, social and economic considerations, which typically cannot be addressed at the project level.

The cumulative impacts that were identified are presented in Table 6-24.

Table 6-24: Anticipated Residual Impacts Post Closure.

SPECIALIST FIELD	ANTICIPATED IMPACT	STATUS (PRE-MITIGATION)
Ecology	Loss of habitat in peripheral areas due to establishment of economic node.	-
Heritage	Damage to the cultural landscape	-

6.8 Impact Assessment for the Proposed Landfill Site

Table 6-25 presents the findings of the impact assessment undertaken. This table identifies the phase, activity, aspect and associated impact for each specialist field of investigation. The significance before and after mitigation is provided together with identified mitigation measures, action plans and identification of a responsible person to monitor the impact during each phase.

Table 6-25: Summarised Impact Assessment.

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
Visual Impact Assessment											
1	Construction	Infrastructure establishment	Cover Material Stockpile	Landscape visual Change	-	M	-	L	Minimise construction duration. Minimise dust fallout,. Minimise light intrusion	Implement dust suppression. Restrict working hours to day time.	Contracted Site Manager
2	Operation	Earth Excavation	Landfill Cells	Change of Visual Character	-	M	-	M	Place visual screens along perimeter fence	Place visual screens along perimeter fence	Superintendent for Newcastle Inner
3	Operation	Infrastructure establishment	Cover Material Stockpile	Change of Visual Character	-	M	-	M	Ensure low visibility of earthworks	Place visual screens along perimeter fence	Superintendent for Newcastle Inner
4	Operation	Infrastructure establishment	Gas Extraction Plant	Change of Visual Character	-	M	-	M	Minimise visual intrusion	Cover material to be a neutral colour in relation to the environment	Superintendent for Newcastle Inner
5	Operation	Infrastructure establishment	Leachate Treatment Plant	Change of Visual Character	-	M	-	M	Minimise visual intrusion	Cover material to be a neutral colour in relation to the environment	Superintendent for Newcastle Inner
6	Operation	Infrastructure establishment	Collection Dam	Change of Visual Character	-	M	-	M	Minimise visual intrusion	Place visual screens along perimeter fence	Superintendent for Newcastle Inner
7	Operation	Heavy machinery and vehicle movement	Associated logistics on site	Change in sense of place	-	M	-	M	None	Refer to Visual Impact Assessment	Superintendent for Newcastle Inner
8	Decommissioning and Closure	Infrastructure removal	Deconstruction activity	Landscape visual Change	-	M	-	M	Minimise decommissioning duration. Minimise dust fallout,. Minimise light intrusion	Implement dust suppression. Restrict working hours to day time.	Superintendent for Newcastle Inner
9	Residual	After closure rehabilitation	Closure of capacity landfill site	Artificial Hills - Change in immediate relief	-	M	-	M	Minimise degradation of overall site	Implement rehabilitation plan	Superintendent for Newcastle Inner
Geohydrological Impact Assessment											
10	Construction	Hydrocarbon spills	Heavy machinery and vehicle movement	Groundwater contamination	-	M	-	M	Containment of all fuel stored on site; Implementation of a groundwater monitoring programme. Avoid spills of any contaminants	Ensure all contaminant areas are lined or bunded. Accurate oil records must be kept (purchased, disposal, and recycled). Ensure that clean-up protocols are in place and adhered to. Adhere to monitoring schedule.	Contracted Site Manager

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
11	Operation	Hydrocarbon spills	Heavy machinery and vehicle movement	Groundwater contamination	-	M	-	L	Containment of all fuel stored on site; Implementation of a groundwater monitoring programme. Avoid spills of any contaminants	Ensure all contaminant areas are lined or bunded. Accurate oil records must be kept (purchased, disposal, and recycled). Ensure that clean-up protocols are in place and adhered to. Adhere to monitoring schedule.	Superintendent for Newcastle Inner
12	Operation	Waste site operation	Spillages or leakages	Groundwater contamination	-	L	-	M	Ensure adequate lining and drainage systems are installed; Ensure surface water runoff is contained and treated before disposal; Groundwater monitoring to ensure early detection of pollution.	Lining and draining system to be implemented as approved by DWS. Implement SWMP. Adhere to monitoring schedule	Superintendent for Newcastle Inner
Hydrology											
13	Construction	Removal of vegetation and land preparation	Disturbance of the soil	Sedimentation/Siltation of nearby watercourses	-	M	-	L	Avoid sedimentation of downstream water courses	Install silt traps to capture sediment before it reaches watercourses; Restrict clearance to footprint area.	Contracted Site Manager
14	Construction	Heavy machinery and vehicle movement	Spillage and leakage of oils, grease and other chemicals	Pollution of nearby watercourses	-	M	-	L	Conduct quick clean-ups after spills;	Oil recovered from vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.	Contracted Site Manager
15	Construction	Removal of vegetation and land preparation	Permanent destruction of stream headwater sections	Reduction of runoff at downstream reaches by approximately 0.5 % of MAR.	-	H	-	M	Treating dirty water from the PCD and then discharge clean treated water into the natural environment to recoup a fraction of the water lost	Refer to storm water management plan	Contracted Site Manager
16	Construction	Removal of vegetation and land preparation	Destruction of aquatic and riparian habitats	Reduced bio-diversity	-	H	-	H	This impact cannot be mitigated	none available	Contracted Site Manager
17	Operation	Infrastructure construction	Increase of paved surfaces	Increased probability of flooding	-	M	-	L	Minimise impervious areas	Adhere to the storm water management plan.	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
18	Operation	Dirty landfill stormflow and leachate seepage	Dissolution of pollutants by incident rainfall and stormflow	Pollution of nearby watercourses	-	M	-	L	Channel dirty storm water and leachate to a pollution control dam	Refer to storm water management plan	Superintendent for Newcastle Inner
19	Decommissioning and Closure	Infrastructure removal	Disturbance of the soil	Siltation of watercourses due to deposition of eroded soils	-	M	-	L	Avoid sedimentation of downstream water courses	Install silt traps to capture sediment before it reaches watercourses; Restrict clearance to footprint area.	Superintendent for Newcastle Inner
20	Decommissioning and Closure	Heavy machinery and vehicle movement	Spillage and leakage of oils, grease and other chemicals	Pollution of nearby watercourses	-	M	-	L	Conduct quick clean-ups after spills;	Oil recovered from vehicles and machinery should be collected, stored and disposed of by accredited vendors for recycling.	Superintendent for Newcastle Inner
Soil study											
21	Construction	Site clearing / preparation	vegetation removal	Soil exposure	-	M	-	M	Limit vegetation clearing	Minimize footprint of impact	Contracted Site Manager
22	Construction	Earth Excavation	Soil compaction/exposure	Soil compaction	-	L	-	L	Limit movement of heavy machinery	Demarcate clear no go areas and restrict movement to construction area only.	Superintendent for Newcastle Inner
23	Operation	Hydrocarbon spills	Oil/Diesel spill from machinery	pollution of soil	-	M	-	M	Avoid spills	Ensure quick clean-up of spills	Superintendent for Newcastle Inner
24	Operation	Waste site operation	Leaching/overtopping of landfill leachate	Pollution of soil	-	M	-	M	Ensure leachate does not overtop cell or leak through lining	Ensure correct lining/sealing of waste as approved by DWS. Monitoring leachate detection system adhere to SWMP	Superintendent for Newcastle Inner
25	Operation	Earth Excavation	excavation of cover material from adjacent cell	Erosion	-	M	-	M	Minimize erosion and runoff	Temporary cover of exposed area during rainfall events Minimize area of exposed soil	Superintendent for Newcastle Inner
26	Operation	Earth Excavation	Incorrect storage of soils	Loss of soil	-	L	-	L	Correct storage of soil	Adhere to soil stockpiling recommendations	Superintendent for Newcastle Inner
27	Decommissioning and Closure	Waste site operation	Leaching/overtopping of landfill leachate	Pollution of soil	-	M	-	M	Ensure leachate does not overtop cell or leak through lining	Ensure correct lining/sealing of waste as approved by DWS. Monitoring leachate detection system adhere to SWMP	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
Social study											
28	Construction	Site clearing / preparation	employment	temp job creation +	+	M	+	M	Employ local labour	Recruit from local Indian village; up-skilling during construction works	Contracted Site Manager
29	Construction	Site clearing / preparation	inflow of job -seekers	decline in local safety -	-	M	-	M	Use local labour as far possible and avoid appointing opportunists who are looking for Peace jobs.	transparent recruitment process; supervision of construction workers; construction within normal hours 7am -5pm	Contracted Site Manager
30	Construction	Site clearing / preparation	movement of construction workers and vehicles	nuisance/decline in human health (dust and noise) -	-	M	-	M	Avoid excessive dust fallout near Indian village	The access route be deviated to avoid the Indian Village unsurfaced roads and ungrassed or unpaved areas must be regularly watered to restrict dust levels;	Contracted Site Manager
31	Operation	Waste site operation	employment	additional job creation +	+	M	+	M	Employ local labour	Vacant and/or additional unskilled jobs from the local village; local suppliers and service providers as far possible from local community	Superintendent for Newcastle Inner
32	Operation	Waste site operation	job seekers and reclaimers	decline in local safety -	-	M	-	L	Waste reclamation and squatting should be discouraged; strict access control, after hours security	Construct security fencing around site. Install CCTV systems long with 24hr security to react quickly to unwanted visitors.	Superintendent for Newcastle Inner
33	Operation	Waste site operation	traffic movement	decline in local safety -	-	M	-	M	Avoid excessive dust fallout near Indian village	The access route be deviated to avoid the Indian Village unsurfaced roads and ungrassed or unpaved areas must be regularly watered to restrict dust levels;	Superintendent for Newcastle Inner
34	Operation	Waste site operation	waste catching fire	decline in local safety -	-	M	-	M	prevent runaway fires	No burning of waste at landfill sites; fire monitoring and management plan (adhere to Environmental Awareness Plan) construct fire breaks	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
35	Operation	Waste site operation	wind-blown litter	decline in human and animal health -	-	M	-	L	Avoid excessive windblown waste creation	Daily waste compaction: litter fences where high winds are present; windblown litter must be picked up and removed from vegetation and fences on daily basis; waste trucks must be closed	Superintendent for Newcastle Inner
36	Operation	Waste site operation	spread of disease	decline in human and animal health -	-	M	-	L	No dumping of waste other than the authorised general waste.	Strict control of prohibited articles on the landfill; daily compaction and covering of waste; appropriate measures to minimise disease vectors (e.g. rats and flies)	Superintendent for Newcastle Inner
37	Operation	Waste site operation	ground and surface water pollution	economic costs of water pollution -	-	M	-	M	Implement control measures to avoid surface water pollution	Adhere to SWMP; no prohibited waste; covering non-infectious animal carcasses with lime and in trenches; on-going ground and surface water monitoring	Superintendent for Newcastle Inner
38	Operation	Waste site operation	perceived disamenity impact (litter , odour, visual)	disinvestment in local economy-	-	H	-	M	Minimise waste impacts as much as possible	on-going air quality monitoring; strict access control; daily waste compaction; effective rodent and vector control; fire management and control plan: litter control: noise management: dust suppression: odour control	Superintendent for Newcastle Inner
39	Operation	Waste site operation	perceived disamenity impact (litter , odour, visual)	devaluation of adjacent properties-	-	M	-	M	Minimise waste impacts as much as possible	on-going air quality monitoring; strict access control; daily waste compaction; effective rodent and vector control; fire management and control plan: litter control: noise management: dust suppression: odour control	Superintendent for Newcastle Inner
40	Operation	Waste site operation	noise impacts	increased noise -	-	M	-	M	Prevent excessive noise levels during operating hours and prevent noise impact after hours.	In the absence of by-laws, national regulations on noise control must be complied with Limit operational hours to daylight hours.	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
41	Operation	Waste site operation	visual intrusion	sense of place -	-	M	-	M	Management of litter;	recommendations of visual assessment report	Superintendent for Newcastle Inner
42	Operation	Waste site operation	perceived disamenity impact (litter , odour, visual)	impact on tourism activities -	-	L	-	L	Access control, daily waste compaction; litter control: odour control; rodent and vector control: fire management and control: noise control, dust suppression; visual impact recommendations	Implement environmental Awareness Plan	Superintendent for Newcastle Inner
43	Decommissioning and Closure	Infrastructure removal	movement of construction workers and vehicles	nuisance/decline in human health (dust and noise) -	-	M	-	M	Avoid excessive dust fallout near Indian village	The access route be deviated to avoid the Indian Village unsurfaced roads and ungrassed or unpaved areas must be regularly watered to restrict dust levels;	Superintendent for Newcastle Inner
44	Decommissioning and Closure	Infrastructure removal	employment	temp job creation +	+	M	+	M	Employ local labour	Recruit from local Indian village; up-skilling during construction works	Superintendent for Newcastle Inner
45	Decommissioning and Closure	Infrastructure removal	employment	perm job losses +	+	M	+	M	Deploy workers to new landfill	Deploy workers to new landfill	Superintendent for Newcastle Inner
46	Decommissioning and Closure	Infrastructure removal	perceived decrease in disamenity impact (litter , odour, visual)	increase value of adjacent properties +	+	H	+	M	No mitigation measure possible	No action plan possible	Superintendent for Newcastle Inner
47	Decommissioning and Closure	Infrastructure removal	decrease in visual intrusion	improvement of sense of place +	+	H	+	M	Progressive rehabilitation of landfill	Adhere to Closure and Rehabilitation Plan	Superintendent for Newcastle Inner
48	Decommissioning and Closure	After closure rehabilitation	local use of rehabilitated land	positive impact of suitable end-use +	+	M	+	M	Final rehabilitation in consultation with local community	Regular community forum meetings	Superintendent for Newcastle Inner
Ecology											

