



REPUBLIC OF TURKEY
MINISTRY OF ENERGY AND NATURAL RESOURCES
GENERAL DIRECTORATE OF STATE HYDRAULIC WORKS

YUSUFELI DAM AND HEPP PROJECT

CHAPTER III

PROJECT PURPOSE

ENVIRONMENTAL IMPACT ASSESSMENT

DRAFT FINAL REPORT (Rev F)



ENVIRONMENTAL CONSULTANCY CO.

ANKARA, July 2006

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	xii
LIST OF FIGURES	xvii
LIST OF APPENDICES	xxiii
LIST OF ABBREVIATIONS	xxiv
EXECUTIVE SUMMARY	
I. INTRODUCTION	I-1
I.1. Energy Sector in Turkey and Policy Background	I-1
I.1.1. Overview	I-1
I.1.2. Energy Policy of Turkey	I-1
I.1.3. Role of Hydropower in Turkey	I-2
I.2. Yusufeli Project Identification and Development Background	I-3
I.2.1. Project History Brief	I-3
I.2.2. Salient Features of the Project	I-5
I.3. Environmental Impact Assessment for the Project	I-6
I.3.1. Regulatory Background	I-6
I.3.2. Environmental Studies for the Project	I-8
I.4. Structure of the EIA Report	I-9
II. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK	II-1
II.1. Laws and Regulations Related to the Environment	II-1
II.1.1. Turkish Legal Framework for Environmental Protection	II-1
II.1.2. Turkish Legal Framework for Conservation of Wildlife and Nature	II-3
II.1.3. Environmental Impact Assessment Procedure in Turkey	II-8
II.2. Compensation and Resettlement Related Legal Framework	II-12
II.2.1. Expropriation Laws and Process	II-12
II.2.2. Resettlement Law and Process	II-13
II.2.3. Institutions Related to Expropriation and Resettlement	II-15
III. PROJECT PURPOSE	III-1
III.1. Social and Economic Policy	III-1
III.2. Present Situation in the Energy Sector	III-2
III.3. Future Energy Sector	III-6
III.4. Role of Yusufeli Project	III-9

	<u>Page</u>
IV. PROJECT DESCRIPTION	IV-1
IV.1. Planning History and Process	IV-1
IV.1.1. Coruh River Development Plan	IV-1
IV.1.2. Status of the Coruh River Development Projects	IV-5
IV.1.3. Coruh River Development Plan and Infrastructure in the Basin	IV-8
IV.1.3.1. Transmission Lines in the Coruh Basin	IV-8
IV.1.3.2. Relocation Roads in the Basin	IV-9
IV.2. Major Features of Yusufeli Project	IV-11
IV.3. Project Location	IV-22
IV.4. Description of Structural Components	IV-22
IV.4.1. Dam and Reservoir	IV-22
IV.4.2. Spillway and Bottom Outlets	IV-26
IV.4.3. Diversion Tunnels and Cofferdams	IV-26
IV.4.4. Penstock and Power Plant	IV-26
IV.4.5. Switchyard and Transmission Line	IV-30
IV.4.6. Borrow and Disposal Areas	IV-30
IV.4.7. Transportation Networks	IV-32
IV.4.7.1. Relocation Roads	IV-32
IV.4.7.2. Access Roads (Service and by-pass Roads)	IV-46
IV.4.7.3. Temporary Arrangements	IV-51
IV.4.8. Camp Facilities	IV-52
IV.5. Construction Techniques and Schedule	IV-54
IV.5.1. River Diversion	IV-54
IV.5.2. Excavation and Foundation Treatment	IV-55
IV.5.3. Dam Construction	IV-57
IV.5.4. Powerhouse Construction	IV-57
IV.5.5. Electrical and Mechanical Equipment	IV-57
IV.5.6. Construction of Relocation Roads	IV-58
IV.6. Construction Labor Requirements	IV-58
IV.7. Reservoir Impounding	IV-59
IV.8. Project Costs	IV-60
IV.9. Operation Characteristics	IV-60
IV.10. Staff Requirements during Operation	IV-66
IV.11. Economic Life of the Project	IV-66

	<u>Page</u>
V. ENVIRONMENTAL BASELINE CONDITIONS	V-1
V.1. Study Area and Sources of Baseline Information	V-1
V.2. Physical Environment	V-4
V.2.1. Physiography	V-4
V.2.2. Geology	V-6
V.2.2.1. General Geology	V-7
V.2.2.1.1. Lithology and Stratigraphy	V-7
V.2.2.1.2. Geological Structure	V-7
V.2.2.1.3. Seismicity	V-10
V.2.2.2. Geology at the Dam Site and in the Reservoir Area	V-11
V.2.2.2.1. Lithology and Stratigraphy	V-11
V.2.2.2.2. Geological Structure	V-14
V.2.2.2.3. Watertightness	V-17
V.2.2.2.4. Slope Stability	V-18
V.2.3. Mineral Resources	V-20
V.2.4. Soils, Erosion and Land Use	V-20
V.2.4.1. Soils and Erosion	V-20
V.2.4.1.1. Soil Characteristics and Erosion Levels in the Reservoir Area	V-20
V.2.4.1.2. Erosion in the Catchment Area	V-21
V.2.4.2. Land Use	V-24
V.2.4.2.1. Settlements in the Area	V-27
V.2.4.2.2. Infrastructure in the Settlements	V-29
V.2.5. Climate and Air Quality	V-29
V.2.5.1. Climate	V-31
V.2.5.2. Air Quality	V-36
V.2.6. Hydrology	V-36
V.2.6.1. Overview of Coruh River Basin	V-37
V.2.6.2. Existing and Planned Hydroelectric Projects	V-37
V.2.6.3. Run-off at Project Site	V-39
V.2.6.3.1. Estimation of Run-off for the Technical Design	V-39
V.2.6.3.2. Updated Flows at the Yusufeli Dam Site	V-40
V.2.6.3.3. Flood Flows	V-40
V.2.6.4. Downstream Hydraulics	V-43
V.2.6.5. Water Quality	V-44
V.2.6.6. Sediment Measurements on Coruh River	V-52
V.2.6.7. Groundwater and Springs	V-54
V.2.6.8. Existing Water Use in the Study Area	V-56

	<u>Page</u>
V.3. Biological Environment	V-59
V.3.1. General Methodology	V-59
V.3.2. Overview of the Study Area	V-62
V.3.3. Vegetation Communities and Flora	V-64
V.3.3.1. Vegetation and Habitat Types	V-64
V.3.3.2. Flora	V-67
V.3.4. Terrestrial and Aquatic Fauna and Habitats	V-70
V.3.4.1. Relevant Turkish Criteria	V-71
V.3.4.2. Terrestrial Fauna	V-71
V.3.4.2.1. Mammals	V-71
V.3.4.2.2. Birds	V-77
V.3.4.2.3. Reptiles and Amphibians	V-85
V.3.4.2.4. Invertebrates	V-86
V.3.4.2.5. Aquatic Fauna	V-86
V.3.5. Species of Conservation note and Turkish and International Concern	V-97
V.3.5.1. Evaluation Criteria	V-97
V.3.5.2. Species of Conservation Note in the Study Area	V-98
V.3.6. Coruh Valley Wildlife Protection Area	V-100
V.4. Downstream Conditions	V-105
V.4.1. Geomorphology	V-105
V.4.2. Hydrology	V-106
V.4.2.1. Hydraulic Conditions	V-106
V.4.2.2. Water Quality	V-106
V.4.2.3. Water/Groundwater Use	V-107
V.4.3. Vegetation and Landuse	V-107
V.4.4. Flora and Fauna	V-110
V.4.5. Aquatic Fauna	V-110
V.4.6. Settlements and Infrastructure	V-111
V.4.6.1. Water Supply and Wastewater Discharge	V-112
V.4.6.2. Transportation Network	V-112
V.5. Socio-Economic Environment	V-113
V.5.1. Sources of Data and Data Collection Methods	V-113
V.5.2. Settlements Affected by the Project	V-115
V.5.3. Demography	V-116
V.5.3.1. Age Structure of Population	V-117
V.5.3.2. Household Structure	V-118
V.5.3.3. Education	V-119
V.5.4. Public Infrastructure	V-120
V.5.4.1. Health Services	V-120

	<u>Page</u>
V.5.4.2. Education Facilities	V-121
V.5.4.3. Transportation Network	V-121
V.5.5. Economic Situation	V-122
V.5.5.1. Economic Activities, Employment and Income	V-122
V.5.5.2. Agricultural Production	V-126
V.5.5.3. Livestock	V-126
V.5.5.4. Forest Products	V-128
V.5.5.5. Commerce	V-129
V.5.6. Landscape	V-129
V.5.7. Cultural Properties	V-131
V.5.8. Tourism	V-132
VI. ENVIRONMENTAL IMPACTS	VI-1
VI.1. Approach to the Assessment of Impacts	VI-1
VI.2. Physical Environment	VI-2
VI.2.1. Physiography and Geology	VI-2
VI.2.1.1. Topography and Loss of Land	VI-2
VI.2.1.2. Geology	VI-3
VI.2.2. Soils	VI-3
VI.2.2.1. Erosion and Sedimentation	VI-4
VI.2.2.1.1. Erosion	VI-4
VI.2.2.1.2. Reservoir Sedimentation	VI-4
VI.2.2.2. Watertightness	VI-4
VI.2.2.3. Seismic Risk	VI-5
VI.2.2.4. Reservoir Induced Seismicity	VI-6
VI.2.2.5. Landslide Risks	VI-6
VI.2.3. Climate	VI-8
VI.2.3.1. Impacts on Local and Regional Climate	VI-8
VI.2.3.2. Greenhouse Gas Emissions from the Yusufeli Reservoir	VI-9
VI.2.4. Air Quality Impacts	VI-16
VI.2.4.1. Assessment Approach and Methodology	VI-16
VI.2.4.1.1. Air Quality Model	VI-16
VI.2.4.1.2. Sources of Air Pollution during Construction	VI-16
VI.2.4.1.3. Dust Emissions from Crushing, Grinding, Haulage and Storage	VI-17
VI.2.4.1.4. Pollutant Emissions from Construction Vehicle Exhausts	VI-17
VI.2.4.2. Impacts on Ambient Air Quality during Construction	VI-17

