Our Ref No: 2022/151

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14th March 2023

Attention: Mr Mel Pillay

REPORT ON THE DESKTOP GEOHYDROLOGICAL INVESTIGATION IN SUPPORT OF AN ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED CATO RIDGE LAND DEVELOPMENT AND RELEASE PROJECT – ETHEKWINI MUNICIPALITY

1. INTRODUCTION

As per our accepted budget proposal and the issued Purchase Orders (No. 161020 and 161022) dated 13/03/2023, we have undertaken the desktop portion of the geohydrological investigation in support of the Environmental Impact Assessment for the Cato Ridge Land Development and Release Project, including the construction of a modular wastewater treatment plant with an effluent discharge point, as well as the related infrastructure including pipelines, collection sumps and pump stations, in the Cato Ridge area of the eThekwini Municipality.

2. SCOPE OF WORK

The undertaken scope of work included:

Phase A – Data Analysis and Reporting

- Review of existing information provided and available

- Preparation of a geohydrological investigation report, detailing:

    - a desktop study of, and collation of information pertaining to, the geohydrology of the study area, including aquifer types

    - the desktop identification and delineation of all known boreholes within a 5 km radius of the site, through the use of the DWS KwaZulu-Natal Groundwater Resource Information Database (KZN GRIP), the DWA National Groundwater Archives (NGA), our in-house borehole database and any information pertaining to possible on-site boreholes that can be supplied by the client. This also allowed for an analysis of historical water quality data, if available

    - an assessment of DWS-mapped structures in proximity to the site, in accordance with the regional geological map

- an assessment of the geohydrological impacts and risks of the proposed development with reference in particular to sewage infrastructure, as well as mitigation measures for any impacts

Our findings and recommendations based on the above follow below.

3. DATA / INFORMATION SOURCES

The following were used as sources of data / information during the formulation of this desktop report:

- Maps:
  - 1 : 250 000 scale 2930 Durban topographic map
  - 1 : 250 000 scale 2930 Durban geological map
  - 1 : 50 000 scale 2930 CB topographic map
  - ESRI ArcMap Imagery

- GIS Databases:
  - DWS KZN GRIP borehole database (2011)
  - Geomeasure Group borehole database (2015)
  - National Groundwater Archive (NGA) Borehole Database (2023)
  - DWS digitized KwaZulu-Natal dolerite dykes, geological faults and lineaments

- Published Information:
  - Groundwater Consulting Services (1995). Characterisation and Mapping of the Groundwater Resources of KwaZulu-Natal Province Mapping Unit 2. *Department of Water Affairs and Forestry*, Pretoria.

4. SITE LOCATION AND PROJECT DESCRIPTION

The proposed Cato Ridge Land Development and Release Project, hereon referred to as the site, is located in the Cato Ridge area in the eThekwini Municipality. The area is accessed via Eddie Hagen Road off the R103, which is in turn accessed off the N3 National Highway at Cato Ridge. The central geographical coordinates of the site are 29º 42’ 26.28” S and 30º 37’ 19.52”E. The site location is shown on the attached Locality Plan – Dwg No. 2022/151 Figure 1.

The proposed site is being developed to make land available for a combination of land use options for future end users to enable social and economic imperatives for the region. The site will be developed for a medium-impact mixed-use land-use scenario and will be targeted towards light industry, warehousing, distribution and logistics precinct. The current footprint of the site is 369.2 ha in extent and will be developed in three (3) phases.

The development will include all the associated infrastructure with Phase 1 including the construction of internal access roads, offices, ablutions, parking lots, container storage areas, roadside stormwater drainage system, bulk stormwater diversion and attenuation ponds, bulk water supply infrastructure, electrical substation and powerlines and a sewer collection pipeline network, collection sumps, pump stations and a 2 megalitre (ML) modular Wastewater Treatment Plants (WTP) and effluent pipeline.

During Phase 2 the modular WTP will be decommissioned once sufficient sewer flow is achieved and the link to the municipal trunk sewer is established. The general site layout is shown on the attached Site Plan – Dwg No. 2022/151 Figure 2.

5. TOPOGRAPHY AND DRAINAGE

The site is situated near the western edge of an extensive north trending plateau which forms part of a bluff landform remnant of the "Ancient African Erosion Surface" (see Area Plan - Dwg No 2022/151 Figure 3).