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
49	Construction	Site clearing / preparation	vegetation removal	Loss of floral species and habitat	-	M	-	M	Minimise construction within natural habitats and in particularly undisturbed grasslands.	Demarcate No go ecologic areas and restrict access to those areas. Rehabilitate a nearby impacted area and relocate all indigenous vegetation from the landfill site to the rehabilitated area (as per offset strategy). Find an alternative brownfields site.	Contracted Site Manager
50	Construction	Site clearing / preparation	vegetation removal	Loss of faunal species and habitat	-	M	-	M	Avoid natural habitats and in particularly undisturbed grasslands.	Demarcate No go ecologic areas and restrict access to those areas. Find an alternative brownfields site.	Contracted Site Manager
51	Construction	Site clearing / preparation	vegetation removal	Loss of high biodiversity importance CBA	-	H	-	M	Stay out of CBA Optimal areas as well as their buffers	Demarcate No go ecologic areas and restrict access to those areas. Rehabilitate a nearby impacted area and relocate all indigenous vegetation from the landfill site to the rehabilitated area (as per offset strategy). Find an alternative brownfields site.	Contracted Site Manager
52	Construction	Site clearing / preparation	vegetation removal	Loss of habitat functionality and connectivity including servicing of Irreplaceable CBA situated to the south of the site	-	H	-	M	Stay out of CBA Optimal areas as well as their buffers	Demarcate No go ecologic areas and restrict access to those areas. Rehabilitate a nearby impacted area and relocate all indigenous vegetation from the landfill site to the rehabilitated area (as per offset strategy). Find an alternative brownfields site.	Contracted Site Manager

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
53	Operation	Waste site operation	Increased traffic	Disturbance of faunal species due to vehicle impacts & noise	-	M	-	M	As operation of the waste site is impossible without increased vehicle traffic this impact will be difficult / impossible to mitigate.	none available	Superintendent for Newcastle Inner
54	Operation	Waste site operation	Increased human density	Loss of biodiversity from peripheral areas due to increased human presence resulting in increased resource extraction, hunting, harvesting of medicinal plants	-	M	-	M	Limit / restrict access to peripheral areas,	Install perimeter fencing and CCTV	Superintendent for Newcastle Inner
55	Operation	Waste site operation	Increased human and vehicle activity	Increased presence of alien invasive species due to increased vehicle traffic, dumping of garden refuge	-	H	-	H	Put alien invasive management plan in place before start of construction.	Implement Alien Invasive Management Plan. Conduct biannual auditing of alien invasive management plan	Superintendent for Newcastle Inner
56	Decommissioning and Closure	Earth Excavation	Alteration of landscape	Decommissioning is likely to result in altered topography of the project area, decreased faunal and floral diversity	-	M	-	M	Ensure that rehabilitation plan is in place prior to commencement.	Implement Closure and Rehabilitation Plan	Superintendent for Newcastle Inner
57	Cumulative	Waste site operation	Increased economic activity in the area is likely to result in establishment of supporting infrastructure & peripheral economic activities	Loss of habitat in peripheral areas due to establishment of economic node.	-	H	-	H	Difficult to mitigate, except through selection of an alternative brownfield site	Choose an alternative site	Superintendent for Newcastle Inner
Wetlands											

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
58	Construction	Site clearing / preparation	Removal of vegetation	Loss of wetland plants and decrease surface roughness	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	All construction activities and access must make use of the existing roads. Laydown yards, camps and storage areas must be beyond the watercourse areas. Where possible, the construction of the crossings must take place from the existing road and not from within the watercourse and associated buffer.	Contracted Site Manager
59	Construction	Site clearing / preparation	Stripping and stockpiling/transporting of top soil	Sedimentation of wetland areas	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided. Sedimentation runoff from site must be limited.	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
60	Construction	Infrastructure establishment	Storm water run-off	Erosion from increased flow velocities into wetland areas	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
61	Construction	Earth Excavation	Excavation of subsoil	Loss of wetland area and soils	-	M	-	M	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
62	Construction	Infrastructure establishment	Clearing of areas for infrastructure	Sedimentation of wetland areas	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
63	Construction	Site clearing / preparation	Alteration to surface runoff flow paths	Erosion, Sedimentation and Desiccation of wetland areas	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
64	Construction	Site clearing / preparation	Increase in sediment inputs & turbidity	Water quality impairment and habitat loss/alteration	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
65	Construction	Infrastructure establishment	Inputs of toxic heavy metal and salt contaminants	Water quality impairment	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Contracted Site Manager
66	Operation	Heavy machinery and vehicle movement	Operation of equipment and machinery vehicles	Compaction, erosion and sedimentation of wetland areas	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
67	Operation	Heavy machinery and vehicle movement	Vehicle activity	Compaction, erosion and sedimentation of wetland areas	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
68	Operation	Waste site operation	Dumping of domestic and industrial waste	Water quality Impairment	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
69	Operation	Waste site operation	Dumping of chemicals, mixes and fuel	Water quality Impairment	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
70	Operation	Chemical spills	Spills and leaks	Water quality Impairment	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
71	Operation	Waste site operation	Alteration of surface runoff flow paths and flows in nearby drainage lines	Erosion, Sedimentation and Desiccation of wetland areas	-	M	-	M	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
72	Operation	Heavy machinery and vehicle movement	Increase in sediment inputs & turbidity	Water quality impairment and habitat loss/alteration	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
73	Operation	Waste site operation	Inputs of toxic heavy metal and salt contaminants	Water quality Impairment	-	M	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
74	Decommissioning and Closure	Infrastructure removal	Removal of infrastructure	Sedimentation of wetland areas	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
75	Decommissioning and Closure	Infrastructure removal	Shaping and landscaping (movement of soil)	Sedimentation of wetland areas	-	M	-	M	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
76	Decommissioning and Closure	Revegetation	Revegetation	Loss of wetland plant diversity. Increased surface roughness	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
77	Residual	After closure rehabilitation	Post Closure Monitoring and Maintenance	Wetland health improvement	-	L	-	L	The wetland areas and 28m buffer zones are no go areas and must be avoided	Refer to Wetland Monitoring and Management Plan	Superintendent for Newcastle Inner
Air Quality											

