Hydrogeological Assessment for the proposed Newcastle Gas Energy Power Plant

Report Prepared for

Newcastle Energy Pty (Ltd)

Report Number 566508/GW

Report Prepared by

srk consulting

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Hydrogeological Assessment for the proposed Newcastle Gas Energy Power Plant

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June 2021

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Executive Summary

Newcastle Energy intend to demolish the existing 18.5 MW cogeneration plant for the construction of a new 100 MW plant (named the Newcastle Gas Energy Power Plant (NGEPP)) at the site situated within the Karbochem Industrial Complex in Newcastle. SRK Consulting (South Africa) (Pty) Ltd, (SRK) was commissioned to carry out an Environmental Impact Assessment (EIA) for the Project.

The groundwater study was conducted as part of the EIA, to establish baseline conditions as well as to characterise the underlying aquifers given the potential risk to construction and foundations posed by the occurrence of shallow groundwater (Gervorkvan Geophysics, 2020). The SRK study approach followed involved, a desktop study, hydrocensus, installation of shallow test holes, falling head tests, water quality analysis and an impact assessment. The following inferences are made from the study results:

- The NGEPP site is underlain by lithologies of the Ecca Group of the Karoo Supergroup comprising sandstone, shale, ferricrete and siltstone intruded by Post-Karoo Dolerite sills and dykes which typically weathers into sand and very fine clayey sand. Based on desktop assessment, there are no major geological structures in the vicinity of the site.
- Weathered micaceous sandstone, dolerite and shale material constitute the shallow aquifer on site, observed from 0.3 meters below ground level (mbgl) and 0.8 mbgl at test holes AH-06 and AH-07 installed within the NGEPP site and from 1 to 6 mbgl in boreholes AA07-01 to AA07-03 drilled in the neighbouring African Amines site approximately 300m east from the NGEPP site (Jones & Wagener 2007).
- The existing chemical storage tanks, chemical containers, filters, septic tank, and effluent sump constitute the potential source of groundwater contamination onsite. Effluent from the power plant is piped and temporarily stored in this sump for pumping to the Karbochem treatment plant.
- The permeability testing of shallow weathered material onsite yielded horizontal hydraulic conductivity ranging from 0.036 m/d to 0.14 m/d, with high horizontal hydraulic conductivity values (up to 1.1 m/d) reported for Karbochem boreholes, (Bohwleki 1996). This moderate permeability range implies that groundwater and potential contaminants would migrate offsite.
- The Hydrocensus survey confirmed the reliance on groundwater for domestic use by the neighbouring farming community approximately 1.3 km west of the site. There are no groundwater users in the immediate vicinity (2 km radius) downgradient of the site.
- The study confirmed shallow groundwater occurrence along the unlined manmade stormwater drainage trench east of the site with localised shallow water table (0.34 mbgl - 0.81 mbgl) observed from augur holes (AH-06 and AH-07). Other augur holes and test pits across the site were dry during field investigation suggesting some artificial recharge to the subsurface from the stormwater drainage channel. This implies that dewatering will not be required if the stormwater drainage is improved or managed, preventing localised groundwater recharge around AH-06 and AH-07.
- Slightly deeper water levels (3 – 13mbgl) were recorded at offsite boreholes. The predominant groundwater flow is southeast toward Karbochem Spruit and associated wetlands. Potential groundwater contamination from site would also follow the same flow paths to the Karbochem Spruit and the wetland downgradient of the site, being the main potential receptor.
- Water quality analytical results confirmed acidic, 3.2 pH units, for the effluent sump sample. As expected, the effluent is characterised by elevated concentrations of dissolved metals with Al, Fe, Mn, Ni, U and Pb exceeding SANS241 drinking water guidelines of 0.3, 2, 0.5, 0,07, 0.015, and 0.01 mg/l respectively. Similarly, poor quality water characterised by elevated Mn, Al, Fe concentrations was recorded in AH-06 and AH-07 compared to the background sample (BH45).

- The background sample (BH45) reports good water quality with no influence from industrial activity. Similarly, the deep aquifer borehole (BH13A) in the vicinity of Brochem plant is of good water quality with constituents below the SANS 241 drinking water guidelines.
- The poor quality observed for Samples AH-06 and AH-07 reflect the impact of the potential historical leaks and/ or the present leaks from the:
  - effluent sump suggesting that the concrete lining has been compromised and the potential plume may have migrated past AH-07. This may also suggest the sump to be another source of perched water in AH-06 and AH-07 vicinity.
  - chemical storage tanks (hydrochloric acid) suggesting historical leaks or concrete lining (bund) has been compromised and plume may have migrated past AH-07.
- No groundwater impacts from the other potential contamination sources (within the existing plant) could be confirmed. Similarly, soil auguring was not successful due to shallow ferricrete immediately downgradient of the sump and therefore the extent of contamination in the sump vicinity could not be confirmed. However, poor management of sewage, chemical storage tanks (acid and caustic soda), effluent in the sump during decommissioning has the potential to impact the soil, surface and groundwater in the area. In addition, without implementation of good controls and management, pollution of the surface and groundwater can occur from the planned power plant.

The following management measures are recommended to mitigate the impacts identified.

Potential groundwater contamination from the current site infrastructure should be avoided by:

- Safely emptying the chemical storage tanks, effluent sump and septic tank onsite before decommissioning of the existing infrastructure to avoid spillages and potential contamination of soil and groundwater in the area.
- Safely removing all potential contamination sources (chemical storge containers, jet engines, filters) from site before decommissioning of the existing infrastructure.
- Managing potential accidental spillage and environment (soil and water) contaminated during decommissioning.
- The existing project site (NGEPP) and proposed area for the LNG facilities and infrastructure should be integrated and a gap analysis be done to develop a Phase II characterisation plan.
- Confirming levels of soil and groundwater contamination for a Phase II site assessment process, which should include geophysical survey to site borehole drilling targets, borehole drilling, aquifer testing and water quality analysis the area in the immediate vicinity of the sump and LNG facility site, groundwater monitoring borehole sites and remediate the site as necessary before subsequent construction of the NGEPP.
- Additional characterisation downgradient of the sump must carried out during phase II investigations (contamination assessment) to confirm the contamination pathways and extent of contamination plume.
- The detailed hydrogeological assessment for LNG facility site as well as the potential for surface and groundwater interaction should form part of Phase II.
- NGEPP chemical storage tanks infrastructure will include the engineered safety bunds. Therefore, no impacts are anticipated during NGEPP construction and operation phases.
- Surface and groundwater monitoring network for the NGEPP should be established and maintained as follows:

  - A minimum of five (5) borehole pairs should be installed into shallow (15 m deep) and deep (30 m) aquifers for adequate coverage of the NGEPP and LNG facilities.
  - Two surface water monitoring stations should be established on the stormwater drainage upgradient (SW1) and downgradient (SW2) of the site for surface water monitoring. This will be feasible during wet season, before construction of NGEPP, during operation and after site closure. Additional two surface water monitoring stations further downgradient of the site upstream of the confluence of the stormwater channel (SW4) and at a downstream point of the proposed LNG facility (SW5).
  - Sampling and analysis of water quality should be conducted monthly during construction, monthly for the first six month following NGEPP construction, followed by quarterly and then bi-annually depending on the results of the first six month's results during operation.
  - Based on this study results, water samples should be analysed for Physiochemical Properties (pH, EC, TDS and Alkalinity), Major ions and Trace metals (including, Al, Fe, Hg, Mn, Ni, and Zn).
  - Additionally, analysis of environmental isotopes (oxygen 18 and deuterium) should be included in the initial round of analysis at MON-BH1S and SW2, to assess the potential for surface water/groundwater hydraulic connections at/near the site.
  - Monitoring should be systematic and consistent so that meaningful interpretations can be made of the datasets.
  - All monitoring data should be compiled on a database for easy access and interpretation.
- Any minor seepage from the construction site should not be discharged on site or to the surface water resource but should be piped off to Karbochem treatment plant for treatment.
- Additional characterisation downgradient of the sump must carried out during phase II investigations (contamination assessment) to confirm the extent of contamination plume.
- The detailed hydrogeological assessment for LNG facility site should form part of Phase II.

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Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (South Africa) (Pty) Ltd (SRK) by Newcastle Energy. The opinions in this Report are provided in response to a specific request from Newcastle Energy to do so. SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate.

List of Abbreviations

Abbreviation	Definition
EIA	Environmental Impact Assessment
EC	Electrical Conductivity
DWS	Department of Water and Sanitation
FHT	Falling Head Test
KZN	KwaZulu-Natal
LNG	Liquified Natural Gas
MAP	Mean Annual Precipitation
mamsl	Meters above mean sea level
mbgl	Meters below ground level
MW	Megawatts
NGA	National Groundwater Archive
NGEPP	Newcastle Gas Energy Power Plant
NWA	National Water Act (No 36 , 1998)
ppm	Parts per million
SANS	South African National Standard
SRK	SRK Consulting (SA) (Pty) Ltd.
SWL	Static Water Level
TDS	Total Dissolved Solids
WARMS	Water Authorisation & Registration Management System
WMS	Water Management System
WUL	Water Use Licence
WULA	Water Use Licence Application

1 Introduction

Newcastle Energy has purchased a Gas-to-Power Cogeneration Plant from Newcastle Cogeneration and intend demolishing the existing 18.5 MW cogeneration plant for the construction of a new 100 MW plant (hereafter referred to as the Newcastle Gas Engine Power Plant (NGEPP)) at the site situated within the Karbochem Industrial Complex in Newcastle (Figure 2-1). The site itself is owned by Karbochem and zoned for industrial use.

Newcastle Energy appointed SRK Consulting South Africa (Pty) Ltd, (SRK) to carry out an Environmental Impact Assessment (EIA) for the Project. A Geotechnical study carried out by Gervorkyan Geophysics in 2020, highlighted the presence of a shallow aquifer on site which may warrant dewatering to lower the water level during the construction of the proposed NGEPP.

The groundwater study was initiated as part of the EIA, to provide baseline condition as well as to characterise the underlying aquifers given the slight instability risk posed by the occurrence of shallow groundwater in the area as highlighted by Gervorkvan Geophysics (2020).

2 Study Objectives and Scope of Work

2.1 Project objectives

This groundwater study was carried out to characterise the groundwater environment in the area, evaluate the requirement for dewatering and assess the potential impacts to the groundwater environment during the construction, operation, and post closure of the NGEPP facility.

2.2 Scope of work

The following study approach was employed:

- A desktop study was conducted to provide an understanding of the general hydrogeology of the area, aquifer characteristics (borehole yields, hydraulic properties), local groundwater use, general water quality, and groundwater recharge;
- A hydrocensus was conducted within a 5 km radius of the site to identify groundwater users in the vicinity, to confirm the groundwater utilisation, to identify users likely to be affected by the project and to gather groundwater level data;
- Hand augered test holes were installed to refusal and falling head tests (FHT) carried out to determine the hydraulic conductivity of the weathered material. The auger holes were backfilled after the FHT;
- Sampling and water quality analysis of:
    - Three surface water samples as follows:
        - SW1 - stormwater upgradient of existing infrastructure to represent background surface water quality
        - SW2 – stormwater downgradient of existing infrastructure, to reflect potential impacts of site activities, and
        - SW3 – in Karbochemspruit further downgradient of Karbochem complex.
    - Seepage samples from two auger holes.
    - Effluent sump.

- Groundwater from a monitoring borehole up-gradient of the Karbochem complex for background water quality characterisation.

- Data interpretation, dewatering evaluations, site conceptualisation and impact assessment.

2.3 Study limitations

The location of the LNG facility to the east of the main NGEPP facility was only confirmed after the fieldwork component of this study was undertaken. Although the proposed LNG facility is likely to be characterised by the same hydrogeological condition as NGEPP site, this study lacks site specific characterisation of the LNG facility site. It is therefore important that a detailed site characterisation of the LNG site be carried out during Phase II investigations as recommended in this report.

91000
96000
101000
-3070000
-3075000
-3080000

Memel Road
Allen Street
Allen Street
N11
Albert Wessels Drive
Asiphephe Drive
Madadeni
Newcastle CBD
Ladysmith Drive
Madadeni Road
Karbochem Road
African Amines plant
Karbochem Spruit
Project site
Proposed area for LNG Facilities

N

Location of the site in South Africa
N3
Site Location
N1
N2

0 0.5 1 2 Kilometers

Legend

- African Amines plant
- Places
- Non-Perennial River
- Perennial River
- Proposed area for LNG Facilities

OSM Roads

- National Freeway
- Main Road
- Arterial Route
- Secondary Road
- Street
- Newcastle Energy project site

Data Source: ESRI Basemap Imagery
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Date: 09/10/2020
Compiled by: INBRO
Project No: 566508
Fig No: 2-1
Revision: A Date: 01 06 2021

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NEWCASTLE GAS ENGINE POWER PLANT

LOCALITY MAP

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3 Project Setting

3.1 Site locality, topography and drainage

The NGEPP Project site is situated adjacent the main gate of the Karbochem Industrial complex in Newcastle, northern KwaZulu-Natal. The Project site is within 2 km and to the south of the Newcastle Airport. It is bound by a wire fence with gated access from Karbochem Road and the proposed LNG facility is situated immediately east of the site within Karbochem complex. The current site infrastructure comprises a disused power plant and associated infrastructure (Figure 3-1).

Figure 3-1 Newcastle Energy, existing plant infrastructure

The project site is characterised by a gentle slope to the southeast towards the Karbochem Spruit, a W-E draining feature (Bohlweki 1996). The Karbochem Spruit drains to the Ingagane River further downgradient of the Karbochem complex. The Ingagane River meanders in an easterly direction and joins the Buffalo River around Madadeni, further east of the study area. Table 3-1 summarises the hydrological characteristics of the Ingagane River. The high evaporation volume creates a deficit in the water balance for this catchment.

Table 3-1 Ingagane River Hydrological Characteristics, (Summarised after Umgeni Water 2020/2021)

River Catchment	Area km^2	Annual Average			
		Evaporation (mm)	Rainfall (mm)	Natural Runoff (million m^3/annum)	Natural Runoff (mm)
Ingagane River (V31)	3948	1435	851	469.9	119

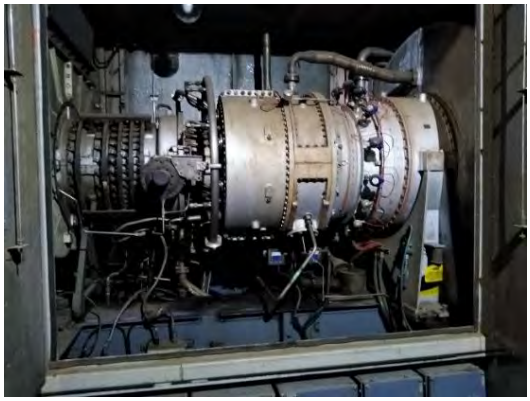
3.2 Existing site condition

The site comprises several old storage containers (possibly used as offices during site operation), an office building, a septic tank, and an existing power plant with associated infrastructure. The power plant was operational until 15 February 2017.

An old fishpond exists adjacent to the boundary fence immediately east of the concrete-lined and covered effluent sump. Effluent from the power plant is piped and temporarily stored in this sump for pumping to the Karbochem pollution control dams, and then to the Karbochem water treatment facility.

A manmade unlined stormwater control trench (channel) runs from NW-SE along the eastern boundary fence.

The material stored onsite, including chemical storage tanks, chemical containers, filters, septic tank, and the effluent sump constitute the potential source of groundwater contamination (see Figure 3-2). However, the material identified as potential contaminants were either bunded or stored on concrete hardstanding surface with no signs of spillages or leakages during the site visit. It is understood that these items will be responsibly disposed of before the construction of the new power plant.



Jet engines

Septic tank

Chemical (HCl and Caustic soda) storage Tanks

Used filters and drip trays

Effluent Sump

Stacked 25 L bottles and 250 L drums of Mono ethylene glycol

Figure 3-2 Potential groundwater contamination sources

3.3 Proposed NGEPP infrastructure

The Proposed NGEPP infrastructure comprises LNG facility, administration building, workshops/warehouses, maintenance area, Power Plant and associated facilities. The proposed LNG facility is located within the Karbochem industrial complex, on site immediately to the east of the NGEPP site.

According to the Gervorkvan Geophysics Report compiled in 2020, the foundation loads for the proposed NGEPP infrastructure are anticipated to be deep, with a minimum foundation load of 150 KN/m^2. This will require some excavation of overburden to the bedrock. The layout of the proposed infrastructure is included in Appendix A.

3.4 Geology and soils

According to 1:250 000 Geological Map Series 2728 Frankfort (Council for Geoscience, (1992)), the Newcastle area is underlain by lithologies of the Permian-age Vryheid (Pv) and Volkrust (Pvo) Formations of the Ecca Group of the Karoo Supergroup, Figure 3-3. These formations consist of fine grained sandstone, shale, siltstone and coal seams intruded by Post-Karoo Dolerite (Jd) sills and dykes, found to a larger extent in the areas north of Newcastle and south west of Karbochem complex. The site-specific lithologies are ferricrete, sandstone, siltstone and dolerite. The underlying lithology weathers into sand and very fine clayey sand, WRC (2002). There are no major geological structures in the site vicinity. Large scale faults occur in the north east and east of Newcastle which may represent areas of high groundwater potential.

3.5 Hydrogeological setting

According to DWAF (2000), aquifers underlying the Newcastle area are intergranular and fractured in nature and largely of the ‘d2 type’ (associated with typical yields in the range from 0.5 to 2 l/s, Figure 3-4). Borehole yields recorded in the “eMadlangeni Rural Water supply” dataset range from 0.01 to 5 l/s (SRK 2015,). The higher borehole yields in the dataset are associated with areas of deep weathering, geological structures such as faults and, dolerite dykes and sill contacts.

The aquifer recharge in the Newcastle and Northern KZN area is calculated by Mdudma (2018) as 4% of the mean annual precipitation (MAP). With an average rainfall of 851 mm/year, groundwater recharge amounts to 34 mm/year.

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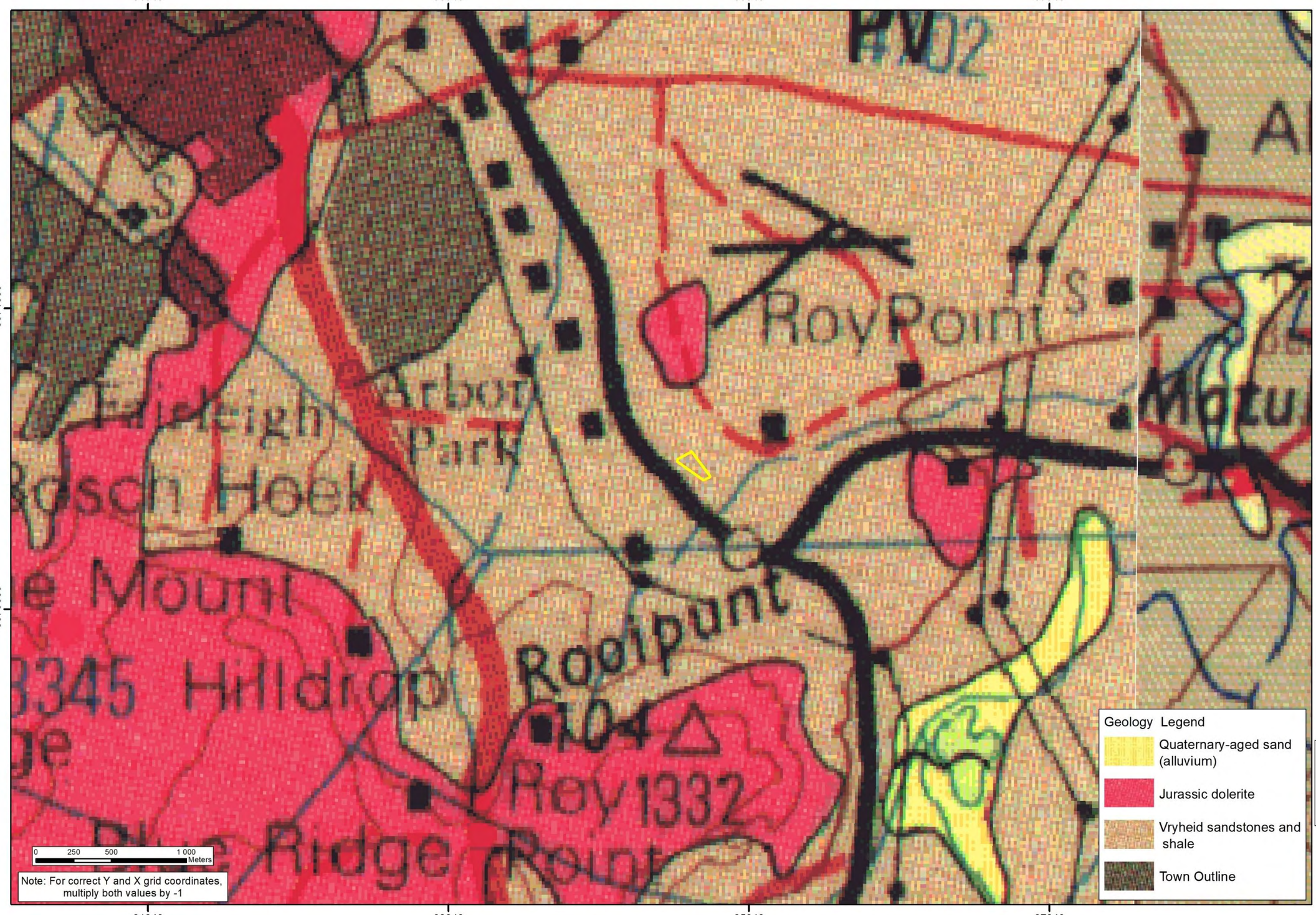
-3076000



91940 93940 95940 97940

Legend

Newcastle Energy Project Site

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Date: 01/02/2021	Compiled by: BRCH
Project No: 566508	Fig No: 3-3

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NEWCASTLE GAS ENGINE POWER PLANT

GEOLOGY OF THE STUDY AREA

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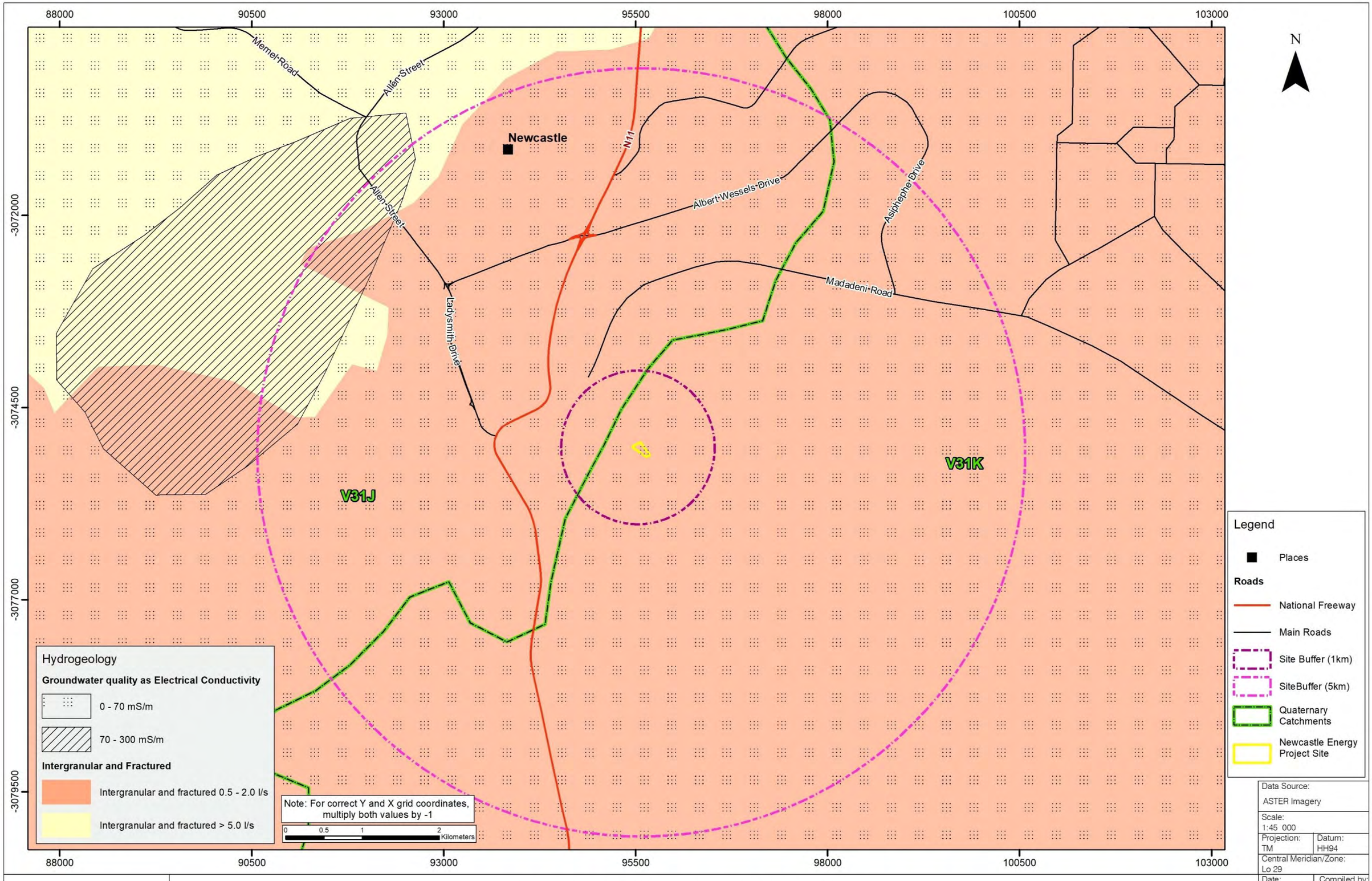

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Date:	15/10/2020
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Project No:	566508
Fig No:	3-4

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NEWCASTLE GAS ENGINE POWER PLANT

HYDROGEOLOGY MAP

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Revision: A Date: 29 01 2021

4 Groundwater Characterisation

4.1 Groundwater occurrence

Both shallow and deep aquifers are recorded within the study area, characterised as follows:

Shallow aquifer - encompasses the shallow weathered Karoo sandstone, dolerite and shale layers which are of moderate to high permeability. Occurs as a shallow perched aquifer with depth varying across the site. The shallow aquifer was observed at depth from 0.3 mbgl (AH-06) within the Newcastle energy site and from 1 to 6 mbgl on the neighbouring African Amines site situated approximately 400m northeast of NGEPP (Jones & Wagener, 2007). Aquifer horizontal hydraulic conductivity ranging from 3.4 x 10^{-01} to 1.1 m/d was reported for Karbochem shallow aquifer monitoring boreholes, (Bohlweki, 1996). Due to the narrow thickness, the shallow aquifer is generally low yielding.

