University of Venda

School of Environmental Sciences

Investigation of Groundwater Potential in Naledi Local Municipality, North West Province, South Africa

Name of student: Ndwambi Khuthadzo

Student number: 11561322

Supervisor: Dr A. Tessema

Co-Supervisor: Dr F. Amponsah-Dacosta

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ABSTRACT

The Naledi Local Municipality is located in the semi-arid regions of South Africa where there is low rainfall. The Groundwater provides the only means of water supply. The geological setting of the area is underlain by the basement rocks, with complex hydraulic properties. Although groundwater studies have been carried out previously, due to the limitation of the hydrogeological data, the groundwater potential and water quality in the area are still poorly understood. The aims of this study were to investigate the factors that control borehole yield in the area, to assess groundwater quality and to correlate the various physical and chemical parameters of groundwater and investigate their sources.

The groundwater potential of the area was assessed using principal component analysis (PCA). The reclassified thematic layers comprising of lithology, lineaments, soil, land use/land cover, drainage, and topography were used as input layers to the PCA. The weighting coefficient for each thematic layer was derived using the Eigenvectors of the PCA. The high lineament density, high stream density and the underlying lithological units were the significant parameters that were controlling the borehole yields. This was followed by the integration of the 6 thematic layers in accordance to their weighting coefficient. Consequently, the groundwater potential map of the area was established and comprises of low, moderate and high groundwater potential areas. The three groundwater potential classes coincide with the underlying lithological domains which are Ventersdorp crystalline aquifer, Kalahari sand aquifer and Malmani dolomite aquifer respectively.

Groundwater quality assessment was conducted based on the physiochemical parameters of the water quality. SANS241 water quality standard was used as the guideline for the interpretation of the water quality in the area. Auxiliary water quality data was supplemented with the field physicochemical data. The charge balance error (CBE) was performed to eradicate the contaminated data. The physiographical parameters were gridded into 200 m cell size grids and interpolated using the Inverse Distance Weight

(IDW) to produce the spatial variation maps. The resulting interpolated maps indicated the pH was entirely within the regulatory standard. The EC, TDS, Cl and NO_3, and F for some of the boreholes exceed the maximum allowable limit for drinking water. The nitrate concentration is high in Stella due to anthropogenic sources such as sewage leaking, on-sight sanitation, and agricultural effluents. The TH in Malmani dolomite was significantly high. These values could be attributed to the dissolution of the dolomites and that consist of high Ca and Mg. Multivariate Factor Analysis was carried out to correlate the various physical and chemical parameters of groundwater and investigate their sources. The results indicated that the groundwater quality in the study area is controlled by both natural and anthropogenic sources.

Radiogenic isotopic analysis was conducted to assess the relative age of water resources within the study area. The Ventersdorp basement aquifer was generally characterized by low tritium values which correspond to the sub-modern groundwater age. The Malmani dolomite aquifer was defined by modern tritium values that hints that the groundwater recharge occurs at a significant level. Analysis of hydrochemical data shows that Na-HCO_3-Cl-SO_4, Mg-Na+K-Cl, Ca-Mg-HCO_3-Cl, and Ca-Mg-HCO_3 are the dominant hydrochemical facies in the area. The tritium content of groundwater in the study area is not indicative of recharge zones and relative age of groundwater.