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
78	Construction	Infrastructure establishment	Heavy construction activity - dust emissions	Dust fallout (daily)	-	M	-	M	water spraying for dust suppression	dust management plan to be implemented during construction phase	Contracted Site Manager
79	Construction	Infrastructure establishment	Heavy construction activity - dust emissions	PM10-daily	-	M	-	M	water spraying for dust suppression	dust management plan to be implemented during construction phase	Contracted Site Manager
80	Construction	Infrastructure establishment	Heavy construction activity - dust emissions	PM10-annual	-	M	-	M	water spraying for dust suppression	dust management plan to be implemented during construction phase	Contracted Site Manager
81	Construction	Infrastructure establishment	Heavy construction activity - dust emissions	PM2.5-daily	-	M	-	M	water spraying for dust suppression	dust management plan to be implemented during construction phase	Contracted Site Manager
82	Construction	Infrastructure establishment	Heavy construction activity - dust emissions	PM2.5-annual	-	M	-	M	water spraying for dust suppression	dust management plan to be implemented during construction phase	Contracted Site Manager
83	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Benzene- annual	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
84	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Toluene-hourly	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
85	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Toluene-daily	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
86	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Ethylbenzene- hourly	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
87	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Xylene-hourly	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
88	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	Xylene-daily	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
89	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	hydrogen sulphide-hourly	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
90	Operation	Waste site operation	Storage of general waste at landfill - gaseous emissions	hydrogen sulphide-daily	-	M	-	M	Reduce waste storage quantities through onsite recycling	Implement a waste sorting programme at landfill. Can purchase a bale machine to recover & bale recyclable materials in order to reduce the amount of waste to storage	Superintendent for Newcastle Inner
Heritage											
91	Construction	Earth Excavation	Excavation through fossil-bearing layers	Damage to or destruction of fossils	-	M	+	M	Find and remove all fossils on site should there be any.	Development and implementation of a Fossil Finds Procedure (FFP)	Contracted Site Manager
92	Construction	Site clearing / preparation	Removal of top soil layer(s)	Damage to or destruction of cultural heritage resources	-	M	+	M	Buffer zones must be established around the identified heritage resources (LFC-001 and LFC-002) to minimise or avoid further damage.	Demarcate and fence off LFC-001 and LFC-002. Restrict access to these sites	Contracted Site Manager

IMPACT DESCRIPTION					SIGNIFICANCE BEFORE MITIGATION		SIGNIFICANCE AFTER MITIGATION		MITIGATION MEASURES	ACTION PLAN	RESPONSIBLE PERSON
NO.	PHASES	ACTIVITY	ASPECT	IMPACT							
93	Construction	Heavy machinery and vehicle movement	Vehicles driven in proximity to sites	Damage to or destruction of cultural heritage resources	-	M	+	M	Buffer zones must be established around the identified heritage resources (LFC-001 and LFC-002) to minimise or avoid further damage.	Demarcate and fence off LFC-001 and LFC-002. Restrict access to these sites	Contracted Site Manager
94	Construction	Infrastructure establishment	Construction of infrastructure	Damage to or destruction of cultural heritage resources	-	M	+	M	Buffer zones must be established around the identified heritage resources (LFC-001 and LFC-002) to minimise or avoid further damage.	Demarcate and fence off LFC-001 and LFC-002. Restrict access to these sites	Contracted Site Manager
95	Construction	Earth Excavation	Excavation through layers which may include previously-unidentified heritage resources	Damage to or destruction of cultural heritage resources	-	M	+	M	Find and remove artefacts of cultural significance.	Development and implementation of a Chance Finds Procedure (CFP)	Contracted Site Manager
96	Cumulative	Infrastructure establishment	Proximity of infrastructure in relation to heritage resources	Damage to the cultural landscape	-	M	+	M	No further mitigation required in terms of heritage resources with negligible CS as they have been included in the HIA report.	none available	Superintendent for Newcastle Inner

7 LIST OF SPECIALIST STUDIES UNDERTAKEN

The following specialist studies have been undertaken with regards to the proposed Newcastle Landfill Operation since the projects inception in 2017:

- Air quality impact assessment;
- Biodiversity impact assessment;
- Geohydrological impact assessment;
- Heritage impact assessment;
- Hydrological impact assessment;
- Noise impact assessment;
- Social and economic impact assessment;
- Soils, land use and land capability assessment;
- Traffic impact assessment;
- Visual impact assessment; and
- Wetland and sensitive landscape assessment.

All these studies are provided in Appendix E.

8 INFORMATION GAPS AND FURTHER ASSESSMENTS REQUIRED

8.1 Compliance with conditions from the Scoping Report Acceptance

The EDTEA accepted the amended Scoping Report based on the conditions as set out in **Table 8-1**. **Table 8-1** details whether the conditions of the amended Scoping Report was complied with, and, where the condition was not complied, provides an explanation as to why. Assessing compliance to the amended Scoping Report conditions was used by the EAP to identify on-going information gaps and further assessments required.

Table 8-1: Conditions of Acceptance of Scoping Report.

CONDITION NUMBER	CONDITION OF ACCEPTANCE	HOW CONDITIONS WERE ADDRESSED
1	Comments and concerns received from the I&APs, KZN Wildlife, Water and Sanitation, AMAFA KwaZulu Natal, and Amajuba District must be addressed in the Environmental Impact Assessment Report (EIAR).	All comments received are specified in the in the IRR presented in Appendix B and Appendix C.
2	The need and desirability of the project must be clearly defined (i.e. indicate environmentally, socially, economically etc.) The public participation process adheres to the requirements of the 2010 EIA regulations.	This is presented in Section 9.
3	The EIAR must contain a detailed project description of each aspect for the applied activity.	This is presented in Section 2. During the impact assessment process, GCS realised that the original EAP who submitted the application, omitted certain activities that should have been included. These activities have been listed in this report for consideration, and an amended application form will also be provided to the EDTEA.
4	The socio-economic study must indicate the measures that will be taken to ensure that the potential decline in property value will not be affected by the impacts associated with the development.	This is presented in the Social Impact Assessment and detailed in the EMP (Appendix D and Appendix E).

CONDITION NUMBER	CONDITION OF ACCEPTANCE	HOW CONDITIONS WERE ADDRESSED
5	The plan of study must include Fauna and Avifauna specialist study as per the recommendations of the Ecological review compiled by SDP Williams Environmental dated 14 February 2014.	This is presented in the Terrestrial Ecological and Biodiversity Impact Assessment (Appendix E).
6	Similar specialist studies conducted at the Greenwich Farm must be conducted at the alternative site for the proposed activity.	No alternative site was made available to the EAP and therefore no studies were conducted at an alternative site.
7	The EMPr must be detailed with realistic mitigation measures and the positive impacts explored must be enhanced.	This is presented in the EMP (Appendix D).
8	The storm water management plan must be included in the EIAR.	This is presented in Section 2.1.9, Appendix D and Appendix E.
9	Clarity is required on whether the application is for a GLOB+ or GAB+ as conflicting information has been presented in the report.	GLOB+ and class A.

8.2 Specialist Specific

The following section describes the information gaps and further assessments required as presented by the various specialists for each field of assessment.

8.2.1 Soil, Land Use and Land Capability Assessment

No specific gaps or limitations identified.

8.2.2 Heritage Assessment

The following limitations and constraints were experienced in the compilation of the heritage report:

- Whilst every attempt was made to obtain the most recent information available, the reviewed literature does not represent an exhaustive list of information sources for the greater study area; and
- Visibility at the site was hampered by the local vegetation, including tall grass and dense copses of trees.

Palaeontological and archaeological resources commonly occur at subsurface levels. These types of resources may not be adequately recorded or documented by assessors without

intrusive and destructive methodologies. Therefore, the reviewed literature, previously completed assessments, and the results of the field survey are in themselves limited to surface observations.

8.2.3 Biodiversity Assessment

The following limitations should be noted for the study:

- The results of this assessment was based on single wet season survey, and therefore seasonal variation was not taken into consideration. Nevertheless, the confidence in the data collected and the report generated is high.

