1 INTRODUCTION

1.1 PROJECT OVERVIEW

Underground storage of natural gas is regarded as an important option for Turkey. With increasing gas consumption, underground storage is needed to balance peak demand with approximately constant gas supply.

BOTAŞ, (Turkish Petroleum Pipeline Corporation) proposes to construct an Underground Natural Gas Storage Facility approximately 200 km south of Ankara in the central part of Turkey, approximately 40 km south of Tuz Golu (or "Salt Lake"): an extensive 162,000 ha salt marsh in the central region of Turkey (Refer to Figure 1 for project location)

The Tuz Golu Basin Underground Natural Gas Storage Project (UNGSP) will create a series of underground gas storage caverns by controlled fresh water dissolving of portions of the extensive underground natural salt formations existing at approximately a depth of 1000 m. A geological screening procedure identified Tuz Golu, as the highest priority Turkish site, where salt caverns could be created. It is a favorable site because: (a) it is not far from Ankara, (b) it is close to the Kayseri-Konya-Seydisehir section of existing Eastern Anatolia Natural Gas Main Transmission Line (approximately 19 km) and (c) an extensive formation of pure rock salt with suitable dimensions and mechanical characteristics is available (d) it is the least seismically active region in Turkey.

To establish the technical feasibility of the Tuz Golu salt structure, BOTAŞ evaluated seismic characteristics of the site, mechanical characteristics of the salt cores, and hydrological requirements for leachate water supply and brine disposal. A detailed environmental impact assessment (EIA) study was conducted to satisfy Turkish Environmental regulatory requirements. The EIA was officially approved by the Ministry of Environment and Forestry (MoEF) on 19.08.2003.

1.2 PROJECT DESCRIPTION

The salt domes are located at approximately 700 m depth, have a thickness of 700-1500 m, and will be leached using fresh water supplied from the Hirfanli Dam (see Section 1.2.1(a) below). The brine (solution) resulting from leaching operations will be discharged to a well defined and officially approved area within Tuz Golu (see Section 1.2.1(b) below).

It is planned to open 12 caverns each having approximately 500,000 m^3 of volume and with a natural gas storage capacity of approximately 80×10^6 m^3 (with maximum

compression, 205 bar) While some of the caverns are opened (construction activity) on one hand, it shall be initiated to store natural gas into the caverns already opened (operation activity) on the other hand. During storage of natural gas, the natural gas shall be compressed by means of compressor and injected to the caverns. In future years, new caverns can be opened if modifications in the national natural gas policy of Turkey recommend such an option.

Completion of the construction phase is expected to take approximately 10 years and the project economic lifetime is estimated to be 50 years.

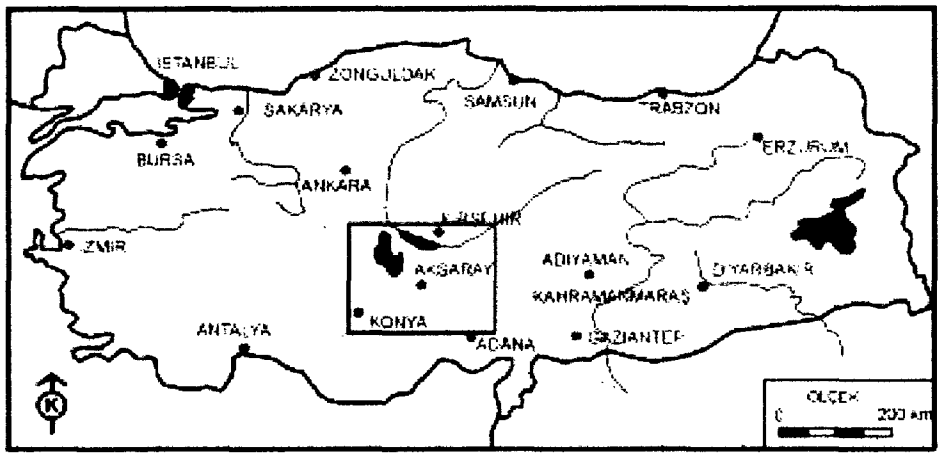
1.2.1 Key project components

(a) Fresh Water Supply Line

Fresh water will be used for leaching the salt caverns. Initially, local groundwater was considered for the fresh water source to open caverns as groups of 2. BOTAŞ later on, to speed up the project implementation, decided to open caverns as groups of 4 instead of 2, which doubles the fresh water demand of the project. However, groundwater shortage was one of the major concerns raised during the first Public Consultation Meeting. As a consequence, BOTAŞ (although there exist no problem for allowance of such an amount of water from groundwater resources by DSI) revised the project design to utilize Hirfanli Dam reservoir located 115 km from the project site as a fresh water source. DSI (State Hydraulic Works), the authority responsible for the water resources allocation in Turkey, provided their official approval for use of the required $10\text{-}12\times10^6$ m^3/yr water from Hirfanli Dam.

Hirfanli Dam, constructed in 1960, is one of the major multi-purpose dams in Turkey, which is used for energy and irrigation. It receives an annual inflow of approximately 2400×10^6 m^3/yr. The water demand of the project, $10\text{-}12\times10^6$ m^3/yr, is less than %0.5 of the inlet flow to the dam reservoir. Therefore, DSI stated that they have no difficulty in supply of this amount of water over the project life and, in addition the existing and future energy and irrigation based projects will not be affected adversely.

Water will be transported by an underground pipeline of approximately 115 km to the project site. The pipeline will be transferred to DSI after the completion of the project to be used for water supply and/or for the irrigation, which will be beneficial for the local people.



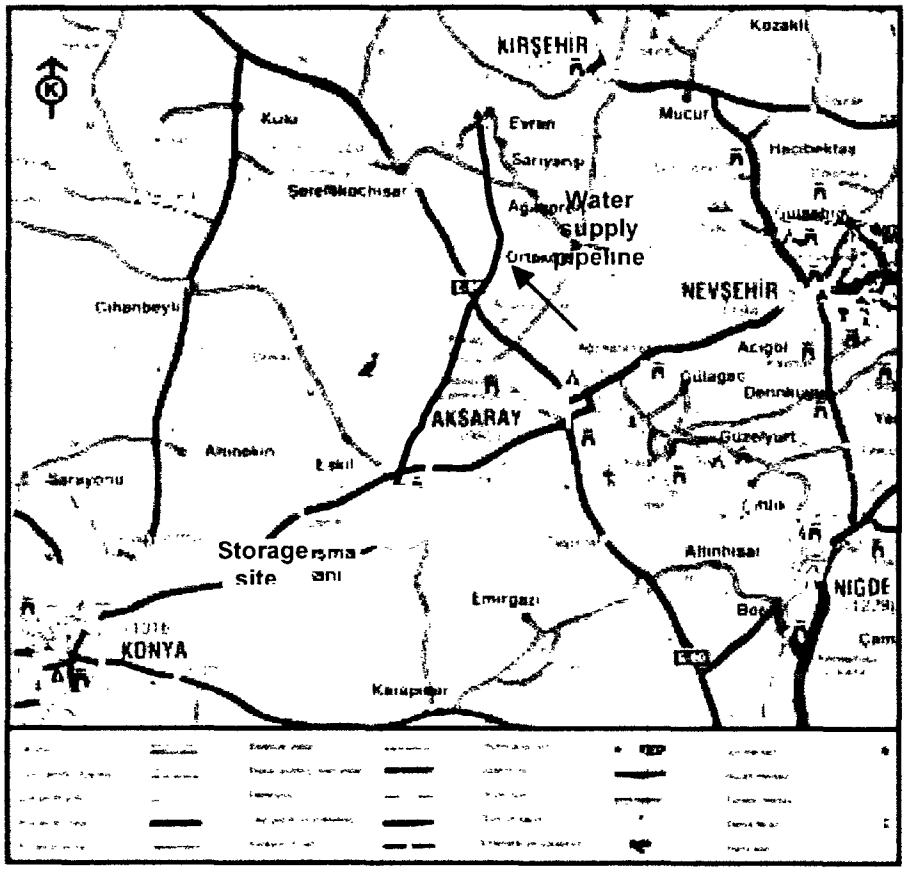


Figure 1. Proposed Location of Project Site and Water Supply Pipeline

(b) Brine Discharge Line

Brine generated as a result of salt deposit leaching (1.120m^3/hr), will be discharged to Tuz Golu via brine discharge line approximately 39 km long. Brine discharge is not expected to have significant adverse impacts on Tuz Golu due to several reasons described below;

- Tuz Golu is underlined by the same salt formation as the project site where the leaching operations will be performed. The lake continuously receives groundwater flows, which contribute brine through natural leaching of these salt formations that exist in Tuz Golu Basin. Thus the creation of the salt storage caverns through leaching is essentially providing the same quality inlet flow, albeit with a man-made process.

- Secondly, the brine will be discharged to the area officially designated by MoEF and Ministry of Agriculture as unproductive in terms of agricultural activities and salt harvesting. In addition, the discharge area was approved by the Council of Experts including MoEF during the EIA process, after determining that no species of interest exist within the discharge area.

(c) Natural Gas Branch Line

Surplus natural gas that arises during summer months shall be taken from Kayseri–Konya–Seydisehir section of existing Eastern Anatolia Natural Gas Main Transmission Line that passes at approximately 14 km north of the project site via a branch line (40" diameter), stored in these caverns and then returned to the national grid when the demand arises.

(d) Surface Facilities

Surface facilities comprised of surface leaching and gas facilities will be constructed. The major components of Surface Facilities are;

For Leaching Process	*For Storage Process*
Cavern site	Compressor station
Leaching Plant	Heater
Freshwater supply plant	Cooler
Brine distributor	Dehydration Unit
Pumps	Metering station
Water flow measurement units	Storage wells
Blanket unit	Filtering unit
Control building	Glycol regeneration plant
	Condensate receiver plant

1.3 Environmental Impact Assessment (EIA) Process

An EIA for the project was prepared in strict accordance with Turkish Environmental Legislation and was approved by the Turkish Ministry of Environment and Forestry (MoEF). An EIA supplement (EIA Annex) was also prepared by BOTAS to address the change in fresh water supply and additional information requirements needed to satisfy World Bank EA policies and procedures (OP/BP/GP 4.01). Thus the Turkish EIA and the EIA Annex together fully satisfy both Turkish and World Bank EA requirements.

Public consultation for the Turkish EIA was conducted at Sultanhani Municipality on 27.03.2003 and a second public consultation for both the Turkish EIA and the EIA Annex was conducted at Agaçören Municipality (close to the water supply line) and Sultanhani Municipalities on 24.03.2005. A Turkish language version of the EIA documents, including EIA Annex was disclosed locally at Aksaray Provinical Directorate of Environment and Forestry and BOTAŞ web site on (The English language version was sent to the World Bank on 27.05.2005 and deposited in the World Bank Infoshop.

An independent Turkish Environmental Consultant accredited by MoEF prepared the EIA study on behalf of BOTAŞ. It was approved by MoEF in 2003. The water supply modification scenario required BOTAŞ to supplement the EIA by preparing an "EIA Revision Report" according to the Turkish EIA Regulation, which was approved by MoEF in 2004. Differing from the EIA Annex prepared to comply with World Bank requirements, only the project description and the new water supply scenario were included in this EIA Revision Report since Turkish EIA Regulation does not require EIA for the water supply pipeline projects.

1.4 BASELINE ASSESSMENT

Present environmental resources within the project site were assessed by site investigations performed by the EIA project team. Comprehensive site studies were conducted to determine the local air, water and soil quality and the biological resources.

The project site and its vicinity are mostly flat (slope %1-3), with an average altitude of 1000 m. The area extending from west and north parts of Sultanhani to Tuz Golu is marshland. There are also small settlements in the vicinity of the project site and these areas are used as "plateaus" where animals are grazed between April and October.

In order to determine seismic characteristics of the region, studies were carried out within an area of 73 km^2. The project site is located in one of the most stable regions in Turkey, which has the least seismicity: an earthquake in the project site is most unlikely

to occur, thus the risk of failure from an earthquake is low. In addition, an internationally recognized seismic expert assessed the situation and determined that the depth and strength of the salt domes, make the failure probability extremely low, and introduce a risk no greater than similar installations world-wide.

The factors taken into account in the course of the selection of the proposed project site are listed below:

- Its proximity to the main pipeline (Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line);
- Its convenience in natural cavern formation and drainage processes;
- Being the lowest risked region regarding the Turkey's seismicity;
- Possessing water resources that are used for other purposes;
- Very low agricultural potential in the region.

1.4.1 Air Quality

There are no significant emission sources within the project site and its vicinity. Since the project region is a rural area, present air quality depends upon emissions that originate from sources used for heating purposes (i.e. coal) and soil. There are not many settlements within the project site and its vicinity; the only existing problem is dust emissions during dry and windy conditions due to the dispersion of clayey soil when dried up.

1.4.2 Water

There exist no surface water source within the vicinity of the project site. One of the major surface water resources of the region is Tuz Golu, located approximately 40 km north of the proposed project site.

1.4.3 Soil

General properties of the soil in the project site, distributions of soil groups, land use conditions, slope and erosion degrees were examined during EIA studies. Accordingly, the soil of project site is covered by III. Class (Suitable for cultivation of appropriate types of crops with special protection measures. Generally, require special care when used for agricultural purposes), dry agriculture (fallowing), pasture and brushwood field. There exist limited agricultural activities at the project site and its vicinity.

1.4.4 Noise

Ambient noise levels were measured at 12 locations in vicinity of the project site considered to be sensitive receptors (settlements close to the project site). The highest background noise levels were measured to be 89.6 dBA at Bucak Plateau during the measurement on February 18-19, 2002, and 89.3 dBA (daytime) at Sultanhani Municipality settlement area during the measurement on November 29, 2000. These noise levels are known occur due to traffic, announcements and animals.

The average daytime values recorded at the nearest locations to the proposed project site were 39.2 dBA at Rasimusagi plateau and 52.5 dBA at Omeraga plateau. These values are considered as typical values for rural areas, at which the noises originate from natural sources and manual activities, rather than mechanical (e.g., industrial and infrastructure) sources.

1.4.5 Flora and Fauna

Endemic and/or rare species were identified in the general region of the Tuz Golu Basin. Species under protection by Bern Convention exist in Tuz Golu Basin. For each of the species under protection, the requirements of the particular laws, regulations and treaties have been reviewed and all specifications will be followed during construction and operation.

The wetlands in the vicinity of the brine discharge pipeline and Tuz Golu are important as a "migratory bird route" and this area is designated as a "Special Environmental Protection Area". About 15 km of brine discharge pipeline route passes through this zone. However, the important bird species do not live in this area. They may be found individually or in small colonies as part of their migration pattern. To minimize any effect to migratory birds, construction of the 15 km section of brine discharge pipeline will be restricted to the period of lowest or no migration activity (July-September)

The Hirfanli dam section, where fresh water pipeline route starts is on the border of a bird wintering area (Tufted duck, Pochard, Red-crested Pochard, White-headed duck, Coot and water birds) and migratory route (Ruddy shell duck). Construction of this section will be carried out between July and August to minimize any effects on migratory and wintering birds and their habitats.

Tuz Golu Basin

Tuz Golu Basin is the water catchment area covering the lake itself, the rivers feeding the lake and other the lakes related with it. Although exact borders are not certain, the area of the basin is around 530,000 hectare with a rough estimation. Since the basin is

a very large area, it is better to discuss the fish species found within the close vicinity of the project components. The small water bodies located within the close vicinity of the project area do not represent a creek type characteristic. Tuz Golu is almost totally dry in the summer and besides, the feeder creeks generally cannot reach the lake in summer months. Thus, with no source of fresh water during the summer, the resulting lake salinity from net evaporation provides an extremely hostile environment for fish habitat, as well as being extremely inhospitable for any plant growth.

There are three main rivers namely Karasu, Pecenek and Insuyu feeding the lakes in the basin, all of which are fresh water. Fish species mentioned in the EIA Report were not observed during field surveys carried out on April 2001. However based on the literature, these species are possibly found in Insuyu River, at approximately 100 km north of the project site (Phoxinellus crassus found in 1960 and Aphanius chandrei found in 1944). The high salinity of the lake and lake basin (including the discharge area) prevent these species from migrating to these sites.

As a result, the proposed project site (including surface facilities and brine discharge area) is poorly inhabited and poorly vegetated with any significant flora and fauna.

1.5 ENVIRONMENTAL IMPACTS

The EIA identified a number of potential impacts associated with both construction and operation phases of the project.

All pipelines will be buried. Therefore key potential impacts are construction of the fresh water pipeline, brine discharge line, and natural gas connector line. There are also potential impacts associated with construction of surface facilities for gas processing, drilling operations and leaching operations.