	<u>Page</u>
VI.2.5. Noise	VI-21
VI.2.5.1. Assessment Approach and Methodology	VI-21
VI.2.5.1.1. Sources of Noise	VI-21
VI.2.5.1.2. Estimation of Noise Levels	VI-22
VI.2.5.2. Impacts of Noise during Construction	VI-23
VI.2.6. Impacts on Hydrology	VI-26
VI.2.6.1. Downstream Flows During Construction and Impoundment	VI-26
VI.2.6.1.1. Relevance of Downstream flows in the context of Downstream dams constructions.	VI-26
VI.2.6.1.2. Downstream Flows During Dam Construction	VI-27
VI.2.6.1.3. Downstream Flows During Impoundment	VI-27
VI.2.6.2. Downstream Discharge during Operation	VI-29
VI.2.6.3. Downstream Release Requirement	VI-33
VI.2.6.3.1. Downstream Release Requirement Until Artvin is built	VI-33
VI.2.6.3.2. Downstream Release Requirement After Artvin is in Operation	VI-35
VI.2.6.4. Flow Modification Downstream of the Coruh Cascade	VI-36
VI.2.6.4.1. Intensity of Flow Modifications	VI-36
VI.2.6.4.2. Evaluation of Relevance for the Downstream Environment	VI-38
VI.2.6.4.3. Riparian Discharge Requirement to Georgia	VI-39
VI.2.6.5. Downstream Erosion, Sediment Trapping and Other Downstream Effects	VI-40
VI.2.6.5.1. Erosion in the Downstream of Yusufeli Dam	VI-40
VI.2.6.5.2. Sediment Retention by Yusufeli and the downstream Dams of the Coruh Cascade	VI-46
VI.2.6.5.3. Impacts on the Yusufeli Reservoir from Future Upstream Projects	VI-58
VI.2.6.6. Water Use	VI-59
VI.2.6.6.1. Dilution of Domestic Waste Water and Diffuse Inputs	VI-59
VI.2.6.6.2. Irrigation	VI-60
VI.2.6.6.3. River Based Tourism, Sports and Recreation	VI-62
VI.2.6.6.4. Reservoir Productivity in Terms of Fisheries	VI-62
VI.2.6.7. Water Quality	VI-63
VI.2.6.7.1. Impacts of Project Construction	VI-66
VI.2.6.7.2. Water Quality during Initial Impoundment	VI-68
VI.2.6.7.3. Reservoir Thermal Stratification	VI-71
VI.2.6.7.4. Reservoir Eutrophication	VI-72
VI.2.6.7.5. Reservoir Oxygen	VI-78

	<u>Page</u>
VI.2.6.7.6. Effects of Downstream Releases	VI-79
VI.2.6.8. Sanitary Risk	VI-86
VI.3. Impacts on the Biological Environment	VI-87
VI.3.1. Impacts on Flora and Vegetation Communities	VI-87
VI.3.1.1. Relevant Impact Factors	VI-87
VI.3.1.2. Loss of Vegetation by Reservoir Impoundment	VI-88
VI.3.1.3. Loss of Flora Species by Reservoir Impoundment	VI-92
VI.3.2. Terrestrial Fauna and Coruh Valley Wildlife Protection Area	VI-95
VI.3.2.1. Coruh Valley Wildlife Protection Area	VI-96
VI.3.2.2. Mammals	VI-98
VI.3.2.3. Birds	VI-100
VI.3.2.4. Reptiles	VI-104
VI.3.2.5. Amphibians	VI-105
VI.3.2.6. Invertebrates	VI-105
VI.3.3. Aquatic Fauna	VI-105
VI.3.3.1. Construction Impacts on Aquatic Habitats and Aquatic Fauna	VI-106
VI.3.3.2. Impacts of Impoundment and Operation on Aquatic Habitats and Aquatic Fauna	VI-107
VI.3.3.2.1. Impact on Water Quality during Impoundment and Operation	VI-107
VI.3.3.2.2. Impact on Hydraulic Characteristics during Impoundment and Operation	VI-112
VI.3.3.2.3. Comparison of Yusufeli Projects with Similar Reservoir Projects and Relevant Impacts on Aquatic Habitats and Aquatic Species	VI-115
VI.4. Impacts on Socio-Economic Environment	VI-118
VI.4.1. Impacts on Population	VI-119
VI.4.2. Impacts on Vulnerable Groups	VI-120
VI.4.3. Impacts on Employment	VI-123
VI.4.4. Impacts on Social Interactions	VI-124
VI.4.5. Impacts in terms of Living Standards	VI-125
VI.4.6. Impacts on Resettlers	VI-126
VI.4.6.1. Considerations of Project Affected Persons (PAPs)	VI-126
VI.4.6.1.1. Considerations Related to Expropriation and Resettlement	VI-126
VI.4.6.1.2. Considerations Related to the Project	VI-127
VI.4.6.2. Impact on PAPs who Opt for Expropriation Compensation (Self Resettlement)	VI-128
VI.4.6.3. Impact on PAPs who Opt for Government Assisted Resettlement	VI-129
VI.4.6.4. Impacts on Host Population	VI-130

	<u>Page</u>
VI.4.7. Impacts Created by the Project up to the Present	VI-130
VI.4.8. Impacts on the Transportation Network	VI-130
VI.4.9. Impacts on Landscape	VI-132
VI.4.10. Impacts on Cultural Properties	VI-133
VI.4.11. Impacts on Tourism	VI-134
VI.5. Impacts of Relocation Roads	VI-139
VI.5.1. General Situation	VI-139
VI.5.2. Land Take by the new Roads	VI-142
VI.5.3. Impacts on Lands, Houses and Property	VI-144
VI.5.4. Impacts on Local Road Communication	VI-149
VI.5.4.1. Connection of Local Roads	VI-149
VI.5.4.2. Disturbance of Local Road Communication During Road Construction	VI-150
VI.5.5. Impacts on Vegetation	VI-150
VI.5.6. Impact on Fauna and Wildlife	VI-151
VI.5.6.1. Construction Disturbance	VI-151
VI.5.6.2. Barrier Effects from the Road Structures	VI-153
VI.5.7. Erosion and Impacts on Soils	VI-154
VI.5.8. Water Pollution and River Impact From Construction	VI-154
VI.5.9. Noise Impact	VI-155
VI.5.9.1. Limit Values and Evaluation Standards	VI-155
VI.5.9.2. Noise Impact from Road Construction	VI-156
VI.5.9.3. Noise Impact from Road Traffic	VI-156
VI.5.10. Ambient Air Quality Impacts	VI-161
VI.5.10.1. Air Impact from Road Construction	VI-161
VI.5.10.2. Ambient Air Impact from Traffic on New Relocation Roads	VI-161
VI.5.11. Air Pollution and Waste from Asphalt Plant	VI-163
VI.5.12 Impacts on Scenery and Visual Amenity	VI-163
VI.6. Transmission Lines (Summary of EIAs)	VI-164
VI.7. Impacts from the Establishment of Relocated Yusufeli Town	VI-170
VI.7.1. General Situation	VI-170
VI.7.2. Land Take and Impacts on Land Use	VI-172
VI.7.3. Impacts on Vegetation and Flora	VI-175
VI.7.4. Impacts on Fauna and Habitats	VI-175
VI.7.5 Impacts on Soils	VI-176
VI.7.6. Impacts on Water Quality	VI-176
VI.7.7. Waste Generation Impact	VI-177
VI.7.8. Noise Impact	VI-177
VI.7.9. Impacts on Air Quality	VI-178
VI.7.10. Impacts on Landscape	VI-178