8.2.4 Wetland Assessment

The following aspects were considered as limitations:

- A single wetland ecology site survey was completed for this assessment. Thus, temporal trends were not investigated;
- It was assumed that the entire project area is proposed as a landfill site.
- The Global Positioning System (GPS) used for wetland delineations is accurate to within five (5) m. Therefore, the wetland delineation plotted digitally may be offset by at least 5 m to either side; and
- Wetland systems identified at desktop level within 500 m of the project area were considered for the identification and desktop delineation, with wetland areas expected to be at risk being the focus for ground truthing.

8.2.5 Hydrological Assessment

No specific gaps or limitations identified.

8.2.6 Geohydrological Assessment

No specific gaps or limitations identified.

8.2.7 Traffic Assessment

No specific gaps or limitations identified.

8.2.8 Air Quality Assessment

No specific gaps or limitations identified.

8.2.9 Visual Assessment

The following assumptions and limitations are applicable to this study:

- All viewsheds were based on terrain level. As such these viewsheds do not incorporate distractive views in the form of vegetation or land-use (infrastructure, buildings, etc.). An enhanced terrain model was created by GCS, incorporating the client supplied surface elevation information along with the regional National Geo-Spatial Information (NGI) derived contours;
- The accuracy and extent of the receptors mapped relates to the accuracy of the landcover dataset used in this study. GCS has however validated the receptor identification process by a field visit, a heads up approach with satellite imagery and aerial photography;
- This level of assessment excludes perception surveys to establish viewer preference and thereby their sensitivity. For example, localised visual perceptions of the economically depressed communities of the population may be influenced rather by the short term economic and job opportunities that will exist rather than the direct visual perception of the project; and
- The major limitation of this study is the unavoidable subjectivity relating to the assessment of the visual impact. Findings will also be restricted to information on hand, as well as the quality of spatial data.

8.2.10 Noise Assessment

The following limitations forms part of the environmental noise impact assessment:

- The prevailing ambient noise levels for the study area was created by far and near noise sources associated with traffic and seasonal agricultural activities with the result that the prevailing ambient noise level may change at times;
- Noise measurements in the presence of winds in excess of 3.0 m/s may impact the outcome of the environmental noise results; and
- The identification of noise measuring points may create a problem in terms of the prevailing noise levels should it not be done with outmost care and in a scientific manner.

8.2.11 Social and Economic Impact Assessment

With regards to the assessment undertaken, the following should be noted:

- The social impact assessment section of the study aims to identify possible social impacts that could occur in future. These impacts are based on existing baseline information. There is thus always some form of uncertainty with regards to the anticipated impact actually occurring, as well as the intensity thereof. Impact predictions have been made as accurately as possible based on the information available at the time of the study;

- The study relied on the information received during the original PPP undertaken as part of the Scoping process. Additional data gathering, research and consultation were undertaken. Sources consulted are not exhaustive and additional information can still come to the fore to influence the contents, findings, ratings and conclusions made;
- Technical and other information provided by the applicant is assumed to be correct;
- Individuals view possible social impacts differently due to their association with the anticipated impact. Impacts could therefore be perceived and rated differently than those contained in the Report; and
- The potential external costs associated with the project was based on information supplied by sub-specialists for the impact assessment of the project.

9 NEED AND DESIRABILITY

The NLM has in their current IDP presented the following vision: "By 2035 Newcastle will be a resilient and economically vibrant city promoting service excellence to its citizens". Whilst the NLM are regarded as a secondary city or a medium sized town, Newcastle competes at a global level and these opportunities must be utilised to the fullest to benefit residents of the town. Projected population figures for the NLM show an increase of approximately 100 000 people over the age of 19 years from 2017 to 2030. Striving towards becoming a city will require the NLM to change its thinking and approach governance and growth with an expanded view focused on city-thinking instead of town-thinking. By adopting such a strong vision, the NLM has to focus on the future goal and implement key projects that will assist in achieving the vision.

As Newcastle begins its journey to becoming a city, the NLM will have to enter a phase of economic diversification and growth. In order to accommodate the predicted population growth of the city, the NLM will require new housing, secure jobs, vibrant industries and resilient service provision. The provision of basic services as this diversification and growth occur are essential, and, in order to accommodate the expected expansion of the city basic service infrastructure needs to be designed to accommodate existing and future needs.

It is for this reason that the proposed Greenwich Landfill Site development has been identified as a key development project within the NLM. The NLM is already under significant pressure to develop a new landfill site due to the existing landfill site rapidly reaching the end of its design life. To avoid the occurrence of illegal dumping and poor management of domestic waste, the establishment of a new landfill site is a necessity and will ensure that pollution issues associated with uncontrolled dumping are avoided.

The proposed Greenwich Landfill Site development has been subjected to significant assessment in order to present a development that meets not only the requirements of a growing city, but also that of engineering best practice and environmental standards. The fact that the proposed landfill site is an engineered site with lined cells, shows that the NLM has taken cognisance of public perception about municipal waste sites (i.e. dumps) and their associated issues. An engineered landfill is designed to cover and compact waste deposited daily at the end of the day thereby minimizing waste being carried by wind from the site. In addition to this, an engineered landfill, because it is lined, will significantly minimize if not eliminate leachate contamination from the landfill entering the environment.

Considering all the factors mentioned above, the proposed Greenwich Landfill Site development is a necessity for the population and growth strategy of the NLM.

10 ENVIRONMENTAL IMPACT STATEMENT

The environmental specialists, when considering their field of speciality only, provided a reasoned opinion whether the project should be authorised or not. The results are presented in **Table 10-1** and further information, if required, is provided in the sections that follow.

Table 10-1: Specialist Assessments Reasoned opinion Summary.

SPECIALIST FIELD	REASONED OPINION
Soils, Land Use and Land Capability	Authorise
Air Quality	Authorise
Noise	Authorise
Heritage	Authorise
Visual	Authorise
Traffic	Authorise
Hydrogeology	Authorise with specific conditions
Hydrology	Authorise with specific conditions
Wetland and Aquatics	Authorise with specific conditions
Biodiversity	Do not authorise
Social and Economic	Do not authorise

Six (6) specialists recommended that the project be authorised based on the operational philosophy and design thereof. Three (3) specialist recommended the project only be authorised if specific mitigation measures are implemented, or if development exclusion/buffer zones are implemented. Two (2) specialists have recommended the project not be authorised due to high impacts of the project relating to more possible job losses compared to minimal to no job creation, and the area being located within a biodiversity sensitive area.

After due consideration of all the specialist reports, proposed management and mitigation measures, the possibility for developmental adjustments, the implementation of developmental exclusion/buffer zones, and the appropriateness and completeness of specific conditions for inclusion in the environmental authorisation, the EAPs responsible for the compilation of this document and undertaking the PPP, are of the opinion that the proposed Newcastle Landfill Operation **should be approved only if the Conditions for Inclusion in the EA (Section 10.1) are implemented and enforced**.

The conditions proposed address the concerns of the five (5) specialists who recommended that the project not be authorised or be authorised only if specific mitigation measures and

exclusion/buffer zones are implemented. The EAPs are of the opinion that proposed project can be successfully implemented and managed in accordance with the proposed Environmental Management Plan if the conditions specified become binding on the Applicant.

10.1 Conditions for Inclusion in the Environmental Authorisation

Should the competent authority decide to approve the project the following specific conditions should be included within the Environmental Authorisation:

1. Construction laydown areas, camps and storage yards must not be within existing watercourses and/or wetlands. [Refer to **Figure 10-1** for a plan showing construction exclusion zones.]
2. The Applicant must ensure that sufficient signage is erected at the entrance of the site detailing, as a minimum, the contact details of the landfill site manager, a 24-hour emergency contact details, and operating hours of the site. Signage must be clear, visual, and in at least three (3) official languages of which one must be English.
3. The Applicant must, for the lifespan of the project and at least five (5) years thereafter, maintain access and internal roads and ensure that the roads are suitably surfaced and maintained in a state of good repair.
4. The Applicant will ensure that access to the site is from the existing N11/access road interchange. Future access and road upgrades must be agreed upon in consultation with SANRAL and/or the provincial roads authority in line with their developmental plans.
5. The Applicant will widen the section of the access road (Road A) at the access road/N11 intersection to 3.5 m in order to accommodate the size of the trucks and construction vehicles.
6. The Applicant will upgrade the entire length of the access road (Road A) to a 2-lane road, one lane per direction, to allow for vehicles going in/out of the site. Once upgraded, road markings and warning signs should be implemented for safety purposes.
7. The Applicant must, in consultation with a heritage specialist, develop and implement a Fossil Finds Procedure as well as a Chance Finds Procedure prior to the commencement of the construction phases. All employees and contractors are to be trained on the contents of the Procedures and proof thereof is required to be kept on file at the operation for the duration of the applicable construction phases.
8. The Applicant will ensure that no cover material is sourced from the Farm Greenwich 8487 HS, portion 0 except for cells 1 – 3. Cover material will have to be sourced from elsewhere and be imported to site.
9. The Applicant must preserve as much natural vegetation as possible and, where preservation is not possible, relocate identified sensitive vegetation species to a

suitably identified area within the Farm Greenwich 8487 HS, portion 0, where successful re-establishment can be established within two (2) years.

