

# Contents

<b>ACKNOWLEDGEMENT</b> .....	<b>6</b>
<b>EXTENDED SUMMARY</b> .....	<b>7</b>
<b>1. INTRODUCTION</b> .....	<b>9</b>
<b>1.1 General Background</b> .....	<b>9</b>
<b>1.2 Objectives of the Project and Structure of the Report</b> .....	<b>9</b>
1.2.1 Specific objectives of the project .....	9
1.2.2 Structure of the report .....	10
<b>1.3 Location and Accessibility</b> .....	<b>10</b>
1.3.1 Location .....	10
1.3.2 Accessibility .....	10
<b>1.4 Population and Settlements</b> .....	<b>11</b>
<b>1.5 Previous Studies in the Area</b> .....	<b>12</b>
<b>1.6 Applied Methodology</b> .....	<b>12</b>
1.6.1 Methods applied in Phase I (desk work) .....	12
1.6.2 Methods applied in Phase II (field work) .....	13
1.6.3 Methods applied in Phase III (post field work) .....	13
<b>2. GEOMORPHOLOGY, SOIL, LAND USE, LAND COVER AND VEGETATION</b> .....	<b>14</b>
<b>2.1 Geomorphology</b> .....	<b>14</b>
<b>2.2 Vegetation Cover</b> .....	<b>14</b>
<b>2.3 Land Use and Land Cover</b> .....	<b>14</b>
<b>2.4 Soil</b> .....	<b>16</b>
<b>3. HYDROMETEOROLOGY</b> .....	<b>19</b>
<b>3.1 Climatic Conditions of the Area</b> .....	<b>19</b>
3.1.1 Precipitation .....	20
3.1.2 Temperature .....	22
3.1.3 Relation between surface temperature and precipitation .....	22
3.1.4 Potential evapotranspiration (PET) .....	23
<b>3.2 Hydrology</b> .....	<b>25</b>
3.2.1 Runoff and flooding in the area .....	26
3.2.2 Baseflow .....	30
<b>4. GEOLOGY</b> .....	<b>32</b>

<b>4.1 Regional Geology</b> .....	32
<b>4.2 Stratigraphy</b> .....	32
<b>4.3 Local Geology</b> .....	33
4.3.1 Quaternary undifferentiated sediments (Q).....	33
4.3.2 Gilo formation (pzt).....	34
4.3.3 Mekonnen basalt (Gog basalt) (pnmb) .....	34
4.3.4 Syn-tectonic granites and granodiorite (gt2) .....	34
<b>4.4 Structures</b> .....	35
<b>5. HYDROGEOLOGY</b> .....	<b>36</b>
<b>5.1 General</b> .....	36
<b>5.2 Aquifer Characterization and Classification</b> .....	36
5.2.1 Quantitative parameters.....	37
5.2.2 Qualitative parameters .....	37
<b>5.3 Aquifers of the Area</b> .....	38
5.3.1 Highly productive porous aquifers.....	38
5.3.2 Moderately productive porous aquifers .....	41
5.3.3 Moderately productive fissured aquifers .....	43
5.3.4 Low productive aquifers in the basement .....	45
<b>5.4 Groundwater points</b> .....	46
5.4.1 Springs.....	46
5.4.2 Boreholes .....	46
5.4.3 Dug wells .....	47
5.4.4 Rivers and wetlands .....	47
<b>5.5 Groundwater Flow, Recharge and Discharge Areas and Conceptual Model</b> .....	47
5.5.1 Groundwater flow .....	48
5.5.2 Recharge areas and recharge mechanisms .....	49
5.5.3 Discharge areas .....	51
5.5.4 Hydrogeological conceptual model .....	51
<b>6. HYDROCHEMISTRY</b> .....	<b>53</b>
<b>6.1 General Hydrochemistry</b> .....	53
<b>6.2 Sampling and Analysis</b> .....	53
<b>6.3 Major Constituents</b> .....	54
<b>6.4 Classification of Natural Water</b> .....	55

<b>6.5 Graphical Presentation of the Hydrochemical Data .....</b>	<b>57</b>
<b>6.6 Hydrochemical Characteristics of Natural Water in the Area .....</b>	<b>58</b>
<b>6.7 Water Quality .....</b>	<b>60</b>
6.7.1 Domestic use.....	60
6.7.2 Irrigation use .....	61
6.7.3 Incrustation and corrosion.....	63
6.7.4 Industrial use.....	64
<b>7. GROUNDWATER RESOURCES, DEVELOPMENT PERSPECTIVE AND POLLUTION .....</b>	<b>66</b>
<b>7.1 Groundwater Resources Assessment .....</b>	<b>66</b>
<b>7.2 Groundwater Resources Development Perspective .....</b>	<b>67</b>
7.2.1 Development of alluvial, reworked eluvial and lacustrine aquifers .....	68
7.2.2 Development of localized fractured and intergranular aquifers .....	68
<b>7.3 Recommended Sites for Well Siting .....</b>	<b>69</b>
<b>7.4 Vulnerability of Groundwater to Pollution .....</b>	<b>70</b>
<b>8. GROUNDWATER DEMAND AND WATER SUPPLY.....</b>	<b>72</b>
<b>9. CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>73</b>
<b>9.1 Conclusions.....</b>	<b>73</b>
<b>9.2 Recommendations .....</b>	<b>73</b>
<b>REFERENCES.....</b>	<b>74</b>