

Contents

ACKNOWLEDGMENT	5
EXTENDED SUMMARY	6
1. INTRODUCTION	8
1.1 General objective of the study	9
1.2 Specific objectives of the study	9
1.3 Location of the study area.....	9
1.4 Accessibility of the study area.....	10
1.5 Review of previous work	11
1.6 Methodology and data available.....	12
1.6.1 Desk study (phase I)	12
1.6.2 Field work (phase II)	12
1.6.3 Post field data assessment and map compilation (phase III)	12
1.7 Data gaps	13
1.8 Population and settlement.....	13
1.9 Water demand	15
2. PHSIOGRAPHY, VEGETATION COVER, SOIL AND LAND COVER	16
2.1 Physiography	16
2.2 Vegetation cover	17
2.3 Soil	17
2.4 Land use and land cover	19
3. HYDROMETEOROLOGY.....	21
3.1 Climate and seasons	21
3.1.1 Precipitation	21
3.1.2 Temperature.....	23
3.1.3 Potential evapotranspiration	24
3.1.4 Actual evapotranspiration.....	26
3.2 Hydrology	26
3.2.1 Surface water network of the area	26
3.2.2 Surface water flow	28
3.2.3 Baseflow	28
4. GEOLOGY	29
4.1 Regional geology	29
4.2 Stratigraphy	29

4.3 Lithology	30
4.3.1 Quaternary alluvium (Qal)	30
4.3.2 Quaternary eluvium (Qel).....	30
4.3.3 Basalts (Qb)	30
4.3.4 Jessoma sandstone (Pj)	32
4.3.5 The Gabredarre formation (Jg).....	32
4.3.6 The Hamanlei formation (Jh).....	33
4.3.7 Adigrat sandstone (Ja)	34
4.3.8 Post tectonic granite (Pgt2).....	34
4.3.9 Granite gneisses (Pgtgn).....	34
4.3.10 Undifferentiated gneisses (Pugn)	34
4.4 Structures	34
5. HYDROGEOLOGY	36
5.1 Hydrogeological characterization.....	36
5.2 Aquifer systems	36
5.2.1 Extensive and moderately productive porous aquifers	37
5.2.2 Limited aquifers with shallow groundwater	37
5.2.3 Extensive highly productive fissured and karst aquifers (Jh1, Jh2).....	38
5.2.4 Extensive moderate productive fissured and karst aquifers (Pj, Qal, Qel, Ja)	38
5.2.5 Low productive aquifers in basement rocks	39
5.2.6 Aquitards	39
5.3 Water points.....	39
5.3.1 Boreholes.....	40
5.3.2 Dug wells	40
5.3.3 River waters.....	41
5.4 Groundwater flow, recharge and discharge.....	41
5.4.1 Groundwater flow	41
5.4.2 Groundwater recharge	42
5.4.3 Groundwater discharge.....	43
5.5 Hydrogeological conceptual model.....	43
6. Hydrochemistry	44
6.1 Sampling and analysis.....	44
6.2 Classification of groundwater.....	44
6.3 Electrical conductivity and total dissolved solids	46
6.4 Major and minor components of groundwater	46
6.5 Water quality.....	48

6.5.1 Domestic use	48
6.5.2 Irrigation	49
6.5.3 Industrial use	50
7. GROUNDWATER RESOURCES ASSESSMENT AND DEVELOPMENT.....	51
7.1 Groundwater resources assessment	51
7.2 Groundwater resources development	52
7.3 Recommended sites for well siting	53
8. CONCLUSIONS AND RECOMMENDATIONS	55
8.1 Conclusions.....	55
8.2 Recommendations.....	55
REFERENCES	56

LIST OF FIGURES

Figure title	Page
Fig. 1.1 Location map of the study area.....	10
Fig. 1.2 Accessibility map.....	11
Fig. 1.3 Administration and woreda population map of the study area.....	14
Fig. 1.4 Dug well in Fik and borehole in Obesha used for both domestic supply and livestock watering.....	15
Fig. 2.1 Physiographic map of the study area.....	16
Fig. 2.2 3D view of physiography of the map sheet.....	16
Fig. 2.3 Bushes and acacia (Girar) in the study area.....	18
Fig. 2.4 Soil map of the study area.....	18
Fig. 2.5 Land cover map of the study area.....	20
Fig. 3.1 Mean monthly precipitation in mm.....	22
Fig. 3.2 Spatial distribution of mean annual rainfall (mm).....	22
Fig. 3.3 Average monthly temperature.....	23
Fig. 3.4 Spatial distribution of mean temperatures within the study area.....	24
Fig. 3.5 Relationship between temperature and elevation.....	24
Fig. 3.6 Potential evapotranspiration graph in mm/month.....	25
Fig. 3.7 Mean monthly potential evapotranspiration versus precipitation.....	25
Fig. 3.8 The Jerer River near Degahabur town.....	27
Fig. 3.9 Drainage map of study area.....	27
Fig. 4.1 Geology of the study area.....	31
Fig. 4.2 Fractured basalt around Fik town.....	32
Fig. 4.3 Cliff-forming Jessoma sandstone around Obele.....	33
Fig. 4.4 Inferred lineaments and drainage system of the study area.....	35
Fig. 5.1 Moderately productive porous aquifers (light blue), aquifers with shallow groundwater (yellow oblique stripes), aquitards (light brown) and aquifers in basement rocks (brown-red).....	37
Fig. 5.2 Highly productive (dark green) and moderately productive (light green) fissured and karst aquifers.....	38
Fig. 5.3 Distribution of inventoried water points within the study area.....	40
Fig. 5.4 Dug well at Fik Weyn.....	41
Fig. 5.5 Groundwater level contour and flow direction map.....	42