10. The Applicant must appoint an ecologist to compile and implement a biodiversity offset strategy should the area associated with the relocation of identified sensitive vegetation species prove to be insufficient (i.e. smaller that the area being permanently altered), in which similar areas of land will be conserved and rehabilitated to a state that is the same, or better, than the current site's state.
11. The Applicant, in consultation with an ecologist, must develop and implement an Alien and Invasive Species Management Procedure whereby the site is assessed annually in the summer and winter seasons for alien and invasive species establishment. The procedure must allow for the mapping of alien and invasive species and the recommendation of applicable and suitable removal methods (i.e. mechanical, biological, and/or chemical) together with timeframes for which the Applicant must achieve eradication goals.

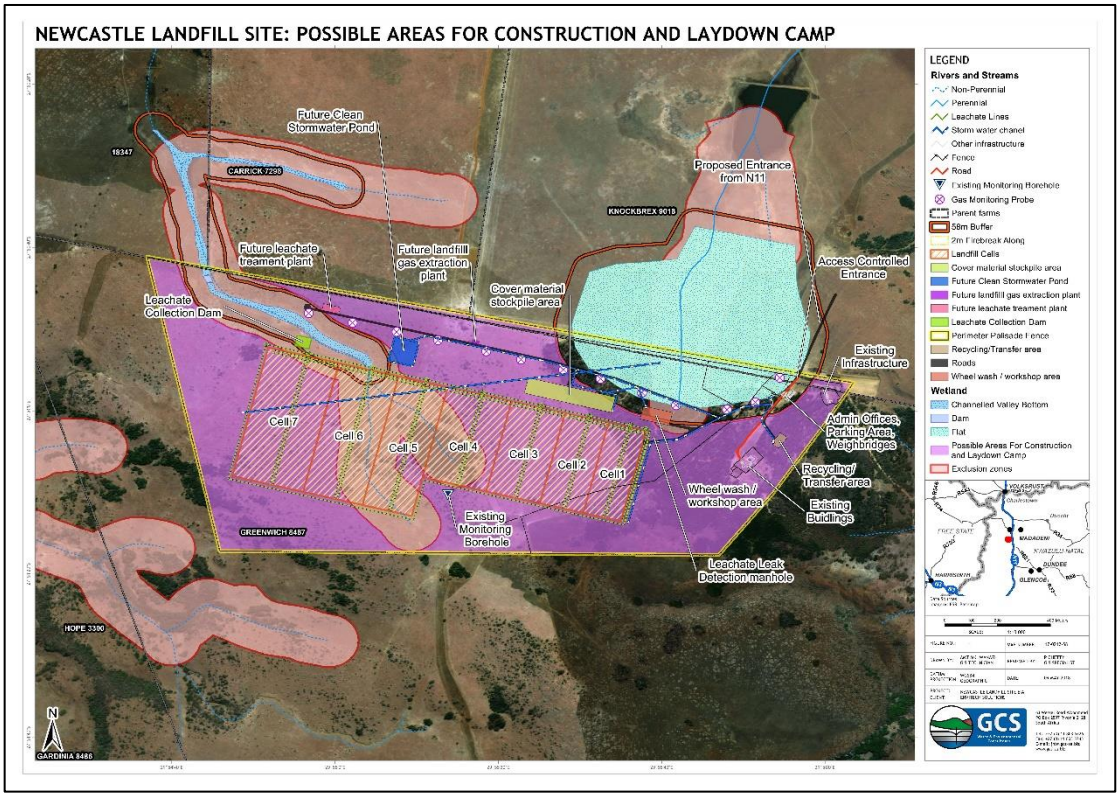


Figure 10-1: Construction Exclusion Zones.

11 CONCLUSION

The proposed Greenwich Landfill Site development has been subjected to significant assessment in order to present a development that meets not only the requirements of a growing city, but also that of engineering best practice and environmental standards. The fact that the proposed landfill site is an engineered site with lined cells, shows that the NLM has taken cognisance of public perception about municipal waste sites (i.e. dumps) and their associated issues. An engineered landfill is designed to cover and compact waste deposited daily at the end of the day thereby minimizing waste being carried by wind from the site. In addition to this, an engineered landfill, because it is lined, will significantly minimize if not eliminate leachate contamination from the landfill entering the environment.

Considering all the factors mentioned above, the proposed Greenwich Landfill Site development is a necessity for the population and growth strategy of the NLM.

The environmental specialists, when considering their field of speciality only, provided a reasoned opinion whether the project should be authorised or not. Six (6) specialists recommended that the project be authorised based on the operational philosophy and design thereof. Three (3) specialist recommended the project only be authorised if specific mitigation measures are implemented, or if development exclusion/buffer zones are implemented. Two (2) specialists have recommended the project not be authorised due to high impacts of the project relating to more possible job losses compared to minimal to no job creation, and the area being located within a biodiversity sensitive area.

After due consideration of all the specialist reports, proposed management and mitigation measures, the possibility for developmental adjustments, the implementation of developmental exclusion/buffer zones, and the appropriateness and completeness of specific conditions for inclusion in the environmental authorisation, the EAPs responsible for the compilation of this document and undertaking the PPP, are of the opinion that the proposed Newcastle Landfill Operation **should be approved only if the Conditions for Inclusion in the EA (Section 10.1) are implemented and enforced**.

The conditions proposed address the concerns of the five (5) specialists who recommended that the project not be authorised or be authorised only if specific mitigation measures and exclusion/buffer zones are implemented. The EAPs are of the opinion that proposed project can be successfully implemented and managed in accordance with the proposed Environmental Management Plan if the conditions specified become binding on the Applicant.

12 REFERENCES

12.1 Hydrology

Fundisi, D. 2018. Hydrological Assessment for the Newcastle Greenwich Landfill Site. pp. 1-158.

Alexander, J., 2002. The Standard Design Flood. South African Institution of Engineers, pp. 26-30.

Chow, 1959. Open Channels Hyadraulics, USA: McGraw-Hill.

Cowan, W., 1956. Estimating hydraulic roughness coefficients. Agricultural Engineering Journal 377, pp. 473-475.

CSIR, 2005. Guidelines for Human Settlement Planning and Design: Volume 2, Pretoria: CSIR Building and Construction Technology.

DWA, 2006. Best Practice Guidelines: Water and Salt Balances, Pretoria: Department of Water Affairs.

DWAF, 2000. Guideline document for the implementation of regulations of use of water for mining and related activities aimed at the protection of water resources, Pretoria: Department of Water Affairs and Forestry.

DWAF, 2006. Best Practice Guidelines for Water Resources Protection in the South African Mining Industry: BPG G3 Water Quality Monitoring Systems, Pretoria: Department of Water Affairs and Forestry.

DWS, 2018. Resource Quality Information Services - Water Quality Data Exploration Tool, 2016,. [Online] Available at: http://www.dwa.gov.za/iwqs/wms/data/000key.asp [Accessed 06 April 2018].

ESRI, 2012. ArcView10.1. s.l.:ESRI.

Geomeasure, 2016. Amended Scoping Report for the Proposed General Waste Landfill site, Newcastle, Newcastle Local Municipality, s.l.: Unpublished specialist report.

James, Rossman and James, 2010. Water Systems Models: User's Guide to SWMM5, 13th Edition., Ontario: CH1 Press.

McCuen, 1996. Hydrology, Washington, DC: FHWA-SA-96-067, Federal Highway Administration.

Peel et al., 2007. Updated world map of the Koppen-Geiger climate classification. Hydrology and Earth System Sciences, p. 1633–1644.

SA Explorer, 2018. Newcastle, South Africa, KwaZulu-Natal Province. [Online]

Available at: http://www.saexplorer.co.za/south-africa/climate/newcastle_climate.asp

SANRAL, 2013. South African Drainage Manual, Pretoria: SANRAL.

Smithers and Schulze, 2000. Design Rainfall Estimation for South Africa, Pretoria: Water Research Commission.

US Army Corps of Engineers, 1995. HEC RAS Hydraulic Modelling Software. Version 4.1. California: s.n.

WRC, 2015. http://www.waterresourceswr2012.co.za/resource-centre/. [Online].

WRC, 2015. Water Resources of South Africa 2012 Study (WR2012). [Online]

Available at: Retrieved from http://waterresourceswr2012.co.za/resource-centre.

12.2 Groundwater

Kruger, M. 2018. Hydrogeological Assessment - Newcastle Landfill Site, KwaZulu-Natal. Pp. 1 68.

Baran and Jonck (2000). 1:500 000 hydrogeological map series 2726 Kroonstad

Council for Geoscience (1992). 1:250 000 geological map series 2728 Frankfort

Department of Water Affairs (DWA) (2012). Aquifer Classification of South Africa

Department of Water Affairs (DWA) (2012). Aquifer Vulnerability of South Africa

Department of Water and Sanitation (DWS) (2013). Groundwater Resource Directed Measures (GRDM). Version 2.3.2.

Department of Water Affairs & Forestry, Second Edition (1998). Waste Management Series.

Minimum Requirements for Waste Disposal by Landfill.

Geomeasure Group (2014). Newcastle Municipality New Landfill Investigation – Final

Geohydrological Investigation Report of Greenwich Farm Candidate Site (REF. NO.: 2012/328)

Geomeasure Group (2015). Draft Scoping Report for the Proposed General Waste Landfill Site, Newcastle, Newcastle Local Municipality. REF. NO.: 2012/328

Geomeasure Group (2016). Amended Scoping Report for the Proposed General Waste Landfill Site, Newcastle, Newcastle Local Municipality (REF. NO.: 2012/328)

Parsons, R. and Conrad, J. (1998). Explanatory notes of the aquifer classification map of South Africa. Water Research Commission: Department of Water Affairs and Forestry. WRC

Report No. KV 116/98. ISBN 1 8845 4568.

