

Contents

ACKNOWLEDGMENT.....	6
EXTENDED SUMMARY.....	7
1. INTRODUCTION.....	9
1.1 Background.....	9
1.2 Objective and scope.....	10
1.2.1 General objective.....	10
1.2.2 Specific objectives.....	10
1.2.3 Scope of the work.....	10
1.3 Location of the study area.....	11
1.4 Population and settlement.....	12
1.5 Water demand.....	13
1.6 Previous work.....	14
1.7 Methodology.....	15
2. PHSIOGRAPHY, VEGETATION, COVER AND SOIL.....	18
2.1 Physiography.....	18
2.2 Vegetation and wildlife.....	21
2.3 Land cover.....	21
2.4 Soil.....	22
3. HYDROMETEOROLOGY.....	25
3.1 Climate.....	25
3.1.1 Precipitation.....	26
3.1.2 Temperature.....	28
3.1.3 Sunshine hours.....	32
3.1.4 Relative humidity.....	32
3.1.5 Wind speed.....	33
3.1.6 Potential evapotranspiration (PET).....	34
3.2 Hydrology.....	36
3.2.1 Surface water network development.....	36
3.2.2 Baseflow.....	37
4. GEOLOGY.....	38

4.1 Stratigraphy.....	39
4.2 Local geology of the project area.....	40
4.3 Structures.....	41
5. HYDROGEOLOGY	43
5.1 Hydrogeological characterization	43
5.2 Elements of the hydrogeological system of the study area.....	43
5.2.1 Extensive and moderately productive porous aquifers.....	44
5.2.2 Extensive and moderately productive fissured aquifers	46
5.2.3 Extensive and moderately productive aquifers with mixed permeability.....	46
5.2.4 Extensive and low productive aquifers in basement rocks.....	48
5.2.5 Aquitards.....	50
5.3 Groundwater points.....	50
5.3.1 Springs.....	50
5.3.2 Boreholes	52
5.3.3 Dug wells	54
5.4 Groundwater flow, recharge and discharge	55
5.4.1 Groundwater flow.....	55
5.4.2 Groundwater recharge.....	55
5.4.3 Groundwater discharge	55
5.5 Hydrogeological conceptual model	55
6. HYDROCHEMISTRY	57
6.1 General hydrochemistry	57
6.2 Major ion constituents.....	58
6.3 Classification and graphical presentation of natural waters	59
6.3.1 Groundwater.....	60
6.3.2 Surface water	62
6.3.3 Rain water	62
6.4 Water quality	62
6.4.1 Temperature	63
6.4.2 pH.....	63
6.4.3 Hardness	65
6.4.4 Electrical conductivity (EC) and total dissolved solid (TDS)	65

6.4.5 Total dissolved solids	66
6.5 Water quality standards.....	68
6.5.1 Drinking water.....	68
6.5.2 Irrigation use	70
6.5.3 Industrial use.....	73
7. GROUNDWATER RESOURCES AND DEVELOPMENT.....	75
7.1 Groundwater resources	75
7.2 Groundwater development	76
7.3 Recommended sites for well siting	78
8. CONCLUSION AND RECOMMENDATION	79
8.1 Conclusions	79
8.2 Recommendations	79
REFERENCES	80