Operation activities are limited to gas injection and withdrawal so few potential operational impacts are identified. Major concerns are related to safety risks for workers and populations at the storage site and along the gas pipeline route.

The potential Project impacts during construction and operation phases are outlined in Tables 1&2 respectively.

All potential impacts have been analyzed and are readily managed through internationally accepted standards of good engineering practices and procedures which will be followed in design, construction and operation of the gas storage and pipeline distribution systems for water, leachate and gas respectively. Potential impacts associated with the brine discharge into Tuz Golu have been determined to be insignificant, since the effluent will be providing water to Tuz Golu in the same manner

and of the same quality as is naturally supplied from the groundwater sources currently feeding the lake. The Environmental Management and Monitoring Plan (EMP) includes cost effective mitigation measures for each identified potential impact. The EMP also includes details of the implementation period monitoring requirements and institutional arrangements for effective environmental management. Reference should be made to the EMP for further details.

Table 1. Summary Table of Impacts-Construction Phase

CONSTRUCTION	IMPACT	PROPOSED MITIGATION MEASURE
Pipeline and Surface Facilities	Excavation/ loss of top-soil	Excavation material will be re-used for trench backfilling and land restoration The vegetative topsoil will be stored properly (by protecting with nylon covers against soil loss related to precipitation) and used for revegetation and landscaping.
	Dust generation due to excavation, material storage, handling and transport	Excavated material will be protected from wind and rain (e.g. using nylon covers and compaction with binding materials) All transportation vehicles that will carry excavation material will be covered The speed of the vehicles will restricted with 30 km/hour on unpaved roads. Dust prone areas will be regularly watered.
	Solid waste generation	Domestic solid wastes and construction wastes will be collected and disposed to the Municipal Solid Waste Disposal area of the nearest Municipality.
	Wastewater generation	Domestic wastewater will be collected in a lined (impermeable) septic tank and removed by the nearest Municipality With the start of operation, septic tank will be replaced by package treatment plant. No industrial wastewater will be generated. Any hydrostatic test water will be discharged to the nearest water body after settling. Various washdown waters (only including suspended solids, oil and grease) will be collected via a distinct line and sent to package wastewater treatment plant after the removal of suspended solids, oil and grease. Waste/residual oils from oil change of the machinery and vehicles will be onsite discretely and given to a firm licensed by MoEF.

Table 1.Cont'd

CONSTRUCTION	IMPACT	PROPOSED MITIGATION MEASURE
Pipeline And Surface Facilities	Noise and vibration due to site preparation and construction activities	No explosives to be used unless required during the construction activities The activities that generate noise will be limited with the hours 06:00 a.m-07:00 pm, and no work will be carried out on official holidays. Employees will be provided with special helmets, earphones or earplugs against noise. The maximum noise levels that workers can subject to will not be exceeded during the construction activities
	Transportation	No access roads will be constructed unless necessary and approved by BOTAŞ. The existing roads will be used to the greatest extent.
	Impacts on flora	In the event that the species protected as per the BERN Convention and the "Vulnerable" species according to Turkish Red Data Book are found, they will be managed in accordance with the Bern Convention specifications. The seeds of these species shall be taken and moved to the similar habitats or protected ex-situ in botanic gardens and greenhouses under the control of universities. These species, found in the vicinity of the site, shall be clearly marked and in no way be collected, chopped and taken off their roots. The construction activities will be limited within the construction corridor.

Table 1.Cont'd

CONSTRUCTION	IMPACT	PROPOSED MITIGATION MEASURE
Pipeline And Surface Facilities	Impacts on fauna	The construction activities will be limited to the construction corridor. Any rare and endangered species will be managed in accordance with the national or international regulations and treaty requirements Construction activities will take place during periods when no migratory bird flight are occuring periods (refer to EMP) A fauna expert shall be employed during the site activities.
	Impacts on Cultural and Natural Assets	No cultural and natural heritage is present on the project site and its vicinity. Turkish chance find procedures will be followed (i.e. cease activities, consult with authority and protection in situ if possible) A cultural expert will remain on-site to issue government if procedures are followed.
	Handling & usage of explosive/ hazardous and toxic materials	Any explosive material will be kept in locked containers. The fuels to be used by the work machines will be purchased from companies with valid operating permits If storage is required, then fuels or hazardous liquids will be stored in properly designed tanks situated on impermeable (e.g. concrete) surfaces with bund to contain any leaks.
Drilling Activities	Oily Waste Waters generation	A wastewater pool with an impermeable lining using geo–membrane will be constructed and an oil trap will be placed in the channel entering to the pool in order to separate oil and petroleum from the wastewater. These wastes will be removed from the area by a firm licensed by MoEF.

Table 1.Cont'd

CONSTRUCTION	IMPACT	PROPOSED MITIGATION MEASURE
	Impacts on Groundwater due to leakage	Casing is placed until reaching the non– leaking formation and the drilling operations are carried out in this casing.Only water based bentonite-clay mud will be used.
	Formation Wastes and Drilling Muds	They will be stored separately from other solid wastes and removed from the area by a firm licensed by MoEF after drying and solidification Mud pits (impermeable) will be opened for the temporary storage of the formation wastes and drilling mud The drilling area and the surrounding of the mud wells will be surrounded with a wire mesh fence and entrance will be locked.
Leaching Operations	Sludge disposal from brine settling tanks	The solid particles (>200 µm) will be kept in settling tanks. The sludge coming from the tanks that will be cleaned at definite times with hand will be collected with mobile containers and disposed to the Municipal Solid Waste Disposal area of Sultanhanı Municipality.
	Sludge disposal from brine settling tanks	The solid particles (>200 µm) will be kept in settling tanks. The sludge coming from the tanks that will be cleaned at definite times with hand will be collected with mobile containers and disposed to the Municipal Solid Waste Disposal area of Sultanhanı Municipality.
	Brine discharge / impacts on lake water quality	Discharge location is in unproductive/arid area (ecologically, and agriculturally, no salt production and determined based on the official maps and site investigations) of Lake It is estimated that the discharge plume will remain within the boundaries of the unproductive area for the complete duration of the leaching operation. The plume will be monitored to assure these estimates are valid.

Table 2. Summary Table of Impacts-Operation Phase

OPERATION	IMPACT	PROPOSED MITIGATION MEASURE
Surface Facilities and Natural Gas Pipeline	Noise (Compressors, etc.)	Installation of silencers to the entry and exit of the cooling fans Procurement of low sound emanating backup motor, pump and compressors Limitation of truck transportation merely with hours of daylight if required
	Fire	A fire protection system will be available at site (Fire detectors sensitive to heat, smoke and flame.Nonautomatic fire extinguishing systems will be available in the site against fire as well)
	Leakage and explosion	In case of leakage of natural gas in closed areas, the area will be immediately ventilated in accordance with best international practice.
	Health, Safety Risks	Education on; • Site security • Environmental protection • First aid • Fire fighting • Health and occupational safety • Risk assessment will be given to the personnel employed.
	Waste generation	Domestic solid wastes will be collected and disposed to the Municipal Solid Waste Disposal area of Sultanhanı Municipality. With the start of operation, septic tank will be replaced by package treatment plant. The discharge water will be used for watering green areas.
	Accidents and Sabotage	Parameters such as pressure, temperature and flow rate will be monitored continuously at certain locations on the line and the caverns, abnormal conditions will be reported to the authorities.Line valves susceptible to pressure will be shut down automatically

1.6 PUBLIC CONSULTATION

The first public consultation has been performed on 27.03.2003 at Sultanhani Municipality with the participation of local people and governmental organizations. The second public consultation has been performed on 24.03.2005 at Ağaçören and Sultanhani Municipalities. The records of both the first and the second public consultation meetings are included in EMP Section-D.

A number of concerns raised during the first public consultation as groundwater usage for leaching operations, since there is a water shortage and the possible impacts on irrigation, seismicity of the area, and brine discharge impacts on Tuz Golu. These issues were fully addressed in EIA Report in details. In addition, the public concerns played an important role in BOTAŞ' decision on selection of the water resource. Taking public concerns into consideration, BOTAŞ revised the project design and decided to utilize Hirfanlı Dam reservoir as fresh water resource.

During the second public consultation, the major concerns were the duration of the construction activities and job opportunities for local people. BOTAŞ representatives stated that the local manpower would be preferred during the construction activities. Local people were also informed that the agricultural activities would not be negatively affected.

TABLE OF CONTENTS

1. INTRODUCTION

Tuz Golu Natural Gas Underground Storage Project will be designed, constructed and operated in compliance with several regulations and legislations. The principles of policy and legislative framework related to the Tuz Golu UNGSP are outlined in the following sections.

1.1 NATIONAL LEGISLATION

Article 56 of Turkish Constitution (1982) recognizes the right of the citizens to live in a healthy and balanced environment. It is the duty of both the state and citizens to develop the environment, maintain the sanitation and protect the environment against pollution.

The Ministry of Environment, established in 1991, is the authority responsible for development and protection of environment, preventing pollution, establishing environmental policies and strategies as well as providing all activities are carried out in compliance with Turkish Environmental Legislation (environment law, all environment related regulations and international conventions) On 01.05.2003, the Ministry of Environment and the Ministry of Forestry were merged based on the fundamental principles of law no 4856 (MoEF).

MoEF is in close cooperation with the other ministries, institutions, governmental and non-governmental organizations during its activities. The Ministries and governmental institutions, which are also responsible for environmental management issues in Turkey, are as follows:

- Ministry of Health
- Ministry of Culture & Tourism
  - General Directorate of Cultural Assets & Museums
- Ministry of Agriculture and Rural Affairs
  - General Directorate of Agricultural Production & Development
  - General Directorate of Protection & Supervision
  - General Directorate of Rural Affairs
- Ministry of Energy and Natural Resources
  - General Directorate of State Hydraulic Works (DSI)
  - General Directorate of Mineral Works
  - General Directorate of Minerals Research & Exploration (MTA)
  - Electric Energy Generation Inc. Co. of Turkey
  - Electric Energy Transmission Inc. Co. of Turkey
  - Electric Energy Distribution Inc. Co. of Turkey
  - General Directorate of State Hydraulic Works

- Ministry of Public Works & Housing
- General Directorate of State Highways
- Provincial Directorates of Public Works and Settlement
- General Directorate of Land Title Deeds and Cadastral Registration.
- General Directorate of Technical Researches and Implementations

Environmental Impact Assessment (EIA)

The EIA Regulation, issued in 1993, dictates that major/important projects, which have potential serious environmental impacts, are subject to Environmental Impact Assessment. This Regulation has been renewed for three times and issued finally in 2003 in line with the European Union (EU) Directive (85/337/EEC and 97/11/EC)

The Regulation provides the administrative and technical procedures and principles for defining and assessing the environmental impacts of the activities listed in the annexes (Annex I and Annex II, EIA List of Activities) and preventing the defined adverse impacts. Construction of water supply pipeline is not included in the list of the activities in Annex I and II of the EIA Regulation, therefore Turkish EIA Regulation does not require an EIA Study for the water supply pipeline.

For projects that do require an EIA study, the competent authority to execute the EIA procedure and approve the EIA Reports in Turkey is the MoEF through its General Directorate of Environmental Impact Assessment and Planning.

The institutions, which are responsible for the EIA Studies in Turkey, are assigned by the Ministry of Environment and Forestry. In this context, the Ministry published in the Official Gazette, issue no. 25383 and date 24.02.2004, a "Qualification Certificate Communique". The applicants are expected, pursuant to the Communique, to assign minimum one Environmental Engineer, two university graduates in different disciplines and a project coordinator experienced in environmental matters. In Turkey, EIA Reports are mostly written by private sector companies; however, several public sector agencies have also received the Qualification Certificate.

For the overall Gas Storage Project, an EIA was required and the procedures specified in the regulation are as follows; a Scope Determination and Evaluation Commission (SDEC) under the chairmanship of the General Directorate of Environmental Impact Assessment and Planning of the Ministry of Environment and Forestry by representatives of the public and governmental authorities are formed. Tasks of the SDEC are as follows;

- To attend the "Public Consultation Meeting",
- To establish the scope and special format for EIA Report,

- To identify the omissions and mistakes in the EIA Report and provide that such omissions and mistakes be completed/corrected.
- To provide expert opinion, either positive or negative, on the EIA Report together with their comments on behalf of the institutions, which they represent.

The Ministry, if deems it necessary considering the theme and type of the project and characteristics of the project site, may invite to SDEC sessions the representatives of universities, institutes, research and specialist institutions, professional chambers, labor unions, associations and NGOs. It is essential that the SDEC members have adequate professional know-how and experience and be authorized duly by respective institutions and corporations, which they represent.

Apart from the Regulation on EIA, the regulations enacted with reference to the Environment Law and implemented in the EIA process, as well as the relevant laws to the Project are described in the below paragraphs.

1.1.1 Laws

Environment Law (no. 2872)

The Environment Law enacted in 1983 sets forth the framework of environmental management and the related legislation, and defines the fundamental principles. The law aims;

- To regulate, on the basis of established legal and technical requirements and in conformity with economical and social development targets, the arrangements and measures to be adopted for protecting and improving the environment as the common asset of all citizens;
- Optimum usage and conservation of land and other natural resources in urban and rural areas;
- Controlling the soil, water and air pollution;
- Raising and assuring the health, civilization and living standards of both the present and future generations by protecting the flora and fauna and their habitats further to protecting the historical and cultural assets of the country.

Cultural Heritage Protection Law (no.2863)

Cultural Heritage Protection Law (23.07.1983, Official Gazette issue no. 18113) stipulates the establishment and tasks of government agencies responsible, as decision-making bodies, for defining the movable and immovable cultural and natural assets to be protected under the law, and for determining the procedures and chance

find principles of these assets. As per Article 4 of the law, in the event that any cultural asset is found, the nearest museum has to be informed within 3 days.

Pastures Law (no.4342)

Pastures Law (28.02.1998, Official Gazette issue no 23272/ Amended by Law No 5178, 08.06.2004 Official Gazette issue no 25486) aims at defining, conserving and developing the pasturelands further to provisions for changing the purpose of allocation of the land when and if necessary and basically de-classifying pastures. This law states that all pastures expropriated by State Authorities lose their status as pastures, subject to the approval of a special commission. As such, even when they are temporarily expropriated, they will no longer re-assume their pasture status.

1.1.2 Regulations

Water Pollution Control Regulation

The Water Pollution Control Regulation (04.09.1988, O.G. no. 19919) aims to provide the legal and technical framework for water pollution control principles for conserving the ground and surface water resources of the country for all types of utilization, ensuring the most efficient/optimum use of these resources and preventing water pollution in the context of economical and social development targets.

Noise Control Regulation

The regulation aims at developing a noise-controlled environment allowing the people to live in comfort and peace, mentally and physically safe. The regulation refers to the principles for establishing the limit levels of noise for settlement areas, the maximum allowable noise levels for industrial zones and construction sites and noise emission values for machinery and defines the terms for noise control. (11.12.1986, O.G. no. 19308)

Soil Pollution Control Regulation

The aim of the regulation is to define the principles for taking necessary measures for preventing and eliminating pollution of soils as receiving medium in the framework of sustainable development targets. This regulation comprises the technical and administrative principles related to the activities, which cause soil pollution, discharge, disposal, leakage of hazardous material and wastes to the soil, the utilization of sludge from treatment and the penal sanctions (10.12.2001, O.G. no. 24609)

Solid Waste Control Regulation

The Solid Waste Control Regulation (14.03.1991, O.G. no. 20814) aims to define, apply and develop all principles, policies and programs for prohibiting all types of activities, including disposal directly or indirectly of all kinds of wastes and residual materials into the receiving medium, their storage, handling, transportation etc. in such a manner that is detrimental to the environment, and for controlling the pollutants causing permanent impacts on air, water and soil and preventing such pollutants to damage the floral and faunal generations, natural assets and ecological balance, by taking under control to a certain degree the management of consumption materials, which are likely to cause adverse impact on environment.

The regulation sets forth the technical and administrative principles for collection, transportation, recovery, revaluation, elimination and making harmless the solid disposals of various types.