Deep aquifer - comprises water-bearing zones associated with the fractures within the Karoo lithology, dolerite contact zones and geological contacts. Few deep aquifer boreholes are situated within the Karbochem complex and are used for groundwater monitoring. Their blowout yields are less than 0.1 l/s. Moderate hydraulic conductivity, ranging from 8.6 x 10^{-2} m/d to 4.32 x 10^{-1} m/d, is reported for the Karbochem deep boreholes, (Bohlweki, 1996).

4.2 Installation of NGEPP test holes

Seven hand augered test holes were installed across the site to allow for in-situ permeability testing of the shallow weathered material (Figure 2-1). The test holes were installed in the vicinity of the backfilled test pits dug for geotechnical investigation by Gevorkyan Geophysics Pty (Ltd). Auguring of Test holes was not successful due to shallow ferricrete around TP04, TP05 and backfilled concrete gravel around TP03. Test hole (AH-01 to AH-10) profiles are included in Appendix B.

Table 4-1 Shallow aquifer test holes description

Hole ID	Date	Lat	Long	Depth	SWL	Comment
		(dec.deg)		(m)	(mbgl)	
AH-01	08/12/20	27.78487	29.9692	0.2	Dry	Hard backfilled gravel mixed with sand
AH-08	08/12/20	27.78609	29.97023	1.3	Dry	Refusal at 1.3 m
AH-09	08/12/20	27.78608	29.97057	0.3	Dry	Refusal at 0.3 m
AH-07	07/12/20	27.78589	29.97043	1.8	0.81	Seepage at 0.7m
AH-06	08/12/20	27.78554	29.97014	1.9	0.34	Seepage at 0.8m, refusal at 1.9 m, auger broke on refusal material
AH-02	08/12/20	27.78522	29.96872	0.2	Dry	Hard backfilled gravel mixed with sand
AH10	08/12/20	27.7862	29.97038	0.42	Dry	Refusal at 0.42 m

Auger holes were installed to refusal which ranged from 0.2 mbgl to 1.9 mbgl, and are shallower than the depth of Test pits (which ranged from 1 – 4.2 mbgl), therefore both auger holes and Test pit profiles are summarised below to define the soils and shallow aquifer underlying the site:

- Unconsolidated gravel mixed with sand, rocks and boulders (Fill material) was observed up to refusal (0.2 m) in the area around test holes AH-02, and AH-01 situated north of the plant and from 0 to 0.3 m in AH-09. The fill material is understood to occur across the site but is thicker in the vicinity of the existing Plant infrastructure. According to the geotechnical investigation report, this material was recorded up to refusal (2 m) in TP01.

- Silty clay was observed in AH-07 from 0.6 m up to refusal 1.8 m as yellowish grey to brown, soft, and silty, with some gravel. This material was observed up to 1.5 m in TP07. Seepage recorded in AH-06 at 0.8 m and AH-07 confirms the presence of a shallow aquifer in this portion of the site.
- Ferricrete occurs below the fill and alluvium as cream/ beige to orange brownish sandy gravel. Moist and seepage condition was recorded at 0.8 m in AH-06 in AH-07. This material comprise ferruginous nodules and was observed up to 2 m in TP-06, 1.3 m (TP03), 1.6 m (TP04), 1.8 m in TP07 and is reportedly underlain by residual dolerite in TP05 and TP06.
- Residual dolerite (Sandy clay) formed as a result of dolerite weathering. This is logged as yellowish orange, firm to stiff, intact, SANDY CLAY – and occurs on top of highly weathered dolerite in large part of the study area - in TP05 (1.4 to 2.2 m), TP06 (2 to 3.6 m), TP08 (0.8-3.2 m), TP09 (2.1 to 3.7 m) and TP10 (1.3 -4 m).
- Residual sand (Clayey sand) formed due to sandstone weathering occurring as yellowish brown, medium dense, medium grained, and slightly moist in TP01 (2 to 2.5 m) and TP02 (1.3-1.6 m). None of the auger holes near these testpits intercepted this material, due to backfill which prevented the augur holes from extending >0.2 m. The low permeability of Sandy clay layer (residual sandstone and residual dolerite) would play a significant role in preventing potential contamination from shallow aquifer to the deep aquifer.
- Sandstone was reported in TP01 and TP02 below residual sand as yellowish orange, completely to highly weathered, medium grained with an abundance of muscovite, highly fractured, and soft.

4.3 Hydraulic testing

The auger holes were in many cases dry and relatively shallow. Consequently, the test holes were subjected to Falling Head Test (FHT).

It is important to note that the auger holes have not fully penetrated the shallow aquifers and lithological material varied in each holes (maximum depth of approximately 2m), hence different permeability response to testing. None of the auger holes have penetrated the deep aquifer.

FHT involved rapid injection of water into uncased test hole to induce rapid displacement of water and measurement of the recession rate using electronic level loggers. FHT was conducted to determine the hydraulic conductivity of the shallow aquifer material which is an essential attribute for the determination of dewatering options and feasibility. FHT results were processed and interpreted using computer program *Aquifer Test 2015.1* developed by Schlumberger Water Services. The test results are summarised in Table 4-2**Error! Reference source not found.**.

The permeability ranging from 0.5 to 0.036 m/d was calculated for the dry test holes. Seepage was recorded only from two test holes (AH-06 and AH07). The hydraulic conductivities of 0.14 and 0.0413 m/d was calculated for AH-06 and AH-07 respectively and is representative of the shallow aquifer in the area, Table 4-2. The large horizontal permeability range was also reported from the Karbochem shallow aquifer monitoring boreholes, and implies that within the fill and shallow aquifer material, groundwater would flow over a distance of at least 5 m to 51 m in a year, (See Table 4-2, after Bohlweki 1996). However slightly lower permeabilities are expected in areas where residual shale (clay/silty clay) dominate.

95350 95450 95550 95650 95750

-3074950

-3075050

-3075150

AH-01
TP01
TP03
TP02
AH-02
TP04
TP06
AH-06
TP05
AH-07
TP07
AH-08
AH-09
TP08
TP09
TP10
AH-10

N

Legend

- Hydraulic Test Hole
- Test Pit
- Stormwater drainage line
- Proposed area for LNG Facilities
- Newcastle Energy Project Site

0 25 50 100 Meters

Note: For correct Y and X grid coordinates, multiply both values by -1

95350 95450 95550 95650 95750

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NEWCASTLE GAS ENGINE POWER PLANT

DISTRIBUTION OF HYDRAULIC TEST HOLES IN RELATION TO TEST PITS IN VUTOMI ENERGY

Data Source:	ESRI Basemap Imagery
Scale:	1:1 500
Projection:	TM
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Project No:	566508
Fig No:	4-1

Revision: A Date: 01 06 2021

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Table 4-2 Summary of horizontal hydraulic conductivities of shallow aquifer material on site

BH ID	Depth (m)	SWL (mbgl)	Assumed Aquifer thickness (m)	Hydraulic conductivity (m/day)	Material
AH-01	0.2	dry	0.2	5.1×10^{-1}	Fill
AH-02	0.2	dry	0.2	Failed test	Fill
AH-06	1.9	0.34	1.9	1.4×10^{-1}	Ferricrete
AH-07	1.8	0.81	1.8	4.13×10^{-2}	Clayey sand
AH-08	1.3	dry	1.3	3.6×10^{-2}	Clayey sand
AH-09	0.3	dry	0.3	Failed test	Sandy clay
AH-10	0.42	dry	0.42	2.82×10^{-1}	Clayey sand

Table 4-3 Summary of horizontal hydraulic conductivities of Karbochem monitoring boreholes, (Bohlweki 1996).

BH ID	Depth (m)	Water strike depth (m)	Blow out yield (l/s)	SWL (mbgl)	Water elevation (mamsl)	Hydraulic conductivity (m/day)	Aquifer
BH1A	26	19	0.04	4.28	1218.72	-	Deep
BH1B	4.5	-	-	-	-	-	Shallow
BH2A	29.8	17	0.13	1.22	1227.78	4.32×10^{-1}	Deep
BH2B	5	-	-	-	-	-	Shallow
BH3A	29.8	21	0	9.61	1222.39	-	Deep
BH4A	30	10.5, 24	0.056	-	-	4.32×10^{-1}	Deep
BH4B	2.6	-	-	-	-	-	Shallow
BH5A	31	6	0	1.67	1218.33	-	Deep
BH8A	30.1	8	0.022	2.5	1211.5	-	Deep
BH9A	29.8	4.5, 17.5	0.083	3.17	1222.83	8.64×10^{-2}	Deep
BH9B	6	-	-	-	-	3.46×10^{-1}	Shallow
BH10A	30	9.5, 27	0.064	13.5	1210.5	4.32×10^{-1}	Deep
BH10B	8.6	-	-	-	-	1.12	Shallow
BH11A	29.8	7.5, 19	0.042	7.57	1214.43	7.78×10^{-1}	Deep
BH11B	8.6	-	-	-	-	-	Shallow
BH12A	29.7	7.5, 19	0.056	3.7	1225.3	3.54×10^{-2}	Deep
BH12B	8.7	-	-	-	-	1.12	Shallow
BH222	-	-	-	12.4	1243.6	-	Deep
BH51B	-	-	-	3.6	1232.4	-	-
BH45	-	-	-	2.3	1242.7	-	-

4.4 Hydrocensus results and groundwater utilisation

Hydrocensus survey was conducted within a 5 km radius from the project site to establish groundwater utilisation around the site and to measure depth to groundwater table. Borehole records from the NGA,

Water Management Systems (WMS) and Water Use Authorisation and Registration Managements Systems (WARMS) databases were used to guide the hydrocensus survey. Detailed hydrocensus results are summarised in Appendix C. Figure 4-2 illustrates the borehole distribution in the vicinity of the site.

The majority of NGA and WARMS boreholes were not found during the Hydrocensus survey. However, a good spatial borehole distribution based on field results, may suggest the high dependence of the rural population on groundwater. The neighbouring farming community relies on groundwater for domestic use. All boreholes (BH1 to BH3) located immediately west of the project site are equipped with submersible pumps and were pumping during the site investigations for this project.

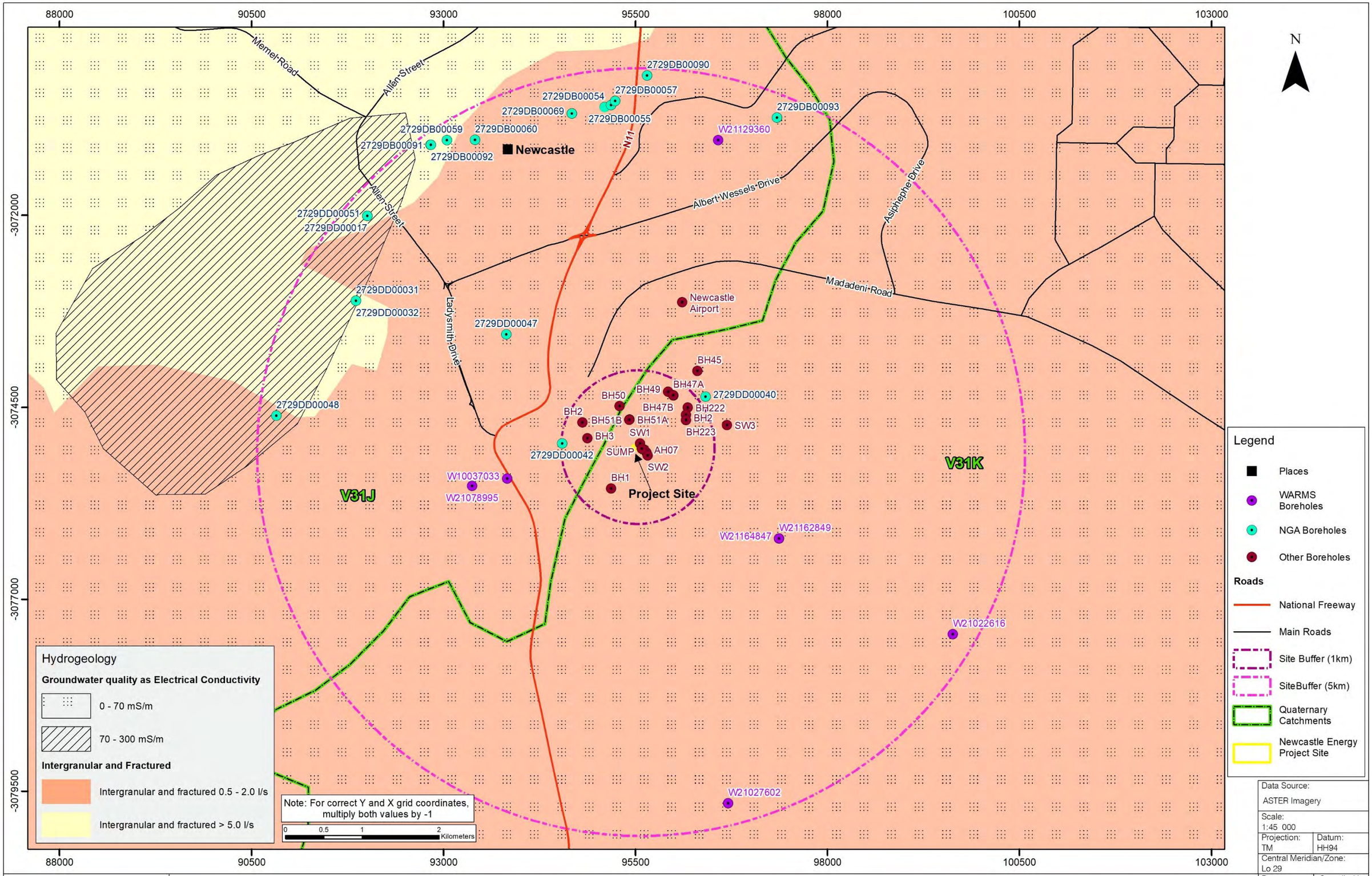
Boreholes located within the Karbochem industrial complex are used for groundwater monitoring. There is no permanent groundwater monitoring borehole within the NGEPP project site.

4.4.1 Groundwater levels and flow direction

The depth to groundwater in the study area varies across the site, controlled by the local geology, existing potential recharge sources, and topography. The NGEPP test holes AH-06 and AH-07 installed within the vicinity of stormwater drainage, had shallow water levels of 0.34 mbgl (1216.66 mamsl) and 0.81 mbgl (1223.19 mamsl) respectively measured in December 2020 compared to 2.3 mbgl (1242.7 mamsl) (BH45) and 3.6 mbgl (1232.4 mamsl) (BH 51B) measured at the nearest upgradient, and offsite Karbochem monitoring boreholes. Other test holes installed within NGEPP site were recorded dry in December 2020 to approximately 2 mbgl. The same seepage observations were made during the geotechnical investigations i.e. shallow seepage present around the same area (TP-06 and TP-07), (Gevorkyan Geophysics, 2020). This may suggest a direct influence of stormwater recharge to the shallow aquifer in the area around AH-06 and AH-07.

The deep aquifer water level range from 1 to 13.5 with the deepest water level of 13.5 mbgl was recorded in borehole BH10A (deep aquifer monitoring borehole) situated within Karbochem complex. This water level range may relate to ongoing groundwater abstraction.

Interpretation of groundwater elevation data suggest that the groundwater flow direction is to the south east toward a W-E drainage line downgradient of the site, Figure 4-3. This implies that the potential contamination from site would follow the same flow pattern and discharge as a baseflow to the W-E Karbochem spruit (south of the site).



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Central Meridian/Zone:	Lo 29
Date:	Compiled by:
15/10/2020	BRCH
Project No:	Fig No:
566508	4-2

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NEWCASTLE GAS ENGINE POWER PLANT (NGEPP) HYDROCENSUS

HYDROCENSUS RESULTS AND BOREHOLE DISTRIBUTION WITHIN 5KM RADIUS

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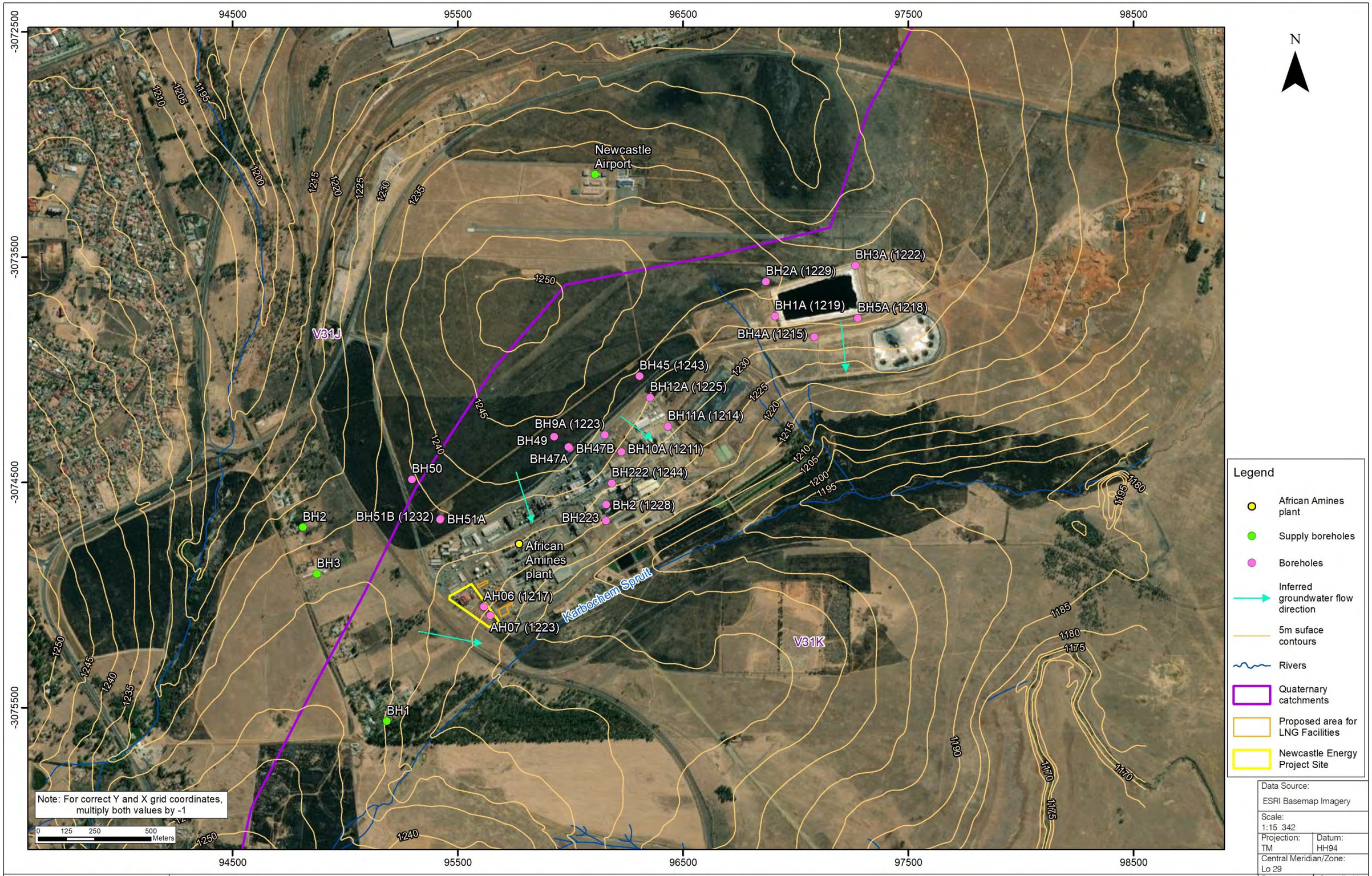
Revision: A Date: 01 06 2021



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Scale: 1:15 342

Projection: TM | Datum: HH94

Central Meridian/Zone: Lo 29

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NEWCASTLE GAS ENGINE POWER PLANT

GROUNDWATER FLOW DIRECTION MAP

Date: 15/10/2020 | Compiled by: BRCH

Project No: 566508 | Fig No: 4-3

Revision: A Date: 01 06 2021

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4.4.2 Dewatering evaluations

According to Gervorkyan Geophysics study undertaken in 2020, foundations will be excavated up to the bedrock (ranging across the site from 1.3 to 4.3 m) to allow construction of the Newcastle Gas Engine Power Plant.