RSA National Geospatial Institute. 2729, 1:50 000 Topographical series.

South African Bureau of Standards (SABS) (2015). South African National Standard: DrinkingWater Part 1: Microbiological, physical, aesthetic and chemical determinants: SANS 2411:2015 2nd Ed. ISBN 978-0-626-29841-8

12.3 Geotech

Sebire, R. 2014. Newcastle municipality new landfill investigation – Geotechnical investigation of Greenwich farm candidate site. p.1-48.

Elges, H.F.W. K. (1985). Problem Soils in South Africa – State of the Art: Dispersive Soils. *The Civil Engineer in South Africa*, **27**, 6 pp.

Jones, G.A. and Davies, P. (1985). Problem Soils in South Africa – State of the Art: Soft Clays *The Civil Engineer in South Africa,* **27**, 8 pp.

O' Sullivan, D. and Quigley, P. (2009). Geotechnical Engineering & Environmental Aspects of Clay Liners for Landfill Projects. *Fehiley Timoney Co. & Irish Geotechnical Services Ltd*. South Dublin County, Ireland. 11 pp.

Poe, D.E. and Lawrence, L. (2004). Approved Site Development Plan – Jones County Solid Waste Landfill, Abilene, Texas – Part III: Site Development Plan, Attachment 4, Geology and Geotechnical Report. *SCS Engineers*, Texas, U.S.A. 65 pp.

Schwartz. K. (1985). Problem Soils in South Africa – State of the Art: Collapsible Soils. *The Civil Engineer in South Africa*, **27**, 10 pp.

Van der Merwe, D.H. (1964). The Prediction of Heave from the Plasticity Index and Percentage Clay Fraction of Soils. The Civil Engineer in South Africa.

12.4 Biodiversity

Kimberg, P. 2018. Biodiversity Assessment associated with the proposed Newcastle Greenwich Landfill Development.

ADU (Animal Demography Unit). 2017. Virtual Museum. Available at http://vmus.adu.org.za/ (Accessed in March 2016)

Bates, M.F., Branch, W.R., Bauer, A.M., Burger, M., Marais, J., Alexander, G.J. & De Villiers, M.S. (EDS). 2014. Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland. Suricata 1. South African National Biodiversity Institute, Pretoria, South Africa.

Bird Atlas Project (SABAP2). 2012. http://vmus.adu.org.za/

Botanical Society of South Africa. 2012 Vegetation Map App [Vector] 2012. Available from the Biodiversity GIS website, downloaded on 29 May 2017.

Du Preez, L.H. & Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Random House Struik, Cape Town.

DWAF: The Regulations on the National Forests Act of 1998 (Act No. 84 of 1998) – published 29 April 2009 in the Government Gazette under the auspices of the Department of Water Affairs and Forestry (DWAF).

DWS (Department of Water and Sanitation) (2014). A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

FrogMap 2015. The Southern African Frog Atlas Project (SAFAP, now FrogMAP). http://vmus.adu.org.za (Accessed in March 2016)

Hockey, P.A.R., Dean, W.R.J. & Ryna, P.G. (eds.) 2005. Roberts – Birds of Southern Africa, VIIth ed. The Trustees of the John Voelker Bird Book Fund, Cape Town.

IUCN, 2017. The IUCN Red List of Threatened Species. Available at www.iucnredlist.org (Accessed in March 2016).

Mucina, L. and Rutherford, M.C. (Eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria South African

North West Department of Rural, Environment and Agricultural Development (READ). (2015) North West Biodiversity Sector Plan. North West Provincial Government, Mahikeng. December 2015.

North West Province of Rural, Environment and Agriculture Department. 2015 North West Terrestrial Critical Biodiversity Areas [Vector] 2015. Available from the Biodiversity GIS website (BGIS), downloaded on 10 August 2017.

SANBI. 2017.Red List of South African Plants version 2017.1. Downloaded from Redlist.sanbi.org on 2017/08/24.

Scott-Shaw, C.R and Escott, B.J. (Eds) (2011) KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map – 2011. Unpublished GIS Coverage [kznveg05v2_1_11_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

South African National Biodiversity Institute (SANBI). NBA 2011 Terrestrial Formal Protected Areas [vector geospatial dataset] 2012. Available from the Biodiversity GIS website, downloaded on 03 August 2017

Skinner J.D. & Chimimba, C.T. 2005. The Mammals of the Southern African Subregion (New Edition). Cambridge University Press. South Africa.

Van Oudtshoorn F. 2004. Gids tot die grasse van Suider-Afrika. Second Edition. Pretoria. Briza Publikasies

Van Wyk, B and Van Wyk, P. 1997. Field guide to trees of Southern Africa. Cape Town. Struik Publishers

Von Staden, L. 2011. *Crotalaria dura* J.M.Wood & M.S.Evans subsp. *dura*. National Assessment: Red List of South African Plants version 2017.1. Accessed on 2017/08/03

12.5 Wetlands

Dlamini, N. 2018. Wetland assessment for the proposed Newcastle Greenwich Landfill Development. P. 1-45.

Department of Water Affairs and Forestry (DWAF) 2005. Final draft: A practical field procedure for identification and delineation of wetlands and Riparian areas.

Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.C., and Collins, N.B. 2009. A Technique for rapidly assessing ecosystem services supplied by wetlands. Mondi Wetland Project.

Macfarlane, D.M., Kotze, D.C., Ellery, W.N., Walters, D., Koopman, V., Goodman, P. and Goge, C. 2007. A technique for rapidly assessing wetland health: WET-Health. WRC Report TT 340/08.

Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. 2014. Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report. WRC Report No TT 610/14, Water Research Commission, Pretoria.

Mucina, L. and Rutherford, M.C. (Eds.) 2006. The vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. South African National Biodiversity Institute, Pretoria South African.

National Water Act (NWA). 2016. Act 36 of 1998. New Nine (9) Water Management Areas of South Africa. National Gazettes, No. 40279 of 16 September 2016.

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical

Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Ollis DJ, Snaddon CD, Job NM, and Mbona N. 2013. Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African Biodiversity Institute, Pretoria.

Rountree MW, Malan H and Weston B (editors). 2012. Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Version 2.0). Joint Department of Water Affairs/Water Research Commission Study. Report No XXXXXXXXX. Water Research Commission, Pretoria.

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

Statistics South Africa (StatsSA). 2010. Water Management Areas in South Africa. http://www.statssa.gov.za/publications/d04058/d04058.pdf. Accessed 20th February 2016.

12.6 Traffic

Birungi, C. 2018. Traffic Impact: Newcastle Landfill. P. 1-41.

12.7 Social Economic

Snyman, I. 2018. Socio-economic impact assessment for the proposed general waste landfill site, Newcastle local municipality, Kwazulu Natal. P. 1-52.

Ackerman, F. and Becker, M. (1990). Economies of Scale at Landfill Sites, , Journal of Resource Management and Technology, Vol 18 no 3, Tellis Institute, Boston

BDA. (2009). The full cost of landfill disposal in Australia, BDA Group, Melbourne

Becker, H. 1997. Social Impact Assessment: Social Research Today. UCL Press

Becker, H.A. and Vanclay, F. 2003. The International Handbook of Social Impact Assessment: Conceptual and Methodological Advances. Edwar Elgar, UK.

Burdge, R.J. 1995. A community guide to Social Impact Assessment. Social Ecology Press: Middleton

De Witt, M. (2012). The Economics of Landfills, Presentation at Sandton Convention Centre, Johannesburg (http://www.slideshare.net/martindewit/the-economics-of-landfills) Accessed 15 October 2014

DEFRA (2003). A study to estimate the disamenity costs of landfill in Great Britain, Cambridge Department for Environment, Food and Rural Affairs, London

Department of Environmental Affairs (2006) Socio-Economic Impact Assessment, Integrated Environmental Management Information Series 22, Department of Environmental Affairs and Tourism (DEAT), Pretoria

Department of Environmental Affairs (2012). National Waste Information Baseline Report. Department of Environmental Affairs, Pretoria, South Africa

Du Plessis, R.(2010). Establishment of composting facilities on landfill sites, Submitted in accordance with the requirements for the degree of Master of Arts, University of South Africa, Pretoria

Du Preez, M. (2009). Determining the negative effect on house values of proximity to a landfill site by means of an application of the hedonic pricing method, Department of Economic History, Nelson Mandela Metropolitan University, East London

Du Preez, M., Aarifah, B., Steven R., Koch F. and R. Gupta (2014). House Values and Proximity to a Landfill: A Quantile Regression Framework, University of University of Pretoria Working Paper: 2014-42 Department of Economics: University of Pretoria, Pretoria

Finsterbusch, K., L.G. Llewellyn and C.P. Wolf. 1983. Social Impact Assessment Methods.

Geomeasure Group (2016) Amended Scoping Report for the Proposed General Waste Landfill Site, Newcastle, Newcastle Local Municipality

Geldenhuys, L.M.M (2012). A Comparative Study of The Roohuiskraal And Marie-Louise Landfill –Sites Indicating Differences In Management Strategies and the Consequences thererof on Operational and Management Issues for partial fulfilment of MA in environmental sciences, University of Johannesburg, Johannesburg

Malarin, H. and W.J. Vaughan (1997)). An Approach to the Economic Analysis of Solid Waste Disposal Alternatives. A Good Practice Paper, Inter-American Development Bank, Washington D.C.