Hazardous Waste Control Regulation

The aim of the regulation is to provide a legal and technical framework for defining the principles, policies and programs for preventing, from production stage until final disposal stage, the hazardous wastes from discharge directly or indirectly into the receiving medium in such a manner that is detrimental to the environment and human health, ensuring control of the production and transportation, prohibiting their import and controlling their export, providing necessary technical and administrative standards for their management, minimizing the production at the source, disposing at the nearest site of disposal if the production is unavoidable, installing adequate facilities of disposal and providing environment-friendly management of these facilities. (27.08.1995, O.G. no. 22387)

Hazardous Chemicals Regulation

The aim of the regulation is to define and ensure implementation of administrative, technical and legal principles, policies and programs for controlling the chemicals, which are detrimental to the environment and human health by contaminating the air, water and soil and damaging the ecological system in the short or long term. The regulation comprises the procedures and principles for the determination, classification, labeling and packing of hazardous chemicals. (11.07.1993, O.G. no. 21634)

Noise Regulation

The regulation refers to measures to be taken to protect the labor against health and safety risks, which may occur due to exposure to noise, particularly the damage to hearing system. (23.12.2003, O.G. no. 25325)

Regulation on Protection and Usage of Agricultural Lands

The regulation refers to principles and rules for the conservation of arable lands, their use in conformity with the intended purpose and for their use outside the purposes of agriculture when and where it is mandatory. It sets forth the fundamental procedures for using the arable lands for non-agricultural purposes such as developing settlement areas, constructing military, industrial, transportation, educational, health care, tourism, storages and warehouses, communication, sportive and agricultural facilities. (10.08.2001, O.G. no. 24489)

Regulation on Pits to be Provided In Places, where Construction of Sewage Treatment is not feasible (19.03.1971, O.G. No. 13783)

1.1.3 Communiques, Decrees And Acts

Principles for the Special Environmental Protection Zone (Official Gazette issue no. 19931 date 16.09.1988), such as Tuz Golu

An "Environmental Protection Committee", which is formed by the undersecretary of Ministry of Cultural and Tourism, General Manager of Environment, General Manager of Forest and the Head of the Authority for the Protection of Special Environmental Areas, is responsible for the application of these rules and principles, mainly deciding the facilities, infrastructure plans and projects allowed to be constructed within the boundaries of Special Environmental Protection Areas and the fundamental principles for permits.

Worker Health and Occupational Safety Act (Official Gazette issue no. 14765 date 11.01.1974).

1.2 INTERNATIONAL CONVENTIONS AND TREATIES

There are a number of international conventions and treaties that Turkey has ratified and entered into force. The ones that are relevant to the project are stated below:

1.2.1 International Convention on Protection of Birds (Paris, 1902)

This Convention was signed and became effective with 17.12.1966 when it was published in the Official Gazette issue no. 12480, for the purpose of conservation of the birds.

Summary of provisions are as follows:

(a) In general, protection to be given to all birds during the breeding season, to migrants during their flight to their breeding grounds, and to endangered species throughout the year
(b) In general, the taking of eggs, shells and young birds to be prohibited
(c) Certain methods of hunting birds to be prohibited or restricted, e.g. snares, nets, poisoned bait, blinded decoy birds, motorboats and motor vehicles
(d) Each party to draw up lists of birds, which may be lawfully taken or killed in compliance with this Convention
(e) Parties to take measures to prevent destruction of birds by water pollution, electric cables, insecticides and poisons, and to educate children and the public in the need for protection of birds

1.2.2 Convention on Conservation of European Wildlife and Their Habitats (Bern, 1979)

The Convention was signed and became effective with 20.02.1984 when it was published in the Official Gazette issue no. 18318 to serve the purpose of conserving the wildlife and their habitats, which is of vital importance considering that many species of the flora and fauna are vulnerable to the risk of extinction, further to the purpose of ensuring in their policies and programs the conservation of the wildlife and their habitats, and that international co-operation be provided for conservation particularly of the migrant faunal species.

In the context of Bern Convention, in Article 6, for the special protection of the wild fauna species specified in Appendix II, the following will in particular be prohibited for these species:

(a) all forms of deliberate capture and keeping and deliberate killing;
(b) the deliberate damage to or destruction of breeding or resting sites;
(c) the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention;

(d) the deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;
(e) the possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognizable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this article.

In Article 7, for the special protection of the wild fauna species specified in Appendix III measures to be taken shall include:

(a) closed seasons and/or other procedures regulating the exploitation;
(b) the temporary or local prohibition of exploitation, as appropriate, in order to restore satisfactory population levels;
(c) the regulation as appropriate of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 FRESH WATER SUPPLY SYSTEM

The Tuz Golu Basin Underground Natural Gas Storage Project (UNGSP), will create a series of underground gas storage caverns by controlled fresh water dissolving of the selected portions of extensive underground natural salt formations existing at approximately a depth of 1000 m.

According to studies, the amount of fresh water required for leaching each cavern is 280 m^3/hour. At the early stages of the project, it was planned to leach 2 caverns simultaneously and supply the total fresh water demand, which is 560 m^3/h, from groundwater resources. However, to speed up the project for the compensation of increasing storage demand within years, BOTAŞ envisages performing leaching operations as groups of 4, instead of 2. In such a case, the fresh water demand of project will increase up to 1.120m^3/h. This amount of water is required for a total period of 7.5 years, the entire duration of the leaching operations.

Initially, local groundwater was considered for the fresh water source and DSI (State Hydraulic Works), the authority responsible for the water resources allocation in Turkey allowed to utilize local groundwater resources. However, due to the water demand increase as a consequence of doubling the leaching operations and the groundwater shortage, which was one of the major concerns raised during the Public Consultation Meeting,.BOTAŞ(although there exist no problem for allowance of such an amount of water from groundwater resources by DSI) revised the project design to utilize Hirfanlı Dam reservoir located 115 km from the project site as a fresh water source and DSI, provided the official approval for use of the required 10-12$\times10^6$ m^3/yr water from Hirfanlı Dam. (Official Letter of DSİ is given in Appendix-1)

Hirfanlı Dam

Hirfanlı Dam, constructed in 1960, is one of the major multi-purpose dams in Turkey, which is used for energy and irrigation. It receives an annual inflow of approximately 2400$\times10^6$ m^3/yr. The water demand of the project, 10-12$\times10^6$ m^3/yr, is less than %0.5 of the inlet flow to the dam reservoir. Therefore, DSI (the letter of DSI is given in (Appendix-1) stated that they have no difficulty in supply of this amount of water over the project life and, in addition the existing and future energy and irrigation based demands on the dam will not be affected adversely. (Refer to Appendix-1)

Fresh water will be transported by an underground pipeline of approximately 119 km to the project site. The pipeline will be transferred to DSI after the completion of the project to be used for water supply and/or for the irrigation to benefit the local people.

1.2 PIPELINE ROUTE SELECTION

Fresh water supply pipeline route (refer to the 1:100.000 scaled route map in Appendix-1) has been selected considering the topographical, geological and environmental conditions and the following general criteria:

- Reducing the length of pipeline routes as far as possible,
- Keeping the route close to and in parallel to the existing natural gas pipeline
- Avoiding existing structures
- Acceleration of the construction process in view of both the time and budget,
- Providing easy access to the pipeline via parallel routing to road
- Keeping away from population centers
- Minimizing disruption to agricultural activities

1.3 PIPELINE DESIGN, TECHNICAL SPECIFICATIONS

1.3.1 Technical Information Related to the Pipeline Construction

The pipeline to be constructed from Hirfanlı Dam to the project site will have an approximate length of 119 km. 31 km section of the pipeline will have diameter of 28", 70 km will have a diameter of 24" and the rest 18 km section will have a diameter of 20".

One of the works to be carried out before the commencement of the construction activities is the determination of the width of right of way (RoW). The map of all infrastructure facilities included along the RoW (such as underground cable, water line, sewage line) will be provided and the construction plan will be made in accordance with this structure.

Activities at the construction stage of pipeline are briefly summarized herein before detailing the potential impacts of these activities, which are given in Section 3.

Clearance and Preparation of RoW

Clearance process includes removal of materials on the RoW, which are likely to impede the progress on the work site. During this process, the topsoil will be removed and stored properly (refer to section 3.1 and EMP for top soil management) along the limits of the RoW.

Trenching

Trenchers and excavators will be used in trenching process. Before laying the pipe into the trench, sand material obtained by sieving the excavation materials will be laid on the trench base.

Pipe Laying

The pipes brought to the area will be welded and lowered in the trench after making the isolation of the welding points.

Backfilling

On completion of pipe laying, the trench is backfilled using, in general, the material from trench excavation.

Hydrostatic Testing

Following the trench backfill, the pipeline is tested hydrostatically for two purposes: testing the strength of the pipeline materials and welds and testing the water tightness of the pipeline.

2 ENVIRONMENTAL BASELINE

2.1 FLORA AND FAUNA

2.1.1 Flora Along the Pipeline Route

The flora species along the water supply pipeline route were researched by the field surveys carried out in March 2005 and these studies were combined with the literature studies (Davis, 1965-1988).

Vegetation

Vegetation types found along the pipeline route corridor are mountain steppe, plain steppe, wetland and grassland. Majority of the pipeline route, between Kızılırmak and 2 km south of Sarıalacalı Village is agricultural area mostly utilized for grain production passes through agricultural areas (wheat, barley and rye). The dominant flora species that are encountered within the agricultural areas are mainly annual or perennial weed species.

Following agricultural areas, the dominant vegetation types observed along the pipeline route is steppe vegetation (both mountain and plain steppe), which is a common vegetation type for the entire Central Anatolian Plateau. However, there are differences between dominant and characteristic species according to bedrock, soil characteristics and anthropogenic effects.

Mountain steppe vegetation seen mainly in the south of Palangic and Susuz Villages is composed of perennial herbs and short bushes. Plain steppe vegetation type is commonly found in north of Kocas Agriculture Enterprises and its near vicinity along the pipeline route. The pipeline route corridor between Sultanhanı and Esmekaya is mainly composed of wetland vegetation. In this section, reed beds and halophytic plant species are dominant. Grassland is present at pipeline section, which passes through south of Seyfe Lake. The species recoded with high frequency are mainly belonged to Leguminosae family:

Endemic Flora Species Along the Pipeline Route

Endangered or protected plant species were not observed along the pipeline route during field surveys. However, endemic species and associated IUCN (1994) risk categories, which previous studies indicated as possibly being found within pipeline route corridor are presented in Table 2.1.

Table 2.1. Endemic Flora Species Along the Pipeline Route

Species	Common Name	IUCN Risk Category
Acanthus hirsutus	Hairy bears breeches	LR-lc
Achillea lycaonica	Milfoil	LR-lc
A. Siehana	"	**VU**
Centaurea kotschyi var. *kotschyi*	Starthistle	LR-lc
Anthemis fumariifolia	Chamomile	LR-lc
A. Pauciloba var. pauciloba	"	LR-lc
Cousinia halysensis		LR-cd
Helichrysum arenarium ssp. aucheri	Everlasting	LR-lc
Salsola anatolica	-	**VU**
Astragalus brachypterus	Milkvetch	LR-lc
A. Lycius	"	LR-lc
Phlomis nissoli	Jerusalem sage	LR-lc
Salvia hypargeia	Sage	LR-lc
Thymus leucostomus var. leucostomus	Thyme	LR-nt
Linum flavum ssp. *scabrinerve*	Golden flax	LR-lc
L. cariense	Flax	LR-lc
Limonium iconicum	-	LR-lc
Verbascum vulcanicum var. *vulcanicum*	Mullein	LR-lc
Allium scabriflorum	Wild onion	LR-lc

LR : "Lower Risk" A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk category can be separated into three subcategories.

nt: : "Near Threatened" Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable

lc : "Least Concern" Taxa that do not qualify for Conservation Dependent or Near Threatened (One of the subcategories of LR)

cd : "Conservation Dependent" Taxa which are the focus of a continuing taxon- or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years

VU : "Vulnerable" A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

These species are not protected by national legislations or international conventions (i.e. Bern or CITES). However, *Achillea sieana* and *Salsola anatolica* are listed as "Vulnerable" (VU) in Turkish Red Data Book and therefore mitigation measures in accordance with the Bern Convention, although not required for these vulnerable species, will be followed as indicated in EMP. Thus, the same procedures for the protected species will also be applied for these 2 vulnerable species.

2.1.2 Fauna

The fauna species along the pipeline route corridor and its vicinity are determined by field studies carried out in March 2005 and literature research. Additionally, observations of the inhabitants in the region were used. The species that are observed

during field surveys and ones that can be found in the site considering the literature are listed in the following sections with their protection status.

Appendices of Bern Convention that Turkey has signed have the force of law and the species listed in them are under protection in Turkey. The protection status of species is also defined by Article 2 of the Terrestrial Hunting Law (dated 05.05.1937, number: 3167) and the pertaining decisions of the MEF, General Directorate of National Parks and Game-Wildlife, Central Hunting Commission are updated each year. According to the 2004-2005 Hunting Season decision of the Central Hunting Commission; hunting and keeping or transporting of the protected species as either alive or dead is forbidden.

In the context of Bern Convention, in Article 6, for the special protection of the wild fauna species specified in Appendix II, the following will in particular be prohibited for these species:

(a) all forms of deliberate capture and keeping and deliberate killing;
(b) the deliberate damage to or destruction of breeding or resting sites;
(c) the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention;
(d) the deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;
(e) the possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognizable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this article.

In Article 7, for the special protection of the wild fauna species specified in Appendix III measures to be taken shall include:

(a) closed seasons and/or other procedures regulating the exploitation;
(b) the temporary or local prohibition of exploitation, as appropriate, in order to restore satisfactory population levels;
(c) the regulation as appropriate of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals.

Once the construction activities start, fauna species found along the pipeline route will have the opportunity and most likely will migrate to similar biotopes nearby. Therefore, the disturbance on them within the construction corridor will be limited. However, the construction workers will be informed and trained about the restrictions and measures given in Article 6 and 7 of Bern Convention. A biologist will regularly monitor the activities and the route corridor and will take all necessary actions if any of these

species are found. As specified in EMP, construction activities will be kept within corridor as much as possible so that the natural habitats out of the construction corridor will not be disturbed.

Amphibians

During field surveys, three amphibian species were found along the water supply pipeline route corridor, which are listed in Table 2.2.

Table 2.2. Amphibian Species

Scientific Name	Common Name	Bern
Bufonidae	**True Toads**	
Bufo bufo	Common Toad	Appendix III
Bufo viridis viridis	Green Toad	Appendix III
Ranidae	**True Frogs**	
Rana ridibunda ridibunda	Marsh Frog	Appendix III

In the context of Bern Convention, for the amphibian species listed in Appendix III, the rules and measures given in Article 7 (see above) will be taken into account.

Reptiles

Reptile species given in the Table 2.3 could not be observed during field surveys on the site. However, according to the literature they are possibly located in this area. All these species are common in Turkey in general, there is no extinction risk.

Table 2.3. Reptile Species

Scientific Name	Common Names	Bern
Testudinidae		
Testudo graeca	Common tortoise	Appendix II
Agamidae		
Agama (Laudakia) stellio stellio	Clown Agama	Appendix II
Agama ruderata ruderata	Agama	Appendix III
Lacertidae		
Lacerta parva	Squamata Lizard	Appendix II
Lacerta trilineata galatiensis	Balkan Green Lizard	Appendix II
Ophisops elegans centranatolia	Snake-Eyed Lizard	Appendix II
Colubridae		
Natrix natrix persa	Grass Snake	Appendix III
Natrix tessellata tessellata	Dice Snake	Appendix II
Coluber caspius	Caspian Snake	Appendix III
Coluber najadum	Dahl's Whip Snake	Appendix II
Eirenis modestus	Dwarf Snake	Appendix III

According to the 2004-2005 Hunting Season decision of the Central Hunting Commission; hunting and keeping or transporting of these species as either alive or dead is forbidden.

In the context of Bern Convention, for the reptile species listed in Appendix II and Appendix III, the rules and measures given in Article 6 and 7 will be taken into account.

Birds

There are 115 bird species estimated to habit in the project vicinity. The mentioned bird species are given in Table 2.4 together with their risk categories according to Kiziroglu[1] (1993).