This study confirmed the shallow groundwater occurrence (seepage) in the vicinity of AH-06 (0.34 mbgl) and AH-07 (0.81 mbgl). These two holes are approximately 50m apart along the NW-SE orientated unlined stormwater drainage channel and the eastern boundary fence. Shallow groundwater was not recorded in any other Test holes and Test pits (including TP08, TP09 and TP10 which are downgradient of AH-07, and are excavated deeper than test holes to 4.3, 4.1 and 4m respectively). This may suggest some infiltration of stormwater to shallow groundwater resource in the vicinity of AH06 and AH-07 during rainfall period.

Significant amount of water drains from the Parking at the Karbochem main security gate and office buildings upgradient through the stormwater drainage during rainfall. The clean stormwater from offsite and from the roof must be collected, attenuated and piped/released downgradient of the site.

During the dry season, flow in the stormwater drainage will cease (see Figure 4-4). The perched shallow groundwater occurrence condition around AH-06 and AH-07 is therefore likely to be seasonal and may not occur during dry season (when there is no rainfall recharge). Therefore, through effective management of stormwater in the area, this will eliminate shallow perched groundwater condition and may allow for the safe construction of the NGEPP to take place without extensive dewatering.

Figure 4-4 Stormwater drainage channel during dry season

5 Water quality assessment

Two groundwater seepage samples (AH-06 and AH-07) were taken onsite after auguring, and before Falling Head Test (FHT). The effluent sump was sampled directly using a disposable plastic bailer and two surface water samples (SW1 and SW2) were collected from the stormwater channel on-site, and a third surface water sample (SW3) was collected from the stream downgradient off-site (Figure 5-1). Borehole BH45 upgradient of the Karbochem complex was sampled after purging to ensure that the representative sample is analysed. Physiochemical properties of water were measured onsite using

calibrated pH, EC meter, Table 5-1. Samples were stored below 4°C onsite until delivery to Talbot & Talbot Laboratory Pty (Ltd) for the analysis of major ions, metals and, total oil and grease.

Table 5-1 Water sampling physio-chemical properties

Sample ID	T° C	pH	EC (µS/m)	TDS (mg/l)
BH45	23.8	7.1	190	80
AH-06	25.5	6.3	230	132
AH-07	21.7	6.4	310	110
SUMP	24.3	4.0	1 940	995
SW1	25.8	6.6	210	9
SW2	23.8	6.3	920	45
SW3	27.1	7.6	400	190

5.1 Groundwater analytical results

It is understood that groundwater onsite is not used for domestic purpose. However, the neighbouring communities rely on groundwater for domestic consumption. As a result, the water quality analytical results were compared to SANS 241 (2015) drinking water quality guidelines, Table 5-2. Water quality analytical results are included in Appendix D.

The highlighted results indicate concentrations that exceed the drinking water quality guidelines and may pose an unacceptable risk to human health with regular consumption. Additionally, analytical results supplied for Borehole 13A (Brochem monitoring borehole) was included in this assessment of the deep aquifer water quality as there is no deep aquifer borehole within the Newcastle Energy site. The following inferences are made from the groundwater quality analytical results:

- The background sample (BH45) reports good water quality with no influence from industrial activity. Similarly, the deep aquifer borehole (BH13A) in the vicinity of Brochem plant is of good water quality with constituents below the SANS 241 drinking water guidelines.
- The pH of effluent from the plant (Sump sample) is acidic (3.2 pH unit). Slightly acidic pH (5.8) was observed for AH-07. As expected, the effluent is characterised by elevated concentrations of dissolved metals with Al, Fe, Mn, Ni, U and Pb and elevated concentrations of Total dissolved solids (1 520 mg/l) and EC (203 mS/m).
- Samples AH-06 and AH-07 report elevated Al and Fe concentrations, and with acidic pH of 5.8 at AH-07. Elevated manganese concentration of 1.53 mg/l was recorded in AH-07. The two sites are situated downgradient of the existing infrastructure including the effluent sump and may reflect the impact of the historical leaks and/ or the present leaks from the plant facility and the sump. This may suggest that the sump is also a source of perched water in AH-06 and AH-07 vicinity.
- Traces of oil and grease (5-11 ppm) are reported in the sump and onsite groundwater samples (AH-06 and AH-07). Oil and grease were not observed in the background sample (BH45) suggesting probably an on-site source.
- There are no boreholes beyond these points to confirm the groundwater quality downgradient. Additional characterisation downgradient of the sump must carried out during phase II investigations to confirm the extent of contamination plume.

It is likely that the sump constitutes a potential local source of groundwater contamination, and it must be safely emptied before decommissioning to minimise potential impact to the soil and water environments in the vicinity.

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NEWCASTLE GAS ENGINE POWER PLANT

SURFACE AND GROUNDWATER SAMPLING POINTS

Data Source:	ESRI Basemap Imagery
Scale:	1:8 000
Projection: TM	Datum: HH94
Central Meridian/Zone:	Lo 29
Date: 29/01/2021	Compiled by: BRCH
Project No: 566508	Fig No: 5-1

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Revision: A Date: 17 05 2021

Table 5-2 Analytical results compared to SANS241 drinking water quality guidelines

SAMPLE ID	SANS 241	Sump	AH-06	AH-07	SW1	SW2	SW3	13A	BH45
pH []	>5 - <9.7	3.2	6.1	5.8	6.5	6.1	7.75	6.66	7.7
Total Cond [mS/m]	<170	203	25.7	29.9	23.6	94.2	40.3	18	20.8
TDS [mg/l]	<1200	1520	180	230	120	674	206	na	140
M Alk. [mg/l $CaCO_3$]	ng	<0.31	60	36	64	31	81	<5	95.9
Ca [mg/l]	ng	152	25	12.1	22	108	27.7	15	16.9
K [mg/l]	ng	3.93	1.79	3.48	1.83	4.71	8.65	2.9	2.28
Mg [mg/l]	ng	23	7.86	5.95	5.49	23	10.1	5.5	4.8
Na [mg/l]	<200	9.56	14.7	37	17.7	41	27.5	12	17.7
Si [mg/l]	ng	<0.01	<0.01	<0.01	<0.01	<0.01	5.92	na	18.4
F [mg/l]	<1.5	<0.03	0.12	<0.03	0.14	0.2	0.237	<0.2	0.115
Cl [mg/l]	<300	497	6.41	18.1	7.13	246	23.4	<0.5	0.561
NO_3 as N [mg/l]	<11	0.51	0.46	0.15	0.3	0.82	1.89	<0.2	0.277
PO_4 [mg/l]	ng	<0.04	<0.04	<0.04	<0.04	<0.04	<0.006	na	0.075
NO_2 as N [mg/l]	<0.9	<0.01	<0.01	<0.01	<0.01	<0.01	0.104	na	0.003
SO_4 [mg/l]	<500	13.5	41.5	62.9	27.7	31.6	56	<5	<0.7
Tot. Oil &G [ppm]	ng	6	11	5	<3	3	<1	na	<1
Ag [mg/l]	ng	<0.01	<0.01	<0.01	<0.01	<0.01	0.004	na	0.004
Al [mg/l]	<0.3	9.16	8.96	40	0.14	0.05	<0.001	na	<0.001
As [mg/l]	<0.01	<0.04	<0.04	<0.04	<0.04	<0.04	0.001	na	0.001
B [mg/l]	ng	0.11	0.05	0.06	0.05	0.07	0.024	na	0.002
Ba [mg/l]	ng	0.56	0.14	0.11	0.07	0.69	0.08	na	0.156
Co [mg/l]	0.5	0.09	<0.02	0.03	<0.02	0.07	0.002	na	0.001
Cr [mg/l]	<0.05	0.04	<0.02	0.04	<0.02	<0.02	<0.001	<0.00028	<0.001
Cu [mg/l]	2	0.07	<0.02	<0.02	<0.02	<0.02	<0.001	na	<0.001
Fe [mg/l]	2	55	2.52	11.2	0.13	0.11	0.038	na	<0.01
Hg [mg/l]	0.006	<0.002	<0.002	<0.002	<0.002	<0.002	0.001	0.00037	0.001
Mn [mg/l]	0.5	4.62	0.06	1.53	<0.02	4.04	<0.001	0.187	<0.001
Mo [mg/l]	ng	<0.11	<0.11	<0.11	<0.11	<0.11	0.003	na	0.003
Ni [mg/l]	0.06	0.06	<0.02	<0.02	<0.02	0.03	0.005	na	0.002
Pb [mg/l]	0.01	0.07	<0.03	<0.03	<0.03	<0.03	0.001	na	0.001
Sb [mg/l]	<0.02	<0.009	<0.009	<0.009	<0.009	<0.009	0.002	na	0.002
Se [mg/l]	0.01	<0.07	<0.07	<0.07	<0.07	<0.07	0.001	na	<0.001
Sr [mg/l]	ng	0.49	0.13	0.08	0.11	0.47	0.167	na	0.271
Ti [mg/l]	ng	<0.03	0.27	1.42	<0.03	<0.03	<0.05	na	<0.05
Tl [mg/l]	ng	<0.02	<0.02	<0.02	<0.02	<0.02	<0.001	na	<0.001
U [mg/l]	0.015	0.11	<0.02	0.03	0.02	0.03	<0.0001	na	<0.0001
V [mg/l]	0.2	<0.02	<0.02	0.05	<0.02	<0.02	<0.001	na	<0.001
Zn [mg/l]	<5	4.03	<0.02	0.02	<0.02	0.93	<0.001	na	<0.001

5.2 Surface water analytical results

Three surface water samples (SW1, SW2 and SW3) were taken on 8 December 2020 and analysed for major ions (cations and anions) to characterise the surface water quality. SW1 is a stormwater sample taken fairly upgradient of the site processes and represent background water quality. SW2 is a stormwater sample taken within the site boundary fence downgradient of the site processes whereas SW3 was sampled from the Karbochem Spruit offsite, further downgradient of both Newcastle Energy site and Karbochem complex, (see Figure 5-1). The following statements summarises the surface water quality:

- Good water quality is reported for the background sample (SW1).
- SW2 reports elevated manganese concentration (4 mg/l) exceeding SANS 241 drinking water guidelines. A similar exceedance was observed at the sump.
- Slightly elevated Electrical conductivity (94.2 mS/m) and Cl levels at SW2 may suggest that seepage from the sump and or other site infrastructure possibly even via shallow groundwater is migrating to stormwater as baseflow.
- SW3 reports good water quality with constituents analysed below SANS 241 drinking water guidelines suggesting that Karbochemspruit is of good water quality and may relate to dilution effect of rain and or Karbochem treated water discharge into Karbochemspruit.
- Traces of oil and grease (3 ppm) was reported for SW2 downgradient of the facility. The background sample (SW1) reported oil and grease concentrations below the laboratory detection limit. This suggests on-site sources influencing the results at SW2.

Generally, the Newcastle Energy surface and shallow groundwater is characterised by slightly elevated concentrations of dissolved salts, with relatively moderately elevated levels of Na, Mg, Ca and Cl.

5.3 Water quality characterisation

The relative major ion concentrations were plotted on Piper and Stiff diagrams (Figure 5-2 and Figure 5-3 respectively). Piper diagram display the water types and stiff diagrams show the dominating ions in water.

The Sump sample and SW2 samples plots at the apex of the Piper diagram denoted by number 1 in Figure 5-2 showing impacted poor quality water relating to high chloride concentration. The dominating ion in Sump and SW2 samples are Cl and NO_3 (see the Stiff diagram in Figure 5-3). The influence of the site infrastructure including sump to groundwater quality downgradient is evident in AH-07 and SW2 which also plot in the upper-right quadrant (saline quality) section of the piper diagram.

The background samples (BH45, SW1), AH-06 and SW3 plots in the left quadrant of the piper diagram (recent water – illustrated by number 2 in Figure 5-2) relating to low concentration of dissolved salts in these samples. Apart from elevated metal concentrations in AH-06 sample, there is a clear ionic correlation between SW1 and AH-06 confirming a hydraulic connection of the stormwater and shallow aquifer material.

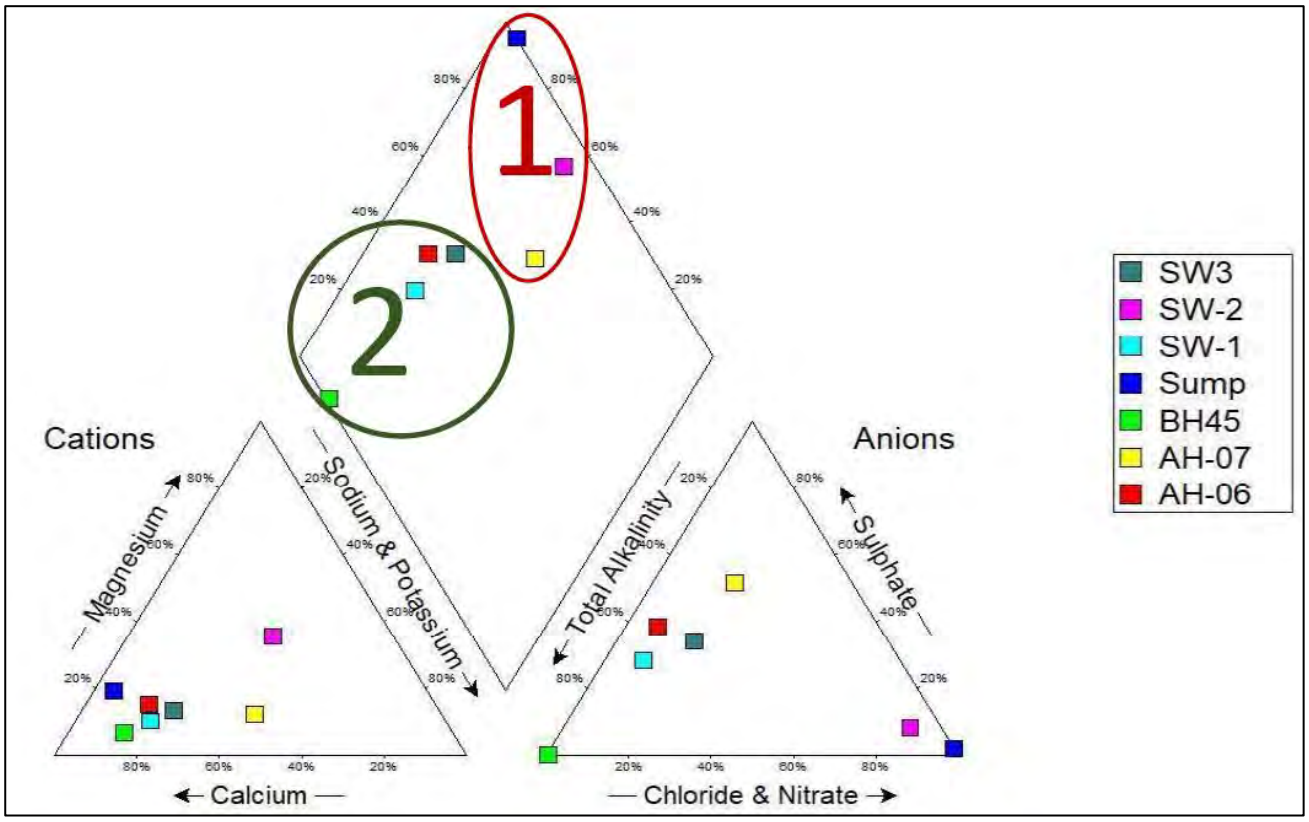

Figure 5-2 Piper diagram – Water types

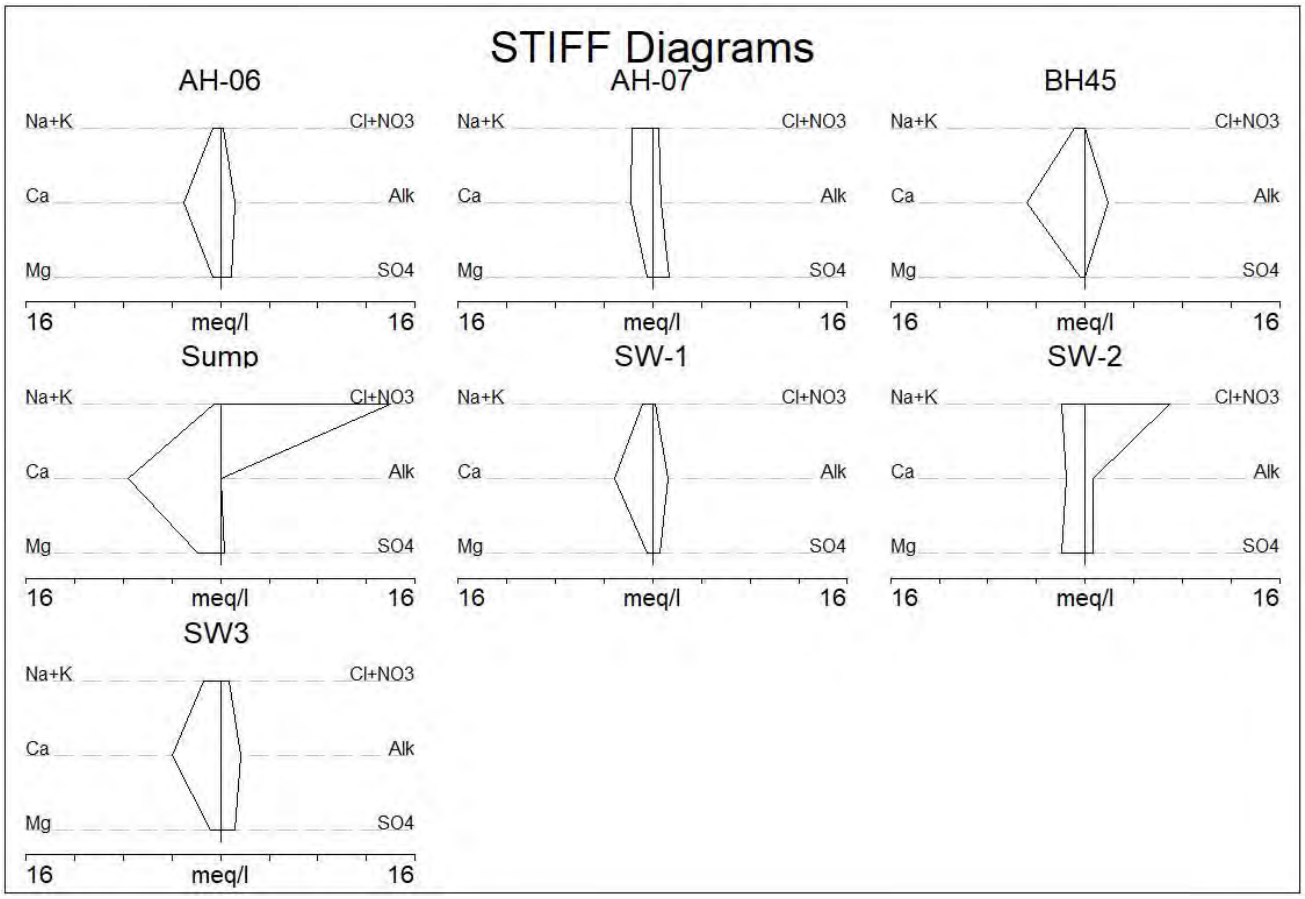

Figure 5-3 Stiff diagrams, dominating ions in water

6 Site conceptualisation

From this investigation, a site hydrogeological understanding (summarised below) was used to develop a Site Conceptual Model (Figure 6-1):

- NGEPP site is located within the Ingagane River Catchment (V31), a sub-catchment to the Buffalo River Catchment. The Ingagane River catchment receive c.851 mm of the MAP, evaporation of c.1435 mm/year and a runoff of c.119mm per annum resulting in groundwater recharge of c. 3% of MAP (26mm/year). The high evaporation leads to deficit in the water balance.
- The Site is underlain by rocks of the Karoo Supergroup comprising sandstone, shale, and siltstone, intruded by the Karoo dolerite. The Karoo lithology is characterised by low primary permeability with low groundwater occurrence potential. In the area, groundwater occurrence is controlled by the degree of weathering, fracturing and geological structures such as faults, and dolerite contacts.
- Groundwater in the area occur at depth from 0.3 to 6m as a shallow aquifer and at depth below 15 mbgl as deep fractured aquifer. In this area, groundwater is moderately vulnerable to some pollutants.
- The existing chemical storage tanks, effluent sump, chemical containers, septic tank, jet engines and filters constitute the potential sources of contamination. These potential contamination sources are either concrete lined with no signs of spillages or leakages observed. It is understood that these items will be removed before the construction of the new power station.
- Aquifer horizontal hydraulic conductivity ranging from 5×10^{-1} to 3×10^{-2} m/d was reported from the onsite test holes with the permeability as high as 1.1 m/d recorded from Karbochem shallow aquifer monitoring boreholes. Horizontal hydraulic conductivity ranging from 8.6×10^{-2} m/d to 4.32×10^{-1} m/d was reported for Karbochem deep boreholes, (Bohlweki, 1996).
- The acidic pH and elevated Trace metal concentration were recorded for the sump sample. Similarly, acidic pH and elevated Trace metal levels are recorded in surface water sample (SW2) collected from the stormwater trench downgradient of the sump compared to SW1, confirming that contaminated water is potentially migrating from the site infrastructure, through the shallow aquifer, and discharge into local drainage/ stormwater lines. It is not evident from this study that the sump is the only source of contamination, but multiple sources including potential historical spillages.
- The predominant groundwater flow is to Southeast toward Karbochem Spruit being the main potential receptor. There are no private groundwater users (human receptors) recorded immediately downgradient of the site.

According to Gervorkyan Geophysics (2020), foundations will be excavated to bedrock to allow construction of the Newcastle Gas Engine Power Plant. The Gervorkyan Geophysics (2020) report suggest that dewatering will be required during construction. However, the findings of this study suggest that the localised shallow water condition around AH-06 and AH-07 relates to inundated stormwater recharge during wet season, implying that prevention of stormwater seepage will reduce this local subsurface recharge. Consequently, extensive dewatering will not be required during NGEPP construction.