	<u>Page</u>
VII. PROJECT ALTERNATIVES	VII-1
VII.1. Background	VII-1
VII.2. Project Type	VII-2
VII.3. Project Location	VII-4
VII.3.1. Coruh Basin Hydropower Development Context	VII-4
VII.3.2. Characteristics of 2 and 3 Dam Alternatives	VII-4
VII.3.3. Comparison Energy Production of 2 and 3 Dam Alternatives	VII-9
VII.3.3.1 General Consideration	VII-9
VII.3.3.2 Comparison of Energy Generation of the 2 and 3 Dam Alternatives	VII-10
VII.3.3.3. Comparison of Effects on Upstream Energy Generation	VII-10
VII.3.3.4. Comparison of Effects on Downstream Energy Generation	VII-10
VII.3.4. Comparison of Investment Costs of 2 and 3 Dam Alternatives	VII-11
VII.3.4.1. General Approach	VII-11
VII.3.4.2. Cost of Dams	VII-11
VII.3.4.3. Cost of Electro-Mechanical Equipment	VII-13
VII.3.4.4. Cost of Relocation Roads	VII-14
VII.3.4.5. Cost of Transmission Lines	VII-15
VII.3.5. Area to be Inundated and Population to be Physically Displaced by the 2-Dam and 3-Dam Alternatives	VII-16
VII.3.5.1. Methodology	VII-17
VII.3.5.2. Results	VII-21
VII.3.6. Costs of Land Acquisition and Resettlement	VII-25
VII.3.6.1. Methodology	VII-25
VII.3.6.2. Resettlement Cost Comparison	VII-31
VII.3.7. Other Considerations	VII-32
VII.3.7.1. Impacts on Upstream Coruh Development	VII-32
VII.3.7.2. Impacts on Coruh River	VII-32
VII.3.8. Summary and Conclusion on Location Alternative	VII-33
VII.4. Project Construction Type and Scale	VII-36
VII.5. Alternative Modes of Operation	VII-46
VII.6. No Action Alternative (No Project Implementation)	VII-46
VIII. ENVIRONMENTAL MANAGEMENT PLAN (EMP)	VIII-1
VIII.1. Purpose and Scope	VIII-1
VIII.2. Organizations and Agencies Responsible for EMP Implementation	VIII-2

	<u>Page</u>
VIII.3. Mitigation Plan	VIII-5
VIII.3.1. Pre-Construction and Construction Phases	VIII-5
VIII.3.1.1. Site Erosion Run-off	VIII-5
VIII.3.1.2. Slope Stability	VIII-6
VIII.3.1.3. Landscaping and Top Soil Utilization	VIII-6
VIII.3.1.4. Air Quality	VIII-7
VIII.3.1.5. Noise	VIII-8
VIII.3.1.6. Water Quality	VIII-9
VIII.3.1.7. Waste Management	VIII-11
VIII.3.1.8. Wildlife Management	VIII-13
VIII.3.1.9. Resettlement and Socioeconomy	VIII-15
VIII.3.1.10. Cultural and Historical Assets	VIII-16
VIII.3.1.11. Environmental Coordination	VIII-17
VIII.3.1.12. Health and Safety	VIII-19
VIII.3.2. Impounding and Operation Phases	VIII-21
VIII.3.2.1. Erosion in the Catchment Area and Reservoir Sedimentation	VIII-21
VIII.3.2.2. Water Quality	VIII-21
VIII.3.2.3. Waste Management	VIII-22
VIII.3.2.4. Wildlife	VIII-23
VIII.3.2.5. Downstream Aquatic Fauna	VIII-24
VIII.3.2.6. Environmental Coordination	VIII-25
VIII.3.2.7. Health and Safety	VIII-25
VIII.4. Monitoring Plan	VIII-37
VIII.4.1. Objectives	VIII-37
VIII.4.2. Environmental Monitoring Coordination	VIII-38
VIII.4.3. Construction Phase	VIII-39
VIII.4.4 Impounding and Operation Phase	VIII-41
VIII.5. Dam Safety and Emergency Response	VIII-56
VIII.5.1. Overview on Parties Involved in Dam Safety for the Project	VIII-56
VIII.5.2. DSI Policy on Dam Safety	VIII-56
VIII.5.3. Dam Safety Measures for Yusufeli Project	VIII-59
VIII.5.4. Emergency Preparedness Plan	VIII-61
VIII.5.4.1. Objective	VIII-61
VIII.5.4.2. Framework for Emergency Preparedness	VIII-61
VIII.5.4.3. Outline of the Emergency Preparedness Plan for the Project	VIII-62
VIII.5.4.3.1. Issues Covered	VIII-62
VIII.5.4.3.2. Actions to be Taken Before a Failure	VIII-63

	<u>Page</u>
VIII.5.4.3.3. Actions to be Taken During a Failure	VIII-64
VIII.5.4.3.4. Actions to be Taken After a Failure	VIII-64
VIII.5.4.3.5. Detailing of the Emergency Preparedness Plan	VIII-65

APPENDICES

LIST OF TABLES

	<u>Page</u>
Table II.1. Turkish Nature Conservation Categories	II-5
Table III.1. Electricity Demand and Production in Turkey (DPT, 2005; TEIAS 2005)	III-6
Table III.2. Developments of Primary Energy and the Production and Consumption of Electricity (Adapted from Eighth Five-Year Development Plan (2001) and 2005 year program, DPT)	III-7
Table IV.1. Coruh River Development Projects	IV-5
Table IV.2. Volume of Fill for the Yusufeli Dam	IV-23
Table IV.3. Type and Volume of Excavation for Project Units	IV-24
Table IV.4. Highway Geometric Standards for Dual Lane Highways (Turkish General Directorate of State Highways)	IV-34
Table IV.5. Tunnel Sections of the Artvin-Erzurum Relocation Road	IV-35
Table IV.6. Bridge Sections of the Artvin-Erzurum Relocation Road	IV-36
Table IV.7. Volumes of Excavation and Fill for the Artvin-Erzurum Relocation Road	IV-37
Table IV.8. Access Roads and Bridges	IV-50
Table IV.9. Major Site Facility Areas	IV-54
Table IV.10. Impoundment Scheme	IV-60
Table IV.11. Estimated Sediment Amount for Yusufeli Reservoir after 50 years	IV-67
Table V.1. Stratigraphic Sequence in the Yusufeli Reservoir Area	V-10
Table V.2. Records of Seismic Activities within a Radius of 50 km from the Dam Site (Ministry of Reconstruction and Settlement, 1995 and 2005)	V-13
Table V.3. List of Faults at Yusufeli Dam Site	V-17
Table V.4. General Properties of Landslides (EPDC, 1990)	V-18
Table V.5. Land Use in the Reservoir Area (<710 m ASL) and Its Surroundings (710-1000 m ASL)	V-26
Table V.6. Settlements to be Affected due to the Yusufeli Project	V-28
Table V.7. Status of the Projects in the Coruh River Basin	V-38
Table V.8. Baseline Water Flow Pattern And Hydraulics Downstream of Planned Dam Axis (Based on average annual flowrate: 126.7 m ³ /s)	V-43
Table V.9. Water Quality Standards According to WPCR	V-45

	<u>Page</u>
Table V.10.	Water Quality Classification Based on the EIE Measurements V-51
Table V.11.	Water Quality Classification Based on the DSI Measurements V-52
Table V.12.	Water Quality Classification Based on onsite measurements by ENCON V-52
Table V.13.	Mean Annual Suspended Sediment Yields and Average River Flow Rates V-54
Table V.14.	Location and Characteristics of the Wells of DSI V-55
Table V.15.	Groundwater Levels in the Drillholes at the Dam Site V-55
Table V.16.	Irrigation Water Use at the Study Area V-57
Table V.17.	Estimated Wastewater Production at the Study Area V-58
Table V.18.	Vegetation Communities in the Study Area V-66
Table V.19.	Distribution of the Flora Species Identified in the Study Area according to Phytogeographic Region V-67
Table V.20.	Endemic (to Turkey) and/or Turkish Red Data Book, IUCN, Bern, CITES-listed Flora Species Identified in the Study Area V-67
Table V.21.	IUCN, Bern, CITES-listed Fauna Species Identified in the Study Area V-70
Table V.22.	Mammals of National and International Concern Identified in the Study Area V-73
Table V.23.	The Bird Species Identified in the Study Area and the Habitat Types V-78
Table V.24.	Birds of National and International Concern Identified in the Study Area V-81
Table V.25.	Reptiles and Amphibians of National and International Concern Identified in the Study Area V-87
Table V.26.	The Distribution Ratio for the Species Captured at the Site V-88
Table V.27.	Fish Species of National and International Concern Identified in the Study Area V-90
Table V.28.	Longitudinal Zonation of the Coruh River and Tributaries V-91
Table V.29.	Coruh Wildlife Reserve Enlargement in 2002 V-101
Table V.30.	Vegetation and Landuse Types in the Reach Downstream of Yusufeli Dam Site V-108
Table V.31.	Population of the Settlements Located Downstream of Yusufeli Dam Site V-111
Table V.32.	Minimum and Maximum Elevation of the Settlements located between Yusufeli and Artvin Dam Sites V-112
Table V.33.	Population of the Settlements to be Affected from the Yusufeli Project V-116
Table V.34.	Age Distribution of People Living in the Surveyed Area V-117