Table 2.4. Bird Species

Scientific Name	Common Name	Turkish RDB	BERN
PODICIPEDIDAE	**Grebes**		
Podiceps cristatus	Great Crested Grebe	A.2	Appendix III
Podiceps grisegena	Red-necked Grebe	A.2	Appendix II
Podiceps nigricollis	Black-necked Grebe	A.2	Appendix II
PHOENICOPTERIDAE	**Flamingos**		
Phoenicopterus ruber	Greater Flamingo	A.2	Appendix II
ANATIDAE	**Wildfowl**		
Anser anser	Greylag Goose	A.2	Appendix III
Anser albifrons	White-fronted Goose	B.2	Appendix III
Tadorna tadorna	Common Shelduck	A.2	Appendix II
Tadorna ferruginea	Ruddy Shelduck	A.2	Appendix II
Anas platyrhynchos	Mallard	A.4	Appendix III
Anas crecca	Teal	A.4	Appendix III
Anas acuta	Northern Pintail	A.4	Appendix III
Anas querquedula	Garganey	A.3	Appendix III
Anas penelope	European Wigeon	A.4	Appendix III
Anas clypeata	Common Shoveler	A.4	Appendix III
Aythya fuligula	Tufted duck	A.2	Appendix II
Aythya ferina	Pochard	A.2	Appendix II
Netta rufina	Red-crested Pochard	A.3	Appendix II
Oxyura leucephala	White-headed duck	A.2	Appendix II
ACCIPITRIDAE	**Hawks, Eagles**		
Aquila chrysaetos	Golden Eagle	A.3	Appendix II
Aquila heliaca	Imperial Eagle	A.2	Appendix II
Circus cyaneus	Northern Harrier	A.3	Appendix II
Buteo rufinus	Long-legged Buzzard	A.2	Appendix II
Buteo buteo	Common Buzzard	A.3	Appendix II
FALCONIDAE	**Falcons**		

[1] KİZİROĞLU, İ.: The Birds of Türkiye. (Species List in Red Data Book). Ankara: Desen Ofset A.S., 1993, 48 S. (TTKD Publication Nr. 20)

Scientific Name	Common Name	Turkish RDB	BERN
Falco tinnunculus	Common Kestrel	A.4	Appendix II
Falco naumanni	Lesser Kestrel	A.3	Appendix II
Falco peregrinus	Peregrine Falcon	A.2	Appendix II
Falco columbarius	Merlin	B.2	Appendix II
Falco vespertinus	Red-footed Falcon	A.2	Appendix II
PHASIANIDAE	**Pheasants, Partridges**		
Alectoris chukar	Chukar	A.2	Appendix III
Coturnix coturnix	Quail	A.4	Appendix III
Grus grus	Common Crane	A.1.2	Appendix II
Anthropoides virgo	Demoiselle Crane	A.1.2	Appendix II
RALLIDAE			
Fulica atra	Coot		Appendix III
RECURVIROSTRIDAE	**Stilts, Avocets**		
Recurvirostra avosetta	Avocet	A.4	Appendix II
CHARADRIIDAE	**Plovers**		
Charadrius dubius	Little Ringed Plover	A.2	Appendix II
Vanellus vanellus	Lapwing	A.4	Appendix III
SCOLOPACIDAE	**Sandpipers**		
Tringa stagnatilis	Marsh Sandpiper	B.3	Appendix II
BURHINIDAE	**Thick-knees**		
Burhinus oedicnemus	Stone Curlew	A.3	Appendix II
GLAREOLIDAE	**Pratincoles**		
Glareola pratincola	Collared Pratincole	A.3	Appendix II
LARIDAE	**Gulls**		
Larus melanocephalus	Mediterranean Gull	A.4	Appendix II
Larus minutus	Little Gull	B.3	Appendix II
Larus argentatus	Herring Gull	-	-
COLUMBIDAE	**Pigeons, Doves**		
Columba palumbus	Woodpigeon	A.4	-
Streptopelia decaocto	Collared Pigeon	-	Appendix III
Streptopelia turtur	Turtle Dove	A.2	Appendix III
CUCULIDAE	**Cuckoos**		
Cuculus canorus	Cuckoo	-	Appendix III
STRIGIDAE	**Owls**		
Athena noctua	Little Owl	A.3	Appendix II
APODIDAE	**Swifts**		
Apus apus	Swift	A.4	Appendix III
Apus melba	Alpine Swift	A.4	Appendix II
MEROPIDAE	**Bee-eaters**		
Merops apiaster	Bee-eater	A.4	Appendix II
CORACIIDAE	**Rollers**		
Coracias garrulus	Roller	A.2	Appendix II
UPUPIDAE	**Hoopoes**		
Upupa epops	Hoopoe	A.2	Appendix II
ALAUDIDAE	**Larks**		
Melanocorypha calandra	Calandra Lark	-	Appendix II
Calandrella brachydactyla	Short-toed Lark	A.3	Appendix II
Alauda arvensis	Skylark	-	Appendix III

Scientific Name	Common Name	Turkish RDB	BERN
HIRUNDINIDAE	**Swallows, Martins**		
Hirundo rustica	Swallow	-	Appendix II
Delichon urbica	House Martin	A.4	Appendix II
MOTACILLIDAE	**Pipits, Wagtails**		
Anthus campestris	Tawny Pipit	A.3	Appendix II
Anthus pratensis	Meadow Pipit	-	Appendix II
Motacilla flava	Yellow Wagtail	-	Appendix II
Motacilla cinerea	Grey Wagtail	A.4	Appendix II
Motacilla alba	Pied Wagtail	A.4	Appendix II
TURDIDAE	**Thrushes, Chats**		
Erithacus rubecula	Robin	-	Appendix II
Luscinia megarhynchos	Nightingale	A.3	Appendix II
Phoenicurus ochruros	Black Redstart	-	Appendix II
Phoenicurus phoenicurus	Redstart	-	Appendix II
Saxicola rubetra	Whinchat	-	Appendix II
Saxicola torquata	Stonechat	-	Appendix II
Oenanthe oenanthe	Northern Wheatear	A.3	Appendix II
Oenanthe hispanica	Black-eared Wheatear	-	Appendix II
Oenanthe isabellina	Isabelline Wheatear	-	Appendix II
Turdus merula	Blackbird	-	Appendix III
Turdus pilaris	Fieldfare	-	Appendix III
Turdus philomelos	Song Thrush	-	Appendix III
SYLVIIDAE	**Warblers**		
Cettia cetti	Cetti's Warbler	A.4	Appendix II
Locustella luscinioides	Savi's Warbler	-	Appendix II
Acrocephalus scirpaceus	Reed Warbler	-	Appendix II
Acrocephalus arundinaceus	Great Reed Warbler	-	Appendix II
Hippolais icterina	Icterine Warbler	A.3	Appendix II
Hippolais pallida	Olivaceous Warbler	-	Appendix II
Sylvia melanocephala	Sardinian Warbler	-	Appendix II
Sylvia hortensis	Orphean Warbler	-	Appendix II
Sylvia curruca	Lesser Whitethroat	-	Appendix II
Sylvia communis	Whitethroat	-	Appendix II
Sylvia borin	Garden Warbler	-	Appendix II
Sylvia atricapilla	Blackcap	-	Appendix II
Phylloscopus trochilus	Willow Warbler	-	Appendix II
MUSCICAPIDAE	**Flycatchers**		
Muscicapa striata	Spotted Flycatcher	-	Appendix II
Ficedula hypoleuca	Pied Flycatcher	-	Appendix II
TIMALIIDAE	**Babblers**		
Panurus biarmicus	Bearded Tit	A.2	Appendix II
AEGITHALIDAE	**Long-tailed Tits**		
Aegithalos caudatus	Long-tailed Tit	A.2	Appendix II
SITTIDAE	**Nuthatches**		
Sitta europaea	Nuthatch	-	Appendix II
Sitta neumayer	Rock Nuthatch	-	Appendix II
Sitta tephronota	Eastern Rock Nuthatch	-	Appendix II
REMIZIDAE	**Penduline Tits**		

Scientific Name	Common Name	Turkish RDB	BERN
Remiz pendulinus	Penduline Tit	A.2	Appendix III
ORIOLIDAE	**Orioles**		
Oriolus oriolus	Golden Oriole	-	Appendix II
LANIIDAE	**Shrikes**		
Lanius collurio	Red-backed Shrike	-	Appendix II
Lanius minor	Lesser Grey Shrike	-	Appendix II
CORVIDAE	**Crows**		
Pica pica	Magpie	-	-
Corvus monedula	Jackdaw	-	-
Corvus corone	Hooded Crow	-	-
Corvus corax	Raven	-	Appendix III
STURNIDAE	**Starling**		
Sturnus vulgaris	Starling	-	-
Sturnus roseus	Rose-coloured Starling	-	Appendix II
PASSERIDAE	**Sparrows**		
Passer domesticus	House Sparrow	-	-
Passer hispaniolensis	Spanish Sparrow	-	Appendix III
Petronia petronia	Rock Sparrow	-	Appendix III
FRINGILLIDAE	**Finches**		
Fringilla coelebs	Chaffinch	-	Appendix III
Serinus serinus	Serin	-	Appendix II
Carduelis chloris	Green Finch	A.4	Appendix II
Carduelis carduelis	Goldfinch	A.4	Appendix II
Carduelis cannabina	Linnet	A.4	Appendix II
EMBERIZIDAE	**Buntings**		
Emberiza hortulana	Ortolan	A.3	Appendix III
Miliaria calandra	Corn Bunting	-	Appendix III

According to the 2004-2005 Hunting Season decision of the Central Hunting Commission; hunting and keeping or transporting of the protected species given in Table 2.4 as either alive or dead is forbidden.

In the context of Bern Convention, for the bird species listed in Appendix II and Appendix III, the rules and measures given in Article 6 and 7 will be taken into account.

The Hirfanli Dam section, where water pipeline route starts is on the border of a bird wintering area (Tufted duck, Pochard, Red-crested Pochard, White-headed duck, Coot and water birds) and migratory route (Ruddy shellduck). Construction of this section will be carried out between July and August to minimize any effects on migratory and wintering birds and their habitats.

Mammals

Since the study area is mostly composed of arable fields, the mammal species are rather few in number. None of the mammal species given in Table 2.5 are observed during the field surveys carried out in March 2005. According to the literature, these species may be possibly found along the pipeline route corridor and its vicinity.

Table 2.5. Mammal Species

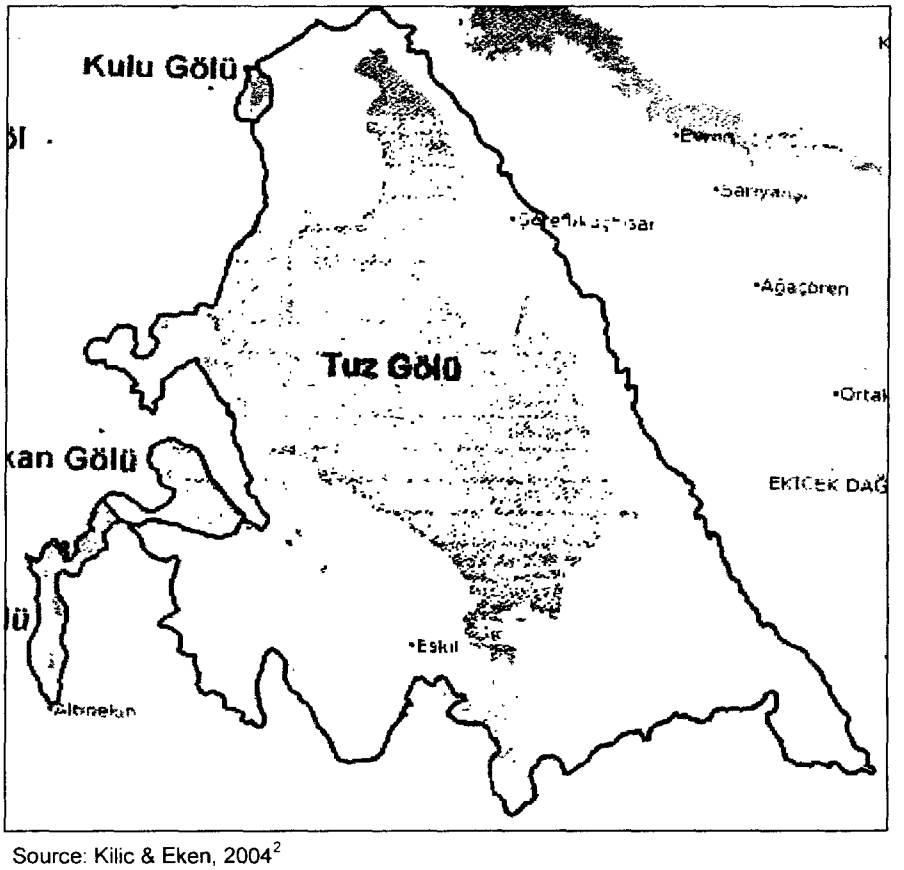
Scientific Name	Common Name	Bern
Erinaceidae		
Erinaceous concolor	Eastern Hedgehog	-
Soricidae		
Crocidura leucodon	Bicoloured White-toothed Shrew	Appendix III
Rhinolophidae		
Rhinolophus ferrumequinum	Great Horseshoe Bat	Appendix II
Rhinolophus hipposideros	Lesser Horseshoe Bat	Appendix II
Rhinolophus mehelyi	Mehely's Horseshoe Bat	Appendix II
Vespertilionidae		
Pipistrellus pipistrellus	Common Pipistrelle	Appendix III
Pipistrellus nathusii	Nathusius' Pipistrelle	Appendix II
Leporidae		
Lepus europaeus	Brown Hare	Appendix III
Sciuridae		
Spermophilus xanthophrymnus	Souslik	Appendix II
Muridae		
Rattus rattus	Black rat	-
Apodemus mystanicus	Rock mouse	-
Mus musculus	Common rat	-
Canidae		
Vulpes vulpes	Red fox	-
Mustellidae		
Meles meles	Eurasian badger	Appendix III
Mustella nivalis	Weasel	Appendix III

Except Brown hare, Red fox, Black rat, Rock mouse, and Common rat, the mammal species given in Table 2.5 are under protection by MoEF and Central Hunting Commission. According to the 2004-2005 Hunting Season decision of the Central Hunting Commission; hunting and keeping or transporting of these species as either alive or dead is forbidden.

In the context of Bern Convention, for the mammal species listed in Appendix II and Appendix III, the rules and measures given in Article 6 and 7 will be taken into account.

2.1.3 Flora and Fauna of Tuz Golu Basin

Tuz Golu Basin is the water catchment area covering the lake itself, the rivers feeding the lake and other the lakes related with it. Although exact borders are not certain, the area of the basin is around 530,000 hectare with a rough estimation. In Figure 2.1, the approximate border of the basin is given. Since the basin is a very large area, it is better to discuss the fish species found within the close vicinity of the project components. The small water bodies located within the close vicinity of the project area do not represent a creek type characteristic. Tuz Golu is almost totally dry in the summer and besides, the feeder creeks generally cannot reach the lake in summer months. Thus, with no source of fresh water during the summer, the resulting lake salinity from net evaporation provides an extremely hostile environment for fish habitat, as well as being extremely inhospitable for any plant growth.

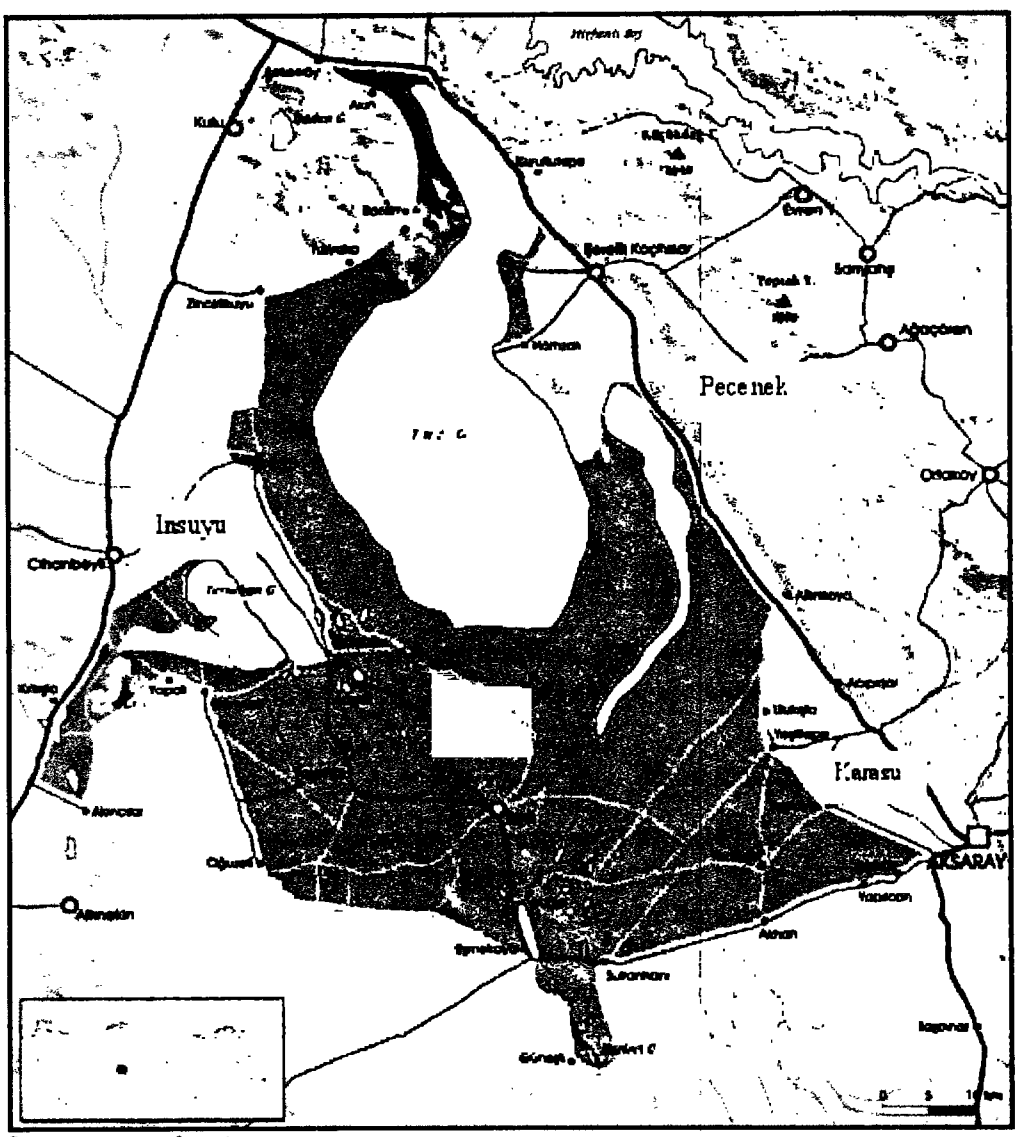


Source: Kilic & Eken, 2004[2]

Figure 2.1. Tuz Golu Basin Border

[2] Kilic DT& Eken G.. 2004. Onemli Kus Alanlari- 2004 Guncellemesi [Important Bird Areas in Turkey- Revision 2004], Doga Dernegi, Ankara

There are three main rivers namely Karasu, Pecenek and Insuyu feeding the lakes in the basin (see Figure 2.2), all of which are fresh water. Fish species mentioned in the EIA Report were not observed during field surveys carried out on April 2001. However based on the literature, these species are possibly found in Insuyu River, at approximately 100 km north of the project site (Phoxinellus crassus found in 1960 and Aphanius chandrei found in 1944). The high salinity of the lake and lake basin (including the discharge area) prevent these species from migrating to these sites.