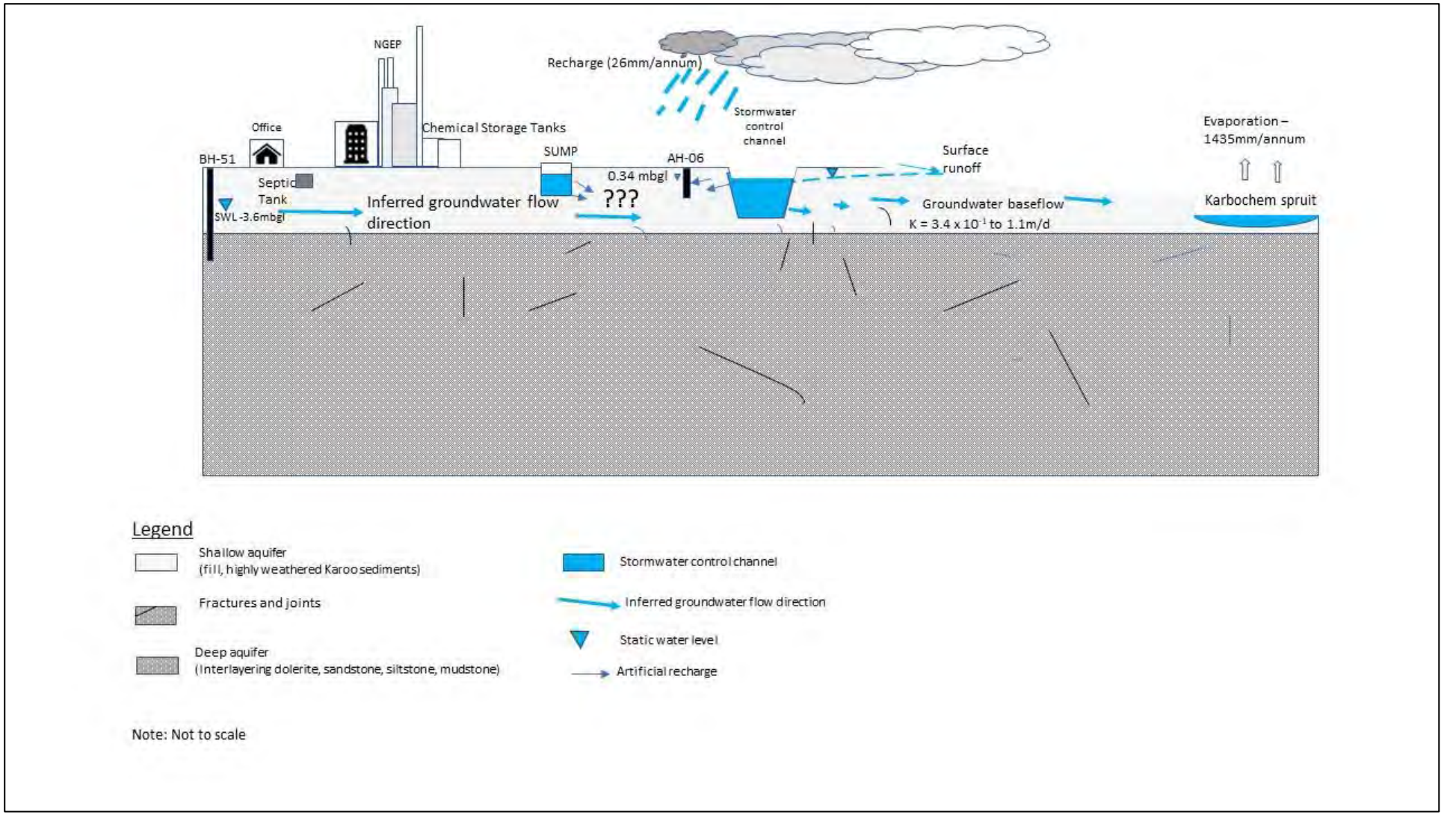

Figure 6-1 NGEPP Site Conceptual Model (SCM).

7 Groundwater Impact Assessment

An impact risk analysis was undertaken based on information collated from the data review, site activity, results of the auger holes installation, FHT results and the water quality analytical results. The significance of impacts identified in this assessment were determined using the methodology described below. The method provides an indication (in relative terms) of the significance of a potential impact.

Risk is defined as the consequence of the event multiplied by the probability of that event. The environmental assessment equivalent is the *severity* plus the *extent* plus the *duration*; this gives a rating for the **consequence of the impact**. The **likelihood of impact occurring** is a rating based on the *frequency of activity* plus the *frequency of the impact*.

The **impact significance** is therefore calculated as the consequence of the impact multiplied by the likelihood of the impact occurring, as per the expression below:

*(Severity + extent + duration) * (frequency of activity + frequency of impact) = impact significance*

Details of the assessment rating is provided in Table 7-1

Table 7-1 Impact assessment rating table

Impact:							
CONSEQUENCE OF IMPACT					**Sub-total:**		
SEVERITY OF IMPACT	RATING		**SPATIAL SCOPE / EXTENT**	RATING		**DURATION OF IMPACT**	RATING	
Insignificant / non-harmful	1		Activity specific	1		One day to one month	1	
Small / potentially harmful	2		Area / site specific	2		One month to one year	2	
Significant / slightly harmful	3		Local area (within 5 km of site)	3		One year to ten years	3	
Great / harmful	4		Regional (neighbouring areas)	4		Life of operation	4	
Extremely harmful	5		National	5		Post closure / permanent	5	
SRK LIKELIHOOD OF IMPACT OCCURRING					**Sub-total:**		
FREQUENCY OF ACTIVITY		RATING		**FREQUENCY OF IMPACT**			RATING	
Annually or less / low		1		Almost never / almost impossible			1	
6 monthly / temporary		2		Very seldom / highly unlikely			2	
Monthly / infrequent		3		Infrequent / unlikely / seldom			3	
Weekly / life of operation / regularly / likely		4		Often / regularly / likely / possible			4	
Daily / permanent / high		5		Daily / highly likely / definitely			5	
Impact rating (current impacts and future potential impacts) without mitigations							
Proposed mitigation:							
SRK CONSEQUENCE OF IMPACT					**Sub-total:**		
SEVERITY OF IMPACT	RATING		**SPATIAL SCOPE / EXTENT**	RATING		**DURATION OF IMPACT**	RATING	
SRK LIKELIHOOD OF IMPACT OCCURRING					**Sub-total:**		
FREQUENCY OF ACTIVITY		RATING		**FREQUENCY OF IMPACT**			RATING	
Impact rating with mitigation measures in place							

The environmental significance of any identified potential impact may be rated as either high, moderate or low on the following basis:

- More than 60 significance value indicates a high (H) environmental significance impact;
- Between 30 and 60 significance value indicates a moderate (M) environmental significance impact; and
- Less than 30 significance value indicates a low (L) environmental significance impact.

For the purposes of this report, the impact assessment considers the potential impacts from the site, both from the decommissioning of the existing infrastructure, and potential impacts likely to emanate from the proposed site activities during construction together with the implemented mitigation measures. The correct size bund walls will be constructed around NGEPP chemical storage facilities to contain any potential spillages and prevent potential contamination. . Therefore, minimal impacts from the chemical storage containers is possible during operation. It is expected that all infrastructure will be removed, and the site rehabilitated post closure. Therefore, minimal potential short-term impacts to water resources are anticipated from the removed chemical storage infrastructure post closure.

Table 7-2 lists and assesses the identified potential groundwater impacts associated with proposed decommissioning of existing infrastructure whereas impacts associated with proposed construction are assessed in Table 7-3. Project impacts to water resources during project operation are assessed in Table 7-4. The assessment considers the risks category before mitigation; and provide possible mitigation measures and then the risk category after mitigation.

Table 7-2 Groundwater Impact assessment and Mitigation during decommissioning of the existing power plant

1. Poor management of contaminated sump water during decommissioning will result in deterioration of groundwater quality in the immediate vicinity							
Spatial extent	**Duration**	**Severity**	**Frequency of activity**	**Frequency of impact**	**Consequence**	**Likelihood**	**Significance**
Impact rating (potential future impacts during decommissioning)							
Site Specific	One month to one year	Potential Harmful	Daily	infrequent	(2+2+2) = 6	(5+3) = 8	Moderate
2	2	2	5	3			48
The proposed mitigation measures and recommendations include: • Safely empty the effluent sump before any decommissioning activity, demolish the sump after removing the potential contamination sources at the plant (chemical tanks, and containers etc) • Contaminated sump water must not be used or discarded on site. This must be transported to the Karbochem effluent treatment plant. • Confirm levels of soil and groundwater (if any) contamination for a Phase II site assessment process and remediate as necessary							
Impact rating with mitigation measures in place							
Site Specific	One Month to a year	Non-Harmful	Very seldom	Almost Never	(2+2+1) = 5	(2+1) = 3	Low
2	2	1	2	1			15
2. Poor management of chemicals (HCl, hydrocarbons and Caustic soda, etc) from the storage facilities onsite during demolition will result in deterioration of groundwater quality in the immediate vicinity							
Spatial extent	**Duration**	**Severity**	**Frequency of activity**	**Frequency of impact**	**Consequence**	**Likelihood**	**Significance**
Impact rating (current status and potential future impacts)							
Site Specific	One month to one year	Potential Harmful	Daily	infrequent	(2+2+2) = 6	(5+3) = 8	Moderate
2	2	2	5	3			48

The proposed mitigation measures and recommendations include: • Safely empty the storage tanks of any chemical content before any decommissioning activity, demolish the bund walls only when the storage tanks are removed. • Empty chemical containers must be handled as hazardous and must be removed from site before any demolition activities.							
Impact rating with mitigation measures in place							
Site Specific	One Month	Non-Harmful	Daily	Almost Never	(2+1+1) = 4	(5+1) = 6	Low
2	1	1	5	1			24
3. Poor management of sewage from the septic tank onsite during demolition will result in deterioration of groundwater quality in the immediate vicinity							
Spatial extent	**Duration**	**Severity**	**Frequency of activity**	**Frequency of impact**	**Consequence**	**Likelihood**	**Significance**
Impact rating (current status and potential future impacts)							
Site Specific	One month to one year	Potential Harmful	Daily	Very seldom	(2+2+2) = 6	(5+2) = 7	Moderate
2	2	2	5	2			42
The proposed mitigation measures and recommendations include: • Safely empty the septic tank before any decommissioning activity, demolish the tank only when the sewage has been removed • The contaminated material including soil must be removed for safe disposal off-site.							
Impact rating with mitigation measures in place							
Site Specific	One day to a Month	Non-Harmful	Daily	Almost Never	(2+1+1) = 4	(5+1) = 6	Low
2	1	1	5	1			24

Table 7-3 Groundwater Impact assessment and mitigation during construction of the proposed NGEPP

4. Impact to surface water – disposal of groundwater seepage to the surface water resource impacting aquatic systems							
Spatial extent	Duration	Severity	Frequency of activity	Frequency of impact	Consequence	Likelihood	Significance
Impact rating (potential future impacts during construction)							
Site Specific	One month to one year	Potential Harmful	Daily	Very seldom	(2+2+2) = 6	(5+2) = 7	Moderate
2	2	2	5	2			42
The proposed mitigation measures and recommendations include: • Potentially minor seepage from the construction site must be captured and disposed of safely at the Karbochem effluent treatment, this is potentially contaminated water and must not be discharged into the surface water resource.							
Impact rating with mitigation measures in place							
Site Specific	One Month	Non-Harmful	Daily	Almost Never	(2+1+1) = 4	(5+1) = 6	Low
2	1	1	5	1			24

Table 7-4 Groundwater Impact assessment and mitigation during NGEPP operation

5. Impact to water – spillage from the chemical storage tanks including LNG facility and other potential contamination sources has the potential to contaminate surface and groundwater resource							
Spatial extent	Duration	Severity	Frequency of activity	Frequency of impact	Consequence	Likelihood	Significance
Impact rating (potential future impacts during operation)							
Site Specific	One month to one year	Potential Harmful	Daily	Very seldom	(2+4+2) = 8	(5+2) = 7	Moderate
2	4	2	5	2			56
The proposed mitigation measures and recommendations include: • All chemical storage facilities including LNG are to be bunded to contain any potential spillages and material handled and stored safely according to MSDS and related guidelines. Any other potential contamination sources (eg. sumps) are to be engineered to prevent leakages and seepage to the groundwater resource. • Water monitoring to be carried out to ensure water contamination is recorded, and management strategies are implemented timeously.							
Impact rating with mitigation measures in place							
Site Specific	One Month	Non-Harmful	Daily	Almost Never	(1+4+1) = 5	(5+1) = 6	Low
1	4	1	5	1			30

8 Conclusions and recommendations

8.1 Conclusions

Groundwater assessment was carried out for the proposed NGEPP site to establish the baseline groundwater characteristics prior construction, and to evaluate shallow aquifer dewatering requirements. The following conclusions are drawn from the observations made:

- The existing chemical storage tanks, chemical containers, filters, septic tank, and effluent sump constitute the potential source of groundwater contamination onsite. It is confirmed that the site infrastructure including current effluent sump is contaminating groundwater and surface water immediately downgradient. Contamination pathways and extent of contamination should be established to guide subsequent remediation process. It is however noted that all potential contamination sources will be removed before the construction of the new power plant.
- The permeability testing of shallow weathered material onsite yielded hydraulic conductivity ranging from 0.036 m/d to 0.14 m/d, with high k values (up to 1.1 m/d) reported for Karbochem boreholes. This moderate permeability range implies that groundwater and potential contaminants would migrate offsite.
- The Hydrocensus survey confirmed the reliance on groundwater for domestic use by the neighbouring farming community approximately 1.3 km west of the site, and Newcastle airport borehole situated upgradient, approximately 2km north of the site. There are no groundwater users in the immediate vicinity (2 km radius) downgradient of the site.
- Depth to water table on site is shallow (0.34 mbgl - 0.81 mbgl) along the stormwater drainage channel. Other test holes across the site were dry during field investigation suggesting some artificial recharge to sub-surface from the inundated stormwater drainage during wet season. This implies that dewatering will not be required if the stormwater drainage is improved or managed and localised groundwater recharge around AH-06 and AH-07 is stopped.
- Slightly deeper water levels (3 – 13mbgl) were observed from offsite boreholes. The predominant groundwater flow is Southeast toward Karbochem Spruit. Potential groundwater contamination

from site would also follow the same flow paths to the Karbochem Spruit and wetlands downgradient of the site, being the main potential receptor. There are no private groundwater users (human receptors) recorded immediately downgradient of the site.

It is confirmed from this study that the site infrastructure including existing effluent sump and or potential historical spillages is impacting the groundwater quality in the vicinity. Poor management of sewage, chemical storage tanks (acid and caustic soda), effluent in the sump during decommissioning has the potential to impact the soil, surface and groundwater in the area. Without good controls and management, pollution of the surface and groundwater can occur from the planned power plant.

8.2 Recommendations

The impacts identified will be ameliorated after implementing the following management measures.

Potential groundwater contamination from the current site infrastructure should be avoided by:

- Safely emptying the chemical storage tanks, effluent sump and septic tank onsite before decommissioning of the existing infrastructure to avoid spillages and contamination of soil and groundwater in the area.
- Safely removing all potential contamination sources (chemical storage containers, jet engines, filters) from site before decommissioning of the existing infrastructure.
- Managing potential spillage; and environment (soil and water) accidentally contaminated during decommissioning.
- The existing project site (NGEPP) and proposed area for the LNG facilities and infrastructure should be integrated and a gap analysis be done to develop a Phase II characterisation plan.
- Confirming levels of soil and groundwater contamination for a Phase II site assessment process, which should include geophysical survey to site borehole drilling targets, borehole drilling, aquifer testing and water quality analysis; and remediate the site as necessary.
- Additional characterisation downgradient of the sump must carried out during phase II investigations (contamination assessment) to confirm the contamination pathways and extent of contamination plume.
- The detailed hydrogeological assessment for LNG facility site and area immediately downgradient of the sump as well as the potential for surface and groundwater interaction should form part of Phase II.
- Residual contamination associated with infrastructure removal must be remediated before subsequent construction of the NGEPP.
- Surface and groundwater monitoring network for the NGEPP (Refer to Figure 8-1) should be established and maintained as follows:
    - A minimum of five (5) borehole pairs should be installed into shallow (15 m deep) and deep (30 m) aquifers for adequate coverage of the NGEPP and LNG facilities.
    - Two surface water monitoring stations should be established on the stormwater drainage upgradient (SW1) and downgradient (SW2) of the site for surface water monitoring. This will be feasible during wet season, before construction of NGEPP, during operation and after site closure. Additional two surface water monitoring stations further downgradient of the site upstream of the confluence of the stormwater channel (SW4) and at a downstream point of the proposed LNG facility (SW5).

- Sampling and analysis of water quality should be conducted monthly during construction, monthly for the first six month following NGEPP construction, followed by quarterly and then bi-annually depending on the results of the first six month during operation.
- Based on this study results, water samples should be analysed for Physiochemical Properties (pH, EC, TDS and Alkalinity), Major ions and Trace metals (which should include, Al, Fe, Hg, Mn, Ni, and Zn).
- Additionally, analysis of environmental isotopes (oxygen 18 and deuterium) should be included in the initial round of analysis at MON-BH1S and SW2, to assess the potential for surface water/groundwater hydraulic connections at/near the site.
- Monitoring should be systematic and consistent so that meaningful interpretations can be made of the datasets.
- All monitoring data should be compiled on a database for easy access and interpretation.

- Any minor seepage from the construction site should not be discharged on site or to the surface water resource but should be piped off to Karbochem treatment plant for treatment.

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NEWCASTLE GAS ENGINE POWER PLANT

PROPOSED NGEPP WATER MONITORING STATIONS

Data Source: ESRI Basemap Imagery	
Scale: 1:2 000	
Projection: TM	Datum: HH94
Central Meridian/Zone: Lo 29	
Date: 15/10/2020	Compiled by: BRCH
Project No: 566508	Fig No: 8-1

Path: G:\566508_NEWCASTLE_ENERGEY_ENV_VHUY\8GIS\GISPROJ\MXD\Groundwater\566508_F8-1_NGEPP_MonitoringStations_A3CL_20210317.mxd

Revision: A Date: 04 06 2021

9 Reference

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Prepared by

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566508/44348/Report

937-6746-1082-MADP-03/06/2021

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Peter Madanda, Pr.Sci.Nat

Principal Consultant

Reviewed by

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566508/44349/Report

9719-83-9390-MAHO-04/06/2021

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Ismail Mahomed, Pr.Sci.Nat

Partner / Principal Scientist

Project Partner

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3858-3914-4060-VHUY-03/06/2021

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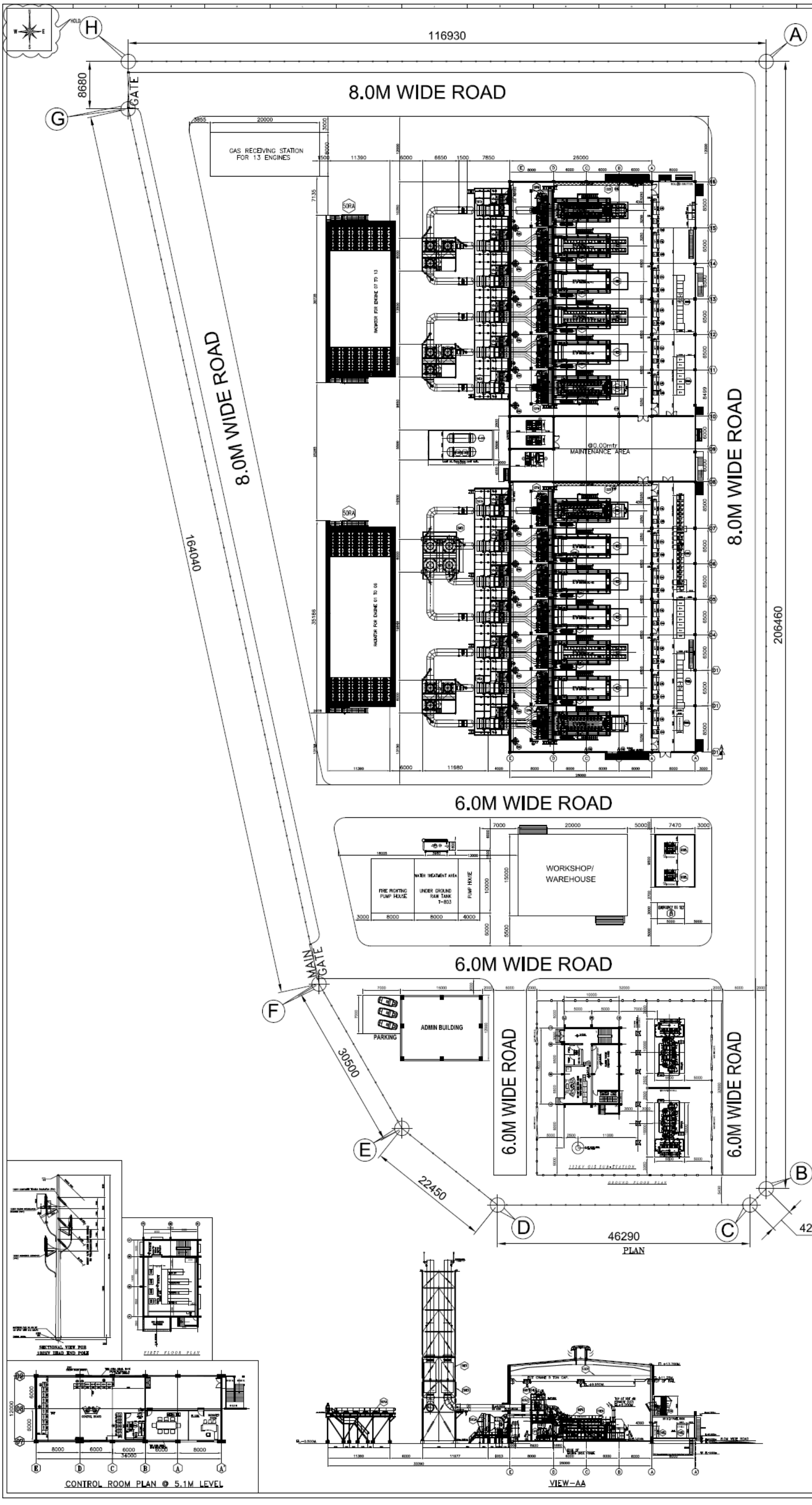
Marius van Huyssteen

Partner

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

Appendices

Appendix A: Power Plant and LNG Facility Layouts



NOTES:

1. All dimensions are in mm, Elevations are in metres, unless otherwise specified.
2. Elevation 0.00m corresponds to Finished Floor Level (FFL) of Engine hall.
3. Outside Engine hall floor FGL (-) 0.500m min/max.
4. North direction to be confirmed depends on site location, indicated Tentatively
5. Explosion Relief Valve location Qty decided during engineering.

SCHEDULE OF MECHANICAL EQUIPMENT

Tag. No.	EQUIPMENT DESCRIPTION	QTY.	WT/Unit, kg
11EN	ENGINE B35:40V20AG1	13 NOS.	
12PM	AUXILIARY MODULE	13 NOS.	
13CR	EOT CRANE ENGINE HALL (5TON)	01 NO.	
14CR	EOT CRANE WORKSHOP (2TON)	01 NO.	
14VA	VENTILATION UNIT	13 SET	
30SA	STARTING AIR COMPRESSOR	02 NOS.	
43LO	LUBE OIL TRANSFER PUMP	01 NO.	
44LO	USED LUBE OIL DRAIN TRANSFER PUMP	01 NO.	
50RA	RADIATOR-02 Nos/Engine	13 SET	
51EX	EXHAUST SILENCER	13 NOS.	
54CA	CHARGE AIR FILTER (BUILT IN WITH SILENCER)	13 NOS.	
59EX	EXHAUST CHIMNEY STRUCTURES	04 NOS.	
84SA	START AIR BOTTLE 3000 Ltrs	13 NOS.	
86LT	LT EXPANSION TANK	13 NOS.	
86HT	HT EXPANSION TANK	13 NOS.	
86LO	CRANKCASE VENTILATION UNIT	13 NOS.	
90EX	PRE-VENTILATION SYSTEM	13 NOS.	
90FG	FUEL GAS MODULE	13 NOS.	
94SA	CONTROL AIR MODULE	06 NOS.	
100SA	MOUNTING PLATE	13 NOS.	
ERV	EXPLOSION RELIEF VALVE	26 NOS.	
-	GAS RECEIVING STATION	01 NO.	
66FG	SLAM SHUT OFF VALVE	01 NO.	
77FG	BLEED OFF VALVE	01 NO.	
99FG	MAIN GAS FILTER	01 NO.	
T-301	LUBE OIL MAKE UP TANK-10KL	01 NO.	
T-302	USED LUBE OIL TANK-10KL	01 NO.	
T-303	LUBE OIL MAINTENANCE TANK-10KL	01 NO.	
T-304	USED LUBE OIL DRAIN TANK-1KL	01 NO.	
T-802	POTABLE WATER TANK 20KL.	01 NO.	
T-803	RAW WATER TANK UNDERGROUND	01 NO.	
T-804	MAKE UP WATER TANK-2KL /06 ENGINE	02 NOS.	