	<u>Page</u>	
Table V.35.	Dependency Ratio of the Population	V-118
Table V.36.	Reasons for Living Away from Home	V-119
Table V.37.	Education Level of the Surveyed Population	V-120
Table V.38.	Multiple Response Table for Sources of Income	V-123
Table V.39.	Occupational Distribution of People in the Surveyed in the Study Area (1 st occupation)	V-124
Table V.40.	Reasons of the Surveyed Population for not Working	V-125
Table V.41.	Distribution of Livestock among Households	V-127
Table VI.1.	Surface Area and Estimated Topsoil Volume at Terrains with Different Land Capability Classes	VI-3
Table VI.2.	Maximum Accelerations (gal [#]) for Different Return Periods (EPDC, 1990)	VI-6
Table VI.3.	Standing Crop of Biomass in the Yusufeli Reservoir prior to Flooding	VI-11
Table VI.4.	GHG Emission and GWP using Average Fluxes according to Figure VI.1	VI-12
Table VI.5.	GWP assuming Fast Decay of Inundated Biomass	VI-12
Table VI.6.	Carbon Balance under Present Baseline Conditions	VI-14
Table VI.7.	Comparison Yusufeli HEPP (Table VI.4) vs. Thermal Power Generation	VI-15
Table VI.8.	Calculated Maximum Ground Level Concentration Values of the Annual and Daily Average	VI-20
Table VI.9.	Maximum Deposition Values (Construction Phase)	VI-21
Table VI.10.	Noise Sources During Construction	VI-22
Table VI.11.	Impoundment Scheme	VI-27
Table VI.12.	Water Levels in the River Section between Yusufeli Dam and Artvin Reservoir and in Artvin Reservoir under Operation Conditions	VI-29
Table VI.13.	Downstream Minimum and Maximum Water Levels Estimate for Impoundment Phase (in case of delay of Artvin Dam) in Relation to the Existing Road Elevation	VI-30
Table VI.14.	Elevation of Settlements and Fields Downstream of Yusufeli Dam in relation to anticipated operational Water Levels in the downstream (in case of Artvin delayed)	VI-32
Table VI.15.	Comparison of Sediment Retention Scenarios in the Coruh Cascade	VI-53
Table VI.16.	Main Waterborne Diseases	VI-86
Table VI.17.	Distribution of Vegetation Communities within and above the Reservoir area (710 m Elevation)	VI-91
Table VI.18.	Coruh Wildlife Reserve: Mitigation and Compensation Balance after Enlargement of the Protected Area	VI-97

	<u>Page</u>	
Table VI.19.	The Birds Breeding in the Study Area and Breeding Elevations	VI-101
Table VI.20.	Habitat Types used by the Reptile Species	VI-104
Table VI.21.	Freshwater Fish Directive, Summary of Imperative Standards	VI-107
Table VI.22.	Fish Species and their Tolerance Range of Selected Environmental Variables	VI-108
Table VI.23	The Fish Species Composition in Kizilirmak River, and Altinkaya and Hirfanli Dams	VI-116
Table VI.24.	Settlements to be Inundated and Areas to be Expropriated Due to the Yusufeli Project	VI-118
Table VI.25.	Road Distances of the Settlements to the District Center before and after Inundation	VI-131
Table VI.26.	Loss of Land by the New Relocation Roads	VI-143
Table VI.27.	Land Impact from the Relocation Roads	VI-144
Table VI.28.	Main Elements of the Artvin-Erzurum Relocation Section	VI-145
Table VI.29.	Main Elements of the Artvin-Bayburt Relocation Section	VI-146
Table VI.30.	Settlements Affected by the Relocation Roads and the Amounts of Land to be Expropriated	VI-148
Table VI.31.	Permanent Service Roads	VI-149
Table VI.32.	Extent of vegetation communities' being affected by the relocation roads	VI-151
Table VI.33.	Allowable Noise Levels for Road Traffic in Settled Areas	VI-155
Table VI.34.	International Reference Limit Values	VI-156
Table VI.35.	Allowable Noise Levels for Construction Activities	VI-156
Table VI.36.	Main Road Standards	VI-157
Table VI.37.	Traffic data for the Year 2003	VI-157
Table VI.38.	Traffic Noise Impact on Settlements	VI-159
Table VI.39.	Realisation Status of the Transmission Lines that will serve the Coruh River Projects	VI-164
Table VI.40	Summary of Impacts and Mitigation Measures as Presented in the Respective EIA Reports of the ETL Projects	VI-166
Table VI.41.	Land Use and Vegetation Types at Yansiticilar Site	VI-175
Table VII.1.	Properties of Alternative Thermal Power Plant Project	VII-2
Table VII.2.	Characteristics of 2-Dam Alternative and 3-Dam Alternative (JICA, 1986)	VII-9
Table VII.3.	Estimation Base for Approximate Dam Embankment Volumes of Kirazli and Oltu Dams	VII-13
Table VII.4.	Reservoir Surface Areas and Agricultural Lands to be inundated under the 2 Dam and 3-Dam Alternatives	VII-22

	<u>Page</u>
Table VII.5. Settlements to be Totally and Partially Inundated by the 2-dam Alternative	VII-23
Table VII.6. Settlements to be Totally and Partially Inundated by the 3-dam Alternative	VII-24
Table VII.7. Available Comparable Information for Estimation of Resettlement Costs	VII-26
Table VII.8. Unit Costs for Estimation of Land Acquisition and Resettlement Costs for 2-dam and 3-dam Alternatives	VII-26
Table VII.9. Costs of Land Acquisition and Resettlement for 2-dam and 3-dam Alternatives	VII-31
Table VII.10. Summary of Costs and Benefits related to the 2 and 3 Dam Alternatives	VII-34
Table VII.11. Economic Comparison 2 dam vs. 3 dam setup for the Middle Coruh Development	VII-35
Table VII.12. Preliminary Comparison of Alternative Dam Types for Yusufeli Project (JICA, 1986)	VII-36
Table VII.13. Comparison of Alternative Dam and Power Plant Types (JICA, 1986)	VII-37
Table VII.14. Effective Storage Volumes (106 m ³) for Alternatives of High Water Level (HWL) and Available Drawdown (JICA, 1986)	VII-37
Table VII.15. Comparison of High Water Level (HWL) and Available Drawdown Alternatives	VII-40
Table VII.16. Comparison of the High Water Levels Studied in the Feasibility Report with respect to Some Associated Impacts	VII-42
Table VII.17. Land Use in the Inundation Area for Alternative High Water Levels	VII-43
Table VII.18. Comparison of Installed Capacity Alternatives	VII-44
Table VIII.1. Agencies and Organizations Responsible for EMP Implementation	VIII-3
Table VIII.2. Mitigation Activities for Pre-construction and Construction Phase	VIII-26
Table VIII.3. Mitigation Activities for Operation Phase	VIII-34
Table VIII.4. Monitoring Activities for Construction Phase	VIII-43
Table VIII.5. Monitoring Activities for Operation Phase	VIII-50
Table VIII.6. Mitigation Activities for New Yusufeli Town Relocation Site	VIII-54
Table VIII.7. Monitoring Activities for New Yusufeli Town Relocation Site	VIII-55

LIST OF FIGURES

		<u>Page</u>
Figure III.1.	Installed Capacities for Electricity Production by Energy Source in 2003	III-4
Figure III.2.	Electricity Production Capacities by Energy Source in 2003	III-4
Figure III.3.	Actual Production of Electricity by Energy Source in 2003	III-5
Figure III.4.	Development in Installed Capacity of Power Plants in Turkey	III-5
Figure III.5.	Electricity Production and Demand between 1989 and 2005	III-8
Figure III.6.	Electricity Production by Source and Associated Installed Capacities (1989 – 2005)	III-8
Figure IV.1.	Location of the Coruh River Basin and the Project Area in Turkey	IV-2
Figure IV.2.	General Plan of the Coruh River Development Projects	IV-3
Figure IV.3.	Longitudinal Profile of the Coruh River Development Plan	IV-4
Figure IV.4.	Power Transmission Line Alignments and Their Connection to the National Network	IV-10
Figure IV.5.	The Existing Road Network and the Relocation Roads	IV-12
Figure IV.6.	Permanent Service Roads from Main Access Roads to the Project Facilities	IV-14
Figure IV.7.	General Setting of the Yusufeli Reservoir	IV-20
Figure IV.8.	General Plan of the Yusufeli Dam and HEPP	IV-21
Figure IV.9.	Typical Section and Profile View of the Yusufeli Dam and HEPP	IV-25
Figure IV.10.	Plan, Profile and Sections of the Diversion Tunnels	IV-27
Figure IV.11.	Power Structure Plan of the Yusufeli Dam and HEPP	IV-28
Figure IV.12.	Power Structure Profile of the Yusufeli Dam and HEPP	IV-29
Figure IV.13.	The Construction Materials Location Map	IV-31
Figure IV.14.	Detailed Map of the Artvin-Erzurum Relocation Road and Storage Locations of Excess Excavation Material	IV-33
Figure IV.15.	Typical Cross Section of the Artvin-Erzurum Relocation Road (Class II)	IV-40
Figure IV.16.	Typical Cross Section of the Artvin-Bayburt Relocation Road (Class III)	IV-41
Figure IV.17.	Typical Road Tunnel Section (Artvin-Erzurum Relocation Road)	IV-42
Figure IV.18.	Typical Bridge Section (Artvin-Erzurum Relocation Road)	IV-43
Figure IV.19.	Typical Retaining Wall Section	IV-44
Figure IV.20.	Typical Box Culvert	IV-45