Source: www.wwf.org.tr

Figure 2.2. Tuz Golu Basin and Feeder Lakes

In addition, an extensive field survey has recently been completed by Hacettepe University, Department of Biology with Prof. Dr. Ali Demirsoy as the project manager on the biodiversity of Tuz Golu. Sampling studies from many creeks and lakes within the Tuz Golu Basin regarding the fishes were also undertaken within the context of the study, but despite extensive field survey, no sample of these species was observed.

For the brine discharge pipeline (the discharge location) route and the unproductive/arid region border of Tuz Golu, refer to the 1:50.000 scaled map in Appendix-3.

2.2 GENERAL GEOLOGY OF THE PIPELINE ROUTE

The geological formations from oldest to youngest along the water supply line route are given below with their characteristics.

Pre-Late Cretaceous Volcanic Rocks (q_{5-6})

These rocks called as Ortaköy Granitoid are comprised of gabbros, layered gabbros, diorite, tonalite, granite, granodiorite, diorite porphyry, and monzonite, syenite, monzodiorite, and leuco-granite and granite porphyry. Gabbros exist as enclaves in granites in some places (or Granites include enclaves of gabbros in some places). These rocks are dark green to black in color, coarsely crystallized, hard and bright. Alteration zones of the rocks are uratilized. The rocks are cut by rhyolite and aplite dykes.

These rocks, which are very hard and require blasting, exist on the hills between Kızılırmak Valley and Aksaray-Ankara Highway.

Upper Miocene - Pliocene (M_3Pl)

Tuzkoy Formation and Pecenek Formation are representative for these ages. Tuzkoy Formation (Atabey et.al, 1987) is composed of fine layered and laminated, worm borrowed siltstone; laminated silty clay stone; fine-layered, worm borrowed sandstones and is partially alternating with tuffite. Siltstones are yellowish-gray colored and fractured. They have the characteristics of silty limestones, where the carbonate content is high. Siltstones are greenish-gray colored and laminated in some places. Siltstones include gypsum crystals and tuffite conformable to the layering.

Another unit of this formation, called as Kesiktepe Member, consists of porous, hard and yellow-pink pumice. These pumices exist together with marbled tuffites. The rocks, which form the Tuzkoy Formations, are more resistant than the other rocks in the region; therefore, they form the high hills and ridges.

These units are formed by deposition of volcaniclastic material into the lake. The approximate thickness of the Tuzkoy Formation is between 50-150 m.

These formations are exposed between Kızılırmak Valley and Aksaray-Ankara highway and the natural gas storage area. In general, the excavation in the area will be possible with machinery; however, in the areas where alteration zones exist, excavation by hand will be possible. No groundwater problem exists in the area. At the hillsides, where the slope is high, there exists the risk of mass movements.

Quaternary (Q and Q_1)

The units corresponding to this age are alluvium in Kızılırmak Valley and Aksaray-Sultanhani Plain.

The alluvium in Kızılırmak Valley contains mainly sand and gravel and, in less amount, clay and silt. The alluvial deposits of Aksaray-Sultanhani Plain; on the other hand, are mainly composed of fine-grained materials such as silt and clay.

Alluvions of both Kızılırmak Valley and Aksaray-Sultanhani Plain are the units saturated with groundwater. Excavation by hand is possible at these locations; however, the major problem is groundwater. The depth of alluvial deposits of Kızılırmak Valley is around 50 m; however, their depth is around 150 m at the Aksaray-Sultanhani Plain.

2.2.1 Structural Geology And Tectonism

The collision of Arabian-African Plate and Tauride-Anatolide Platform corresponding to the closure of southern branch of Neotethys Ocean and initiating the Neotectonic period in Miocene resulted in escaping of Central Anatolia in westward direction along North Anatolian and East Anatolian Faults. The western parts were uplifted and the region turned into an inland sea. In order to reduce the stress owing to the uplifting, certain areas became the side of extension generating grabens with normal faults. These grabens also induced strike slip faults along which Tuz Gölü basin and Konya basin were formed. Tuz Gölü basin has NW-SE striking trend and is bounded by Aksaray Fault.

The northern branch of Neotethys Ocean closed at the end of Upper Cretaceous accompanied by the nappes advancing from north to south. These nappes caused the deformation of the rocks in the region. In the study area, Aksaray and Sultanhanı Faults are present (Refer to Figure 2.3 and 2.4)

Aksaray Fault

Aksaray Fault, also known as Tuz Gölü Fault, bounds the eastern margin of Tuz Gölü. The fault is N30°W trending right-lateral strike slip fault; however, it also exhibits dip slip fault components at 300–500 m. Based on the active fault map of Turkey, it is the only active fault within the boundaries of project site. Freshwater pipeline crosses this active fault.

Sultanhanı Fault

Sultanhanı Fault is a NW-SE trending, dip-slip fault and passes through Sultanhanı. The up thrown block of the fault includes Tuz Golu and Insuyu Formations; whereas, the downthrown block involves Tuz Golu Formation.

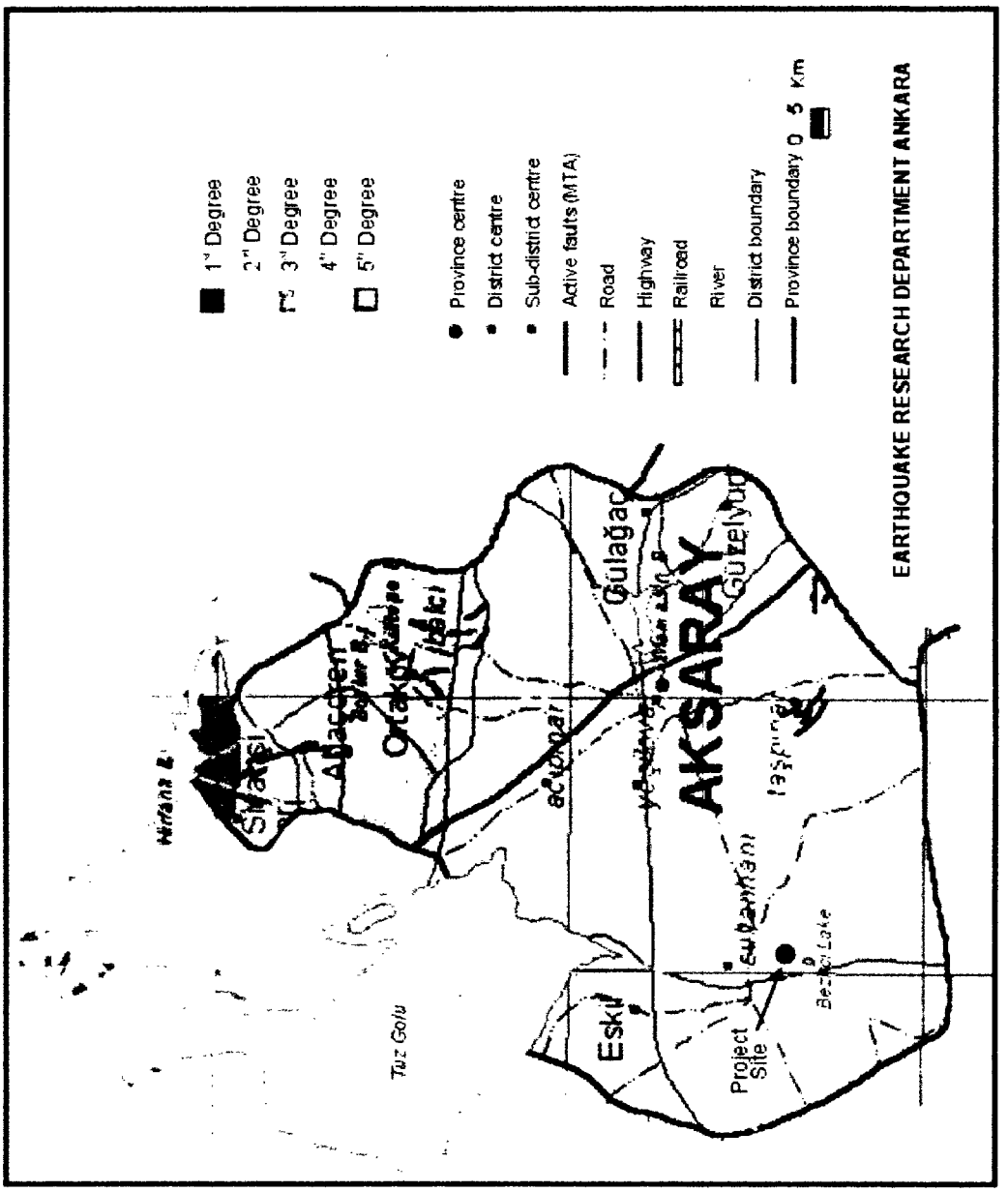


Figure 2.3 Earthquake zones of Aksaray

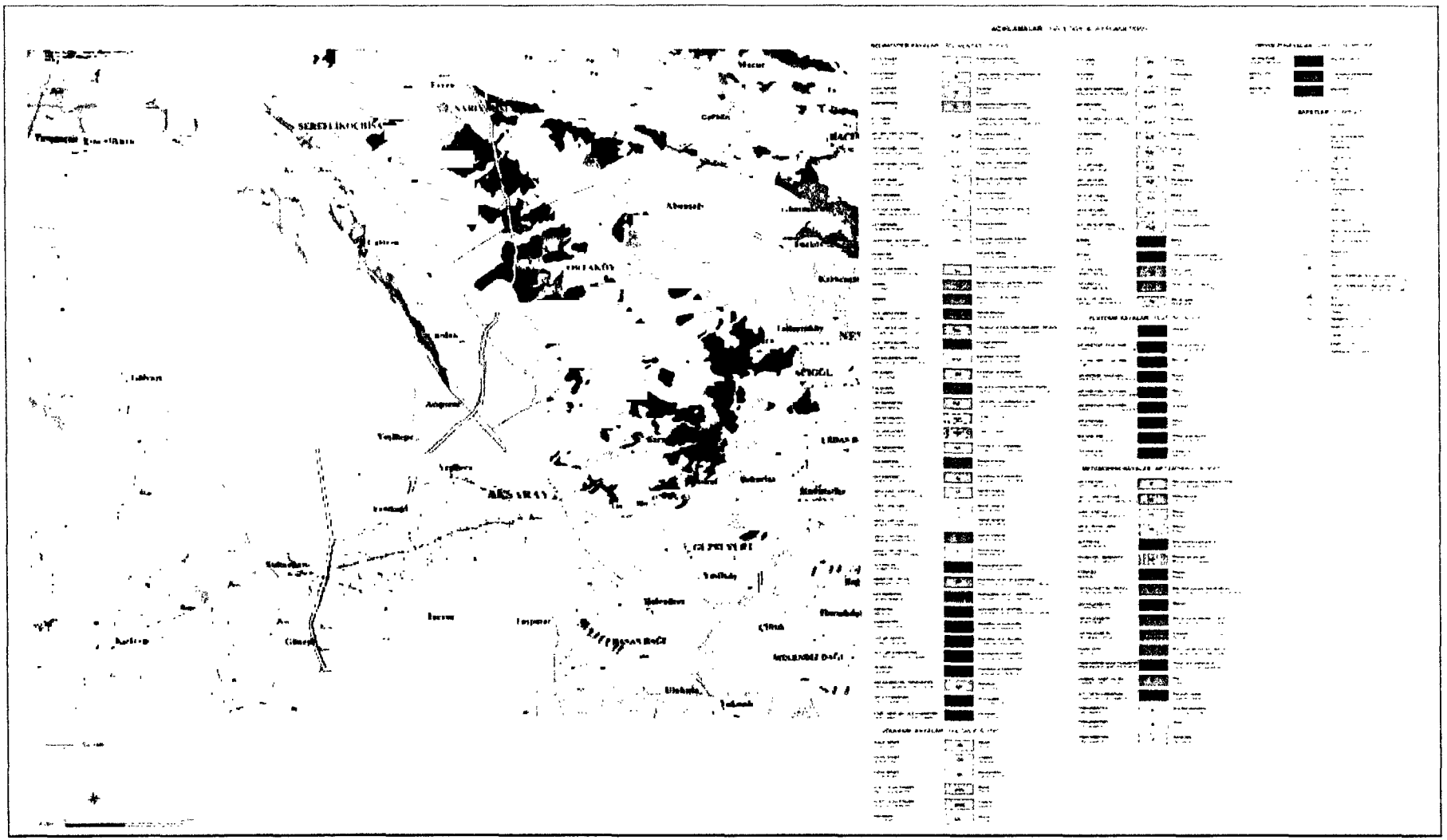


Figure 2.4 General Geology along the Pipeline Route

2.3 SOIL CHARACTERISTICS

All agricultural areas along the fresh water pipeline route have been identified based on the four categories, which are namely, suitability for cultivation, land use type, erosion degree and major soil groups. The details of classification are given in below tables. In order to determine the major soil groups along the pipeline route, the land use maps, prepared by the General Directorate of Rural Services were used. According to the information obtained by digitizing of the maps of interest, the major soil groups were determined.

Table 2.6. Land Use Capability Classes

Capability Class	Suitability for Cultivation	Agricultural Limiting Factors	Length (km)	Ratio (%)
I	Suitable for cultivating most of the crop types.	Very few or no limitations.	22,89	20,02
II	Suitable for long-term cultivation of a large variety of crops	Requires special mitigation measures against soil and water losses.	9,56	8,36
III	Suitable for cultivation of appropriate types of crops with special protection measures. Generally, require special care when used for agricultural purposes.	Prone to erosion and requires artificial drainage when cultivated.	28,05	24,53
IV	Suitable for cultivation of a few special agricultural species by appropriate ploughing. Generally, require special care when utilized for agricultural purposes.	Severe limitations in terms of soil depth, stone content, moisture and slope.	27,33	23,90
V	Flat or mild sloped, stony or very wet soil, not suitable for cultivation by ploughing. Generally, utilized as meadows or forest area.	Pertains a poor drainage and a structure not suitable for ploughing.	-	-
VI	Not suitable for cultivation by ploughing. Mostly utilized as pastureland or forest area.	Very severe limitations in terms of slope and shallow soil.	17,56	15,36
VII	Not economical for agricultural purposes, but suitable for poor pastureland or forestation.	Limitations in terms of shallow soil, stone content, slope and erosion.	8,97	7,84
VIII	Not suitable for vegetation. Can be utilized as recreation area or as shelter area for wildlife.	Lack of soil.	-	-

Table 2.7. Land Use Type

Land Use Type	Length (km)	Ratio (%)
Dry Agriculture (Fallowed)	65,39	55,49
Pastureland	36,96	33,63
Irrigated Agriculture	14,29	12,13
Horticulture (Dry)	0,84	0,71
Horticulture (Irrigated)	0,64	0,54
Hirfanli Dam Lake	0,56	0,48

Table 2.8. Erosion Degree

Erosion Degree		Length (km)	Ratio (%)
0	None or Very Little	51,26	50,17
1	Moderate	15,18	11,22
2	Severe	43,17	31,90
3	Very Severe	9,08	6,71

Table 2.9Major Soil Groups

Major Soil Group	Length (km)	Ratio (%)
Brown soils	55,22	46,52
Alluvial soils	33,79	28,47
Hydromorphic alluvial soils	1,46	1,23
Regosols	12,35	10,41
Reddish Brown	2,52	2,12
Colluvial soils	4,79	4,04
Chestnut Colored	8,00	6,74
Lake	0,56	0,47

2.4. POPULATION

According to the 2000 population census, the total population of Aksaray is 396.084, 50.5% and 49.5% of which constitute urban and rural population, respectively. There are seven districts in Aksaray Province. Among these, the Central District, Sultanhani Municipality of Central District, Sarıyahşi, Ağaçören and Ortaköy Districts are the settlements that will be mostly impacted from the proposed pipeline construction. The settlements along the pipeline route (refer to Figure 2.5) and their populations according to 2000 population census are presented in Table 2.10 below.