SCHEDULE OF ELECTRICAL EQUIPMENT

TAG NO	EQUIPMENT DESCRIPTION	QTY.	WT/Unit, kg
10EL	MV PANEL BOARD	01 NO	-
20EL	BATTERY CHARGER	01 NO	-
21EL	220V DC BATTERY BANK	01 NO	-
30EL	ENGINE CONTROL CABINET (ECC)	13 NOS	-
31EL	ENGINE MOTOR CONTROL CABINET (EMCC)	13 NOS	-
50EL	NEUTRAL GROUNDING TRANSFORMER (NGT)	13 NOS	-
60EL	PLANT CONTROL CABINET (PCC)	02 NOS	
70EL	UTILITY CONTROL CABINET (U1)	02 NOS	-
71EL	BATTERY CONTROL CABINET (B1)	07 NOS	-
80EL	GENERATOR CONTROL CABINET (G1)	13 NOS	-
91EL	EMERGENCY PUSH BUTTON	04 NOS	-
96EL	AUXILIARY TRANSFORMER	02 NOS	-
99EL	BLACK START D.G SET	01 NO	-
101EL	PCCP	01 NO	-
-	BSDG DISTRIBUTION PANEL	01 NO	-
-	MLDB	01 NO	-
-	MPDB	01 NO	-
-	NETWORK SWITCH PANEL	01 NO	
-	WEATHER STATION PANEL	01 NO	

REFERENCE SURVEY DOCUMENT
LEASEHOLD DIAGRAM FILE NO: NEW CASTLE/217
SR NO: 448/2008
AREA AVAILABLE AS PER LEASE : 1.78 Hectare

NOTES & LEGENDS FOR 132KV GIS SUB-STATION:-

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. THE PHYSICAL APPEARANCE AND THE DIMENSIONS OF ALL PANELS ARE INDICATIVE ONLY, THE EXACT DIMENSIONS SHALL BE INCORPORATED AFTER THE APPROVAL OF GA DRAWINGS OF THE RESPECTIVE EQUIPMENTS OR PANELS.
3. THIS DRAWING SHALL BE REFERED ONLY FOR PANEL ARRANGEMENT PURPOSE TO CHECK ADEQUATE CLEARANCES.
4. HEIGHT OF ACID PROOF TILEING SHALL BE UP TO 2.1 MTR. IN BATTERY ROOM
5. DOORS IN SWITCHGEAR ROOM/CABLE VAULTS/BATTERY ROOM SHALL BE FIRE RATED FOR 2 HOURS.
6. BATTERY ROOM FLOOR SHALL BE WITH ACID PROOF TILES.
7. 132KV LA FOR TRANSFORMER TO BE FITTED ALONG WITH BUSHING.

LEGENDS :-

PANEL NO.	PANEL DESCRIPTION
1CRP	O/G-1 CONTROL & RELAY PANEL
2CRP	BUS PT
T1CRP	TRAFO.1 CONTROL & RELAY PANEL
T2CRP	TRAFO.2 CONTROL & RELAY PANEL
RT1	RTCC PANEL TRAFO.-1
RT2	RTCC PANEL TRAFO.-2
SCP	SCADA PANEL
BC	BATTERY CHARGER

FOR TENDER PURPOSE ONLY
PRELIMINARY ISSUE

Rev:	Date:	Revision Note:	Drawn By:	Checked By:	Approved By:
2	21.10.2020	GAS MODULE BLOCKED/SECTIONAL VIEW FOR 132KV DEAD END POLE ADDED	RA	N.S	BHASKAR
1	13.10.2020	GIS SWITCH YARD UPDATED	RA	N.S	BHASKAR
0	06.10.2020	PRELIMINARY ISSUE	N.S	G.S	BHASKAR

CUSTOMER : VUTOMI - NEW CASTLE - SOUTH AFRICA

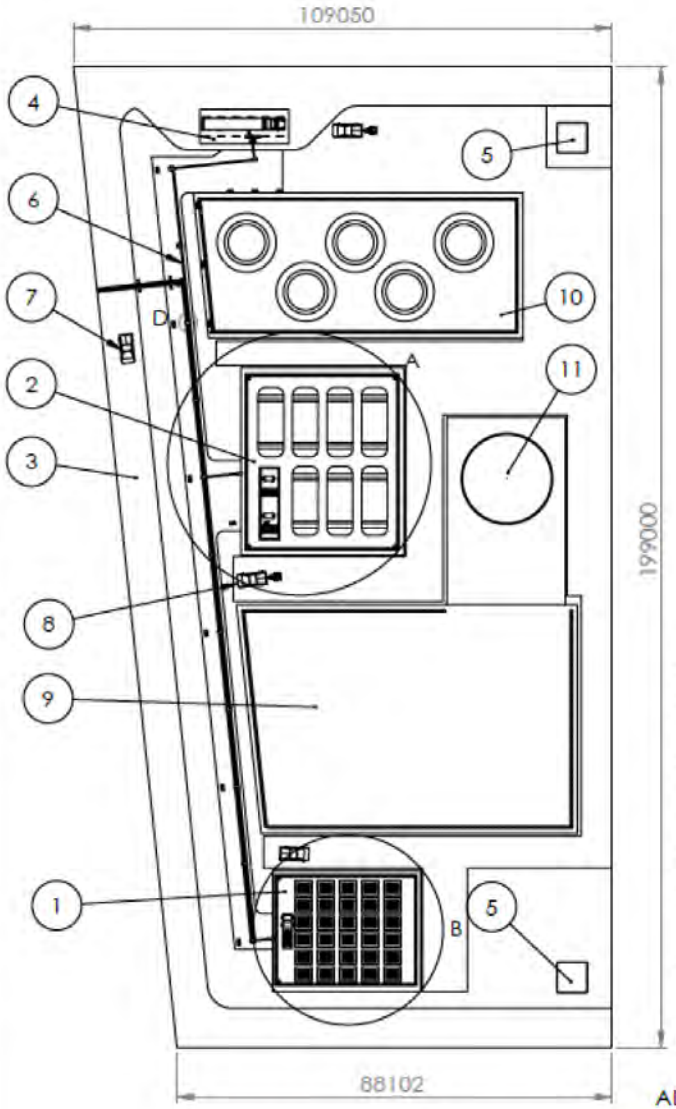
PROJECT : 13 X B35:40 V20 AG GAS BASED ENGINE POWER PLANT

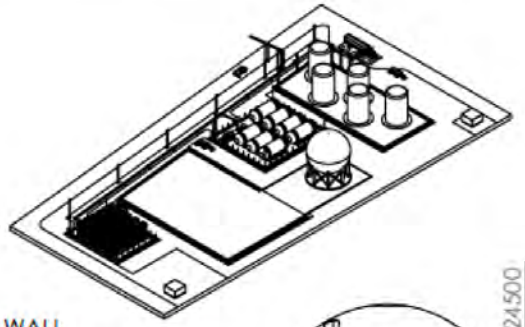
Title: POWER PLANT LAYOUT

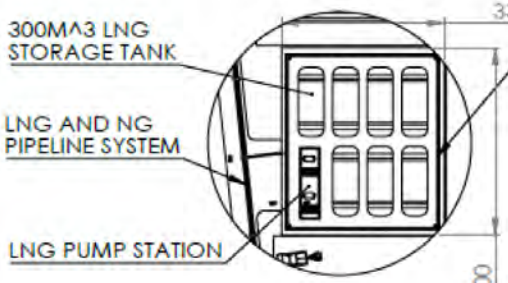
Rolls Royce Power System Bergen Engines

Reference: XXXXXX | Originator: Rolls-Royce | Date: 06.10.2020 | Scale: 1:235 | Format: A0 | Sheet: 01/01

Mass (Kg): NA | Drawing No: 13ST-11-001 | Revision: 2







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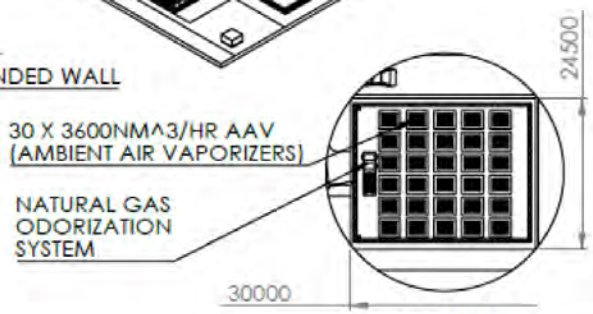

DETAIL B
SCALE 1 : 800

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	VOLCO POWER REGASIFICATION FACILITY	AMBIENT AIR VAPORIZERS 30X 3600NM^3/HR	1
2	LNG TANK FARM 2100M^3	7X 300M^3 LNG CRYOGENIC TANKS	1
3	EXISTING KARBOCHEM SERVICE ROAD	ASPHALT ROAD FOR KARBOCHEM TENANTS	1
4	LNG DISPENSING STATION	TRUCK DISPENSING AND LOADING SYSTEM	1
5	VOLCO POWER LOGO	VOLCO POWER SIGNAGE	2
6	LNG AND NG PIPELINE	GAS PIPELINE SYSTEM	1
7	COMPANY VEHICLE	4x4 TYPE VEHICLES	2
8	COMPANY CAR WITH PARTS TRAILER	SERVICE VEHICLE	2
9	EXISTING BUNDED AREA	LARGE BUNDED AREA FOR EXISTING KARBOCHEM TENANTS	1
10	EXISTING STORAGE FACILITY	BUNDED AREA WITH 5x TANKS FOR EXISTING KARBOCHEM TENANTS	1
11	EXISTING SPHERICAL STORAGE TANK	STORAGE TANK FOR KARBOCHEM TENANTS	1

DETAIL D
SCALE 1 : 200

THE CRYOGENIC PIPELINE TO STORAGE TANK FACILITY. TOTAL PIPELINE LENGTH 158000MM (158M)

THE NATURAL GAS LINE TO THE VUTOMI GAS ENGINE FACILITY

ALL DIEMENSIONS ARE GIVE IN MILLIMETERS MM

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETERS
SURFACE FINISH:
TOLERANCES:
LINEAR:
ANGULAR:

VUTOMI ENERGY PTY LTD

DO NOT SCALE DRAWING | REVISION G

VOLCO POWER PROPOSAL

	NAME	SIGNATURE	DATE
DRAWN	JUSTIN	JUSTIN.T	04/21
CHK'D	DALE	DALE.F	04/21
APPV'D	SETH	SETH.O	04/21
MFG			
Q.A			

MATERIAL:

WEIGHT:

TITLE:
VOLCO POWER LNG STORAGE & REGASIFICATION FACILITY

DWG NO. A3

SCALE: 1:2000 SHEET 1 OF 1

Appendix B: Lithological logs

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HOLE No: AH-01
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20

0.00

FILL material , comprising unconsolidated pebbles, rocks, sand mixed with gravel, dry

0.20

NOTES

1) Hole augured 75 mm to 0.2 m
2) Refusal at 0.2 m
3) Augur hole is dry

Casing Id	Well Construction

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 8 Dec 2020
DATE :
DATE : 01/02/2021 13:27
TEXT : ..66508NCEnegyGOLIAH01.txt

ELEVATION : 1241
X-COORD : 27.78487
Y-COORD : 29.9692

HOLE No: AH-01

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New Castle Energy

LEGEND

Sheet 1 of 1

JOB NUMBER: 566508

FILL {SA32}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 01/02/2021 13:27
TEXT : ..66508NCEnegyGOLIAH01.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND

SUMMARY OF SYMBOLS

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New Castle Energy

HOLE No: AH-02
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20

0.00

FILL comprising unconsolidated pebbles, rocks, sand and gravel, dry, hard

0.20

NOTES

1) Hole augured 75 mm to 0.2 m
2) Refusal at 0.2 m
3) Augur hole is dry

Casing Id	Well Construction

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 8 Dec 2020
DATE :
DATE : 01/02/2021 13:29
TEXT : ..66508NCEnegyGOLIAH02.txt

ELEVATION : 1240
X-COORD : 27.785218
Y-COORD : 29.96872

HOLE No: AH-02

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New Castle Energy

LEGEND
Sheet 1 of 1

JOB NUMBER: 566508

	FILL	{SA32}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 01/02/2021 13:29
TEXT : ..66508NCEnegyGOLIAH02.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

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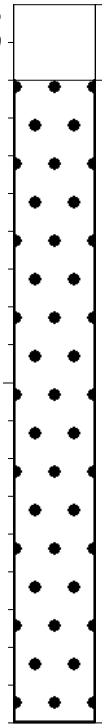
New Castle Energy

HOLE No: AH-06
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20



0.00

TOP SOIL , brownish grey, clayey, very fine

0.20

FERRICRETE - Sandy gravel, cream/ beige to orange brownish, moist, gravelly at 1.9m.

1

1.90

NOTES

1) Hole augured 75 mm to 1.9 m.

2) Seepage at 0.8m

Casing Id	Well Construction

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda

TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 8 Dec 2020
DATE :

DATE : 01/02/2021 13:31
TEXT : ..66508NCEnegyGOLIAH06.txt

ELEVATION : 1217
X-COORD : 27.78554
Y-COORD : 29.97014

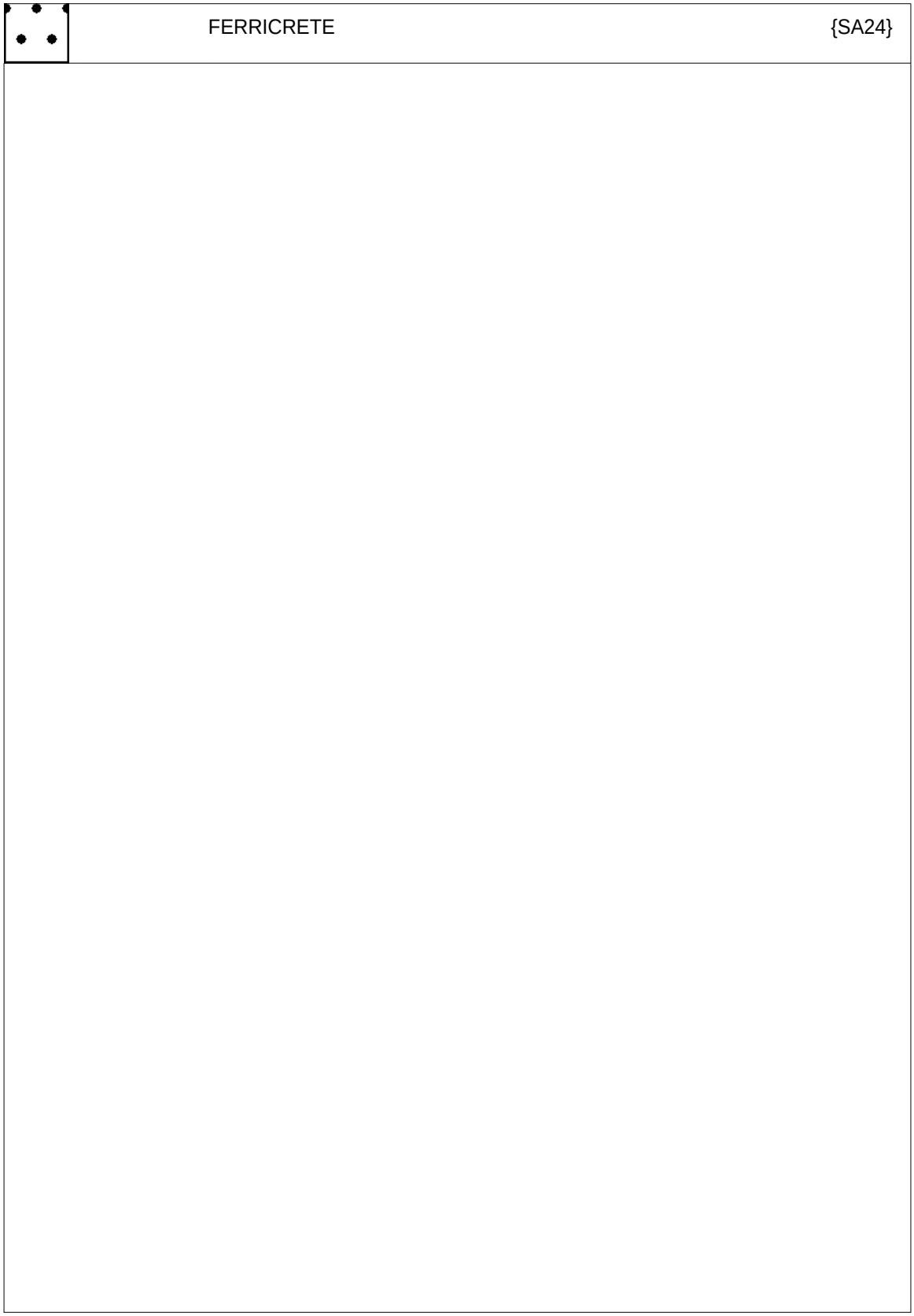
HOLE No: AH-06

srk consulting **New Castle Energy**

LEGEND
Sheet 1 of 1

JOB NUMBER: 566508

FERRICRETE {SA24}



CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 01/02/2021 13:31
TEXT : ..66508NCEnegyGOLIAH06.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

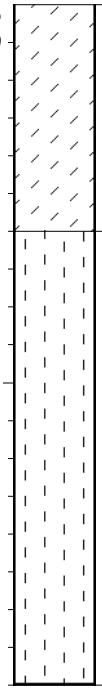
srk consulting

New Castle Energy

HOLE No: AH-07
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20



0.00 CLAYEY SAND , orange with red and brown mottles, moist @ 0.7m

0.60 SILTY CLAY , yellowish grey to brown, soft, some gravel

1

1.80

NOTES

1) Hole augured 75 mm to 1.8 m
2) Refusal at 1.8 m
3) Seepage at 0.7m

Casing Id	Well Construction

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 7 Dec 2020
DATE :
DATE : 01/02/2021 13:38
TEXT : ..66508NCEnegyGOLIAH07.txt

ELEVATION : 1224
X-COORD : 27.78589
Y-COORD : 29.97043

HOLE No: AH-07

srk consulting

New Castle Energy

LEGEND
Sheet 1 of 1

JOB NUMBER: 566508

	SILTY	{SA07}
	CLAYEY	{SA09}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE :
DATE : 01/02/2021 13:38
TEXT : ..66508NCEnegyGOLIAH07.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND
SUMMARY OF SYMBOLS

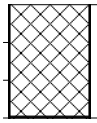
srk consulting

New Castle Energy

HOLE No: AH-09
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20



0.00

FILL , dark brown, unconsolidated, sandy gravel, slightlly moist

0.30

NOTES

1) Hole augured 75 mm to 0.3 m.

2) Augur hole is moist

Casing Id	*Well Construction*

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 8 Dec 2020
DATE :
DATE : 01/02/2021 13:43
TEXT : ..66508NCEnegyGOLIAH09.txt

ELEVATION : 1220
X-COORD : 27.78608
Y-COORD : 29.97057

HOLE No: AH-09

srk consulting

New Castle Energy

LEGEND

Sheet 1 of 1

JOB NUMBER: 566508

FILL {SA32}

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION :
DIAM :
DATE :
DATE :

DATE : 01/02/2021 13:43
TEXT : ..66508NCEnegyGOLIAH09.txt

ELEVATION :
X-COORD :
Y-COORD :

LEGEND

SUMMARY OF SYMBOLS

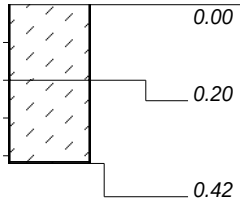
srk consulting

New Castle Energy

HOLE No: AH-10
Sheet 1 of 1

JOB NUMBER: 566508

Scale 1:20



CLAYEY SAND , dry, light grey, very soft

CLAYEY SAND , dry, ligh grey with orange lenses, very soft

NOTES

1) Hole augured 75 mm to 0.42 m
2) Refusal at 0.42 m
3) Augur hole is dry

Casing Id	Well Construction

CONTRACTOR :
MACHINE : Hand Augur
DRILLED BY :
PROFILED BY : P. Madanda
TYPE SET BY :
SETUP FILE : BH1PG-A4.SET

INCLINATION : Vertical
DIAM : 75 mm
DATE : 8 Dec 2020
DATE :
DATE : 01/02/2021 13:47
TEXT : ..66508NCEnegyGOLIAH10.txt

ELEVATION : 1226
X-COORD : 27.7862
Y-COORD : 29.97038

HOLE No: AH-10

srk consulting

New Castle Energy

LEGEND
Sheet 1 of 1

JOB NUMBER: 566508

	CLAYEY	{SA09}

CONTRACTOR :	*INCLINATION :*	*ELEVATION :*
MACHINE :	*DIAM :*	*X-COORD :*
DRILLED BY :	*DATE :*	*Y-COORD :*
PROFILED BY :	*DATE :*	
TYPE SET BY :	*DATE : 01/02/2021 13:47*	
SETUP FILE : BH1PG-A4.SET	*TEXT : ..66508NCEnegyGOLIAH10.txt*	

LEGEND
SUMMARY OF SYMBOLS

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP01
Sheet 1 of 1

JOB NUMBER: GG010-20

Scale 1:20

0.00 Slightly moist, orange brown, medium dense, medium to coarse grained, gravelly SAND with an abundance of rocks and boulders - FILL.

2.00 Slightly moist, yellowish brown, medium dense, medium grained, clayey SAND - RESIDUAL SANDSTONE.

2.50 Yellowish orange, completely to highly weathered, medium grained with an abundance of muscovite, highly fractured, soft rock - SANDSTONE.

4.20

NOTES

1) Refusal depth at 4.2m.

2) Water seepage: Not encountered

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

ELEVATION : 1236
X-COORD : 29.96923
Y-COORD : -27.78490

HOLE No: TP01

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

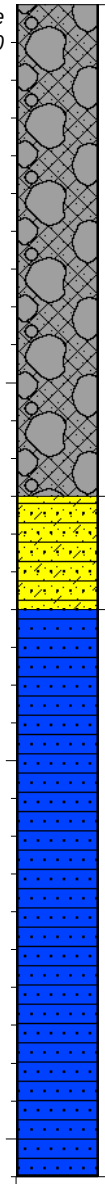
dot PLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP02
Sheet 1 of 1

JOB NUMBER: GG010-20

Scale 1:20



0.00 Slightly moist, orange brown, medium dense, medium to coarse grained, gravelly SAND with an abundance of rocks and boulders - FILL.