	<u>Page</u>
Figure IV.21. Typical Pipe Culvert	IV-45
Figure IV.22. General Layout of The Bypass and Site Access Roads	IV-49
Figure IV.23. General Layout of the Site Facilities	IV-53
Figure IV.24. Time Schedule	IV-56
Figure IV.25. Hydraulic Data for Yusufeli Project	IV-62
Figure IV.26. Hydrological Data for Yusufeli Project	IV-63
Figure IV.27. Spillway Discharge Curve	IV-64
Figure IV.28. Outflows from Yusufeli Dam for Operating Conditions	IV-68
Figure IV.29. Yusufeli Reservoir Natural Inflows and Outflows	IV-68
Figure IV.30. Yusufeli Reservoir Artificial Inflows and Outflows	IV-69
Figure IV.31. Yusufeli Reservoir Operating Water Levels	IV-69
Figure V.1. Land Use and Vegetation Cover Map	V-2
Figure V.2. Elevation Map of the Area	V-5
Figure V.3. Geological Map of the Region and Gorgulu and Vecanket Landslide Areas	V-8
Figure V.4. Stratigraphical Columnar Sectional View of the Region	V-9
Figure V.5. Tectonic Map of the Region	V-12
Figure V.6. Seismic Map of the Region	V-12
Figure V.7. Geological Map of the Dam Site	V-15
Figure V.8. Geological Section View of the Yusufeli Dam Axis	V-16
Figure V.9. Main Soil Groups in the Project Area (within 1000 m A.S.L contour)	V-22
Figure V.10. Soil Sampling Locations and the Index Results	V-23
Figure V.11. Soil Erosion Risk Map of Yusufeli Catchment Area	V-25
Figure V.12. Locations of the Meteorological and Flow Gauging Stations	V-30
Figure V.13. Monthly Precipitation in the Yusufeli Project Area	V-33
Figure V.14. Monthly Temperatures in the Yusufeli Project Area	V-34
Figure V.15. Wind Speed and Direction in DMI Stations	V-35
Figure V.16. Annual Flows at Yusufeli Dam Site	V-41
Figure V.17. Minimum, Average and Maximum Flows at Yusufeli Dam Site	V-41
Figure V.18. Minimum, Average and Maximum Flows and Exceedance of Minimum Flow at Yusufeli Dam Site	V-42
Figure V.19. The Study Area	V-61
Figure V.20. Schematic Representation of Longitudinal Zonation of the Coruh River and Tributaries	V-92
Figure V.21. Land Cover of the Previous (before 2002) and Enlarged (after 2002) Coruh Valley Wildlife Protection Area	V-104

	<u>Page</u>	
Figure V.22.	Landuse Pattern in the Downstream of the Project between Yusufeli and Artvin Dam Sites	V-109
Figure V.23.	Locations of the Historical Monuments in the Study Area	V-133
Figure VI.1.	Areal Fluxes of Carbon Dioxide and Methane from Temperate Reservoirs (based on Louis et al., 2000)	VI-10
Figure VI.2.	Daily Average Concentration Curves for PM ($\mu\text{g}/\text{m}^3$) (Construction Phase)	VI-19
Figure VI.3.	Annual Average Concentration Curves for PM ($\mu\text{g}/\text{m}^3$) (Construction Phase)	VI-19
Figure VI.4.	Estimated Noise Levels by Distance (Arpacik, Ishan, Sebzeciler, Irmakyani and Morkaya villages) (Construction Phase)	VI-24
Figure VI.5.	Estimated Noise Levels by Distance (Cevreli and Tekkale villages –Road paving) (Construction Phase)	VI-24
Figure VI.6.	Estimated Noise Levels by Distance (Cevreli and Tekkale villages -Road excavation and filling) (Construction Phase)	VI-25
Figure VI.7.	The Main Cross-Sections Chosen Along the Coruh River between Yusufeli Dam Site and Minimum Operational Level Headwater of Deriner Reservoir	VI-31
Figure VI.8.	Historical Minimum Flow	VI-34
Figure VI.9.	Impact on flows at Muratli by operation of Yusufeli HEPP	VI-37
Figure VI.10.	Yusufeli Discharge Duration Graph vs. Natural Flow Duration Curve	VI-40
Figure VI.11.	Shear Stress Duration Graphs	VI-42
Figure VI.12.	Eroding Landslide (at 6.8 km downstream of Yusufeli Dam site)	VI-43
Figure VI.13.	Sediment Cone of a Small Tributary (at 11 km downstream of Yusufeli Dam site)	VI-43
Figure VI.14.	Road Embankment (8.8 km downstream of Yusufeli Dam site)	VI-44
Figure VI.15.	Maintenance Works at the Channel Embankment (1.9 km downstream of Yusufeli Dam site)	VI-44
Figure VI.16.	Widened Channel section with Temporary Gravel Bars (2.3 km downstream of Yusufeli Dam site)	VI-45
Figure VI.17.	River Section with Coarse Boulders and Rock forming the Channel (15.6 km downstream of Yusufeli Dam site)	VI-46
Figure VI.18.	Batumi Coastal Region (November 2005)	VI-48
Figure VI.19.	Schema of Sediment Retention Calculation over a Cascade of Reservoirs	VI-51
Figure VI.20.	Longitudinal Pattern of Sediment Retention in the Middle and Lower Coruh Cascade (Brune's method)	VI-52

	<u>Page</u>
Figure VI.21. Longitudinal Pattern of Sediment Retention in the whole Coruh Cascade (Brune's method)	VI-52
Figure VI.22. Water Quality Modeling Approach	VI-67
Figure VI.23. Initial Impoundment – Storage Volume and Decay of Organic Matter (vegetation and soil)	VI-70
Figure VI.24. Initial Impoundment – Water Quality of Hypolimnion and Downstream Release	VI-70
Figure VI.25. Lake Stratification	VI-74
Figure VI.26. 10-Year Temperature Profile Change Estimate for Yusufeli Reservoir Minimum Withdrawal Conditions	VI-74
Figure VI.27. 10-Year Temperature Profile Change Estimate for Yusufeli Reservoir Maximum Withdrawal Conditions	VI-75
Figure VI.27a. 10-Year Temperature Profile Change Estimate for Yusufeli Reservoir Average Withdrawal Conditions	VI-75
Figure VI.28. Trophic State of Yusufeli Reservoir according to the Vollenweider-Model	VI-76
Figure VI.29. Comparison of Total Nitrogen and Phosphate Concentrations Through Water Column (March, July, September, October)	VI-77
Figure VI.30. Change in Diatom Concentration through Water Column in Time	VI-77
Figure VI.31. Estimated DO Profile Change	VI-80
Figure VI.32. Estimate of Change in Downstream Water Temperature for Yusufeli Reservoir Minimum Withdrawal Conditions	VI-82
Figure VI.33. Estimate of Change in Downstream Water Temperature for Yusufeli Reservoir Maximum Withdrawal Conditions	VI-82
Figure VI.33a. Estimate of Change in Downstream Water Temperature for Yusufeli Reservoir Average Withdrawal Conditions	VI-83
Figure VI.34. Estimate of Downstream NH ₄ -N, NO ₃ -N, PO ₄ -P Concentrations for different Inflow Phytoplankton Biomasses	VI-84
Figure VI.35. 10-Year DO Profile Change Estimate for Yusufeli Reservoir (1995-2004)	VI-85
Figure VI.36. Major Vegetation Cover / Habitat Types in the Study Area in relation to the Reservoir High Water Level	VI-89
Figure VI.37. Vegetation Communities in the Study Area	VI-90
Figure VI.38. Distribution of Critically Endangered (CR) Species (TRDB) in the Study Area in relation to the Reservoir Line	VI-93
Figure VI.39. Distribution of Endangered (EN) Species (TRDB) in the Study Area in relation to the Reservoir Line	VI-93
Figure VI.40. Distribution of Vulnerable (VU) Species (TRDB) in the Study Area in relation to the Reservoir Line	VI-94

	<u>Page</u>	
Figure VI.41.	Distribution of Data Deficient (DD) Species (TRDB) in the Study Area in relation to the Reservoir Line	VI-94
Figure VI.42.	Impact of Estimated Reservoir Temperature and DO Profiles on Fish Species	VI-117
Figure VI.43.	Temperature and DO Measurements in Altinkaya Dam	VI-117
Figure VI.44.	Status of Tekkale Citadel After Impoundment	VI-135
Figure VI.45.	Status of Hamzat I and Hamzat II Chapels After Impoundment	VI-136
Figure VI.46.	Cevreli Citadel and the Future Yusufeli Reservoir	VI-137
Figure VI.47.	Scene of Ishan Church from the Satellite Image	VI-138
Figure VI.48.	Noise Dipersion Graph in Artvin-Erzurum Relocation Road (Class II, 3000 vehicles/day) (Future Traffic on Relocation Roads)	VI-163
Figure VI.49.	Noise Dipersion Graph in Artvin-Bayburt Relocation Road (Class III, 2500 vehicles/day) (Future Traffic on Relocation Roads)	VI-163
Figure VI.50.	The Conceptual Plan for the Yansiticilar Relocation Site	VI-171
Figure VI.51.	Planned Bridge Across the Barhal River	VI-173
Figure VI.52.	Land Use and Vegetation Types at Yasiticilar Site	VI-174
Figure VII.1.	Middle Coruh Basin 2-Dam System Layout	VII-5
Figure VII.2.	Middle Coruh Basin 3-Dam System Layout	VII-6
Figure VII.3.	Superimposed Longitudinal Profile of 2 and 3 Dam Alternatives	VII-8
Figure VII.4.	Area to be Inundated by 2-Dam Alternative	VII-18
Figure VII.5.	Area to be Inundated by 3-Dam Alternative	VII-19
Figure VII.6.	The Area to be Inundated by the 3-Dam Alternative	VII-20
Figure VII.7.	The Reservoir Capacity and Area Curves in the Optimization Studies for Yusufeli Project	VII-38
Figure VII.8.	The Change of B/C Ratio for Different High Water Level and Effective Storage Capacity of the Reservoir	VII-39
Figure VII.9.	Area to be Inundated Water Levels of 720 m, 710 m, 700 m and 690 m	VII-41