Masange, H., (2014) The Role of Environmental Governance in Municipal Waste Management: Newcastle (Kzn) as Case Study, Submitted as part of Master's Degree in Governance and Political Transformation, University of the Free State, Bloemfontein

Mukherjee S. and P. Nelliyat (2007). Comprehensive Assessment of Water Management in Agriculture, Discussion Paper 4: International Water Management Institute, Sri Lanka 2007

Nahman, A. (2011). Pricing Landfill Externalities: Emissions and Disamenity Costs in Cape Town, South Africa, Waste Management 31 2046 – 2056, Elsevier

Newcastle Advertiser (2017). Sanco Marches for Service Delivery and Corruption, In https://newcastleadvertiser.co.za/107079/sanco-marches-for-service-delivery-and-corruption/. Accessed 13 March 2018

Newcastle Local Municipality (2017) 4th Generation Integrated Development Plan (2017/18 – 2021/22)

Petty, D. (2012).) Assessment of Biosecurity Risks for Livestock and Poultry Associated with Proposed Landfill Development at Atlantis or Kaalbaskraal, Chief State Veterinarian Biosecurity, GDARD, Johannesburg

Soderstrom, E.J. 1981. Social Impact Assessment: Experimental Methods and Approaches.

South African Reserve Bank (2014) National Accounts: Statistical Annexure, SARB, Pretoria

Statistics South Africa (2017). Quarterly Labour Force Survey: First Quarter, Stats SA, Pretoria

Swarts S., King, D., Simpson, Z., Havenga J. and Goedhals-Gerber L. (2012). Calculation of Freight Externality Costs for South Africa, Journal of Transport and Supply Chain Management, University of Johannesburg, Johannesburg

Van der Walt, G.L (2011). Logistical cost model accounting for the impact of road quality and road works in South Africa, Submitted in partial fulfilment of the requirements for the degree Bachelors in Engineering, University of Pretoria, Pretoria

Weisbrod, G. and Weisbrod B. (1997).Measuring Economic Impacts Of Projects And Programs, Economic Development Research Group, Boston

Western Cape Government (2013). State of the Environment Outlook Report, Western Cape Department of Environmental Affairs & Development Planning, Cape Town

12.8 Air quality

Perumal, S. 2018. Baseline air quality & plan of study report Newcastle Landfill.

Ackerman, F. and Becker, M. (1990). Economies of Scale at Landfill Sites, , Journal of Resource Management and Technology, Vol 18 no 3, Tellis Institute, Boston

BDA. (2009). The full cost of landfill disposal in Australia, BDA Group, Melbourne

Becker, H. 1997. Social Impact Assessment: Social Research Today. UCL Press

Becker, H.A. and Vanclay, F. 2003. The International Handbook of Social Impact Assessment: Conceptual and Methodological Advances. Edwar Elgar, UK.

Burdge, R.J. 1995. A community guide to Social Impact Assessment. Social Ecology Press: Middleton

De Witt, M. (2012). The Economics of Landfills, Presentation at Sandton Convention Centre, Johannesburg (http://www.slideshare.net/martindewit/the-economics-of-landfills) Accessed 15 October 2014

DEFRA (2003). A study to estimate the disamenity costs of landfill in Great Britain, Cambridge Department for Environment, Food and Rural Affairs, London

Department of Environmental Affairs (2006) Socio-Economic Impact Assessment, Integrated Environmental Management Information Series 22, Department of Environmental Affairs and Tourism (DEAT), Pretoria

Department of Environmental Affairs (2012). National Waste Information Baseline Report. Department of Environmental Affairs, Pretoria, South Africa

Du Plessis, R.(2010). Establishment of composting facilities on landfill sites, Submitted in accordance with the requirements for the degree of Master of Arts, University of South Africa, Pretoria

Du Preez, M. (2009). Determining the negative effect on house values of proximity to a landfill site by means of an application of the hedonic pricing method, Department of Economic History, Nelson Mandela Metropolitan University, East London

Du Preez, M., Aarifah, B., Steven R., Koch F. and R. Gupta (2014). House Values and Proximity to a Landfill: A Quantile Regression Framework, University of University of Pretoria Working Paper: 2014-42 Department of Economics: University of Pretoria, Pretoria

Finsterbusch, K., L.G. Llewellyn and C.P. Wolf. 1983. Social Impact Assessment Methods.

Geomeasure Group (2016) Amended Scoping Report for the Proposed General Waste Landfill Site, Newcastle, Newcastle Local Municipality

Geldenhuys, L.M.M (2012). A Comparative Study of The Roohuiskraal And Marie-Louise Landfill –Sites Indicating Differences In Management Strategies and the Consequences thererof on Operational and Management Issues for partial fulfilment of MA in environmental sciences, University of Johannesburg, Johannesburg

Malarin, H. and W.J. Vaughan (1997)). An Approach to the Economic Analysis of Solid Waste Disposal Alternatives. A Good Practice Paper, Inter-American Development Bank, Washington D.C.

Masange, H., (2014) The Role of Environmental Governance in Municipal Waste Management: Newcastle (Kzn) as Case Study, Submitted as part of Master's Degree in Governance and Political Transformation, University of the Free State, Bloemfontein

Mukherjee S. and P. Nelliyat (2007). Comprehensive Assessment of Water Management in Agriculture, Discussion Paper 4: International Water Management Institute, Sri Lanka 2007

Nahman, A. (2011). Pricing Landfill Externalities: Emissions and Disamenity Costs in Cape Town, South Africa, Waste Management 31 2046 – 2056, Elsevier

Newcastle Advertiser (2017). Sanco Marches for Service Delivery and Corruption, In https://newcastleadvertiser.co.za/107079/sanco-marches-for-service-delivery-and-corruption/. Accessed 13 March 2018

Newcastle Local Municipality (2017) 4th Generation Integrated Development Plan (2017/18 – 2021/22)

Petty, D. (2012).) Assessment of Biosecurity Risks for Livestock and Poultry Associated with Proposed Landfill Development at Atlantis or Kaalbaskraal, Chief State Veterinarian Biosecurity, GDARD, Johannesburg

Soderstrom, E.J. 1981. Social Impact Assessment: Experimental Methods and Approaches.

South African Reserve Bank (2014) National Accounts: Statistical Annexure, SARB, Pretoria

Statistics South Africa (2017). Quarterly Labour Force Survey: First Quarter, Stats SA, Pretoria

Swarts S., King, D., Simpson, Z., Havenga J. and Goedhals-Gerber L. (2012). Calculation of Freight Externality Costs for South Africa, Journal of Transport and Supply Chain Management, University of Johannesburg, Johannesburg

Van der Walt, G.L (2011). Logistical cost model accounting for the impact of road quality and road works in South Africa, Submitted in partial fulfilment of the requirements for the degree Bachelors in Engineering, University of Pretoria, Pretoria

Weisbrod, G. and Weisbrod B. (1997).Measuring Economic Impacts Of Projects And Programs, Economic Development Research Group, Boston

World Health Organization, WHO Air Quality Guidelines for Europe, 2nd edition, WHO Regional Office for Europe, 2000, Copenhagen, Denmark (WHO Regional Publications, European Series, No 91).

12.9 Noise

Van der Merwe, B. 2018. Proposed Newcastle Landfill Site on a portion of the farm Greenwich 8784 Newcastle Kwazulu Natal. P. 1 -49.

Constitution of the Republic of South Africa, 1996: (Act 108 of 1996). http://www.environment.co.za/environmental-laws-and-legislation-in-South-Africa. Accessed 12 March 2010.

DEAT (2004a) - Overview of Integrated Environmental Management Information Series. Department of Environment Affairs and Tourism (DEAT), Pretoria;

Constitution of the Republic of South Africa, 1996: (Act 108 of 1996). http://www.environment.co.za/environmental-laws-and-legislation-in-South-Africa. Accessed 12 March 2010.

Environmental, Health and Safety Guidelines for Community Noise, World Health Organisation, Geneva, 1999;

Environmental Protection Agency (EPA). Office of Environmental Enforcement (OEE) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4). April, 2012. http://www.epa.ie › About Us Organisational Structure. Accessed 12 July 2012.

Google Earth, 2010, http//www.google.com/earth/download-earth.html. Accessed 12 May 2016;

IEMR, 2000 – Effects of noise on Wildlife. Institute for Environmental Monitoring and Research. ISSN: 1481-0336;

International Organization for Standardization – ISO (1993). ISO 9613-1:1993. Attenuation of sound during propagation outdoors – Part 1. Calculation of the absorption of sound by the atmosphere;

International Organization for Standardization – ISO (1993). ISO 9613-1:1993. Attenuation of sound during propagation outdoors – Part 2. General method of calculation;

Noise Control Regulations - Noise Regulations of 1992. GN154 as promulgated in Government Gazette No. 13717 dated 10 January 1992;

RSA, 1996. Statute of the Republic of South Africa – Constitutional Law, No 108 of 1996;

Rogers & Maxwell. Wind Energy Explained, Theory, Design and Application. DOI: 10 1002/04 70846127. Copyright © 2002. John Wiley & Sons Ltd;

SANS 10357 of 2004 – The calculation of sound propagation by the concave method (SANS, 2004);

SANS 10210 of 2004 – Calculating and predicting road traffic noise (SANS, 2004);

SANS 10328 of 2008 – Methods for environmental noise impact assessments (SANS, 2008);

SANS 10103 of 2008 – The measurement and rating of environmental noise with respect to annoyance and to speech communication (SANS, 2008);

World Bank, 1995, Guidelines for community noise. International Finance Corporation General Concerns. http://www.who.euromat.org. Accessed 20 July 2012

12.10 Heritage

Hardwich, S. 2018. Environmental impact Assessment for the Newcastle Landfill Project. P. 1-53.