1.30 Slightly moist, yellowish brown, medium dense, medium grained, clayey SAND - RESIDUAL SANDSTONE.

1.60 Yellowish orange, completely to highly weathered, medium grained with an abundance of muscovite, highly fractured, soft rock - SANDSTONE.

3.10

NOTES

1) Refusal depth at 3.1m.

2) Water seepage: Not encountered

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1237
X-COORD : 29.96874
Y-COORD : -27.78518

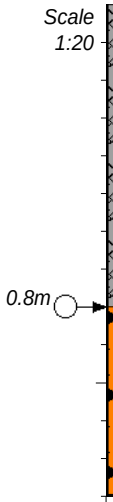
HOLE No: TP02

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP03
Sheet 1 of 1

JOB NUMBER: GG010-20



0.00

Slightly moist, orange brown, medium dense, medium to coarse grained, clayey SAND with an abundance of rocks and boulders - FILL.

0.80

Slightly moist, orange brown with dark orange stains, medium dense to dense, sandy GRAVEL with iron nodules - FERRICRETE.

1.30

NOTES

1) Refusal depth at 1.3m.

2) Water seepage: Slight at 0.8m.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1234
X-COORD : 29.96968
Y-COORD : -27.78499

HOLE No: TP03

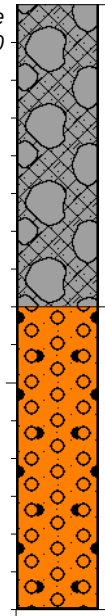
dot PLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP04
Sheet 1 of 1

JOB NUMBER: GG010-20

Scale 1:20



0.00 Slightly moist, orange brown, medium dense, medium to coarse grained, clayey SAND with an abundance of rocks and boulders - FILL.

0.80 Slightly moist, orange brown with dark orange stains, medium dense to dense, sandy GRAVEL with iron nodules - FERRICRETE.

1.60

NOTES

1) Refusal depth at 1.3m.

2) Water seepage: Not encountered.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)
TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020
DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1232
X-COORD : 29.96964
Y-COORD : -27.78554

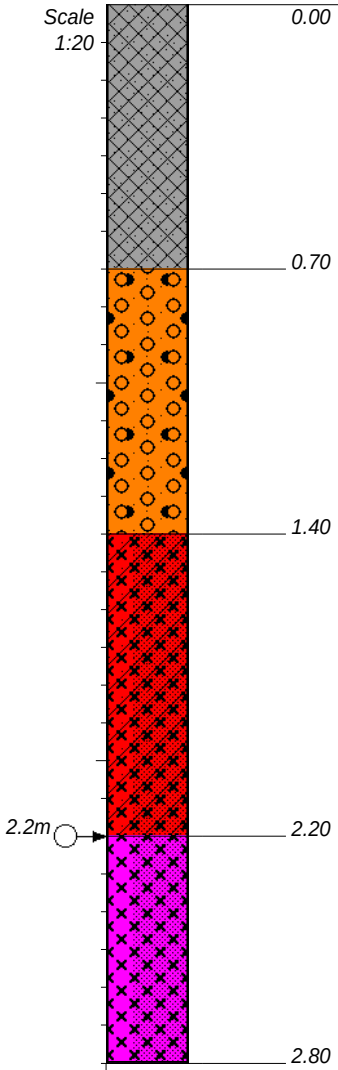
HOLE No: TP04

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP05
Sheet 1 of 1

JOB NUMBER: GG010-20



0.00 — Slightly moist, dark brown, loose to medium dense, fine grained, SAND - FILL.

0.70 — Slightly moist, orange brown with dark orange stains, medium dense to dense, sandy GRAVEL with iron nodules - FERRICRETE.

1.40 — Slightly moist, yellowish orange, firm to stiff, intact, SANDY CLAY - RESIDUAL DOLERITE.

2.20 — orange brown to black, highly weathered, fine grained, highly fractured, soft rock - DOLERITE.

2.80

NOTES

1) Refusal depth at 2.8m.

2) Water seepage: Slight at 2.2m.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)
TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020
DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1227
X-COORD : 29.96968
Y-COORD : -27.78583

HOLE No: TP05

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP06
Sheet 1 of 1

JOB NUMBER: GG010-20

0.00 Slightly moist, dark brown, loose to medium dense, fine grained, SAND - FILL.

0.80 Slightly moist, orange brown with dark orange stains, medium dense to dense, sandy GRAVEL with iron nodules - FERRICRETE.

2.00 Slightly moist, yellowish orange, firm to stiff, intact, SANDY CLAY - RESIDUAL DOLERITE.

3.60 orange brown to black, highly weathered, fine grained, highly fractured, soft rock - DOLERITE.

4.30

NOTES

1) Refusal depth at 4.3m.

2) Water seepage: Slight at 2.0m.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)
TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020
DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1222
X-COORD : 29.97013
Y-COORD : -27.78552

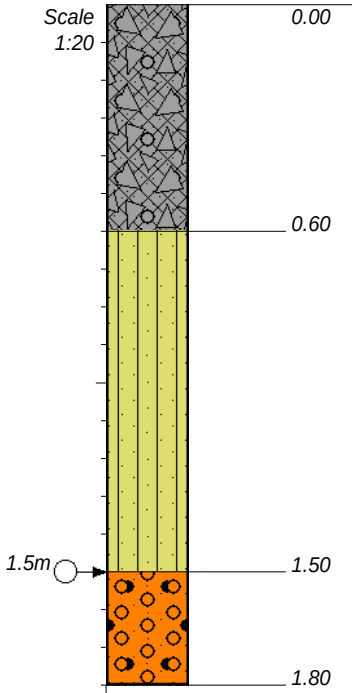
HOLE No: TP06

dot PLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP07
Sheet 1 of 1

JOB NUMBER: GG010-20



Slightly moist, light brown to orange, loose to medium dense, fine to medium grained, gravelly SAND with rubble - FILL.

slightly moist, dark brown with orange and black nodules, loose to medium dense, medium grained, sandy SILT - ALLUVIUM.

Slightly moist, orange brown with dark orange stains, medium dense to dense, sandy GRAVEL with iron nodules - FERRICRETE.

NOTES

1) Refusal depth at 1.8m.

2) Water seepage: Slight at 1.5m.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1224
X-COORD : 29.97040
Y-COORD : -27.78591

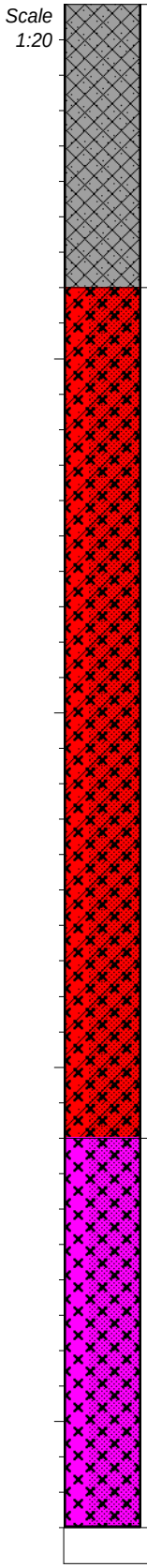
HOLE No: TP07

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP08
Sheet 1 of 1

JOB NUMBER: GG010-20



0.00 — Slightly moist, dark brown, loose to medium dense, fine grained, SAND - FILL.

0.80 — Slightly moist, yellowish orange, firm to stiff, intact, SANDY CLAY - RESIDUAL DOLERITE.

3.20 — orange brown to black, highly weathered, fine grained, highly fractured, soft rock - DOLERITE.

4.30

NOTES

1) Refusal depth at 4.3m.

2) Water seepage: Not Encountered.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1225
X-COORD : 29.97021
Y-COORD : -27.78609

HOLE No: TP08

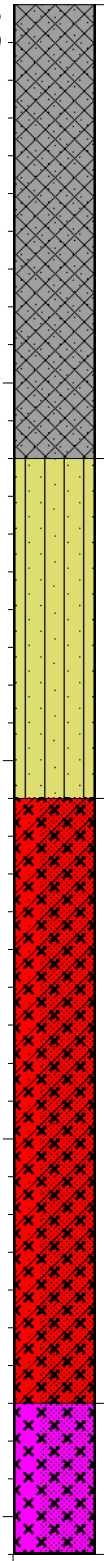
dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP09
Sheet 1 of 1

JOB NUMBER: GG010-20

Scale 1:20



0.00 Slightly moist, dark brown, loose to medium dense, fine grained, SAND - FILL.

1.20 slightly moist, dark brown with orange and black nodules, loose to medium dense, medium grained, sandy SILT - ALLUVIUM.

2.10 Slightly moist, yellowish orange, firm to stiff, intact, SANDY CLAY - RESIDUAL DOLERITE.

3.70 orange brown to black, highly weathered, fine grained, highly fractured, soft rock - DOLERITE.

4.10

NOTES

1) Refusal depth at 4.1m.

2) Water seepage: Not ecnountered.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

ELEVATION : 1225
X-COORD : 29.97058
Y-COORD : -27.78613

HOLE No: TP09

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

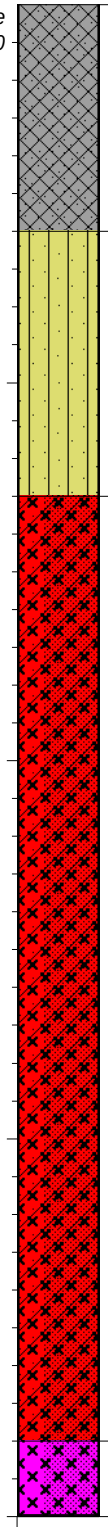
dotPLOT

Vutomi Energy
100 MW IPP Power Plant

HOLE No: TP10
Sheet 1 of 1

JOB NUMBER: GG010-20

Scale 1:20



0.00	Slightly moist, dark brown, loose to medium dense, fine grained, SAND - FILL.
0.60	slightly moist, dark brown with orange and black nodules, loose to medium dense, medium grained, sandy SILT - ALLUVIUM.
1.30	Slightly moist, yellowish orange, firm to stiff, intact, SANDY CLAY - RESIDUAL DOLERITE.
3.80	orange brown to black, highly weathered, fine grained, highly fractured, soft rock - DOLERITE.
4.00	

NOTES

1) Refusal depth at 4.0m.

2) Water seepage: Not encountered.

CONTRACTOR : Calcrete Pty Ltd
MACHINE : Doosan 225 LCV
DRILLED BY :
PROFILED BY : Nishen Govender (Pr. Sci. Nat.)

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

INCLINATION : Vertical
DIAM :
DATE :
DATE : 18 November 2020

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

ELEVATION : 1225
X-COORD : 29.97034
Y-COORD : -27.78622

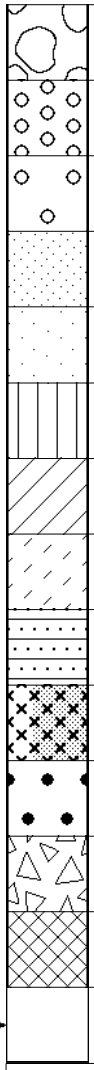
HOLE No: TP10

dotPLOT

Vutomi Energy
100 MW IPP Power Plant

LEGEND
Sheet 1 of 1

JOB NUMBER: GG010-20



BOULDERS	{SA01}
GRAVEL	{SA02}
GRAVELLY	{SA03}
SAND	{SA04}
SANDY	{SA05}
SILT	{SA06}
CLAY	{SA08}
CLAYEY	{SA09}
SANDSTONE	{SA11}
DOLERITE	{SA18}{SA42}
FERRICRETE	{SA24}
RUBBLE	{SA31}
FILL	{SA32}
WATER SEEPAGE/water strike	{CH50}

13.5

CONTRACTOR :
MACHINE :
DRILLED BY :
PROFILED BY :

INCLINATION :
DIAM :
DATE :
DATE :

ELEVATION :
X-COORD :
Y-COORD :

TYPE SET BY : N. Govender
SETUP FILE : STANDARD.SET

DATE : 20/11/2020 14:44
TEXT : ..castle\Pits\TestPits.TXT

LEGEND
SUMMARY OF SYMBOLS

Appendix C: Summary of Hydrocensus results

BH ID	Lat	Long	Elevation (mamsl)	Owner	BH Depth (m)	Equipment	Status	SWL (mbgl)	Comment
BH1	-27.79015	29.96581	1239	Snips Guest House	60	Submersible Pump	Pumping	not measured	Water supply BH, reportedly strong with good water quality
BH2	-27.78241	29.96196	1235	AC Swanepoel	Unknown	Submersible Pump	Pumping	not measured	Water supply BH, reportedly strong with good water quality
2729DB00054	-27.74531	29.96454	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00055	-27.74531	29.96455	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00056	-27.74507	29.96539	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
BH3	-27.78427	29.96261	1233	Mountain View B&B	Unknown	Submersible Pump	Pumping	not measured	Water supply BH, Pumping
2729DB00057	-27.7446	29.96594	Unknown	Unknown	Unknown	Submersible Pump	Unknown	not measured	NGA database, BH not found
2729DB00059	-27.74936	29.94377	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00060	-27.74928	29.94746	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00069	-27.7461	29.96022	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00089	-27.7461	29.96023	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00090	-27.74156	29.97014	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
BH50	-27.78046	29.96685	1234	Karbochem Mon	Unknown	Monitoring BH	Unequiped	not measured	BH locked
BH51A	-27.78202	29.96816	1236	Karbochem Mon	Unknown	Monitoring BH	Unequiped	not measured	BH locked
BH51B	-27.78206	29.96814	1236	Karbochem Mon	Unknown	Monitoring BH	Unequiped	3.6	Casing stickup-0.9m, concrete plinths-0.3m
BH49	-27.7787	29.97324	1241	Karbochem Mon	Unknown	Monitoring BH	Unequiped	not measured	Casing stickup-0.7m, concrete plinths-0.3m
BH47B	-27.77916	29.97394	1243	Karbochem Mon	6	Monitoring BH	Unequiped	not measured	Screen (3-6m)
BH47A	-27.77911	29.9739	1243	Karbochem Mon	32?	Monitoring BH	Unequiped	not measured	About 4m from BH47B, Screen from 26-32m
BH45	-27.77625	29.97707	1245	Karbochem Mon	Unknown	Monitoring BH	Unequiped	2.3	upgradient Mon BH
AH07	-27.78589	29.97043	1224	Karbochem Mon	Unknown	Monitoring BH	Unequiped	0.81	Vutomi energy Test hole
AH06	-27.78554	29.97014	1217	Karbochem Mon	Unknown	Monitoring BH	Unequiped	0.34	Vutomi energy Test hole
SW3	-27.78259	29.98105	1227	Karbochem Mon	SW	DOWNGRADIENT	Surface water	N/A	SW downgradient
SW2	-27.78623	29.97059	1228	Karbochem Mon	SW	Monitoring BH	Unequiped	N/A	PLANT downstream
SW1	-27.78484	29.96958	1232	Karbochem Mon	SW	Monitoring BH	Unequiped	not measured	PLANT upstrean
2729DB00091	-27.74992	29.94161	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00092	-27.74992	29.94162	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DB00093	-27.7464	29.98731	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00017	-27.75833	29.93333	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00031	-27.7683	29.9319	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00032	-27.76831	29.9319	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00038	-27.75834	29.93333	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00040	-27.77928	29.97818	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00042	-27.78489	29.95929	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
2729DD00047	-27.77211	29.95181	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, BH not found
Newcastle APT Borehole	-27.76817	29.975401	1238	Newcastle Airport	Unknown	Unknown	Unknown	Not measured	Reportedly a water supply
BH222	-27.78055	29.97586	1256	Brochem Plant	Unknown	Monitoring BH	Unequiped	12.4	Upgradient, Brochem Plant
BH2	-27.78141	29.97561	1229	Brochem Plant	Unknown	Monitoring BH	Unequiped	1.22	Near Brochem
BH223	-27.78205	29.97561	1243	Brochem Plant	2.9	Monitoring BH	Unequiped	dry	Near Brochem/Parking lot
2729DD00048	-27.78188	29.92151	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, Borehole not found
2729DD00051	-27.75833	29.93334	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	NGA database, Borehole not found
W10037033	-27.789062	29.952074	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21022616	-27.806944	30.011111	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21129360	-27.7491	29.9796	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21162849	-27.795861	29.988056	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21164847	-27.795861	29.988056	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21027602	-27.82704	29.98161	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole
W21078995	-27.78998	29.94744	Unknown	Unknown	Unknown	Unknown	Unknown	not measured	WARMS Database, no borehole

Appendix D: Water quality analytical Certificate

[008366/20], [2021/01/11]

Certificate of Analysis

Project details

Customer Details

Customer reference:	NEWCASTLE_ENERGY_ENVIRONMENTAL_SERVIES (566508)
Quotation number:	Q2012-019_B
Order number:	11234
Company name:	SRK CONSULTING DURBAN
Contact address:	SECTION A, 2ND FLOOR, IBM HOUSE, 54 NORFOLK TERRACE, OFF BLAIR ATHOLL, WESTVILLE, 4001
Contact person:	PETER MADANDA

Sampling Details

Sampled by:	CUSTOMER
Sampled date:	2020/12/09

Sample Details

Sample type(s):	WATER SAMPLES
Date received:	2020/12/11
Delivered by:	COURIER SERVICE
Temperature at sample receipt (°C):	23.0
Deviations:	025068/20,025069/20,025070/20,025071/20,025072/20 - Sample matrix not identified

Report Details

Testing commenced:	2020/12/11
Testing completed:	2020/12/22
Report date:	2021/01/11
Our reference:	008366/20

Analytical Results

Methods	Determinands	Units	025068/20	025069/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SUMP 09.12.2020	NEWCASTLE ENERGY, KARBOCHEM COMPLEX: AH-07 08.12.2020
Chemical				
85	Dissolved Calcium	mg Ca/ℓ	152	12.1
85	Potassium	mg K/ℓ	3.93	3.48
85	Dissolved Magnesium	mg Mg/ℓ	23	5.95
84	Sodium	mg Na/ℓ	9.56	37
87	Dissolved Silver*	mg Ag/ℓ	<0.01	<0.01
87	Dissolved Aluminium	mg Al/ℓ	9.16	40
88	Dissolved Arsenic	mg As/ℓ	<0.04	<0.04
87	Dissolved Boron	mg B/ℓ	0.11	0.06
87	Dissolved Barium	mg Ba/ℓ	0.56	0.11
87	Dissolved Beryllium	mg Be/ℓ	<0.02	<0.02
87	Dissolved Cadmium	mg Cd/ℓ	<0.02	<0.02
87	Dissolved Cobalt	mg Co/ℓ	0.09	0.03
87	Dissolved Chromium	mg Cr/ℓ	0.04	0.04
87	Dissolved Copper	mg Cu/ℓ	0.07	<0.02
87	Dissolved Iron	mg Fe/ℓ	55	11.2
86	Dissolved Mercury	mg Hg/ℓ	<0.002	<0.002
87	Dissolved Lithium	mg Li/ℓ	<0.02	<0.02
87	Dissolved Manganese	mg Mn/ℓ	4.62	1.53
87	Dissolved Molybdenum	mg Mo/ℓ	<0.11	<0.11
87	Dissolved Nickel	mg Ni/ℓ	0.06	<0.02
87	Dissolved Lead	mg Pb/ℓ	0.07	<0.03
91	Dissolved Sulphur*	mg/ℓ	5.2	21
89	Dissolved Antimony	mg Sb/ℓ	<0.009	<0.009
88	Dissolved Selenium	mg Se/ℓ	<0.07	<0.07
87	Dissolved Tin	mg Sn/ℓ	<0.02	<0.02
87	Dissolved Strontium	mg Sr/ℓ	0.49	0.08
87	Dissolved Titanium	mg Ti/ℓ	<0.03	1.42
87	Dissolved Thallium	mg Tl/ℓ	<0.02	<0.02
87	Dissolved Uranium	mg U/ℓ	0.11	0.03
87	Dissolved Vanadium	mg V/ℓ	<0.02	0.05
87	Dissolved Zinc	mg Zn/ℓ	4.03	0.02
87	Dissolved Zirconium*	mg Zr/ℓ	<0.02	0.03

Methods	Determinands	Units	025068/20	025069/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SUMP 09.12.2020	NEWCASTLE ENERGY, KARBOCHEM COMPLEX: AH-07 08.12.2020
Calc.	Sum dissolved metal concentration*	mg/ℓ	268	135
10G	Total Alkalinity	mg $CaCO_3$/ℓ	<0.31	36
16G	Chloride	mg Cl/ℓ	497	18.1
2A	Electrical Conductivity at 25°C	mS/m	203	29.9
18G	Fluoride	mg F/ℓ	<0.03	<0.03
65Gc	Nitrate	mg N/ℓ	0.51	0.15
65Gb	Nitrite	mg N/ℓ	<0.01	<0.01
52	Total Oil & Grease*	mg/ℓ	6	5
1	pH at 25°C	pH units	3.2	5.8
66G	Orthophosphate	mg P/ℓ	<0.04	<0.04
67G	Sulphate	mg SO_4/ℓ	13.5	62.9
41	Total Dissolved Solids at 180°C	mg/ℓ	1520	230

Methods	Determinands	Units	025070/20	025071/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: AH-06 08.12.2020	NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SW1 08.12.2020
Chemical				
85	Dissolved Calcium	mg Ca/ℓ	25	22
85	Potassium	mg K/ℓ	1.79	1.83
85	Dissolved Magnesium	mg Mg/ℓ	7.86	5.49
84	Sodium	mg Na/ℓ	14.7	17.7
87	Dissolved Silver*	mg Ag/ℓ	<0.01	<0.01
87	Dissolved Aluminium	mg Al/ℓ	8.96	0.14
88	Dissolved Arsenic	mg As/ℓ	<0.04	<0.04
87	Dissolved Boron	mg B/ℓ	0.05	0.05
87	Dissolved Barium	mg Ba/ℓ	0.14	0.07
87	Dissolved Beryllium	mg Be/ℓ	<0.02	<0.02
87	Dissolved Cadmium	mg Cd/ℓ	<0.02	<0.02
87	Dissolved Cobalt	mg Co/ℓ	<0.02	<0.02
87	Dissolved Chromium	mg Cr/ℓ	<0.02	<0.02
87	Dissolved Copper	mg Cu/ℓ	<0.02	<0.02
87	Dissolved Iron	mg Fe/ℓ	2.52	0.13
86	Dissolved Mercury	mg Hg/ℓ	<0.002	<0.002
87	Dissolved Lithium	mg Li/ℓ	<0.02	<0.02