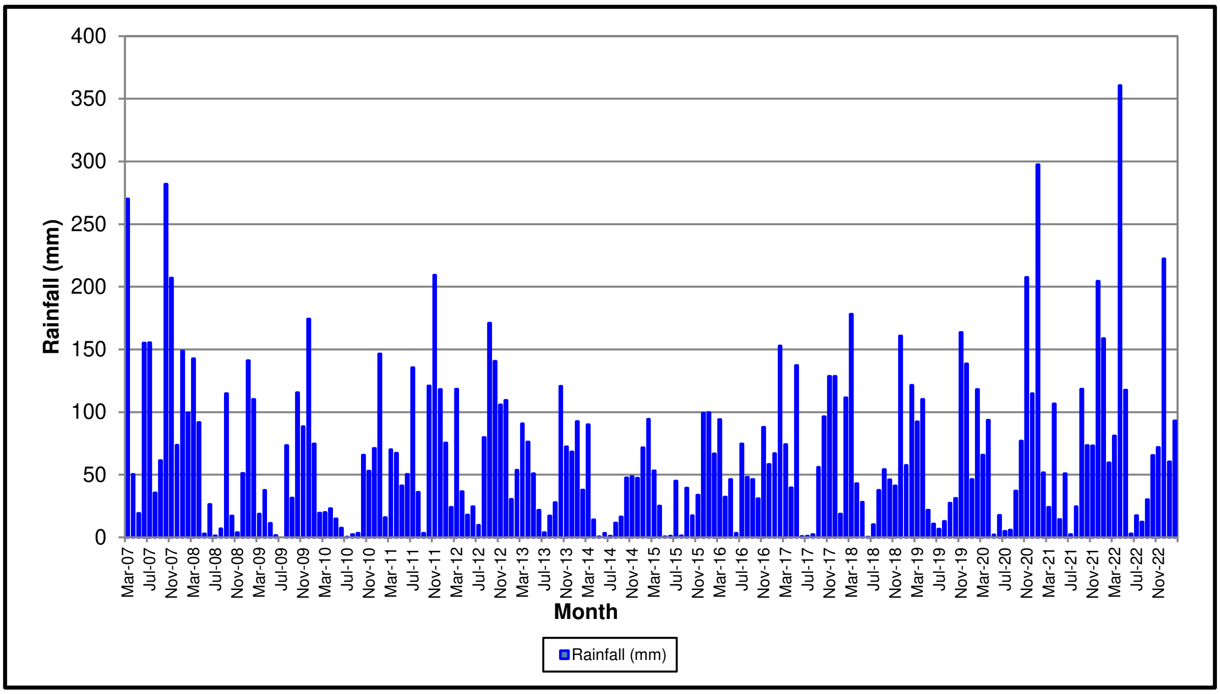
The elevation of the study area is approximately 780 m AMSL (above mean sea level) with a topographic variation of about 15 m. This plateau terminates in vertical cliffs and/or very steep slopes to the west, north and east. Elevations of the drainage features below this plateua range between 300 and 400 m AMSL (see Area Plan Dwg 2005/042 Figure 2).

The surface topography of the area encompassing the site is planar and drainage is generally westerly toward minor tributaries of the Mshwati River which is in turn a tributary of the Msunduze River in the Mgeni River catchment.