Table 2.10. Settlements along the pipeline route and population

District	Settlements	Population
Sarıyahşi	Bekdik	581
Sarıyahşi	Boğazköy	3041
Ağaçören	Kütüklü	351
Ağaçören	Panlı	4983
Ortaköy	Hacımahmutuşağı	278
Ortaköy	Pınarbaşı	369
Ortaköy	Hacıibrahimuşağı	542
Ortaköy	Hıdırlık	392
Ortaköy	Karapınar	227
Ortaköy	Camuzluk	362
Central	Altınkaya	2474
Central	Hanobası	1535
Central	Cerit	345
Central	Bostanlık	74
Central	Sapmaz	517
Central	Baymış	445
Central	Yeşiltepe (Kırgıl)	3439
Central	Yeşilova	4837
Central	Yenikent	4981
Central	Sultanhanı	10.104

SIS, Census 2000

2.5 ECONOMICAL CHARACTERISTICS

The socio-economical structure of Aksaray is mainly based on agriculture and animal husbandry in rural areas. The main sectors of the regional economy are evaluated in detail in the following paragraphs.

Agriculture

The sugar beet and cereals are the major types of crop in Aksaray, comprising of more than half of the total agricultural areas. The sugar beet and cereals are cultivated on the wetlands while barley, rye and wheat are cultivated on the dry agricultural lands. Distribution of the land use types in Central, Ağaçören, Ortaköy and Sarıyahşi Districts of Aksaray, which are located along the pipeline route, are given in below tables.

Table 2.11. Land use distribution of the districts located along the pipeline route

District	Agricultural area (Ha)	Forest and Shrubbery (Ha)	Pasture Meadow (Ha)	Other (Ha)	Total Area (Ha)
CENTRAL	222.975	8.891	150.621	31.468	413.955
AĞAÇÖREN	29.922	---	18,548	3,147	51.617
ORTAKÖY	45.643	1.937	30.612	4.938	83.130
SARIYAHŞİ	16.071	---	46	1.575	17.692

Table 2.12. Agricultural Area Distribution of the districts located along the pipeline route

District	Agricultural Area (Ha)	Irrigated Agricultural Area (Ha)	Dry Agricultural Area (Ha)
CENTRAL	222.975	25.758	196.217
AĞAÇÖREN	29.922	478	29.444
ORTAKÖY	45.643	5.620	40.023
SARIYAHŞİ	16.071	1.030	15.041

Animal Husbandry

The animal husbandry has the second important place in the Province of Aksaray following the agriculture. The animal breeding including the sheep breeding is performed in all sections of the province. The animals bred in the province are marketed within the surrounding provinces and districts.

Bee breeding is also noted as another field of animal husbandry as traditionally performed in the province, and it is performed on the plateaus, especially around Mountain Hasan.

The Sub-district of Sultanhani is one of the most developed animal husbandry centers of the region owing its position. The animal products such as meat, milk and spring wool can be supplied in the sub-district.

Service Sector

The service sector constitutes the second important sector of the Province of Aksaray. Many people work within the fields of trade, transportation, construction, carpeting, training and health and in the public institutions.

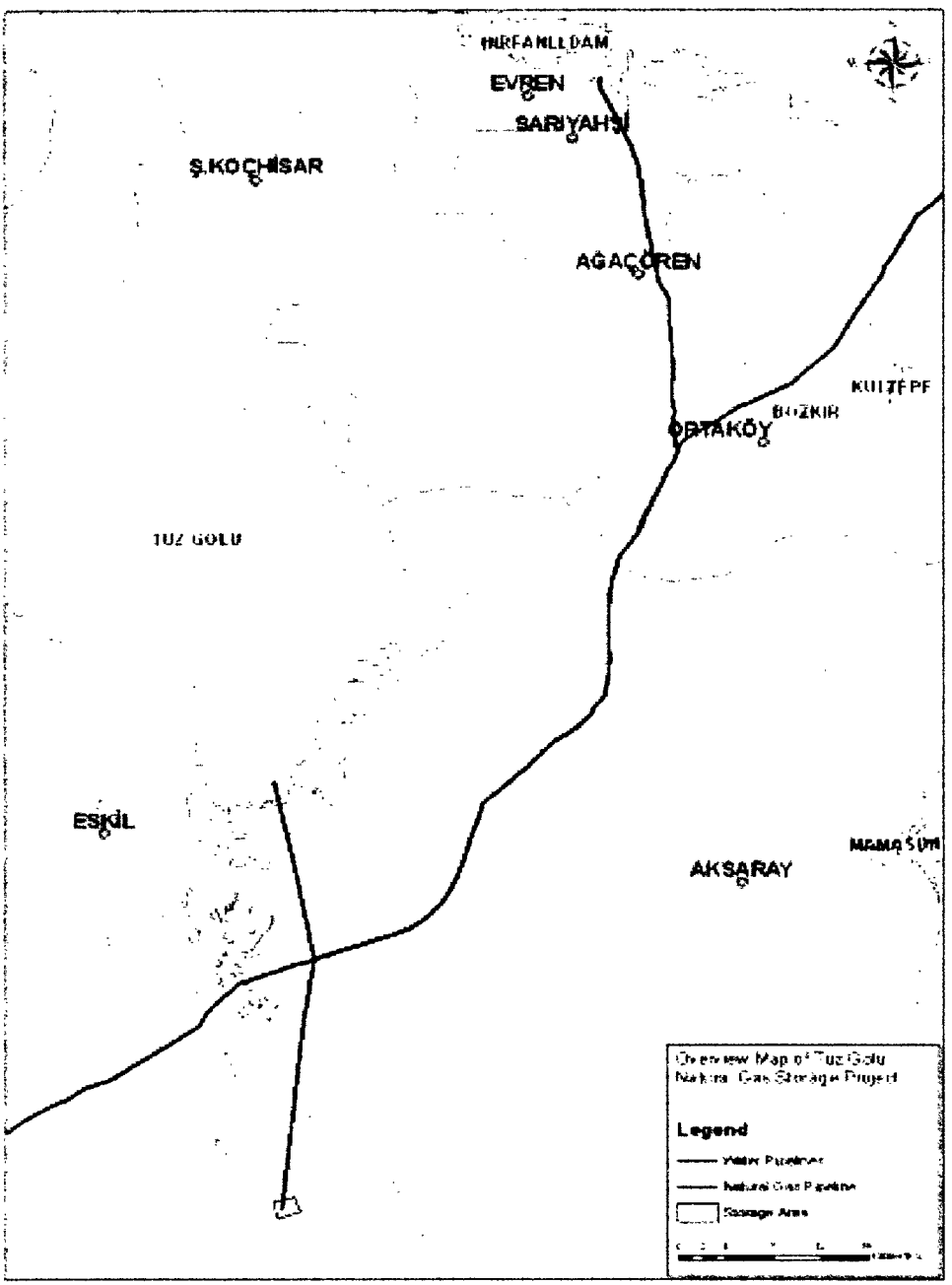


Figure 2.5 The major settlements along the pipeline route

2.6 CULTURAL HERITAGE

During the preliminary route surveys, no archaeological and cultural assets along the fresh water pipeline route corridor have been observed. However, in the event that any cultural asset is found during the construction activities, the construction activity will be ceased and the nearest museum will be informed within 3 days as per Article 4 of the Cultural Heritage Protection Law (23.07.1983, Official Gazette issue no. 18113)

3 POTENTIAL IMPACTS AND MITIGATION

The major potential impacts of pipeline construction activities are briefly explained in the below sections and summarized in Table 3.1. Reference should be made to the Environmental Management and Monitoring Plan for further details.

3.1 SITE PREPARATION ACTIVITIES/EXCAVATION

Trench excavation will be reused for backfilling and landscaping purposes. The vegetative topsoil is comprised of soil layers, which are rich in humus, active in terms of microorganism activities, suitable for the plants to grow and 5-40 cm deep from the surface. These layers will be stripped off and stored adjacently as piles in areas that are not in use on site. In the course of this storage, the top of soil piles will be covered by nylon covers and the soil loss (erosion) related to precipitation will be prevented. Following the construction phase this vegetative soil, which is rich in minerals, will be used in landscape studies.

Regarding these conditions, it is considered that the excavation planned to be realized in the construction site will have no important adverse impacts on the topography of the region and natural landscape.

3.2 DUST

Dust emission will be possible to be encountered during the construction activities due to various sources such as soil stripping, excavations, transportation on unpaved roads and construction materials to be fallen from the vehicles. In the course of the construction the dust emitting processes such as breaking, grinding will not be required.

With the intention to minimize the probable impacts regarding the dust emission and to keep the dust emissions at the lowest level, the vicinity of the related areas will be regularly watered. Besides, all transportation vehicles to carry excavation materials on site will be covered. The speed of the vehicles will be restricted with 30 km/hour on unpaved roads.

The filling material to be used will be procured from the closest locations to the construction site. Moreover, it will be paid attention to not to allow the trucks to pass on the mud on their wheels to the main roads on rainy days.

All excavation material will be protected with the precautions preventing dusting as of indicated in Article 7 of Air Quality Protection Regulation to prevent the effect of wind and rain, i.e. usage of nylon covers, compressing with binding materials.

3.3 WASTE GENERATION

During the construction of water supply line, solid wastes from various sources will be created. These sources can be classified as domestic wastes, residual oils resulting from the oil change of machines and vehicles, other solid wastes (iron pieces, steel, packing materials, material over sieve, etc.)

Domestic solid wastes and construction wastes, such as iron pieces, steel, packing materials and material over sieve (excavation material which is excess of backfilling) will be formed as well will be collected and disposed at the dumpsite of the nearest Municipality.

The disposal of the residual oils arisen from the oil change of the machines and vehicles during the construction of the pipeline will be carried out in compliance with the Hazardous Waste Control Regulation (HWCR). Waste/residual oils will be stored onsite discretely and given to a firm licensed by MoEF.

Domestic wastewater will be collected in a lined (impermeable) septic tank and removed by the nearest Municipality. No industrial wastewater will be generated.

3.4 NOISE AND VIBRATION

There will be no explosion during the construction activities, unless required. During the construction activities, the precautions indicated in Worker Health and Occupational Safety Act/Article 22[3] will be taken and accordingly, the employees will be provided with special helmets, earphones or earplugs that are protective against noise. In addition;

- The maximum noise levels that the employees may be subject to as given in Noise Control Regulation (NCR), are given in Table 2. These values will not be exceeded during the construction activities.

[3] The noise levels, where heavy and dangerous activities are not performed, shall not exceed 80 dBA. At the areas, where the working activities, generating higher noise levels due to the requirements are conducted, the noise levels shall be 95 dBA maximum. However, in such a case, the workers shall be given protective equipments, i.e. special helmets, earphones or earplugs against noise.

- The operations causing noise will be limited within the hours 06:00– 1900, which is stated in Noise Control Regulation and is defining the daylight hours.
- The works will be restricted with the activities generating low noise levels at nights and on official holidays.

3.5 IMPACTS ON BIOLOGICAL ENVIRONMENT

As it is described in above sections, the most of the endemic flora species along the pipeline route corridor are wide spread in Turkey and in low-risk category. Therefore, there is no need to take special measures to protect these species during construction the activities. Only 2 flora species (*Salsola anatolica* and *A. siehana)* are categorized as vulnerable. Prior to the construction activities, the locations of these species within the pipeline route corridor will be determined via field surveys by competent botanists and the seeds of these species will be collected, moved to the similar habitats or protected ex-situ in botanic gardens and greenhouses under the control of universities. The seeds will be replanted in the same habitat after completion of the construction. In addition, any specie under protection found in the vicinity of the project site, shall be clearly marked and in no way be collected, chopped and taken off their roots. The construction activities will be limited to the construction corridor.

A range of measures will be adopted during the construction and reinstatement phases to mitigate potential impacts on the biological environment, including the following.

Experienced ecological advisors will be employed by Contractor and Environmental Monitoring Company (see EMP) during construction activities, who will regularly monitor the activities and observe for the occurrence of protected species and check nests of any mammalian and birds within the boundaries of the project site and the construction corridor, and advise on a site-specific precautions based on the sensitivity of the species. Construction activities will be limited to the construction corridor.

The Hirfanli dam section, where water pipeline route starts is on the border of a bird wintering area due to wintering (Tufted duck, Pochard, Red-crested Pochard, White-headed duck, Coot and water birds) and migratory route (Ruddy shell duck). Construction of this section will be carried out between July and August to minimize any effects on migratory and wintering birds and their habitats.

Table 3.1. Summary Table of Impacts

IMPACT	PROPOSED MITIGATION MEASURE
Excavation/ loss of top-soil	Excavation material will be re-used for trench backfilling and land restoration The vegetative topsoil will be stored properly (by protecting with nylon covers against soil loss related to precipitation) and used for revegetation and landscaping.
Dust generation due to excavation, material storage, handling and transport	Excavated material will be protected from wind and rain (e.g. using nylon covers and compaction with binding materials) All transportation vehicles that will carry excavation material will be covered The speed of the vehicles will restricted with 30 km/hour on unpaved roads. Any exposed dust prone areas (e.g. roads) will be regularly watered (particularly during hot, dry, windy weather conditions).
Wastewater generation	Domestic wastewater will be collected in a lined (impermeable) septic tank and removed by the nearest Municipality. No industrial wastewater will be generated. Various wash down waters (only including suspended solids, oil and grease) will be collected via a separate line. After the removal of suspended solids, oil and grease, it will be used for watering green areas. Any hydrotest water (containing suspended solids and any coarse material) will be discharged to the nearest water body after settling. Waste/residual oils from oil change of the machinery and vehicles will be stored onsite separately and given to a firm licensed by MoEF.

Table 3.1 Cont'd

IMPACT	PROPOSED MITIGATION MEASURE
Solid waste generation	Domestic solid wastes and construction wastes will be collected and disposed to the official Municipal Solid Waste Disposal area of the nearest municipality.
Noise and vibration due to site preparation and construction activities	No explosives to be used unless required during the construction activities. Local residents will be informed of any use of explosives at least "5" days before intended use. The activities that generate noise will be limited with the hours 06:00 a.m-07:00 pm, and no work will be carried out on official holidays. Employees will be provided with special helmets, earphones or earplugs against noise. The maximum noise levels that workers can be subjected to will not be exceeded during the construction activities
Transportation	No access roads will be constructed unless necessary and approved by BOTAŞ. The existing roads will be used to the greatest extent.
Impacts on flora	In the event that the species protected as per the BERN Convention and the "Vulnerable" species according to Turkish Red Data Book as are found, they will be managed in accordance with Bern Convention specifications. The seeds of these species shall be taken and moved to the similar habitats or protected ex-situ in botanic gardens (under the inspection of Monitoring Company, see EMP section C) and greenhouses under the control of universities. These species, found in the vicinity of the site, shall be clearly marked and in no way be collected, chopped and taken off their roots. Construction activities will be limited to construction corridor.