Methods	Determinands	Units	025070/20	025071/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: AH-06 08.12.2020	NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SW1 08.12.2020
87	Dissolved Manganese	mg Mn/ℓ	0.06	<0.02
87	Dissolved Molybdenum	mg Mo/ℓ	<0.11	<0.11
87	Dissolved Nickel	mg Ni/ℓ	<0.02	<0.02
87	Dissolved Lead	mg Pb/ℓ	<0.03	<0.03
91	Dissolved Sulphur*	mg/ℓ	15	11
89	Dissolved Antimony	mg Sb/ℓ	<0.009	<0.009
88	Dissolved Selenium	mg Se/ℓ	<0.07	<0.07
87	Dissolved Tin	mg Sn/ℓ	<0.02	<0.02
87	Dissolved Strontium	mg Sr/ℓ	0.13	0.11
87	Dissolved Titanium	mg Ti/ℓ	0.27	<0.03
87	Dissolved Thallium	mg Tl/ℓ	<0.02	<0.02
87	Dissolved Uranium	mg U/ℓ	<0.02	0.02
87	Dissolved Vanadium	mg V/ℓ	<0.02	<0.02
87	Dissolved Zinc	mg Zn/ℓ	<0.02	<0.02
87	Dissolved Zirconium*	mg Zr/ℓ	<0.02	<0.02
Calc.	Sum dissolved metal concentration*	mg/ℓ	77	59
10G	Total Alkalinity	mg $CaCO_3$/ℓ	60	64
16G	Chloride	mg Cl/ℓ	6.41	7.13
2A	Electrical Conductivity at 25°C	mS/m	25.7	23.6
18G	Fluoride	mg F/ℓ	0.12	0.14
65Gc	Nitrate	mg N/ℓ	0.46	0.30
65Gb	Nitrite	mg N/ℓ	<0.01	<0.01
52	Total Oil & Grease*	mg/ℓ	11	<3
1	pH at 25°C	pH units	6.1	6.5
66G	Orthophosphate	mg P/ℓ	<0.04	<0.04
67G	Sulphate	mg SO_4/ℓ	41.5	27.7
41	Total Dissolved Solids at 180°C	mg/ℓ	180	120

Methods	Determinands	Units	025072/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SW2 08.12.2020
Chemical			
85	Dissolved Calcium	mg Ca/ℓ	108
85	Potassium	mg K/ℓ	4.71

Methods	Determinands	Units	025072/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SW2 08.12.2020
85	Dissolved Magnesium	mg Mg/ℓ	23
84	Sodium	mg Na/ℓ	41
87	Dissolved Silver*	mg Ag/ℓ	<0.01
87	Dissolved Aluminium	mg Al/ℓ	0.05
88	Dissolved Arsenic	mg As/ℓ	<0.04
87	Dissolved Boron	mg B/ℓ	0.07
87	Dissolved Barium	mg Ba/ℓ	0.69
87	Dissolved Beryllium	mg Be/ℓ	<0.02
87	Dissolved Cadmium	mg Cd/ℓ	<0.02
87	Dissolved Cobalt	mg Co/ℓ	0.07
87	Dissolved Chromium	mg Cr/ℓ	<0.02
87	Dissolved Copper	mg Cu/ℓ	<0.02
87	Dissolved Iron	mg Fe/ℓ	0.11
86	Dissolved Mercury	mg Hg/ℓ	<0.002
87	Dissolved Lithium	mg Li/ℓ	<0.02
87	Dissolved Manganese	mg Mn/ℓ	4.04
87	Dissolved Molybdenum	mg Mo/ℓ	<0.11
87	Dissolved Nickel	mg Ni/ℓ	0.03
87	Dissolved Lead	mg Pb/ℓ	<0.03
91	Dissolved Sulphur*	mg/ℓ	11
89	Dissolved Antimony	mg Sb/ℓ	<0.009
88	Dissolved Selenium	mg Se/ℓ	<0.07
87	Dissolved Tin	mg Sn/ℓ	<0.02
87	Dissolved Strontium	mg Sr/ℓ	0.47
87	Dissolved Titanium	mg Ti/ℓ	<0.03
87	Dissolved Thallium	mg Tl/ℓ	<0.02
87	Dissolved Uranium	mg U/ℓ	0.03
87	Dissolved Vanadium	mg V/ℓ	<0.02
87	Dissolved Zinc	mg Zn/ℓ	0.93
87	Dissolved Zirconium*	mg Zr/ℓ	<0.02
Calc.	Sum dissolved metal concentration*	mg/ℓ	194
10G	Total Alkalinity	mg $CaCO_3$/ℓ	31
16G	Chloride	mg Cl/ℓ	246
2A	Electrical Conductivity at 25°C	mS/m	94.2
18G	Fluoride	mg F/ℓ	0.20

Methods	Determinands	Units	025072/20
			NEWCASTLE ENERGY, KARBOCHEM COMPLEX: SW2 08.12.2020
65Gc	Nitrate	mg N/ℓ	0.82
65Gb	Nitrite	mg N/ℓ	<0.01
52	Total Oil & Grease*	mg/ℓ	3
1	pH at 25°C	pH units	6.1
66G	Orthophosphate	mg P/ℓ	<0.04
67G	Sulphate	mg SO_4/ℓ	31.6
41	Total Dissolved Solids at 180°C	mg/ℓ	674

Refer to the “Notes” section at the end of this report for further explanations.

Where a deviation has been noted, the validity of the results may be affected. Results should be used with this consideration in mind.

Specific Observations

None

Quality Assurance

Technical signatories

Notes to this report

Limitations

This report shall not be reproduced except in full without prior written approval of the laboratory.
Results in this report relate only to the samples as taken, and the condition received by the laboratory.
Any opinions and interpretations expressed herein are outside the scope of SANAS accreditation.
The decision rule applicable to this laboratory is available on request.
Sample preparation may require filtration, dilution, digestion or similar. Final results are reported accordingly.
Where the laboratory has undertaken the sampling, the location of sampling and sampling plan are available on request. Talbot Laboratories is guided by the National Standards SANS 5667-3:2006 Part 3 Guidance on the Preservation and Handling of Water Samples; SANS 5667-1:2008 Part 1 Guidance on the Design of Sampling Programmes and Sampling Techniques and SANS 5667-2:1991 Part 2: Guidance on Sampling Techniques.
Customers to contact Talbot Laboratories for further information.

Uncertainty of measurement

Talbot Laboratories' Uncertainty of Measurement (UoM) values are:

- Identified for relevant tests.
- Calculated as a percentage of the respective results.
- Applicable to total, dissolved and acid soluble metals for ICP element analyses.
- Available upon request.

Analysis explanatory notes

Tests may be marked as follows:

^	Tests conducted at our Port Elizabeth satellite laboratory.
*	Tests not included in our Schedule of Accreditation and therefore that are not SANAS accredited.
#	Tests that have been sub-contracted to a peer laboratory.
NR	Not required -shown, for example, where the schedule of analysis varied between samples.
σ	Field sampling point on-site results.
a	Testing has deviated from Method.

**********End of Report**********

analytical services
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FINAL CERTIFICATE OF ANALYSIS

SRK Consulting (SA) (Pty) Ltd
SRK House, 265 Oxord Road
Illovo

Contact: Peter Madanda
Tel. No.: +27 11 441 1111
Email: PMadanda@srk.co.za

Date Required 2020-12-21
Client Provided Information:

PROJECT 566508
NEW CASTLE ENERGY

Report Revision 0
Test Start Date: 11/12/2020
Test Complete Date: 19/01/2021

sanas Testing Laboratory T0184

Notes
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[2] Not SANAS accredited analysis and not included in the SANAS schedule of accreditation for this laboratory.
[3] Outsourced not performed by this laboratory.
[4] Deviations: N/A unless specifically stated below.

TECHNICAL SIGNATORY: Ricardo Kayser

				Sample ID: 760398	Sample ID: 760399
				BH45 09/12/2020	SW3 09/12/2020
				Type: Water	Type: Water
Analysis	Analyte	Unit	Test Method	value	value
Anions by Photometry	Chloride Cl (1)	mg/l	UIS-EA-T034 (1)	0.561	23.4
	Fluoride F (1)	mg/l	UIS-EA-T034 (1)	0.115	0.237
	Nitrate NO3 (2)	mg/l	UIS-EA-T034 (1)	1.23	8.36
	Nitrate NO3 as N (1)	mg/l	UIS-EA-T034 (1)	0.277	1.89
	Nitrite NO2 (2)	mg/l	UIS-EA-T034 (1)	0.01	0.341
	Nitrite NO2 as N (2)	mg/l	UIS-EA-T034 (1)	0.003	0.104
	Phosphate PO4 (1)	mg/l	UIS-EA-T034 (1)	0.075	<0.0059
	Phosphate PO4 as P (1)	mg/l	UIS-EA-T034 (1)	0.0243	<0.0059
	Sulphate SO4 (1)	mg/l	UIS-EA-T034 (1)	<0.7	56
Calculated Total Dissolved	TDS by Summation (2)	mg/l	UIS-CP-T003 (2)	99.2	128
Calculated Total Dissolved Solids from EC	TDS by EC*6.5 (2)	mg/l	UIS-CP-T001 (2)	135	262
	TDS by EC*7 (2)	mg/l	UIS-CP-T001 (2)	146	282
Determination of Oil and	Total Oil and Grease (2)	ppm	UIS-EA-T007 (2)	<1	<1
Dissolved Elements in Water by ICP-OES	Ca (1)	mg/l	UIS-EA-T007 (1)	16.9	27.7
	K (1)	mg/l	UIS-EA-T007 (1)	2.28	8.65
	Mg (1)	mg/l	UIS-EA-T007 (1)	4.80	10.07
	Na (1)	mg/l	UIS-EA-T007 (1)	17.71	27.45
	Si (2)	mg/l	UIS-EA-T007 (1)	18.4	5.92
Electrical Conductivity	TC Temperature (2)	Deg C	UIS-EA-T001 (1)	24.6	24.6
	Tot Cond @25C (1)	mSm	UIS-EA-T001 (1)	20.8	40.3
	Total Conductivity (1)	mS/m	UIS-EA-T001 (1)	20.8	40.3
Ion Balance Error Gallery	Ion Error Balance (2)	%	UIS-CP-T005 (2)	11.2	-1.63
	Sum of Anions (2)	me/l	UIS-CP-T005 (2)	1.66	3.75
	Sum of Cations (2)	me/l	UIS-CP-T005 (2)	2.08	3.63
P and Total (M) Alkalinity	P Alkalinity (1)	mg/l CaCO3	UIS-EA-T001 (1)	<0.6	<0.6
	Total (M) Alkalinity (1)	mg/l CaCO3	UIS-EA-T001 (1)	95.9	81
pH	pH (1)		UIS-EA-T001 (1)	7.7	7.75
	pH Temperature (2)	Deg C	UIS-EA-T001 (1)	25	25
Total Dissolved Solids	Total Dissolved Solids at	mg/l	UIS-EA-T005 (1)	140	206
Trace elements in liquids by ICP-MS	Ag (2)	mg/l	UIS-AC-T100 (2)	0.004	0.004
	Al (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	As (2)	mg/l	UIS-AC-T100 (2)	0.001	0.001
	B (2)	mg/l	UIS-AC-T100 (2)	0.002	0.024
	Ba (2)	mg/l	UIS-AC-T100 (2)	0.156	0.08
	Be (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	Cd (2)	mg/l	UIS-AC-T100 (2)	<0.0001	<0.0001
	Co (2)	mg/l	UIS-AC-T100 (2)	0.001	0.002
	Cr (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	Cu (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	Fe (2)	mg/l	UIS-AC-T100 (2)	<0.01	0.038
	Hg (2)	mg/l	UIS-AC-T100 (2)	0.001	0.001
	Mn (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	Mo (2)	mg/l	UIS-AC-T100 (2)	0.003	0.003
	Ni (2)	mg/l	UIS-AC-T100 (2)	0.002	0.005
	Pb (2)	mg/l	UIS-AC-T100 (2)	0.001	0.001
	Sb (2)	mg/l	UIS-AC-T100 (2)	0.002	0.002
	Se (2)	mg/l	UIS-AC-T100 (2)	<0.001	0.001
	Sn (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	Sr (2)	mg/l	UIS-AC-T100 (2)	0.271	0.167
	Ti (2)	mg/l	UIS-AC-T100 (2)	<0.05	<0.05
	Tl (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001
	U (2)	mg/l	UIS-AC-T100 (2)	<0.0001	<0.0001
	V (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001

				Sample ID: 760398	Sample ID: 760399
				BH45 09/12/2020	SW3 09/12/2020
				Type: Water	Type: Water
Analysis	Analyte	Unit	Test Method	value	value
	Zn (2)	mg/l	UIS-AC-T100 (2)	<0.001	<0.001

1st Addendum to the Hydrogeological Assessment Report:
Specialist CV and Declaration of Independence

Ismail Mahomed

Partner / Principal Hydrogeologist

Profession	Hydrogeologist
Education	BSc (Hons), Environmental Geology, University of Witwatersrand, 1995
	BSc, Geology, University of Witwatersrand, 1994
Registrations/ Affiliations	Pr. Sci. Nat (South Africa), 400070/01
	Member of the Groundwater division of the GSSA

Specialisation

Dewatering and depressurisation, hydrogeological characterisation, numerical groundwater modelling and isotope hydrology.

Expertise

Ismail Mahomed has been involved in the field of hydrogeology for the past 20 years. His expertise includes:

- mine dewatering and pore pressure investigations;
- numerical groundwater modelling;
- feasibility studies and due-diligence;
- assessing environmental impact and liability;
- sub-surface contamination characterisation and assessments;
- water supply investigations;
- surface and groundwater quality monitoring and management.

Employment

2016 – present	SRK Consulting (Pty) Ltd, Principal Hydrogeologist and Partner, Johannesburg
2007 – 2016	SRK Consulting (Pty) Ltd, Hydrogeologist, Johannesburg
2002 – 2007	SRK Consulting (Pty) Ltd, Scientist, Durban
1999 – 2002	KLM Consulting Services, Hydrogeologist, Sunrella
1998 – 1999	Molosiwa Bruin and Associates, Hydrogeologist, Wilmington

Publications

Various publications in groundwater and water management.

Languages

English – read, write, speak

Ismail Mahomed

Partner / Principal Hydrogeologist

Publications

1. McCarthy T.S., Humphries M.S., Mahomed I., Le Roux P., Verhagen B.Th. (2012): “Island forming processes in the Okavango Delta, Botswana”, Geomorphology, 179, 249-257

2. Mahomed I., Chimhanda W., Armstrong R. (2013): Simulated Pore Pressure in Highwalls of Open Pit Mines. Proceedings of the 13th Biennial Conference of the Groundwater Division of the GSSA

3. Terrell C., Lorentz S, Mahomed I, Duthe D and Chetty K (2015) Groundwater and Surface Water Interaction Study for the Ingula Wetland. Proceedings of the 14th Biennial Conference of the Groundwater Division of the GSSA

Ismail Mahomed

Partner / Principal Hydrogeologist

Key Experience: Feasibility studies, dewatering, due diligences

Location:	Zambia
Project duration & year:	2018-20
Client:	FQM Kalumbila Mines
Name of Project:	Enterprise Nickel Deposit Feasability Study
Project Description:	Investigate groundwater in relation to the proposed pit
Job Title and Duties:	Reviewer
Value of Project:	USD 59 620

Location:	DRC
Project duration & year:	2019/20
Client:	MMG
Name of Project:	Sokoroshe Pit Feasibility Study
Project Description:	Groundwater investigation for feasibility and ESIA study input
Job Title and Duties:	Reviewer

Location:	Zimbabwe
Project duration & year:	2020
Client:	Mimosa Mines
Name of Project:	Feasibility Study on Mimosa Mines New Tailings Storage Facility
Project Description:	Bankable Feasibility Study (BFS) for a proposed new Tailings Storage Facility (TSF).
Job Title and Duties:	Principal hydrogeologist
Value of Project:	R 6 Million

Location:	South Africa
Project duration & year:	2020
Client:	Mintails
Name of Project:	First Phase Due Diligence Report on the Key Chrome Assets of Glencore and Merafe Chrome in South Africa
Project Description:	Review at a high level risk associated with various operation.
Job Title and Duties:	Principal hydrogeologist
Value of Project:	R 2 Million

Location:	South Africa
Project duration & year:	2019\20
Client:	Petra Diamonds– Cullinan Diamonds
Name of Project:	Cullinan Diamond Mine StatusQuo Groundwater Assessment
Project Description:	groundwater assessment to establish thestatus quo of water ingress into the mine workings, from both surface and groundwater sources, and confirmation of the effects of water ingression into the mine workings.
Job Title and Duties:	Principal hydrogeologist and reviewer
Value of Project	R400 000

Location:	Qatar
Project duration & year:	2019
Client:	Bilfinger
Name of Project:	Review of Mesaieed Industrial City Sub-Surface Drainage System
Project Description:	Review and verification of proposed drainage system to manage groundwater ingress and minimise infrastructure damage.
Job Title and Duties:	Principal hydrogeologist and project manager
Value of Project:	US 70 000

Ismail Mahomed

Partner / Principal Hydrogeologist

Key Experience: Feasibility studies, dewatering, due diligences

Location:	Nigeria
Project duration & year:	2018/9
Client:	Lafarge-Holcim
Name of Project:	Hydrogeological and Geotechnical Assessment of the Shagamu Quarry
Project Description:	Hydrogeological and Geotechnical Assessment of the Shagamu Quarry to determine the upward pore pressure from underlying sand unit and its affect on quarry safety should the quarry deepen.
Job Title and Duties:	Principal hydrogeologist and project manager
Value of Project:	USD 74 255

Location:	DRC
Project duration & year:	2014 – 2019
Client:	MMG
Name of Project:	Design and implementation of dewatering system, Kinsevere Mine
Project Description:	Scoping through to Feasibility Study level hydrogeological assessments.
Job Title and Duties:	Principal hydrogeologist and reviewer
Value of Project:	+ US 200 000

Location:	DRC
Project duration & year:	2018
Client:	ERG, Frontier Mine
Name of Project:	Model Update for Frontier Mine
Project Description:	Revised recharge rates using remote sensing and SWAC. Updated numerical to incorporate revised geological model, pit plans and considered various dewatering scenarios to update the model of the Frontier Mine in the DRC.
Job Title and Duties:	Principal hydrogeologist and project manager
Value of Project:	US$ 49 044.00

Location:	Zambia
Project duration & year:	2018
Client:	Mimosa Resources
Name of Project:	Hydrogeological assessment for the Fishtie-Kashime Copper Project
Project Description:	Baseline hydrogeological assessment for a greenfields copper project
Job Title and Duties:	Principal hydrogeologist and project manager
Value of Project:	US$ 132 016.00

Location:	Iran
Project duration & year:	2018
Client:	Kerman Parand Golfam Mine Co
Name of Project:	Scoping Level Hydrogeological and Geotechnical studies for the Golgohar 1 Iron Ore Mines
Project Description:	Identify key data gaps and impacts associated with planned expansion of pit
Job Title and Duties:	Principal hydrogeologist
Value of Project:	US$ 82 600.00

Location:	Kolwezi
Project duration & year:	2018
Client:	Lerexcom
Name of Project:	High level scoping study for the Lerexcom Project
Project Description:	Identify likely water management issues and risk that the feasibility study should address for this greenfield project.
Job Title and Duties:	Principal hydrogeologist
Value of Project:	US 8 850

Ismail Mahomed

Partner / Principal Hydrogeologist

Key Experience: Feasibility studies, dewatering, due diligences

Location:	South Africa
Project duration & year:	2018
Client:	Gold One Limited, Orion Resource
Name of Project:	Technical Review of the Blyvooruitzicht Gold Mine and Associated Assets
Project Description:	Considered historical and planned mining to define water risk and impacts inline with financial reporting standards
Job Title and Duties:	Principal hydrogeologist
Value of Project:	Confidential

Location:	South Africa
Project duration & year:	2018
Client:	Gold One Limited
Name of Project:	Due Diligence Review of the Burnstone Gold Mine and Associated Assets
Project Description:	Considered historical and planned mining to define water risk and impacts inline with financial reporting standards
Job Title and Duties:	Principal hydrogeologist
Value of Project:	Confidential

Location:	Northern Cape, South Africa
Project duration & year:	2016 - 2017
Client:	Finsch Diamond Mine
Name of Project:	Block 5 dewatering
Project Description:	Dewatering strategy of Block 5
Job Title and Duties:	Hydrogeologist - field work, planning and project manager.
Value of Project:	R500 000

Location:	Botswana
Project duration & year:	2015, 2017
Client:	Boteti Mining
Name of Project:	Karowe Diamond Mine
Project Description:	Geotechnical and Groundwater Review
Job Title and Duties:	Review mines current hydrogeological management and controls
Value of Project:	R404 938

Location:	Iran
Project duration & year:	2013 - 2017
Client:	IBECO
Name of Project:	Mine design for Sarchesmeh Copper Pit
Project Description:	Determine pit dewatering requirements
Job Title and Duties:	Hydrogeologist – groundwater team lead, data analyses, report.
Value of Project:	Euro 280 000

Key Experience: Resource Assessments, Reserve Determination, Water Supply and Contaminated Land

Managed and performed peer review on several water supply project in support of WULA, water monitoring projects and contaminared land. Recent clients include Clover and Coca Cola Beverages South Africa.

Tsumbedzo Peter Madanda

Principal Scientist

Profession	Hydrogeology
Education	GDE, Mining, University of the Witwatersrand, 2012 BSc (Hons), Geohydrology, University of Free State, 2006 BSc, Geology, University of Venda, 2002
Registrations/ Affiliations	Pr.Sci.Nat, SACNASP, 400240/08
Awards	Golder Associate Africa (Pty) Ltd: Top achievement award, delighting the Customer, 2015 Golder Associates Africa (Pty) Ltd: Long Service award, 2018

Specialisation

Groundwater, contaminated land characterisation, site conceptualisation, risk assessments and remedial recommendation; baseline studies for EIA and WULA inputs; water monitoring – network design and program audits; mine dewatering studies and implementation.

Expertise

Peter has been involved in the field of hydrogeology for the past 16 years. His expertise includes:

- groundwater supply feasibility assessment, resources exploration and development;
- contaminated land characterisation, site conceptualisation, risk assessments and remedial recommendation;
- baseline studies for EIA and WULA inputs; water monitoring – network design and program audits;
- mine dewatering studies and implementation;
- project involvement includes; project management, managing field work programmes involving site overseeing of drilling and testing activities, aquifer characterisation, contaminated land investigations and remediation, site conceptualisation, client liaison and reporting.