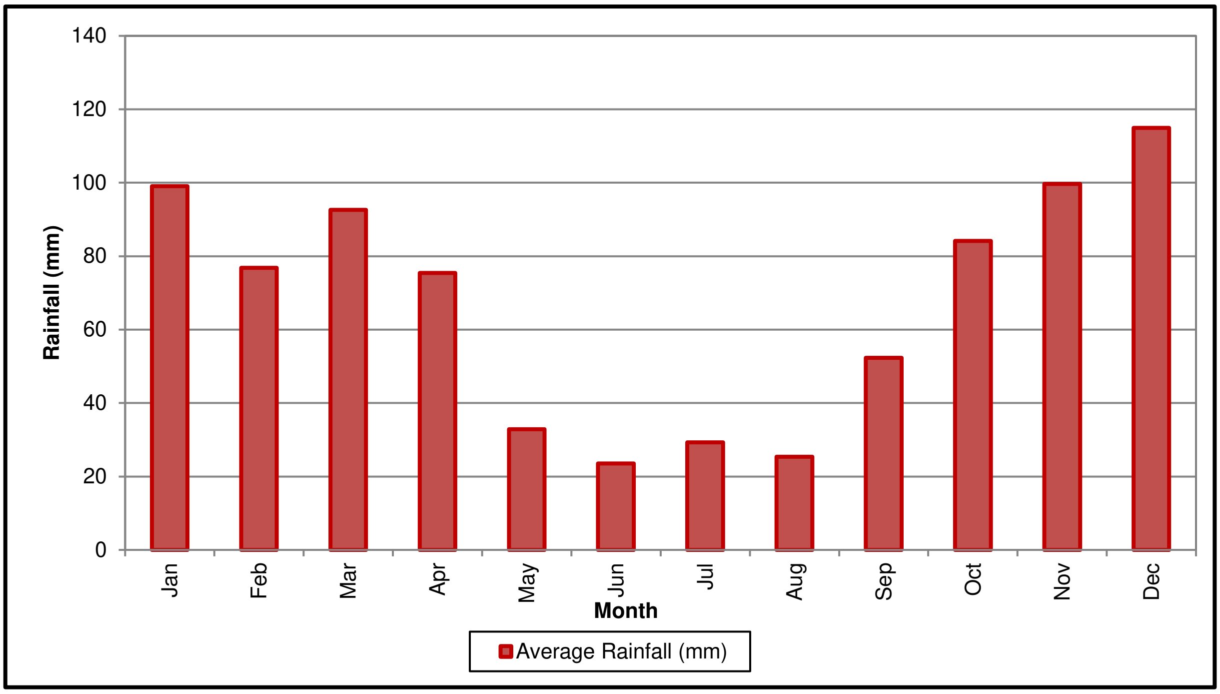
6. RAINFALL AND EVAPORATION

The rainfall in the area is quite variable and long term data has revealed that the KwaZulu-Natal coastal region and its immediate hinterland is subject to cyclic "wet and dry" periods. Research suggests cyclic rainfall patterns can be attributed to the El-Nino effect and in wet cycles the rainfall can exceed 1300 mm/annum whilst the total rainfall in the dry cycle could be less than 400 mm/annum.

Although rainfall is generally quite steady and of low to medium intensity, high intensity rainfall does occur when cut-off lows develop along the coast. Rainfall data measured by the automated weather station which is managed by Messrs EnviroNgaka on behalf of Assmang Cato Ridge Works (ACRW) shows the variable rainfall events, as shown on Graph 1 below which shows recorded rainfall data from March 2007 till February 2023.



Graph 1: Assmang Monthly Rainfall Data – Historic – March 2007 to February 2023



Graph 2: Assmang Average Monthly Rainfall – March 2007 to February 2023

7. GEOLOGY AND GEOHYDROLOGY

7.1 GEOLOGY

The published 1: 250 000 scale Geological Sheet, 2930 Durban, shows that the plateau and hence the study area is underlain entirely by a capping of sub-horizontally bedded sandstone of the Natal Group that rests unconformably on the massive granite gneiss of the Mapumulo Suite of the Natal Structural and Metamorphic Province (see Geological Plan - Dwg No 2022/151 Figure 4).

These formations have been subjected to severe tectonic activity associated with the break-up of Gondwana and numerous mainly N, NW and NE trending displacement faults occur in the region. The “tilted blocks” formed by this activity have resulted in repetition of geological formations in the coastal region and numerous Jurassic age dolerite dykes and sills have intruded into planes of weakness within the host rock formations.

7.1.1 Natal Group

The Natal Group comprises sub-horizontally bedded layers of pink and purple, medium- and fine-grained arkosic and agrillaceous sandstone with subordinate layers of off-white ortho-quartzite and lenses of maroon shale. The regional dip of these sediments ranges from 5º - 15º east to southeast.

7.1.2 Maphumulo Suite

The granite gneiss of this stratigraphic unit comprises light grey, pink and white medium- to coarse-grained granite gneiss, which contains numerous pegmatite and quartz veins.

This ancient formation is relatively massive but the weathered profile often extends to depths of over 40 m.

7.2 SOILS

7.2.1 Natal Group

The soils derived from weathering of the Natal Group include colluvial topsoil comprising loose to medium dense, non-plastic, light brown, fine-grained silty sands with a characteristic pinkish hue and a thickness ranging between 0.5 and 1.2 m. These soils represent the Fernwood form.

Residual soil profiles are generally well developed and often extend to depths of > 2m. These profiles which are often separated from the colluvium by a light grey G-horizon comprising grey mottled yellow, stiff, structured, gritty, silty clay representative of the Katspruit form.