LIST OF BOXES

		<u>Page</u>
Box IV.1.	Summary of Major Project Characteristics	IV-16
Box V.1.	Characteristics of the Fish Species of the Study Area	V-93
Box V.2.	Sources of Income	V-122
Box VIII.1.	Downstream Releases During Impoundment	VIII-24

LIST OF APPENDICES

- Appendix A. List of Preparers and Contributors
- Appendix B. Bibliography
- Appendix C. Glossary
- Appendix D. Photograph Album
- Appendix E. Vegetation-Landuse-Habitat Mapping Report
- Appendix F. Soil Assessment Report
- Appendix G. Catchment Area Erosion Risk Modeling Report
- Appendix H. Hydrology and Water Quality Baseline Data
- Appendix I. Hydro-Modeling Report
(Reservoir Water Quality and Downstream Flow Modeling)
- Appendix J. Air Quality and Noise Modeling Report
- Appendix K. Summary of Public Consultation Activities
- Appendix L. Chronological List Of Agreements, Study Documents And
Written Communication Between The Governments Of Turkey
And Georgia
- Appendix M. Impact Interaction Matrix
- Appendix N. Wild Goats Management Plan Study Outline

LIST OF ABBREVIATIONS

AIGM	General Directorate of Disaster Affairs
ASL	Above Sea Level
B/C	Benefit-cost ratio
Bern Convention	Convention on the Conservation of European Wildlife and Natural Habitats
BOD	Biological Oxygen Demand
BTEP	Thousand Tons of Petroleum Equivalent
CHY	Cable Head Yard
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CR	Critically Endangered
COD	Chemical Oxygen Demand
dB	Decibels
DD	Data Deficient
DIE	State Institute of Statistics
DMI	General Directorate of State Meteorological Institute
DO	Dissolved Oxygen
D/S	Downstream
DPT	State Planning Organization
DSI	General Directorate of State Hydraulic Works
EC	Electrical Conductivity
EDF	Electric de France
EIA	Environmental Impact Assessment
EIE	General Directorate of Electrical Power Resources Survey and Development Administration
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENCON	ENCON Cevre Danismanlik Ltd. Sti. (Environmental Consultancy Co.)
EN	Endangered
ENE	East-northeast
ENPEP	Energy and Power Evaluation Program
EPDC	Electric Power Development Company
ERL	IUCN (European) Red List
ETL	Electric Transmission Lines
EU	European Union
EUAS	Turkish Electricity Production Corporation
GCCW	Georgian Centre for Wildlife Conservation

GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GNP	Gross National Product
GWh	Giga Watt Hour
HH	Household
HEPP	Hydroelectric Power Plant
HSE	Health, Safety and Environment
HWCR	Hazardous Waste Control Regulation
HWL	High Water Level
IBA	Important Bird Area
ICOLD	International Commission on Large Dams
IPP	Independent Power Producers
IRR	Internal rate of return
IMS	Integrated Management System
IUCN	The World Conservation Union
JICA	Japan International Cooperation Agency
KEP	Kilogram Petroleum Equivalent
KGM	General Directorate of State Highways
KHGM	General Directorate of Rural Affairs
kWh	Kilo Watt Hour
Leq	Noise Level Equivalent
LTL	Long Term Limits
MAED	Model for Analysis of Energy Demand
MAK	Central Hunting Commission
MARA	Ministry of Agriculture and Rural Affairs
MCE	Maximum Credible Earthquake
MoEF	Ministry of Environment and Forestry
MENR	Ministry of Energy and Natural Resources
MOH	Ministry of Health
MPWS	Ministry of Public Works and Settlement
MTA	General Directorate of Mining Exploration and Research
MW	Mega Watt
MWCR	Medical Waste Control Regulation
MWL	Maximum Water Level
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration Environmental Data Service
OECD	Organization for Economic Cooperation and Development
OP	World Bank Operational Policy

PAP	Project Affected Person
PIO	Public Information Office
PM	Particulate Matter
RAP	Resettlement Action Plan
ROW	Right of Way
RS	Remote Sensing
SE	Southeast
SRF	Special Resettlement Fund
SS	Suspended Solids
STL	Short Term Limits
SY	Switch Yard
TCK	General Directorate of State Highways
TDS	Total Dissolved Solids
TEIAS	Turkish Electricity Transmission/Distribution Corporation
TKN	Total Kjeldahl Nitrogen
TKVKK	Trabzon Natural Wealth Preservation Committee
TPAO	Turkish Petroleum Corporation
TPE	Total Petroleum Equivalent
TPP	Thermal Power Plant
TRDB	Turkish Red Data Book
TSWCR	Turkish Solid Waste Control Regulation
TUGEM	General Directorate of Agricultural Production and Improvement
UNDP	United Nations Development Programme
U/S	Upstream
VU	Vulnerable
WB	World Bank
WCD	World Commission on Dams
WEC	World Energy Council
WPCR	Water Pollution Control Regulation
WWF	World Wildlife Foundation

III. PROJECT PURPOSE

Social and economic development of Turkey is going in parallel to the industrial development. Energy is a crucial necessity for social, economic, and industrial development. Turkey needs to exploit domestic energy sources to attain its goals and activities, and has an important potential for hydropower development with its relatively rich surface water resources. Thus, hydroelectric energy is one of the most important domestic energy sources of Turkey (Section I.1.3).

Hydroelectric energy being a renewable energy resource is a very significant source of energy generation in the long run as extensive scientific research on the world's energy resources has shown that fossil sources are rapidly being depleted. Moreover, adverse effects from carbon dioxide emissions from fossil fuel based power generation on global warming are undisputed.

Yusufeli Project will provide for the generation of reliable, inexpensive and renewable energy. The following sections discuss the energy needs of Turkey associated with the development goals of the country.

III.1. Social and Economic Policy

Five Year Development Plans, prepared by the State Planning Organization (DPT), generally govern Turkish social and economic goals and policies. These include policies on the sectors and issues affecting social and economic development, such as energy and industrialization policies. The principal goals of the Eighth Five Year Development Plan (2001), covering the years 2001-2005, are establishing a stable and sustainable development environment by implementing macroeconomic, social, cultural and structural harmonization policies and enhancing its competitiveness and adaptive capability in economy along with the ultimate objective of EU membership. To achieve these objectives, DPT has estimated that growth of Gross Domestic Product (GDP) should be annually around 6.5% for this period, while inflation should be reduced to single digits, and economic annual growth rate should be about five percent (DPT, 2001).

III.2. Present Situation in the Energy Sector

In Turkey, primary energy and electricity consumption have steadily increased since 1950's. While around 800 GWh in 1950's, this amount has increased 190 times today, to 151,000 GWh/year (DSI, 2005). In this period, primary energy consumption has annually increased by an average of 5.2% and electricity consumption by about 11% (DPT, 2001). In Turkey, even though the gross electrical energy consumption per capita reached about 2,100 kWh in 2004, it is seen that this value is lower than the world average, which is 2,500 kWh/capita. The primary energy production was increased to 23,956 thousand tons of petroleum equivalent in 2003 (DPT, 2004).

By the end of 2003, the total installed power in Turkey was 35,587 MW. Among these, 22,990 MW (58.7%) is thermal and 12,597 MW (35.3%) is hydraulic power plants. In 2003 electrical energy production was 140,580 GWh and 105,190 GWh (74.8%) was supplied from thermal and 35,390 GWh (25.1%) from hydroelectric power plants (DPT, 2004). The most significant developments in production were observed in thermal plants using natural gas and oil products, and to an extent hydraulic energy (DPT, 2004). The theoretical hydroelectric potential in Turkey is 433 billion kWh and the potential that can technically and economically be put into use is calculated to be 127 billion kWh (DSI, 2005).

In 1980's, lignite investments were given emphasis in the energy production. Production reached to 51 million tons/year, as of 1994. However, in 1990's Turkish governments gave priority to the hydroelectric power plants in order to use renewable resources in energy production. In addition, health and environmental problems associated with mainly air pollution caused by the power plants based on lignite were also among the reasons of preferring hydropower for energy supply. Total primary energy consumption reached 83,804 thousand tons of petroleum equivalent by the end of 2003 (MENR, 2004).

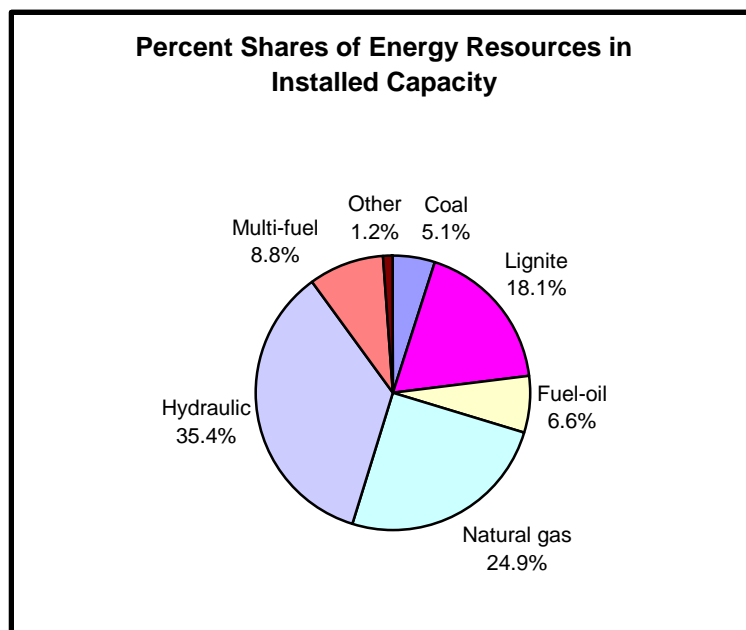
Oil products have 39.1% share and natural gas has 21.8% share in the energy sector, which have approximately 50% and 95% dependency on imported resources, respectively (TPAO, 2002). The share of power plants and industry in consumption increased while the share of residences decreased with time.