Employment

2018 – present	SRK Consulting (Pty) Ltd, Principal Scientist, Durban
2008 – 2018	Golder Associates Africa (Pty) Ltd, Hydrogeologist, Midrand
2005 – 2008	KLM Consulting Services (Pty) Ltd, Hydrogeologist, Lanseria
2003 – 2005	KLM Consulting Services (Pty) Ltd, Junior Hydrogeologist, Lanseria
2002 – 2003	Mothopong Consulting Services (Pty) Ltd, Graduate geologist in training, Groblersdal, Limpopo

Publications

None

Publications

English – read, write, speak
Venda – read, write, speak
Afrikaans – read, write

Tsumbedzo Peter Madanda

Principal Scientist

Key Experience: Hydrogeology – mining and water supply

Location	Zvishavane, Zimbabwe
Project duration & year:	5 Month, 2020
Client:	Mimosa Mining Company
Name of Project:	Mimosa TSF4 Baseline groundwater investigations
Project Description:	Specialist Groundwater studies for the Mimosa TSF expansion
Job Title and Duties:	Project hydrogeologist – overseeing the field work, data analysis and reporting
Value of Project:	N/A

Location:	Vereeniging, South Africa
Project duration & year:	4 Month, 2019
Client:	Afrimat, SA Block (Pty) Ltd
Name of Project:	Specialist Hydrogeological studies for WULA
Project Description:	Baseline groundwater Specialist study to support the WULA process.
Job Title and Duties:	Project Hydrogeologist doing field work, project management
Value of Project:	N/A

Location:	Pretoria, South Africa
Project duration & year:	One year
Client:	Cullinan Diamond Mine (Pty) Ltd (CDM), Cullinan,
Name of Project:	Groundwater Status Quo for Cullinan Diamond Mine
Project Description:	CDM Mine Dewatering
Job Title and Duties:	Project management, fieldwork involving seepage mapping, reporting and client liaison
Value of Project:	N/A

Location:	CCBSA Depots in Devland, Nigel, Polokwane, Midrand, Pretoria
Project duration & year:	2 Months each
Client:	Coca Cola Beverages South Africa (CCBSA),
Name of Project:	Specialist Groundwater studies for CCBSA sites
Project Description:	Groundwater Specialist Studies to support Water Use Licence Application (WULA)
Job Title and Duties:	Field work, data interpretation, and report compilation
Value of Project:	N/A

Location:	Pinetown, Durban
Project duration & year:	1 Month (2018)
Client:	RPC Astrapak, JJ Precision
Name of Project:	Groundwater Feasibility assessment for JJ Precision Plastics site, Pine town
Project Description:	Groundwater exploration and development for plastic factory water supply
Job Title and Duties:	Principal Scientist, Project management, reporting and client liaison
Value of Project:	N/A

Location:	Kwadabeka, Durban
Project duration & year:	3 Months (2018)
Client:	City of Ethekwini Metropolitan Municipality
Name of Project:	Kwadabeka Agri-tourism Water Supply Borehole Establishment
Project Description:	Groundwater resources exploration and development for Rural and Agriculture water Supply
Job Title and Duties:	Principal Scientist: Final report compilation
Value of Project:	N/A

Tsumbedzo Peter Madanda

Principal Scientist

Key Experience: Hydrogeology – mining and water supply

Location:	Kamoa Copper Mine, Katanga Province, Democratic Republic of Congo
Project duration & year:	4 Month (2017).
Client:	Ivanhoe, Kakula Mine.
Name of Project:	Kakula Coper Mine groundwater baseline studies.
Project Description:	Groundwater baseline studies.
Job Title and Duties:	Project hydrogeologist: Groundwater investigations for mine dewatering evaluations
Value of Project:	N/A
Location:	Kamoa Copper Mine, Katanga Province, Democratic Republic of Congo
Project duration & year:	One year, 2013-2014
Client:	Ivanhoe, Kamoa Mine
Name of Project:	Kamoa Copper Mine, Southern Wellfield development.
Project Description:	Groundwater resource characterisation and development for Kamoa Copper Mine.
Job Title and Duties:	Project Hydrogeologist: Groundwater site characterisation for project feasibility, water supply and mine dewatering – Duties included site overseer, client liaison, groundwater system conceptualisation, water supply feasibility and development for Kamoa Mine Bulk Mine Water Supply.
Value of Project:	N/A
Location:	Mozambique - Pemba, Nacala, Quellimane, Montepuez and Nampula
Project duration & year:	11 Months (2012)
Client:	RJ Burnside - FIPAG
Name of Project:	Five Cities Water supply Project
Project Description:	Groundwater investigations for Bulk Water Supply
Job Title and Duties:	Hydrogeologist: Site oversight, client liaison and management of field activities including siting, borehole drilling, borehole rehabilitation based on the Bacterial (BART) Tests results, well yield testing and abstraction rates recommendations considering current and future demand, and risk of sea water intrusion and reporting.
Value of Project:	N/A
Location:	Vereeniging, South Africa
Project duration & year:	5 Month (2011)
Client:	Anglo Coal, New Vaal Lifex Coal mine
Name of Project:	Baseline groundwater studies
Project Description:	Groundwater Baseline studies for Anglo Coal New Vaal Lifex extension Project.
Job Title and Duties:	Hydrogeologist – geophysical survey, borehole siting, supervision of drilling and aquifer testing activities, water sampling, data analysis and reporting.
Value of Project:	N/A
Location:	Solwezi, Zambia.
Project duration & year:	7 Month (2011).
Client:	Barrick, Lumwana Gold Mine.
Name of Project:	Lumwana mine Hydrogeological studies
Project Description:	Groundwater baseline and Mine dewatering studies.
Job Title and Duties:	Project Hydrogeologist – Site overseeing of borehole drilling and testing activities, site conceptualisation, client liaison and reporting.
Value of Project:	N/A

Tsumbedzo Peter Madanda

Principal Scientist

Key Experience: Hydrogeology – mining and water supply

Location:	Randfontein, South Africa
Project duration & year:	2 Month (2010)
Client:	Rand Uranium
Name of Project:	Groundwater Assessment for TSF deposits into old abandoned pit
Project Description:	Groundwater feasibility study of disposing the TSF and mining material into the abandoned pits and for the pyrite storage facility in Randfontein area. The
Job Title and Duties:	Hydrogeologist - Contractor Management, Client liaison, fieldwork, data interpretation and reporting
Value of Project:	N/A
Location:	Kimberly, South Africa
Project duration & year:	2 Months (2009)
Client:	De Beers Diamond Mines
Name of Project:	Mining and groundwater impact assessment
Project Description:	Evaluation of derelict mining impacts to groundwater resources in and around Kimberly.
Job Title and Duties:	Hydrogeologist – Fieldwork involving Geophysical Survey, borehole drilling and test pumping, water sampling, data analysis and reporting.
Value of Project:	N/A
Location:	Mokopane, South Africa
Project duration & year:	2 Month (2008)
Client:	Lonmin Platinum, Akanani Platinum Mine
Name of Project:	Akanani Mine, groundwater baseline studies
Project Description:	Hydrogeological investigations were conducted in Akanani for baseline characterisation and water quality monitoring.
Job Title and Duties:	Hydrogeologist – Borehole siting, drilling and testing supervision, client liaison and report compilation.
Value of Project:	N/A

Key Experience: Geohydrology (environmental geology)

Location:	Natcos, Fynland Site 2, Island View, Durban
Project duration & year:	5 Month (2017)
Client:	Natcos (Pty) Ltd
Name of Project:	Natcos Site 2 contaminated land investigation
Project Description:	Contaminated land investigation was conducted in Island view to delineate the contamination plume, risk assessment and evaluation of remedial techniques.
Job Title and Duties:	Consulting Hydrogeologist – Contractor management, field work (soil vapour survey, borehole siting, drilling, slug testing and falling head tests), data analysis, site conceptualisation (Source – pathway – receptor), remedial evaluation and recommendation, client liaison, and reporting.
Value of Project:	N/A
Location:	Scaw Metals, Union Junction, and Steel Wire Rope Germiston, Johannesburg
Project duration & year:	2 Month (2016)
Client:	Scaw Metals, Union Junction
Name of Project:	Contaminated Land Investigation
Project Description:	Site characterisation and contamination plume delineation at Union Junction and Steel Wire Rope to determine the remedial requirements.
Job Title and Duties:	Hydrogeologist - Project management, fieldwork including contractor management, fieldwork, client liaison, data analysis, site conceptualisation and report compilation.
Value of Project:	N/A

Tsumbedzo Peter Madanda

Principal Scientist

Key Experience: Geohydrology (environmental geology)

Location:	Lanxess Isithebe, Mandeni, Kwa-Zulu Natal
Project duration & year:	4 Month (2015)
Client:	Lanxess (Pty) Ltd
Name of Project:	Lanxess site characterisation and remediation
Project Description:	Site characterisation and remediation,
Job Title and Duties:	Site Manager - Oversight of the remediation activities, soil contamination assessment, site cleanliness confirmatory sampling and ambient levels monitoring with the PID, groundwater monitoring, data interpretation and reporting.
Value of Project:	N/A
Location:	Tarkwa, Ghana
Project duration & year:	4 Months (2014)
Client:	Goldfields, Tarkwa Gold Mine
Name of Project:	Baseline Groundwater Studies
Project Description:	Groundwater Baseline site characterisation for the construction of TSF at Akotansi dump.
Job Title and Duties:	Project Hydrogeologist – Groundwater investigations to determine liner requirement for the waste rock dump and TSF extension. Groundwater occurrence, aquifer hydraulic properties, flow directions, baseline water quality, site conceptualisation and recommendations.
Value of Project:	N/A
Location:	Liqhobong, Lesotho
Project duration & year:	2 Month (2013)
Client:	Liqhobong Diamond Mine
Name of Project:	Liqhobong Diamond Mine Baseline groundwater studies
Project Description:	Baseline groundwater investigation to characterise underlying aquifers in terms of groundwater occurrence, aquifer hydraulic properties, and water quality to inform TSF lining requirements.
Job Title and Duties:	Project Hydrogeologist – Task and contractor management, field work, client liaison, data analysis and reporting.
Value of Project:	N/A
Location:	Kathu, Sishen Iron Ore Mine, Northern Cape, South Africa
Project duration & year:	4 Month (2012)
Client:	Anglo American, Sishen Mine.
Name of Project:	Contaminated groundwater investigation
Project Description:	Hydrocarbon contamination investigations
Job Title and Duties:	Hydrogeologist - Site characterisation and management of remediation of several sites contaminated with diesel in Sishen Mine
Value of Project:	N/A

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

Hydrogeological Assessment for the proposed Newcastle Gas Energy Power Plant.

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:				
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)		Percentage Procurement recognition	
Specialist name:	Tsumbedzo Peter Madanda			
Specialist Qualifications:	BSc Hons (Geohydrology)			
Professional affiliation/registration:	Pr.Sci.Nat			
Physical address:	Norfolk House 54 Norfolk Terrace Westville 3630			
Postal address:	P.O.Box 1969 Westville 3630 South Africa			
Postal code:	3630	Cell:	0723009952	
Telephone:	+27-(0) 31 279-1200	Fax:		
E-mail:	PMadanda@srk.co.za			

2. DECLARATION BY THE SPECIALIST

I, Tsumbedzo Peter Madanda, declare that –

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

SRK Consulting - Certified Electronic Signature

srk consulting

566508/44313/Other

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This signature has been printed digitally. The Author has given permission for its use for this document. The details are stored in the SRK Signature Database

Signature of the Specialist

SRK Consulting South Africa Pty (Ltd)

Name of Company:

29 April 2021

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Tsumbedzo Peter Madanda, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

SRK Consulting - Certified Electronic Signature

srk consulting

566508/44313/Other

1583-9951-9796-[illegible]

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Signature of the Specialist

SRK Consulting South Africa (Pty) Ltd

Name of Company

29 April 2021

Date

Bissesar

Signature of the Commissioner of Oaths

29/04/2021

Date

Bissesar

I certify that the deponent has acknowledged that he/she knows and understands the contents of this declaration Sworn to/affirmed and Signed before me at Westville *on* 29/04/2021

Reesha Bissesar (Administrator)

REF No: 9/1/8/2 (R/O) KZN (Pinetown)

Commissioner of Oaths

2nd Addendum to the Hydrogeological Assessment Report: External Peer Review

THE WATERWORX GROUP
Making the Connection

6 Whitehall Place
Greenbury, Phoenix
Durban, 4068
South Africa
T: +27 (0) 31 502 1317
E: ravenk@thewaterworxgroup.co.za

31 May 2021
202104 SRK/NGEPP REP REVIEW_20210531

The Project Manager
SRK Consulting (South Africa) (Pty) Ltd
Section A Second Floor, Suite 02/B1
Norfolk House
54 Norfolk Terrace, off Blair Atholl Drive
Westville 3630
South Africa

Attention: Marius Van Huyssteen

Technical Review of SRK Report No. 566508/GW: Hydrogeological Assessment for the Proposed Newcastle Gas Energy Power Plant

1. Introduction and Scope

The WaterWorx Group (Pty) Ltd (TWWG) was appointed by SRK Consulting (South Africa) (Pty) Ltd, (SRK), for a technical review of "SRK Report No. 566508/GW: Hydrogeological Assessment for the proposed Newcastle Gas Energy Power Plant, May 2021", in order to comply with a request from the Department of Environment, Forestry and Fisheries (DEFF) for an external review to verify SRK's independence. TWWG's brief includes a technical review and documentation of the main findings and recommendations in a letter format (this letter).

2. SRK's Scope of Work

The SRK scope of work and approach for a hydrogeological assessment for the Proposed Newcastle Gas Energy Power Plant (NGEPP) is summarised as follows:

- A desktop review following assimilation of existing information for the project area.
- Hydrocensus to obtain groundwater levels, record physical chemical parameters and existing usage of water resources.
- Intrusive assessment/s with auguring and sampling to obtain baseline geological, hydrological and chemical data.
- Dewatering evaluation based on historical and current site data.
- Construction of a hydrogeological site conceptual model that incorporates potential sources of contamination from existing and proposed infrastructure and operations, potential preferred pathways and potential environmental receptors.
- Conduct risk and impact assessment based on the source-pathway-receptor model, and identification of mitigatory measures to minimise risk of impact.
- Recommendations that include implementation of mitigatory measures, remediation, establishment of a monitoring network and frequency of monitoring to create a baseline for the pre-construction, construction and closure phases of site operations.

3. Main Findings and Comments

TWWG's main findings, arising from a detailed technical review of the SRK Report, are constituted by the following:

- At the very outset, it is evident that the assessment conducted by SRK is consistent with the scope summarised above.
- With the late inclusion of the area proposed for the LNG facility and related infrastructure to the east of the existing site, a major data gap appears to have manifested which will require additional characterisation and monitoring for a wholistic understanding of the broader project site.
- The approach followed by SRK to augur at testpits locations which where completed during a previous geotechnical assessment by Gevorkyan Geophysics in 2020, needs to be justified as the characterisation appears incomplete in the mid-section of the site and specifically downgradient of the effluent sump.
- The selection of the Karbochem BH45 as a representative upgradient borehole needs to be justified, even though boreholes exist closer to the site and upgradient, examples of which include BH3, BH2, BH51A or B etc
- Additional information for the stormwater channel needs to be included, as the current description is limited and confusing. The uncertainty around whether this feature is natural or man-made arises from the following:
    - The geology recorded at augur holes AH-06 and AH-07 which is consistent with fluvial deposits such as alluvial sand and gravel, may indicate a minor the presence of a minor alluvial aquifer.
    - Shallow water table in both AH-06 and AH-07 whereas testpits (up to 4 mbgl) and Karbochem shallow monitoring boreholes (up to 8.7 mbgl) do not record any water occurences.
    - Availability of surface water for sampling at SW1 and SW2 locations and subsequent inclusion of these locations into the proposed monitoring plan imply some permanence associated with this system.
- Hydraulic conductivity (K) values calculated and obtained for the shallow subsurface are high and are likely Horizontal K-values (K_H). SRK needs to confirm this and the Hydrogeological Site Conceptual Model (HSCM) would need to describe the movement sense of potential contaminants arising at the site in both the horizontal and vertical directions.
- Groundwater flow direction has not been determined for the site at a local scale which is essential to determine flow paths for potential migration of potential sources.
- The potential for surface water and groundwater interaction requires discussion.
- An evaluation of dewatering for the site is provided, which describes the water occurrence at AH-06 and AH-07 as artificially recharged by the stormwater channel. If this is the case, then a more robust description of the "stormwater channel" history and attributes needs to be included in order to dispel the possibility of a minor alluvial aquifer of limited lateral extent.
- The discussion and interpretation of the hydrochemical data for the augur holes, effluent sump and surface water requires revision. There are clear relationships arising between AH-06, SW1 and SW3 and the effluent sump sample has a very distinct impacted signature which may not be related to the impacted signature at AH-07.
- The HSCM describes and shows a direct linkage between the effluent sump and the groundwater environment which is incorrect, as the area downgradient of the effluent sump has not been characterised and the existence of a pathway has not been confirmed.
- Whilst the impact assessment has been largely addressed for the demolition phase (of the existing facilities) and for the construction and operation of future facilities, the potential impact associated with dewatering needs to be included.
- Recommendations in the SRK report may require some revision following consideration of the main findings and comments arising from TWWG's review.

4. Additional Recommendations

The following require consideration:

- That the existing project site (NGEPP) and proposed area for the LNG facilities and infrastructure be integrated and a gap analysis be done to develop a Phase II characterisation plan.
- That Phase II characterisation include drilling, hydraulic testing and sampling.
- Borehole pairs (shallow - ~15 m depth, and deep - ~30 m depth) be constructed at spatially representative positions to obtain groundwater levels, hydraulic characteristics and hydrochemical

data to strengthen the HSCM for the site. These would be installed at upgradient, onsite (mid sections) and down gradient positions of existing and future potential sources of contamination.

- A further recommendation is that geophysical techniques be employed to determine drilling positions (if possible).
- The total project construction footprint be re-examined to determine potential for overlap with the shallow water occurrence along the "stormwater channel" and a detailed methodology be developed to characterise and assess dewatering options during wet and dry season conditions.
- That the SRK recommendations around sampling frequency and monitoring of chemical parameters for the groundwater be adopted.
- Further allowance too include an initial round of analysis at specific groundwater monitoring locations in close proximity of surface water monitoring sites for isotopes oxygen 18 and deuterium to assess the potential for surface water/groundwater hydraulic connections at/near the site.
- That the proposed surface water monitoring locations SW 1 and SW2 on the stormwater channel be retained for periodic sampling and that additional locations on the Karbochem Spruit, upstream of the confluence of the stormwater channel and at a downstream point of the proposed LNG facility be included.

Yours faithfully,

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3 June 2021
566508

Principal Environmental Scientist
SRK Consulting (South Africa) (Pty) Ltd
MVanHuyssteen@srk.co.za

Attention: Marius van Huyssteen

Dear Mr. Van Huyssteen

Response to Peer Review of the Newcastle Energy Hydrogeological Report

SRK Consulting (South Africa) (Pty) Ltd. (SRK) has been appointed as the Environmental Assessment Practitioner (EAP) to undertake the required environmental applications on behalf of Newcastle Energy for the proposed project.

The groundwater study was initiated as part of the feasibility study but used to inform the EIA, to provide baseline condition as well as to characterise the underlying aquifers given the slight instability risk posed by the occurrence of shallow groundwater in the area as highlighted by Gervorkvan Geophysics (2020). As the Hydrogeological study was undertaken by an in-house specialist, the WaterWorxs Group (Pty) Ltd was appointed by SRK to undertake a peer review.

This letter details the comments received from the peer reviewer on the 31 May 2021 and the associated responses by SRK in Table 1 below.

Table 1: Comments and Responses

Peer Review Comment	SRK Response
At the very outset, it is evident that the assessment conducted by SRK is consistent with the project scope of work.	Noted with thanks.
With the late inclusion of the area proposed for the LNG facility and related infrastructure to the east of the existing site, a major data gap appears to have manifested which will require additional characterisation and monitoring for a wholistic understanding of the broader project site.	Agreed – This has been added as a recommendation.
The approach followed by SRK to augur at testpits locations which where completed during a previous geotechnical assessment by Gevorkyan Geophysics in 2020, needs to be justified as the	Noted - Additional text has been provided outlining the methodology followed.

Peer Review Comment	SRK Response
characterisation appears incomplete in the mid-section of the site and specifically downgradient of the effluent sump.	
The selection of the Karbochem BH45 as a representative upgradient borehole needs to be justified, even though boreholes exist closer to the site and upgradient, examples of which include BH3, BH2, BH51A or B etc	Noted – additional text has been provided in the report and this has been addressed.
Additional information for the stormwater channel needs to be included, as the current description is limited and confusing. The uncertainty around whether this feature is natural or man-made arises from the following: - The geology recorded at augur holes AH-06 and AH-07 which is consistent with fluvial deposits such as alluvial sand and gravel, may indicate a minor the presence of a minor alluvial aquifer. - Shallow water table in both AH-06 and AH-07 whereas testpits (up to 4 mbgl) and Karbochem shallow monitoring boreholes (up to 8.7 mbgl) do not record any water occurrences. - Availability of surface water for sampling at SW1 and SW2 locations and subsequent inclusion of these locations into the proposed monitoring plan imply some permanence associated with this system.	Noted - additional text has been provided in the report confirming the stormwater trench to be man-made.
Hydraulic conductivity (K) values calculated and obtained for the shallow subsurface are high and are likely Horizontal K-values (KH). SRK needs to confirm this and the Hydrogeological Site Conceptual Model (HSCM) would need to describe the movement sense of potential contaminants arising at the site in both the horizontal and vertical directions.	Noted - this has been addressed.
Groundwater flow direction has not been determined for the site at a local scale which is essential to determine flow paths for potential migration of potential sources.	Noted – this has been addressed.
The potential for surface water and groundwater interaction requires discussion.	Noted - this will form part of Phase II. Report recommendation has been updated.
An evaluation of dewatering for the site is provided, which describes the water occurrence at AH-06 and AH-07 as artificially recharged by the stormwater channel. If this is the case, then a more robust description of the “stormwater channel” history and attributes needs to be included in order to dispel the possibility of a minor alluvial aquifer of limited lateral extent.	Noted – additional text provided in the report.
The discussion and interpretation of the hydrochemical data for the augur holes, effluent sump and surface water requires revision. There are clear relationships arising between AH-06, SW1 and SW3 and the effluent sump sample has a very distinct impacted signature which may not be related to the impacted signature at AH-07.	Noted - this has been addressed.
The HSCM describes and shows a direct linkage between the effluent sump and the groundwater environment, which is incorrect, as the area downgradient of the effluent sump has not been characterised and the existence of a pathway has not been confirmed.	Noted – the HSCM has been updated.
Whilst the impact assessment has been largely addressed for the demolition phase (of the existing facilities) and for the construction and operation of future facilities, the potential impact associated with dewatering needs to be included.	Noted – this has been addressed.
Recommendations in the SRK report may require some revision following consideration of the main findings and comments arising from TWWG’s review.	Noted – report has been updated with TWWG’s recommendations.
Additional Recommendations	
The following require consideration: - That the existing project site (NGEPP) and proposed area for the LNG facilities and infrastructure be integrated and a gap analysis be done to develop a Phase II characterisation plan.	Noted – report recommendations updated.

Peer Review Comment	SRK Response
That Phase II characterisation include drilling, hydraulic testing and sampling: - Borehole pairs (shallow - ~15 m depth, and deep - ~30 m depth) be constructed at spatially representative positions to obtain groundwater levels, hydraulic characteristics and hydrochemical data to strengthen the HSCM for the site. These would be installed at upgradient, onsite (mid sections) and down gradient positions of existing and future potential sources of contamination.	Noted – report recommendations updated.
- A further recommendation is that geophysical techniques be employed to determine drilling positions (if possible).	Noted – this has been included in recommendations.
- The total project construction footprint be re-examined to determine potential for overlap with the shallow water occurrence along the “stormwater channel” and a detailed methodology be developed to characterise and assess dewatering options during wet and dry season conditions.	Noted – this has been included in recommendations.
- That the SRK recommendations around sampling frequency and monitoring of chemical parameters for the groundwater be adopted.	Noted with thanks.
- Further allowance too include an initial round of analysis at specific groundwater monitoring locations in close proximity of surface water monitoring sites for isotopes oxygen 18 and deuterium to assess the potential for surface water/groundwater hydraulic connections at/near the site.	Noted - report recommendations updated.
- That the proposed surface water monitoring locations SW 1 and SW2 on the stormwater channel be retained for periodic sampling and that additional locations on the Karbochem Spruit, upstream of the confluence of the stormwater channel and at a downstream point of the proposed LNG facility be included.	Noted - report recommendations updated.

Yours faithfully,

SRK Consulting (South Africa) (Pty) Ltd

SRK Consulting - Certified Electronic Signature

srk consulting

566508/44348/Letter

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Peter Madanda *PrSciNat*
Principal Consultant