These soil profiles diminish in thickness toward the edge of the plateau, where there is no residual clay over the bedrock and there are numerous areas east of Assmang where the sandy colluvial topsoil has been mined for plaster sand and in some areas, clay has been mined for use in the plant.

7.2.2 Maphumulo Suite

The scant soil cover derived from granite occurs in the broken, steeply undulating topography west of the site and Assmang.

A typical soil profile comprises a dark grey, sandy loam Orthic A-horizon over the soft, reddish orange, weathered granite saprolite. The transition is gradual and these soils are representative of the Glenrosa form.

7.3 GEOHYDROLOGY AND AMBIENT GROUNDWATER QUALITY

7.3.1 Natal Group

The Natal Group represents a secondary or fractured rock aquifer which comprises a sub-horizontally bedded widely jointed “brittle” rock mass of about 40 - 60 m thick. This formation has negligible primary porosity and permeability and most groundwater storage and movement occurs within joints, fractures or bedding planes within the rock mass.

Groundwater recharge within this elevated and exposed study area is totally rainfall dependent and can only gain access into the rock mass via the joints and fractures in the rock mass. Recharge is, however, limited to remnant pore-water absorbed by the sandy subsoils, which is not lost to the atmosphere via evaporation or evapotranspiration. This recharge would be minimal and is estimated to be less than 2 % of MAP.

In areas of intense fracturing, which is normally associated with “brittle deformation” of the rock mass in close proximity to faults or dolerite intrusions, the joints are often dilated and “clean” and these localised, highly permeable zones offer preferential groundwater flow paths which enhance recharge and rock mass permeability. Under ideal conditions borehole yields of up to 10 l/s can be obtained within these discrete fractured zones.

The sustainability of these aquifers is a factor of rainfall recharge and aquifer through-flow. However, in this study area, aquifer through-flow is insignificant due to the elevated and isolated nature of the geohydrological environment.

The KwaZulu-Natal Hydrogeological Map in “*Characterisation and Mapping of the Groundwater Resources KwaZulu-Natal Province Mapping Unit 2*” January 1995, which was prepared for the former Department of Water Affairs and Forestry (DWAF) by Groundwater

Consulting Services, depicts this as an area of poor groundwater development potential with expected borehole yields ranging from 0.5 to 1 l/s. Mean EC values range from 30 to 100 mS/m, and although the groundwater generally meets with most of the recommended limits of the SABS 241:2015 Standards for Drinking Water, the water is often slightly acidic and may contain high levels of iron and manganese, which detracts from the suitability of this source for domestic and industrial use.

The groundwater gradient on the plateau area is very mild and mirrors the surface topography. This gradient is influenced by the bedding of the formations and proximity to the edge of the escarpment where localised steep gradients and changes in regional flow direction may occur.

7.3.2 Maphumulo Granite Gneiss

Unweathered granite gneiss is usually quite massive and as a result this formation is considered a marginal secondary or fractured rock aquifer.

The unconformable sandstone / granite contacts is generally quite "tight" but as a result of the significant age difference (>1000 million years) between these stratigraphic units, isolated thin zones of weathering occur sporadically below this contact zone to offer inter-granular storage and enhanced permeability. Boreholes drilled to intersect this contact zone usually produce yields ranging from 0.1 to 0.3 l/s.

Geological reconnaissance carried out in the Nagle Dam/Reservoir Hills transfer tunnel has also shown that the granite / dolerite contact zones are generally quite tight due to "welding".

The groundwater gradient in this stratigraphic unit normally mirrors the surface topography and a spring line occurs at the foot of the sub-vertical cliff faces where the sandstone / granite contacts day light.

8. <u>DESKTOP STUDY AND GROUNDWATER QUALITY</u>

8.1 DESKTOP HYDROCENSUS

A desktop study of the area was conducted using the DWS KZN GRIP database and the NGA Borehole Database, as well as our own in-house database (Geom BH Data), which typically represent the most up to date and complete data sets for the study area. Water quality data was also attained from the ACRW groundwater database which is managed by Geomeasure Group on behalf of ACRW. Geomeasure Group have conducted the monthly and quarterly surface water and quarterly groundwater sampling at ACRW since 2009.

The results of this exercise indicated that fifty (50) borehole record occurs within a 5 km radius of the site (see attached Area Plan – Dwg No. 2022/151 Figure 2). The desktop study borehole data has been presented in Tables 1 to 4 in Appendix A. It must be noted that many of the records across the databases are duplicates. It is likely that there are unrecorded / "unregistered" boreholes within the area.