Table 3.1. Cont'd

IMPACT	PROPOSED MITIGATION MEASURE
Impacts on fauna	Decisions of Central Hunting Commission shall be complied with. Construction activities will be limited to the construction corridor. A fauna expert shall be employed by the Construction Contractor to monitor construction activities. The expert will recommend, as appropriate, and discuss with the Monitoring Company any mitigation, which may be necessary to bring any observed impacts to acceptable levels. Implementation of any recommended mitigation would only proceed after mutual agreement is reached between Monitoring Company, the Construction Contractor and the Construction Contractor fauna expert. Any rare and endangered species will be managed in accordance with the national or international regulations and treaty requirements.
Handling & usage of explosive/ hazardous and toxic materials	Any explosive material will be kept in locked containers and appropriately labeled. The fuels to be used by the work machines will be purchased from companies with valid operating permits If storage is required, then fuels or hazardous liquids will be stored in tanks situated on impermeable (e.g. concrete) surfaces with bund to contain any leaks. Warning signs will be placed on the storage tanks, etc.
Impacts on Cultural and Natural Assets	A cultural expert will remain on-site to issue government if procedures are followed. Turkish chance find procedures will be followed (i.e. cease activities, consult with authority and protection in situ if possible)

Table 3.1. Cont'd

IMPACT	PROPOSED MITIGATION MEASURE
Health and safety risks	Warning signs will be placed in the field against possible work accidents/dangerous conditions The workers will be equipped with necessary safety equipments (e.g. shatter proof work glasses, protective work shoes, etc.) in accordance with Worker Health and Occupational Safety Act (Official Gazette dated 11.01.1974 and numbered 14765). The area will be fenced and entrances to and exits from the construction site will be either guarded or locked. An emergency response plan will be developed and necessary training will be given. (Just before the construction activity starts. During the detailed design, it will be prepared by Contractor and BOTAŞ will approve)

TABLE OF CONTENTS

A. MITIGATION PLAN

Phase	Issue	Mitigating Measure*	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
PIPELINE and SURFACE FACILITIES Water Supply Brine Discharge Natural Gas Branch Line	Excavation	• Excavation material will be re-used for trench backfilling and land restoration • The vegetative topsoil will be stored properly (by protecting with nylon covers against soil loss related to precipitation) and used for revegetation and landscaping.	Minor	Construction Contractor	During Construction	
	Dust generation due to excavation, material storage, handling and transport	• Excavated material will be protected from wind and rain (e.g. using nylon covers and compaction with binding materials) • All transportation vehicles that will carry excavation material will be covered • The speed of the vehicles will restricted with 30 km/hour on unpaved roads. • Any exposed dust prone areas (e.g. roads) will be regularly watered (particularly during hot, dry, windy weather conditions).	Minor	Construction Contractor	During Construction	
	Solid waste generation at worksite	• Domestic solid wastes and construction wastes will be collected and disposed to the official Municipal Solid Waste Disposal area of the nearest municipality.	Minor	Construction Contractor	During Construction	

* All items designated as responsibility of Contractor will be specified in the bid documents

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Wastewater generation at worksite	• Domestic wastewater will be collected in a lined (impermeable) septic tank and removed by the nearest Municipality. • No industrial wastewater will be generated. • Various washdown waters (only including suspended solids, oil and grease) will be collected via a separate line. After the removal of suspended solids, oil and grease, it will be used for watering green areas. • Any hydrotest water (containing suspended solids and any coarse material will be discharged to the nearest water body after settling. • Waste/residual oils from oil change of the machinery and vehicles will be stored onsite separately and given to a firm licensed by MoEF. (Refer to Annex for the discharge standards given in Water Pollution Control Regulation)	Minor	Construction Contractor	During Construction	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Noise and vibration due to site preparation and construction activities	• No explosives to be used unless required during the construction activities. Local residents will be informed of any use of explosives at least "5" days before intended use. • The activities that generate noise will be limited with the hours 06:00 a.m-07:00 pm, and no work will be carried out on official holidays. • Employees will be provided with special helmets, earphones or ear plugs against noise. • The maximum noise levels that workers can be subjected to will not be exceeded during the construction activities[1]	Minor	Construction Contractor	During Construction	
	Transportation	No access roads will be constructed unless necessary and approved by BOTAŞ. The existing roads will be used to the greatest extent.	Minor	Construction Contractor	During Construction	

[1] Refer to the Annex for the related Article of Worker Health and Occupational Safety Act and the noise levels

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Impacts on flora (due to site clearance)	• In the event that the species protected as per the BERN Convention and the "Vulnerable" species according to Turkish Red Data Book as are found, they will be managed in strict accordance with the Bern Convention specifications. • The seeds of these species shall be taken and moved to the similar habitats or protected ex-situ in botanic gardens (under the inspection of Monitoring Company, see Section C) and greenhouses under the control of universities. These species, found in the vicinity of the site, shall be clearly marked and in no way be collected, chopped and taken off their roots. • Construction activities will be limited to the construction corridor.	Minor	Construction Contractor	During Construction	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Impacts on fauna (disturbance during the construction activities)	• Decisions of Central Hunting Commission shall be complied with. *(refer to the Annex)* • Construction activities will be limited to the construction corridor. • Any rare and endangered species will be managed in accordance with the national or international regulations and treaty requirements • Construction activities will take place during periods when no migratory bird flight are occurring (July-September for 15 km section of brine discharge pipeline; July–August for construction at Hirfanlı Dam section) • A fauna expert shall be employed by the Construction Contractor to monitor construction activities. The expert will recommend, as appropriate, and discuss with the Monitoring Company any mitigation, which may be necessary to bring any observed impacts to acceptable levels. Implementation of any recommended mitigation would only proceed after mutual agreement is reached between Monitoring Company, the Construction Contractor and the Construction Contractor fauna expert.	Minor	Construction Contractor	During Construction	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Health and safety risks	• Warning signs will be placed in the field against possible work accidents/dangerous conditions • The workers will be equipped with necessary safety equipments (e.g. shatter proof work glasses, protective work shoes, etc.) in accordance with Worker Health and Occupational Safety Act (Official Gazette dated 11.01.1974 and numbered 14765). • The area will be fenced and entrances to and exits from the construction site will be either guarded or locked. • An emergency response plan will be developed and necessary training will be given. (Just before the construction activity starts. During the detailed design, it will be prepared by Contractor and BOTAŞ will approve)	Minor	Construction Contractor	During Construction	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Handling & usage of explosive/hazardous and toxic materials	• Any explosive material will be kept in locked containers and appropriately labeled. • Fuels to be used by the work machines will be purchased from companies with valid operating permits • If storage is required, then fuels or hazardous liquids will be stored in tanks situated on impermeable (e.g. concrete) surfaces with bund to contain any leaks. • Warning signs will be placed on the storage tanks, etc.	Minor	Construction Contractor	During Construction	
	Drainage (for surface facilities)	The drainage system will be formed at the base level of the buildings and combined with the grid canals and manholes to be formed in the construction area	Minor	Construction Contractor	During Construction	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Impacts on Cultural and Natural Assets	• A cultural expert will monitor the construction activities continuously • Turkish chance find procedures will be followed (i.e. cease activities, consult with museum authority and protection in situ as required)	Minor	Construction Contractor	During Construction	
DRILLING ACTIVITIES	Oily Waste Waters	A wastewater pool with an impermeable lining using geo–membrane will be constructed and an oil trap will be placed in the channel entering to the pool in order to separate oil and petroleum from the wastewater. After oil and grease removal, oily residue will be given to a firm licensed by MoEF; remaining water will be used for watering green areas.	Minor	Construction Contractor	During Drilling Activities	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
	Impacts on Groundwater due to leakage of drilling mud fluids	▪ Casing will be cemented until reaching the impermeable formation along the drilling section. The drilling operations will be carried out inside this casing. ▪ Only water based bentonite clay drilling muds containing no toxic materials will be used.	Minor	Construction Contractor	During Drilling Activities	
	Formation Wastes and Drilling Muds	• Mud pits (lined) will be opened for the temporary storage of the formation wastes and drilling mud and they will be removed from the area by a firm licensed by MoEF after solidification (drying). • The drilling area and the surrounding of the mud pit will be surrounded with a wire mesh fence and entrance will be locked. Warning signs will be placed at the entrance.	**Minor**	Construction Contractor	During Drilling Activities	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
CONSTRUCTION						
LEACHING OPERATIONS	Sludge from brine settling tanks	The solid particles (>200 µm) will be collected in settling tanks. The sludge will be removed manually every 15 days and collected with mobile containers and disposed to the official Municipal Solid Waste Disposal area of Sultanhanı Municipality.	Minor	Construction Contractor	During Leaching Operations	
	Impacts of brine discharge on lake water quality	• Discharge location is in unproductive/arid area in terms of ecological characteristics and agricultural activities and also there exist no salt production) of Lake (based on the official maps and field surveys) • It is estimated that the discharge plume will remain within the boundaries of the unproductive area for the complete duration of the leaching operation. The plume will be monitored to assure these estimates are valid.	**Minor**	Construction Contractor	During Leaching Operations	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
OPERATION						
	Noise (Pump and Compressors, etc.)	• Installation of silencers to the entry and exit of the cooling fans • Procurement of low sound emanating backup motor, pump and compressors • Limitation of truck transportation merely with hours of daylight if required • Noise levels will be in accordance with Turkish standards (refer to Annex)		BOTAŞ	During Operation	
	Fire	A fire protection system will be available at site (Fire detectors sensitive to heat, smoke and flame, nonautomatic fire extinguishing systems will be available in the site against fire as well)		BOTAŞ	During Operation	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
OPERATION						
	• Accidents and Sabotage	• Parameters such as pressure, temperature and flow rate will be monitored continuously at certain (at well head locations and at line valves.) locations on the line and the caverns, abnormal conditions (i.e. sudden pressure drop) will be reported to the authorities • Line valves sensitive to sudden pressure drops will shut down automatically.		BOTAŞ	During Operation	
	Health and Safety	Education on; • Site security • Environmental protection • First aid • Fire fighting • Health and occupational safety • Risk assessment will be given to the personnel employed.		BOTAŞ	During Operation	

Phase	Issue	Mitigating Measure	Cost of Mitigation (If Substantial)	Responsibility	Start Date	End Date
OPERATION						
	Leakage and explosion (pipeline)	In case of leakage of natural gas in closed areas (possibility of ignition and explosion of the accumulated gas cloud), the area will be immediately ventilated in accordance with best international practice (e.g. ventilation fans, sparkless motors)		BOTAŞ	During Operation	
	Emergency Cases	BOTAŞ, will inform the relevant governorships, municipalities, etc. prior to the commencement of gas storage and send to them the emergency response plans (*refer to EIA Report, Section 8.2.2)*		BOTAŞ	During Operation	
	Waste generation	• Domestic solid wastes will be collected and disposed to the Municipal Solid Waste Disposal area of Sultanhanı Municipality. • With the start of operation, septic tank will be replaced by package treatment plant. The discharge water will be used for watering green areas..		BOTAŞ	During Operation	

B. MONITORING PLAN

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
Construction of Pipeline and Surface Facilities	Top soil storage	Top soil storage area to be identified by Contractor and approved by BOTAS prior to use	Visual	Weekly during construction activities		Environmental Monitoring Company	During construction activities	
	Storage and Disposal of excavated material	Designated disposal areas along the pipeline routes and at Surface Facilities	Visual	Weekly during construction activities		Environmental Monitoring Company	During construction activities	
	Covering of vehicles, which carry excavation material	Work site boundaries at the location, where loading will be performed.	Visual	At random, but averaging weekly during construction activities		Environmental Monitoring Company	During construction activities	
	Dust Level	Excavation, material storage, handling areas	Visual	Weekly during construction activities. More frequently (2-3 times/week) during hot, dry, windy conditions		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Solid Waste (Collection, storage and disposal)	Work site boundaries (at the solid waste storage area)	Visual	Initially once a week, if satisfactory subsequently monthly		Environmental Monitoring Company	During construction activities	
	Domestic wastewater management Septic tank lined	Septic tank	Visually for leaks (Sudden decrease in the level)	Weekly		Environmental Monitoring Company	During construction activities	
	Washing waters management Suspended solids (ss), oil and grease	At the exit of the washing water treatment area (for ss, oil grease removal)	• Gravimetric analysis for ss • Hexane solubility test for oil and grease	Weekly initially then monthly		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Hydrotest water disposal (either settled before discharge for suspended solids and any coarse material removal)	At the hydrotest water collection tank prior to discharge	Visual (not necessary to make physical/chemical analysis)	Before discharge		Environmental Monitoring Company	During construction activities	
	Waste/residual oils collection and removal	Waste oil containers (either collected separately and removed by firms licensed by MoEF)	Visual	Once a week Check certification/check validity of license before engaging the firm		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Noise level dB[A]	Along the pipeline route and surface facilities construction areas	Noise measurements by sound level meter with weighting options (constant ,slowly changing noise and impulsive noise) also measuring sound pressure level (SPL)	During major construction activities and if there are local complaints		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Health and Safety •Use of equipments By employees against noise •Warning signs •Safety equipments of workers •Adoption of safety rules (for security of site and excavation, scaffold and heavy vehicles, etc)	Work site boundary Before entering workplace	Visual	Random, but averaging once/week. If violations are observed, frequency will be increased		Environmental Monitoring Company	During construction activities	
	Work site safety (either fenced and entrance & exit are kept under control)	Work site boundary	Visual	Random, but averaging once/week. If violations are observed, frequency will be increased		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Storage of explosive material (either in locked containers)	Storage area	Visual	Random, but averaging once/week. If violations are observed, frequency will be increased to daily		Environmental Monitoring Company	During construction activities	
	Storage of fuels or hazardous liquids	Storage tank (either stored in properly designed tanks situated on impermeable surface with bund)	Visual	Before initial use of storage facilities Monthly check for leaks		Environmental Monitoring Company	During construction activities	
	Fuel purchase (from the licensed firms)	Before delivery is allowed to fill storage tanks	Visual (check certification)	Upon arrival at site		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Drainage of surface facilities area and impermeability of internal roads	Facilities area	Visual	During site preparation and construction of facilities (Check during rainy conditions)		Environmental Monitoring Company	During construction activities	
	Flora under protection	Along the pipeline route and at the surface facilities area	Visual monitoring, recording and reporting by university trained ecological expert (to be approved by BOTAŞ	Weekly during construction activities (if necessary ,then more frequent, to be decided by BOTAŞ)		Environmental Monitoring Company	During construction activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Fauna under protection and the construction periods for wintering and migratory birds	Along the pipeline route and at the surface facilities area	Visual monitoring, recording and reporting by university trained ecological expert (approved by BOTAŞ)	Weekly during construction activities (if necessary ,then more frequent, to be decided by BOTAŞ)		Environmental Monitoring Company	During construction activities	
Drilling Activities	Oily wastewaters collection and storage	Wastewater pool (either lined and oil trap functioning properly)	Visual	Weekly or daily if problems are observed		Environmental Monitoring Company	During drilling activities	
	Removal of oily wastewater by Licensed Companies	Plant site	Visual	According to removal schedule to be determined prior to the construction activity		Environmental Monitoring Company	During drilling activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Casing usage against leakage of drilling mud	Drilling area	Pressure monitoring of the drilling casing to see if there is a rapid decrease	Continuously, during drilling activity		Environmental Monitoring Company and also whoever will be monitoring the drilling activity and well pressure.	During drilling activities	
	Formation wastes and drilling muds storage and removal	Mud pits for leakage Controlled entrance to mud pit area Disposal by licensed firm	Visual Check certification. Check validity of license before engaging the firm	Weekly		Environmental Monitoring Company	During drilling activities	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
Leaching Operations	Brine quality/Receiving water quality (salt content, pH, heavy metals,)	At diffuser location Tuz Gölü (brine discharge) Measurements to be made upstream and downstream of diffuser as well as on either side. Attempts will be made to characterize the brine discharge "plume" and how/if it is evolving with time compared to predictions to ensure it remains in the unproductive area	Conductivity meter, pH meter Atomic absorption -key parameters –compare to receiving water in unproductive area	Monthly		Environmental Monitoring Company	During Leaching operations	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
Operation	Noise from Compressor Stations	• Compressor Station at the project sites • At the nearest settlement area	Noise measurements by sound level meter with weighting options (constant ,slowly changing noise and impulsive noise) also measuring sound pressure level (SPL);	Measurement at the start of operation, and then any complaints from local residents		BOTAŞ	During operation	
	Domestic Wastewater	Wastewater treatment plant effluent	Effluent analysis for basic quality parameters (pH, BOD, suspended solids)	Weekly initially then monthly if operation stable In accordance with the official discharge permit)		BOTAŞ	During operation	

Phase	What Parameter is to be monitored?	Where is the parameter to be monitored?	How is the parameter to be monitored/ type of monitoring equipment?	When is the parameter to be monitored- frequency of measurement or continuous?	Monitoring Cost What is the cost of equipment or contractor charges to perform monitoring	Responsibility	Start Date	End Date
	Fire protection system	At surface facilities area	Visual and regularly scheduled simulations	Monthly initially, quarterly if no problems observed		BOTAŞ	During operation	
	Leakage and explosion	Gas storage area, surface facilities	Methane detectors	Continuous		BOTAŞ	During operation	

C INSTITUTIONAL ARRANGEMENTS

Organization Overview

In order to provide an efficient co-ordination,

- BOTAŞ,
- Construction Contractor,
- Independent Environmental Monitoring Company to be hired by BOTAŞ,
- Ministry of Environment & Forestry (MoEF) MoEF, EIA Monitoring and Control Department and its associated units.

have to work in coordination in both technical and managerial matters. Please refer to the Organization Chart for the information flows and the responsible parties in BOTAŞ and its Contractor.