AMAFA, 2017. The Heritage Inventory. [Online]

Available at: http://www.heritagekzn.co.za/sites/inventory [Accessed 05 February 2018].

Amajuba District Municipality, 2014. Amajuba District Municipality Integrated Development Plan, Newcastle: Amajuba District Municipality.

Bamford, M., 2012. Palaeontological Impact Assessment for Majuba Underground Coal Gasification Project, Mpumalanga, Marion Bamford: Report prepared for Royal Haskoning DHV.

Bamford, M., 2014. Best Practice for Palaeontological Chance Finds: Proposed extension into adjacent Block 4 reserve of Syferfontein Mine (Sasol), Mpumalanga, Unpublished Report: The Evolutionary Studies Institute.

Bamford, M., 2016. Environmental Authorisation for the Proposed Imvula Mine: Palaeontological Impact Assessment addendum to the Heritage Impact Assessment, Johannesburg: Digby Wells Environmental.

Behrens, J. & Swanepoel, N., 2008. Historical archaeologies of southern Africa: precedents and prospects. In: N. Swanepoel, A. Esterhuysen & P. Bonner, eds. Five Hundred Years Rediscovered: South African precedents and prospects. Johannesburg: Wits University Press, pp. 23-39.

Clark, J., 1982. The Cultures of the Middle Palaeolithic/Middle Stone Age. In: R. Oliver, ed. The Cambridge History of Africa. Cambridge: Cambridge University Press.

Deacon, H. & Deacon, J., 1999. Human Beginnings in South Africa. Johannesburg: David Phillip.

Delius, P., Maggs, T. & Schoeman, A., 2014. Forgotten World: The Stone-Walled Settlements of the Mpumalanga Escarpment. First ed. Johannesburg: Wits University Press.

Derwent, S., 2006. KwaZulu-Natal Heritage Sites: A guide to some great places. Cape Town: New Africa Books.

Esterhuysen, A. & Smith, J., 2007. Stories in Stone. In: P. Delius, ed. Mpumalanga: History and Heritage: reclaiming the past, defining the future. Pietermaritzburg: University of KwaZulu-Natal Press, pp. 41-67.

Gasa, N., 2016. Amended Scoping Report for the proposed General Waste Landfill Site, Newcastle, Newcastle Local Municipality, Geomeasure Group: Unpublished report.

Groenewald, G. & Groenewald, D., 2014. Palaeontological Heritage of Mpumalanga, Clarens: Unpublished SAHRA Palaeotechnical Report.

Huffman, T. N., 2007. Handbook to the Iron Age: The Archaeology of Pre-Colonial Farming Societies in Southern Africa. Durban: University of KwaZulu-Natal Press.

Johnson, M. R. et al., 1996. Stratigraphy of the Karoo Supergroup in southern Africa: an overview. Journal of African Earth Sciences, 23(1), pp. 3 - 15.

Johnson, M. R. et al., 2006. Sedimentary Rocks of the Karoo Supergroup. In: M. R. Johnson, C. R. Anhaeusser & R. J. Thomas, eds. The Geology of South Africa. Johannesburg: The Geological Society of South Africa and Council for Geosciences, pp. 461-500.

Makhura, T., 2007. Early Inhabitants. In: Mpumalanga: History and Heritage.. Pietermaritzburg: The University of KwaZulu-Natal Press, pp. 91-135.

Mitchell, P., 2002. The Archaeology of Southern Africa. Cambridge: Cambridge University Press.

Mucina, L. & Rutherford, M. C., 2010. The Vegetation of South Africa, Lesotho and Swaziland. CD Version ed. Pretoria: Strelitzia: South African National Biodiversity Institute.

NLM, 2017. 4th Generation Integrated Development Plan (2017/18 - 2021/22), Newcastle: Newcastle Local Municipality.

Open Up, 2017. Wazimap updated with 2016 Municipal Election Results and new municipalities. [Online] Available at: https://openup.org.za/articles/wazimap-2016-update.html [Accessed 28 February 2018].

Rubidge, B., 2013a. Palaeontological Scoping Report - Dolerite burrow pits Sasol Mining (Pty) Ltd, Delmas: JMA Consulting (Pty) Ltd.

Rubidge, B., 2013b. Palaeontological Scoping Report - Sasol Shondoni conveyor, Delmas: JMA Consulting (Pty) Ltd.

SAHRA, 2013. SAHRIS Fossil Heritage Layers: Karoo Jurassic Dolerite Suite. [Online] Available at: http://www.sahra.org.za/sahris/fossil-layers/karoo-jurassic-dolerite-suite [Accessed 27 February 2018].

SAHRA, 2017. Palaeosensitivity Map. [Online] Available at: http://www.sahra.org.za/sahris/map/palaeo [Accessed 15 February 2018].

South African History, 2014. First South African War 1880-1881. [Online] Available at: http://www.sahistory.org.za/node/16629 [Accessed 05 March 2018].

Statistics South Africa, 2011. Statistics by Place. [Online] Available at: http://www.statssa.gov.za/?page_id=964 [Accessed 28 February 2018].

Swanepoel, N., Esterhuysen, A. B. & Bonner, P., 2008. Five Hundred Years Rediscovered: Southern African Precedents and Prospects. Johannesburg: Wits University Press.

Wazimap, 2017. Wazimap. [Online] Available at: https://wazimap.co.za/ [Accessed 28 February 2018].

Williams, N. & Brundy, S., 2014. Ecological review of the preferred candidate site for the development of a landfill - Greenwich Farm, Newcastle, Williams Environmental and SDP: Unpublished report prepared for Geomeasure Group (Pty) Ltd.

Winter, S. & Baumann, N., 2005. Guidelines for involving heritage specialists in EIA processes: first edition.CSIR Report No ENV-S-C 2005 053 E, Cape Town: Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning.

12.11 Visual

Chetty, P. 2018. Newcastle Landfill: Visual Impact Assessment. P. 1-48

Ladislav Mucina & Michael C. Rutherford (eds). 2006, The Vegetation of South Africa, Lesotho and Swaziland. SANBI. "Vegmap".

IFC Performance Standards on Environmental and Social Sustainability - Effective January 1, 2012

Landscape Institute and the Institute of Environmental Assessment and Management. (2008), Guidelines for Landscape and Visual Impact Assessment (GLVIA). Second Edition, E & FN Spon Press.

Climate Newcastle. Meteoblue. [Online] Available at https://www.meteoblue.com/en/weather/forecast/modelclimate/Newcastle_south-africa_995397 [Accessed 3 April 2018].

Oberholzer, B. (2005). Guideline for involving visual & aesthetic specialists in EIA processes: Edition 1. CSIR Report No ENV-S-C 2005 053 F. Republic of South Africa, Provincial Government of the Western Cape, Department of Environmental Affairs & Development Planning, Cape Town.

12.12 Soils, Land Use and Land Capability

Jacobs, Haden. 2018. Greenwich landfill soil report. P. 1-57.

Bonner and Varner. (1965). *Plant Biochemistry*. London: Academic Press.

Chamber of Mines South Africa/Coaltech. 2007. Guidelines for the rehabilitation of mined land.

Google Earth. (2017). *Google Earth*. Retrieved from Google: https://www.google.com/earth/

Harivandi *et al*. (1992). *Salinity and turfgrass culture*. Madison: American Society of Agronomy.

Little and Nair. (2009). *Recommended Practice for Stabilisation of Sulphate Rich Subgrade*

Soils: Threshold Sulphate Levels in Soils. Washington DC: National Academy of Sciences. NEMA. (1998). *National Environmental Management Act (NEMA)*. Pretoria: Department of Environmental Affairs: Government Gazette.

NEMWA. (2008). *National Environmental Management: Waste Act, Act 59 of 2008*. Pretoria:

Department of Environmental Affairs.

NWA. (n.d.). The National Water Act, 1998 (Act no. 36 of 1998). Pretoria: South Africa.

Schoeman et al. (2002). Development and application of a land capability classification system for South Africa. Pretoria: Agricultural Research Council.

Silva. (2012). toxicity Targets in Plants. Journal of Botany, 1-8.

Soil Classification Working Group. (1991). The Soil Classification System of South Africa.

Pretoria: Soil Science of South Africa.

WRC. (2012). Water Resources of South Africa Study. Pretoria: Water Research Commission.

APPENDIX A: A3 FIGURES

APPENDIX B: PUBLIC CONSULTATION REPORT (SCOPING PHASE)

APPENDIX C: PUBLIC CONSULTATION REPORT (ENVIRONMENTAL IMPACT ASSESSMENT PHASE)

APPENDIX D: ENVIRONMENTAL MANAGEMENT PLAN

APPENDIX E: SPECIALIST ASSESSMENTS

APPENDIX F: PRELIMINARY DESIGN REPORT