Available details of the borehole records are summarised as follows:

Borehole Depth Range:	6.00 – 270.00 m bgl *
Static Water Level	0.89 – 39.61 m bgl
Blow Yields:	Dry – 5.00 l/sec
Water Strike Depths:	2.00 – 270.00 m bgl
Borehole Use:	Domestic and Monitoring

** m bgl: metres below ground level.*

As seen in the data table in Appendix A, the data available is useful and from investigations in the area, the groundwater is generally a poor water supply source due to low yields and boreholes often being dry. The area is served by reticulated Municipal water supply and the majority of the boreholes on and around the site are used for monitoring purposes. The available data shows that a shallow / perched water table is evident on the site.

8.2 GROUNDWATER QUALITY

From Geomeasure Group's routine sampling undertaken at ACRW an extensive groundwater quality database is available.

As seen on Area Plan – Dwg No. 2022/151 Figure 2, the ACRW monitoring boreholes located on the various phases of the proposed site include the following boreholes:

- BH Doornrug Deep and BH Doornrug Shallow
- BH SH 1 Deep and BH SH 1 Shallow
- BH 1 Deep and BH 1 Shallow
- BH F2

The detailed water quality data from the previous thirteen (13) sampling events (dated from January 2020 to December 2022) have been included in Tables 6 to 11 in Appendix B.

The water quality data suggests that the groundwater is generally of excellent quality with none of the determinants exceeding the SANS 241: 2015 Drinking Water Standards limits in six (6) of the seven (7) monitoring boreholes on site.

The monitoring data shows that the groundwater quality generally shows the following ranges, with the exception of monitoring BH F2:

pH:	5.99 – 7.99
Electrical Conductivity:	22.9 – 121.80 mS/m*
Sodium:	14.63 – 133.70 mg/l
Chloride:	21.75 – 364.20 mg/l
Fluoride:	<0.05 – 0.93 mg/l
Iron:	<50.00 – 4060.00 ug/l
Manganese:	<50.00 – 400.00 ug/l
Total Organic Carbon:	<10.00 – 22.50 mg/l

** mS/m: milliSiemens/meter*
mg/l: milligram/litre
ug/l: microgram/litre

Borehole BH F2 located in the Phase 1 area of the site consistently shows levels / concentrations of electrical conductivity, sodium, chloride, iron and manganese in excess of the SANS 241: 2015 Drinking Water Standards and therefore renders the groundwater unsuitable as a potable source. Fluoride is also sporadically elevated. These elevated concentrations are naturally occurring and are likely attributable to low recharge resulting in increased salt dissolution times.

During the routine sampling at ACRW, the static water levels in each of the monitoring boreholes are recorded; this data is utilised in conjunction with the surveyed elevation of each of the monitoring boreholes to derive the reduced groundwater levels in the shallow and deep aquifers. The spatially modelled shallow and deep groundwater data and flow directions are shown on the attached RSGWL Plan – Dwg No. 2022/151 Figure 5 and RDGWL Plan – Dwg No. 2022/151 Figure 6. From these plots it can be seen that the shallow and deep groundwater flow in the vicinity of the site is in a westerly direction toward the lower lying adjacent valley lines.

9. PROJECT INFORMATION AND GEOHYDROLOGICAL ASSESSMENT

As discussed previously, the development will include a sewer collection pipeline network, collection sumps, pump stations and a 2 megalitre (ML) modular Wastewater Treatment Plant (WTP) and effluent pipeline. During Phase 2 the modular WTP will be decommissioned once sufficient sewer flow is achieved and the link to the municipal trunk sewer is established.

At a desktop level, the main pollution source identified on site would be the modular WTP and associated reticulation network.

One of the geohydrological risks in terms of sewage pipelines, pump stations and WTP is the failure of the systems resulting in accidental spillages. Whilst the site is underlain by consolidated sediments, spillages, especially if they are not attended to urgently, could infiltrate into the shallow groundwater depending on the size of the spillage. If the shallow and deep aquifers are geohydrologically linked, then impacts could migrate to the deep aquifer. In addition, the tributaries in the valley line to the west of the site could be impacted through baseflow. However, the spillage would need to be rather substantial to result in any significant impacts. If managed and maintained correctly, however, the risks of accidental spillages are low.