The electricity demand of the country is estimated by Ministry of Energy and Natural Resources based on the statistics related to realizations in the consumption in the past years and expectations (future trends) related to the population, economic and industrial growth of the country, by using MAED (Model for Analysis of Energy Demand). This model was developed by International Atomic Energy Agency. In addition, together with the Argonne National Laboratory (USA) they developed Energy and Power Evaluation Program (ENPEP), which has BALANCE (Balance of Energy Supplies and Demands), IMPACTS (Environmental Burdens and Resource Requirements of the Energy Sector) and ELECTRIC (WASP III - Wien Automatic System Planning Package) modules. These models are being used by the Ministry of Energy and Natural Resources to estimate the demand in Turkey and the estimation results are provided to DPT for future planning.

In 1995, installed capacity reached to 21,148 MW and electricity production was 86,300 GWh. In 1997, the installed capacity of electricity power plants reached 21,889 MW and 103,300 GWh of electricity production was realized. In 1998, installed capacity was estimated to be 23,702 MW and electricity production as 111,000 GWh. In 2000, the installed capacity of all electric power plants in Turkey was 27,391 MW and 124,200 GWh of electricity was produced, where the production capacity was 146,400 GWh. In 2003, the installed capacity of all electric power plants in Turkey was 35,587 MW and 140,580 GWh of electricity was produced, where the production capacity was 206,695 GWh.

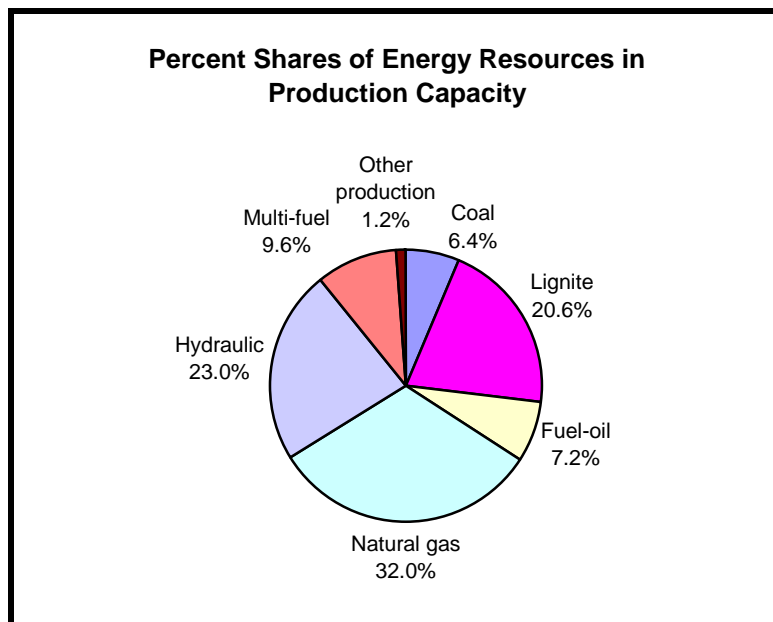
The percent share of energy resources in installed capacity (sum of the nominal capacities of all generators in a power plant, measured in MW) and production capacity (the electrical energy generation capacity of the generators in a power plant in a certain time period, measured as kWh or GWh) in the year 2003 are presented in Figure III.1 and Figure III.2 respectively. In addition, percent share of energy resources in actual production for the same year (2003) is given in Figure III.3. The change of installed capacity (thermal and hydro power plants and total) with years is shown in Figure III.4.

The reserve margin of the total energy production was 23% in 1994, but dropped to 4% in 1996. The demand for electricity was met with the amount of production as of 1997, but energy shortages were faced in late 1999 and in 2000 as the demand was increasing rapidly and energy investments require long planning, development and implementation periods (DPT, 2001). The economic crisis that Turkey lived through 2001 also affected the demand for energy, since consumption was considerably decreased based on the decrease in industrial production levels, and electricity demand was met safely in the second half of 2001 and first half of 2002. In 2003 and 2004 the trend of economic growth was followed with the increasing energy demand, which was met safely with the produced energy, though 71.5% of this production was dependent on imported sources. There have been improvements in the implementation of the Electricity Market Law (No: 4628) in 2003 and 2004, which aims the establishment of a competitive free market for the involvement of private sector in electricity production. However, continuing of planned investments to meet electricity demand safely in the coming years, during the establishment of this free market, is still considered to be very important by DPT (DPT, 2004).



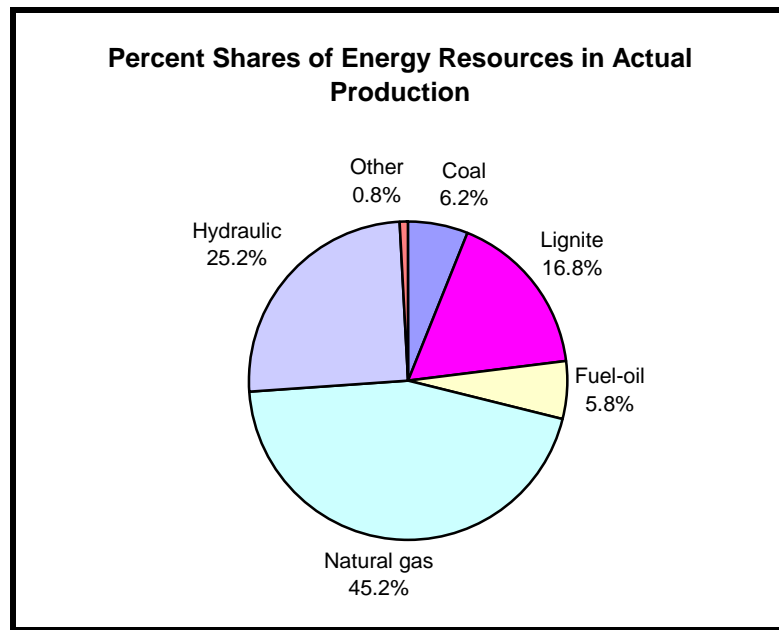
Source: Compiled From DPT, 2004

Figure III.1. Installed Capacities for Electricity Production by Energy Source in 2003



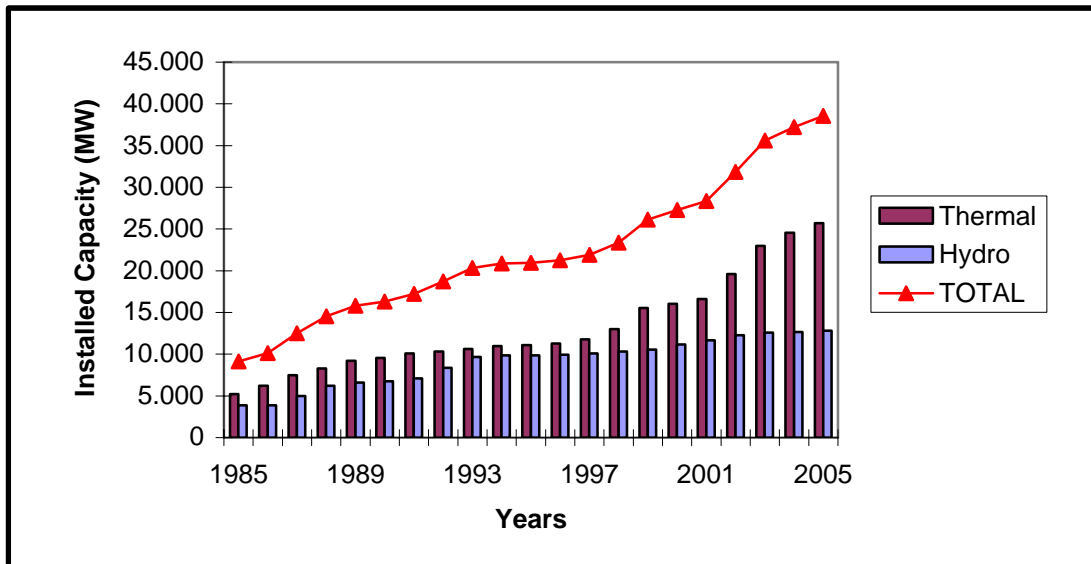
Source: Compiled From DPT, 2004

Figure III.2. Electricity Production Capacities by Energy Source in 2003



Source: Compiled From DPT, 2004

Figure III.3. Actual Production of Electricity by Energy Source in 2003



Source: Compiled From DPT, 2004

Figure III.4. Development in Installed Capacity of Power Plants in Turkey

III.3. Future Energy Sector

In the framework of the expectations of economic growth and population increase aimed in the Eighth Five Year Plan period, it is estimated that total energy demand will increase by an average of 6.2 percent annually and will reach 93.3 MTEP (million tons of petroleum equivalent) in 2005 (DPT, 2004). Projections of long-term electricity demand based on alternative growth scenarios indicate that demand will reach 195,000 GWh in 2005 and 285,000 GWh in 2010 (DPT, 2004). Electricity demand in Turkey since 1995 and forecasted needs for 2005 are given in Table III.1 together with the actual electricity production values and electricity consumption values per capita until 2005.

Electricity production of thermal and hydropower plants is presented in Figure III.5 together with the total production and demand from 1989 to 2005. In addition, primary energy production and associated production capacities are shown in Figure III.6.

It was estimated that installed capacity of power plants should increase to 42,783 MW in order to meet the electricity demand, which is 195,000 GWh, by the end of 2005 with a 20% reserve in the production capacity (DPT, 2004, 2005). With these developments, total energy consumption per capita will reach 1,291 kg oil equivalent and electricity consumption per capita to 2,241 kWh in the year 2005. Developments of primary energy and the production and consumption of electricity are given in Table III.2.

Table III.1. Electricity Demand and Production in Turkey (DPT, 2005; TEIAS, 2005)

Year	Electricity Demand (GWh)	Electricity Production (GWh)
1995	85,551	86,247
2000	128,295	124,922
2001	126,872	122,725
2002	132,553	129,400
2003	141,151	140,580
2004	151,400	152,000
2005	162,000	162,600
2006 (est.'d)	176,400	206,457
2007 (est.'d)	180,248	216,821
2008 (est.'d)	191,677	217,166
2009 (est.'d)	203,827	223,957
2010 (est.'d)	216,747	224,708
2011 (est.'d)	230,399	233,899
2012 (est.'d)	244,951	248,289
2013 (est.'d)	260,401	265,329

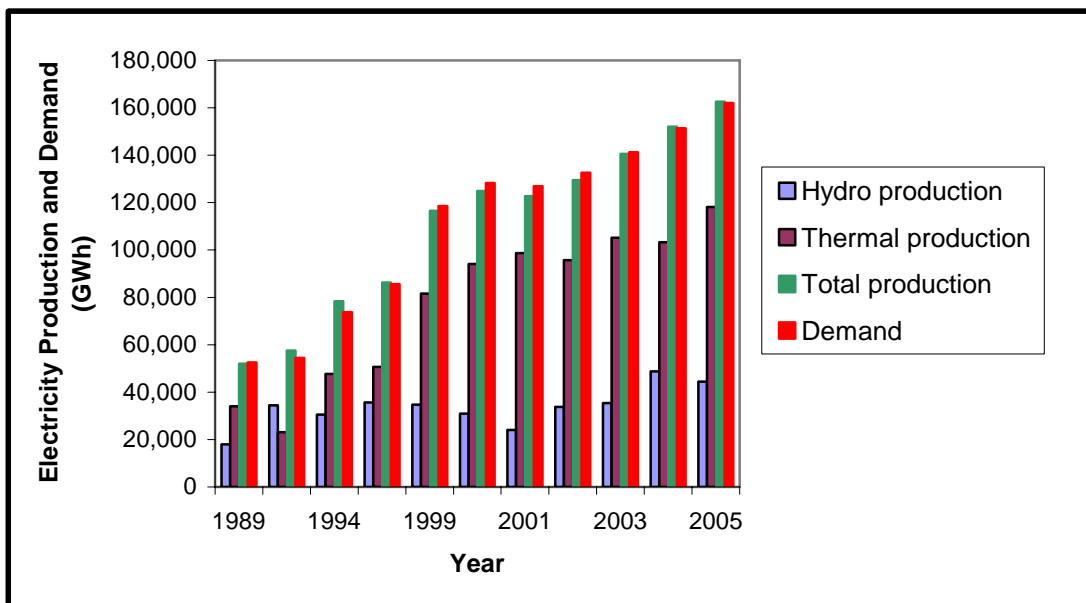
Table III.2. Developments of Primary Energy and the Production and Consumption of Electricity (Adapted from Eighth Five Year Development Plan (2001), and 2005 Year Program, DPT)

	Year / Unit	2000	2001	2002	2003	2004	2005 (estimated)
Primary Energy							
Production	BTEP	27,621	26,159	24,884	23,956	24,750	26,617
Consumption	BTEP	81,193	75,883	78,322	83,936	87,903	93,335
Consumption Per Capita	KEP	1,204	1,109	1,129	1,193	1,232	1,1,291
Electricity							
Installed Generation Capacity	MW	27,264	28,332	31,846	35,587	37,207	38,552
Thermal	MW	16,070	16,640	19,586	22,990	24,540	25,720
Hydraulic	MW	11,194	11,692	12,260	12,597	12,667	12,832
Production	GWh	124,922	122,725	129,400	140,580	152,000	162,600
Thermal	GWh	94,010	98,653	95,668	105,190	103,240	118,150
Hydraulic	GWh	30,912	24,072	33,732	35,390	48,760	44,450
Import	GWh	3,786	3,588	3,588	1,158	500	500
Export	GWh	413	433	435	587	1,100	1,100
Consumption	GWh	128,295	126,872	132,553	141,151	151,400	162,000
Consumption Per Capita	KWh	1,903	1,855	1,910	2,006	2,122	2,241

BTEP: Thousand tons of petroleum equivalent

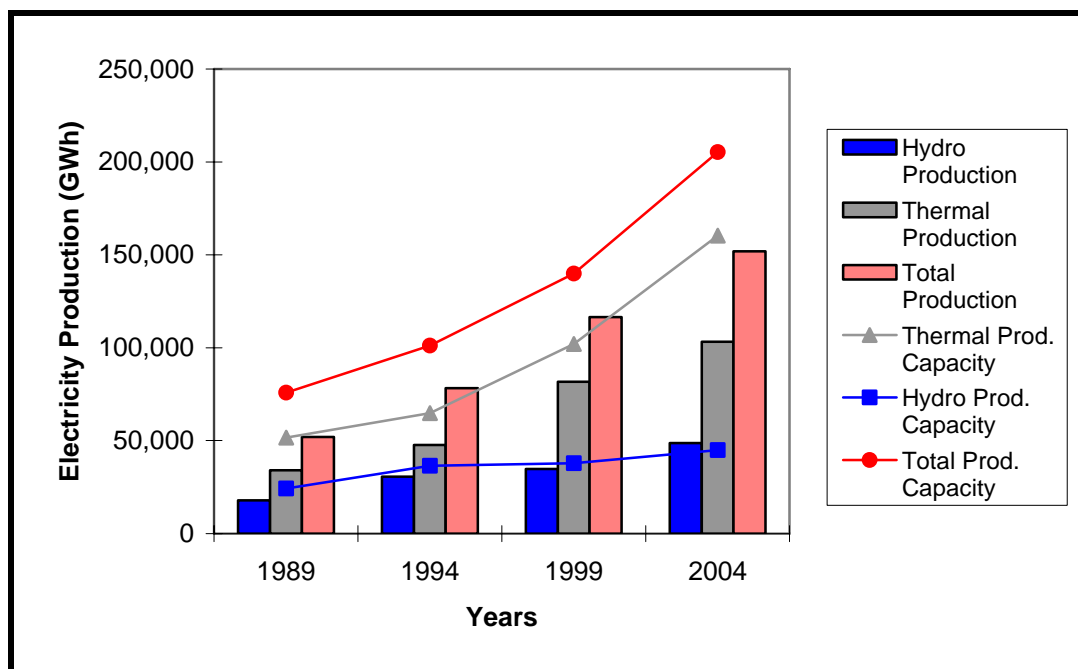
KEP : Kilogram petroleum equivalent

GWh : Gigawatt hour



Source: Compiled From DPT, 2004

Figure III.5. Electricity Production and Demand Between 1989 and 2005



Source: Compiled From DPT, 2004

Figure III.6. Electricity Production by Source and Associated Installed Capacities (1989 – 2005)

III.4. Role of Yusufeli Project

The total installed hydro capacity in Turkey was 11,194 MW in 2000 and is expected to be 12,832 MW by 2005. Yusufeli Dam and Hydroelectric Power Plant Project is expected to be contributing to the energy production in Turkey by the year 2013 with its 540 MW installed capacity. Therefore, Yusufeli HEPP, with its relatively large installed capacity and high annual electricity generation (1,705 GWh/year), is expected to meet about 0.6% of the total electricity demand of the country envisaged for 2013 (assuming a yearly increase of 6.4% in the demand). Yusufeli Project will be an important electricity generation facility for achieving Turkish long-term energy goals (TEIAS, 2005). Furthermore, most important domestic and renewable energy sources of Turkey are hydraulic sources. Less than 50% of the feasible hydraulic potential is exploited as of today and meeting the energy demand required for the development of the country by using domestic sources is an important priority. In this context Yusufeli is one of the major projects.

Within the Coruh hydropower cascade, by its high regulating capacity Yusufeli Project will provide benefits to the production capacity of the downstream hydroelectric power plants that are under operation (Muratli Project) and construction (Deriner and Borcka projects). Thus, it is the key project of Coruh River Development Plan, which will be utilized for energy generation of 8,320 GWh/year, when all the proposed projects (10 projects) are taken into operation. Yusufeli and the 4 downstream projects (Artvin, Deriner, Borcka, Muratli) will produce an annual energy of 6,331 GWh with 1,957 MW installed capacity. Both the energy and firm powers of the downstream projects will be increased. It was estimated that Yusufeli Project will increase the firm energy of Deriner, Borcka and Muratli projects by 467 GWh/year and an increase of 160 MW in dependable power of these plants will be realized (DSI, 2001).