Mitigation measures to reduce impacts would involve the following:

- design of the WTP, pipeline network and pump station connections by a competent engineer.
- construction of the WTP, pump stations and pipeline under the supervision of a competent engineer and through the use of competent contractors using suitable / appropriate construction materials.
- provision of training to any staff who may work with said infrastructure to ensure the efficient management of the pump stations.
- timeous response times to the clean-up and repairs in the event of an accidental spillage.

10. CONCLUSIONS

Based upon the above information, the following can be concluded:

- Geomeasure Group has undertaken the desktop portion of the geohydrological investigation for the Environmental Impact Assessment for the proposed Cato Ridge Land Development and Release Project in the eThekwini Municipality.
- The study area is directly underlain by sandstones of the Natal Group as well as granite gneiss of the Mapumulo Suite of the Natal Structural and Metamorphic Province.
- "*Characterisation and Mapping of the Groundwater Resources KwaZulu-Natal Province Mapping Unit 2*" January 1995, which was prepared for the former Department of Water Affairs and Forestry (DWAF) by Groundwater Consulting Services, depicts the Natal Group sandstones in this area having a poor groundwater development potential with expected borehole yields ranging from 0.5 to 1 l/s. In areas of intense fracturing, which is normally associated with "brittle deformation" of the rockmass in close proximity of faults or dolerite intrusions, the joints are often dilated

and "clean" and these localised, highly permeable zones offer preferential groundwater flow paths which enhance recharge and rockmass permeability. Under ideal conditions borehole yields of up to 10 l/s can be obtained within these discrete fractured zones.

- The unconformable sandstone / granite contacts is generally quite "tight" but as a result of the significant age difference (>1000 million years) between these stratigraphic units, isolated thin zones of weathering occur sporadically below this contact zone to offer inter-granular storage and enhanced permeability. Boreholes drilled to intersect this contact zone usually produce yields ranging from 0.1 to 0.3 l/s.

- The ambient groundwater quality in the area is generally quite good, although the groundwater in the Natal Group is often slightly acidic and may contain high levels of iron and manganese, which detracts from the suitability of this source for domestic and industrial use, according to literature.

- The findings of the desktop hydrocensus indicated that fifty (50) borehole records occur within a 5 km radius of the area, although some records are duplicates across the different databases. It is likely that there are unrecorded / "unregistered" boreholes within the area.

- Seven (7) monitoring boreholes forming part of the ACRW borehole monitoring network are located on the different phases of the site. The water quality data from the routine groundwater sampling undertaken at ACRW suggests that the groundwater is generally of excellent quality with none of the determinants exceeding the SANS 241: 2015 Drinking Water Standards limits in six (6) of the seven (7) monitoring boreholes on site on a regular basis. One (1) monitoring borehole, BH F2, consistently shows levels / concentrations of electrical conductivity, sodium, chloride, iron and manganese in excess of the SANS 241: 2015 Drinking Water Standards and therefore renders the groundwater unsuitable as a potable source. Fluoride is also sporadically elevated. These elevated concentrations are naturally occurring and are likely attributable to low recharge resulting in increased salt dissolution times.

- The proposed development will include a sewer collection pipeline network, collection sumps, pump stations and a 2 megalitre (ML) modular Wastewater Treatment Plant (WTP) and effluent pipeline. During Phase 2 the modular WTP will be decommissioned once sufficient sewer flow is achieved and the link to the municipal trunk sewer is established. The main pollution source identified on site would therefore be the modular WTP and associated reticulation network.

- One of the geohydrological risks in terms of sewage pipelines, pump stations and WTP is the failure of the systems resulting in accidental spillages. Whilst the site is underlain by consolidated sediments, spillages, especially if they are not attended to urgently, could infiltrate into the shallow groundwater depending on the size of the spillage. If the shallow and deep aquifers are geohydrologically linked, then impacts could migrate to the deep aquifer. In addition, the tributaries in the valley line to the west of the site could be impacted through baseflow. The spillage however would need to be rather substantial to results in any significant impacts. If managed and maintained correctly, however, the risks of accidental spillages are low.

- There is little perceived risk posed to the geohydrological environment from this project, provided the mitigation measures mentioned in the recommendations are adhered to.

11. RECOMMENDATIONS

Based upon this report, the following is recommended:

- An environmental control officer should be appointed to oversee the construction of the WTP, pipeline and connection of the pipeline to the pump station.

- The mitigation measures proposed in Section 9 of this report should be followed.

We trust that this report meets your immediate requirements in this matter. Please do not hesitate to contact the undersigned if you require any further information.

Prepared by:

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GEOMEASURE GROUP (PTY) LTD.