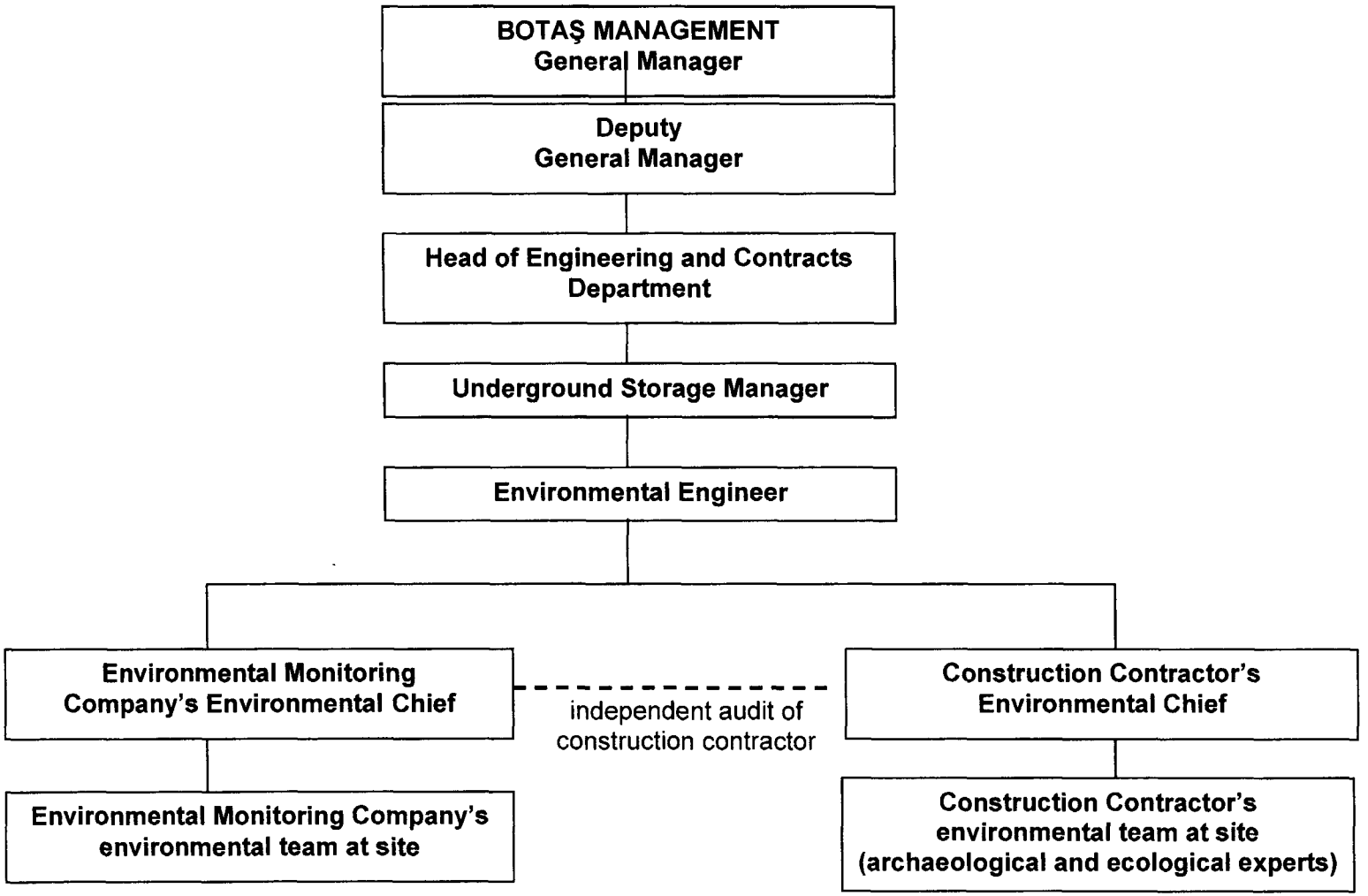
With reference to the Environmental Management Plan (EMP), monitoring and control are of critical importance for minimizing the environmental impacts during project implementation.

BOTAŞ Management (refer to the chain in the chart) together with the department that will be responsible for the construction activities will ensure that all construction related activities of Contractor(s) comply with approved EMP. To achieve this, BOTAŞ will regularly monitor and evaluate the Contractor's field activities and performance through auditors.

Environmental Engineer of BOTAŞ directly connected to Underground Storage Manager, will be responsible for coordinating and supervising the monitoring activities. BOTAŞ will also carry out an independent auditing programme through an Environmental Monitoring Company, which will inspect the field activities of Contractor(s) and directly report to BOTAŞ.

Roles And Responsibilities

BOTAŞ Contractor(s) will be responsible for the adoption of the EMP during the construction phase, implementation of all mitigation measures stated in EMP and required to be in compliance with the EMP together with the project' environmental standards. In order to achieve this, BOTAŞ Contractor(s) will adopt a self-control/monitoring mechanism and formulate his own management plan including regular self inspection and auditing programme, which will be reviewed in terms of consistency with EMP and approved by BOTAŞ prior to construction. BOTAŞ Contractor(s) through assigning a full time "Environmental Engineer", will prepare the progress reports (weekly) based on the monitoring plan detailing works completed within the respective period, results of measurements and supervisions further to the problems encountered on the site and have direct contact with BOTAŞ Environmental Engineer. The progress reports should also include a work schedule for the next period.


BOTAŞ MANAGEMENT
General Manager
Deputy
General Manager
Head of Engineering and Contracts
Department
Underground Storage Manager
Environmental Engineer
Environmental Monitoring
Company's Environmental Chief
independent audit of
construction contractor
Construction Contractor's
Environmental Chief
Environmental Monitoring Company's
environmental team at site
Construction Contractor's
environmental team at site
(archaeological and ecological experts)

BOTAŞ will hire an "Environmental Monitoring Company" for independent monitoring the BOTAŞ Contractor(s) activity. Environmental Monitoring Company will weekly review and comment on the weekly reports written and presented by the Contractor(s), inspect the work sites, review the environmental performance of the project and the Contractor's field activities, carry out environmental control analyses and data collection as defined in EMP, and report the findings both to the Contractor's Environmental Engineer and BOTAŞ Environmental Engineer, in weekly basis. The reports should detail environmental problems encountered on the site, deficiencies in protection measures and recommendations for solutions. Responsibility for solving the reported problems and remedying the reported deficiencies rests with the Contractor(s) may possibly need approval from BOTAS if either the schedule is affected or money is needed to make the recommended solutions. The Environmental Monitoring Company should integrate into this studies the site visits and environmental control analyses, and propose solutions for any bottlenecks environmentally encountered on the site.

Weekly and Monthly reports by Environmental Monitoring Company will be provided to BOTAŞ for review and approval of BOTAŞ Environmental Engineer who will evaluate data collected and analyses, perform verification visits during construction and operation activities incase needed, and prepare a final report including summary of the activities and recommended actions, if necessary.as monthly basis, which needs to be reviewed and approved by the UGS Manager. Incase any significant action is required (such as stopping the construction or needs money), BOTAŞ Management will be informed.

At the project site, daily meetings initially (but the frequency may be changed by BOTAŞ, depending on the work progress) with the participation of Environmental Monitoring Company's, Contractor's and BOTAŞ's site supervisors, to discuss the daily activities, and take decisions. With BOTAS authorization and approval, the Contractor(s) will be responsible for adoption of the decisions and to perform the required actions.

Compliance and non-compliance with EMP identified during the inspection and audits will be recorded by Environmental Monitoring Company and reported to BOTAŞ immediately. BOTAŞ Management will take necessary actions in such a case stop the activities in the case of Contractor's non-compliance with EMP and take the corrective actions.

BOTAŞ will submit Summary Reports to World Bank quarterly basis indicating the activities and actions taken, as well as project progress.

The monitoring process should involve the contribution of the MoEF. The Independent Environmental Monitoring Company will also report to the MoEF periodically during the construction activities in a requested time schedule and format.

During the operation phase of the project, the unit in BOTAŞ that will be responsible for the operation will be totally responsible for the monitoring of the activities and reporting.

BOTAŞ, at that stage, will either continue on working with the Environmental Monitoring Company, which performs the monitoring during the construction phase, or hire another company (in a time based-reimbursable basis) for making the necessary measurements as defined in the operation phase of the monitoring plan and reporting the measurement results to BOTAŞ. The environmental engineer of the department responsible for the operation of the project will review and evaluate these results and prepare the reports quarterly including any recommended actions to the BOTAŞ Management.

D. CONSULTATION WITH LOCAL NGOs AND PROJECT-AFFECTED GROUPS

First Public Consultation

Announcement

The notification of the consultation was announced by newspaper (named POSTA) on 21.03.2003. In addition the consultation place and date was announced by loudspeaker at several times along the week before meeting by Sultanhani Municipality.

to the local people.

Date of Consultation

27.03.2003

Location

Sultanhani Municipality Meeting Hall

Participators

The members of EIA Review and Evaluation Commission formed by Ministry of Environment were invited to participate to the Public Consultation Meeting, which are as follows;

- Ministry of Environment
  Authority for the Protection of Special Environmental Areas
  General Directorate of EIA and Planning
  General Directorate of Environmental Protection
  General Directorate of Environmental Pollution Prevention and Control
- Ministry of Agriculture & Rural Affairs
- Ministry of Culture & Tourism
- Ministry of Forest
- General Directorate of Minerals Research & Exploration/MTA
- General Directorate of Mineral Works
- General Directorate of State Hydraulic Works/DSI
- General Directorate of Rural Affairs
- General Directorate of Turkish Petroleum Corporation/TPAO
- Aksaray Provincial Directorate of Environment
- Aksaray Provincial Directorate of Health
- Aksaray Provincial Directorate of Agriculture

In addition to the above governmental organizations, local people were informed about the meeting and invited.

Attended

- BOTAŞ Representatives
  Ethem Tozlu/Project Manager, Ertuğ Öztürk, Gamze Emre,Ayça Elgin
- ENVY Inc.
  Ayşegül Korur, Tahir Çebi, Hakan Yılmaz
- Ministry of Environment/General Directorate of EIA and Planning
  Çağatay Dikmen, Nevin Beyhan, Evren Sapmaz

- Sultanhani Municipality (Phone: 0382 242 20 05)
  Seyit Temel/Major
- Aksaray Provincial Directorate of Environment
  Handan Kesgin, Mustafa Erbaş
- Aksaray Provincial Directorate of Agriculture
  Doğan İpek
- General Directorate of Minerals Research & Exploration (MTA)
  Selami Toprak
- General Directorate of Mineral Works
  Sadi Akdemir
- Headman of Cumhuriyet District
  Mustafa Arslanhan
- Headman of Türkistan District
  Mahmut Süslü
- Headman of Selçuk District
  Mustafa Şanlı
- Headman of Zafer District
  Fevzi Saman
- Local people (22 persons)

Names of local people attended the meeting are; Abdullah Kara, İsmail Söylemez, Hamza Böge, Ayhan Kara,İsmail Dölek, Mehmet Sarı, Hasan Soysal, İsmail Sarıgül, Mustafa Kara, Sadi Saman, Veysel Koyuncu, Abdullah Dölek, Murat Ağır, Ramazan Dağlı, Vegis Böge, Mevlut Dölek, Ahmet Duymaz, Hüseyin Ayhan, Veysel Ağır, Memiş Solak, Rasim Kara, Doğan İpek.

Anyone who wants to contact these local people may contact with "Headmans (muhtar) through contact with Sultanhani Municipality.

Meeting Program/Schedule

Before the Public Consultation Meeting, a site visit with the participation of the representatives of Ministry of Environment, General Directorate of Minerals Research & Exploration, General Directorate of Mineral Works, ENVY Inc. and BOTAŞ representatives, was performed. The Public Consultation Meeting was held at 02:00 p.m. at the Sultanhani Municipality Meeting Hall. The chairperson Handan Kesgin, head of Aksaray Provincial Directorate of Environment, gave brief information to the attendees, which was then followed by the presentation by ENVY Inc. During the presentation, the need for the project, how the EIA Report has been prepared, the project site, potential impacts of the project and the proposed mitigation measures as well as the results were described. The questions raised were answered by ENVY Inc. and BOTAŞ representatives.

Summary Meeting Minutes

The questions of attendees were as follows:

Question: What are the reasons for not using surface water instead of groundwater during the creation of caverns?

Answer: During the alternative evaluation for water supply, the necessary researches were made. Accordingly, no surface water could be determined at a location nearby the project area in the surroundings. The closest surface water source is the Eşmekaya Lake located approximately 30 km northwest of the area. The 4.500 ha area at the mentioned region has been declared as a Site Area in 1992 under the name of Eşmekaya Reed Bed, and declared as Wild Life Protection Area in 1994. In this respect, it will not be possible to obtain the approximately 570 m^3/h (~ 4.993.200 m^3/year) water requirement necessary for the proposed project from a site area. Additionally, bringing water from a source 30 km distant would add extra costs to the project.

The above mentioned explanations are given at Final Report Section 7.3.

Due to the groundwater shortage of the region and the project revision (opening of 4 caverns simultaneously instead of 2), althougyh there exist no problem related to the allowance of this amount of water from groundwater resources, BOTAŞ decided to utilize Hirfanli Dam reservoir located 115 km from the project site as a fresh water source. DSI (State Hydraulic Works), the authority responsible for the water resources allocation in Turkey, provided their official approval for use of the required 10-12×10^6 m^3/yr water from Hirfanli Dam.

Question: How much area will the project cover? Will the regional stockbreeding be affected from the project? Will the project prevent animal transits?

Answer: The project is comprised of (I) surface plants / facilities, (ii) wellheads and (iii) pipelines. The area of the surface facilities is 500 m x 800 m. The wellheads possess a very small area, and it is estimated that this area will be at most 20 m x 20 m. The pipelines will pass underground. In this respect, except for the surface facilities and wellheads, no area will be occupied to negatively affect the animal transit or the agricultural activities.

Question: What measures will be taken for to prevent collapsing and leakage possibilities at the wells opened by TPAO in the proximity and the cavities at 100-300 m depths when natural gas is pumped to the caverns?

Answer: During the drilling activities, it is possible that cavities or groundwater sources be present at the formations transited until an impermeable area is reached. In this case, casing will be placed along the drilling cross section until the impermeable formation and the drilling activities shall be executed within this caisson. In this way, there will not be any leak or leakage when any cavity is reached.

In this respect, the drilling activities performed at both of the wells have been realized in the explained manner. For both of the wells, a caisson has been placed until an impermeable formation is reached at approx. 660 m, and the drilling activities were performed within this

caisson. Therefore, it has been prevented for the underground sources to be negatively affected from potential drilling mud leak.

Question: What are the measures to be taken during drilling studies for the collapses that may arise due to the possibility of mud filling to these cavities located underground?

Answer: The answer to this question is the same as the preceding one.

Question: What will be the environmental effect of the nitrogen gas used for impermeability?

Answer: When it is considered that the nitrogen gas ratio in the air we breathe is 78%, it is not foreseen that the nitrogen gas used in the scope of the project to have any negative effect.

Question: How good is the durability to earthquakes?

Answer: The project site is located at one of the least seismic and most stable regions of Anatolia. However, the past seismic history of Turkey provides evidence that earthquake of 6,5 magnitude can arise at almost any unexpected location within the country. Consequently, in terms of the results of such a variable case, it would be a more foresighted approach to account for a "long-term" seismic risk in the site. When evaluated in long term (average return period within 5000 year term), PGA (peak ground acceleration) will be about 0,3g. When evaluated in short term (which is approximately 500 year return period), PGA will bear a value of 0,17g.

In this respect, during the design of the facilities in the project site, the earthquake magnitude that has been estimated with the worst case scenario has been taken into account. In this manner, every kind of measure has been taken for the surface facilities in case an earthquake occurs. Additionally, the studies performed at the project site, point out that the caverns to be constructed 700 m below the ground will not be affected from any seismic activity.

However, there will be safety valves at the caverns at several depths along the line extending from the surface down to the cavern mouth. These valves will not only be automatically closed during earthquakes, but also in case of all extraordinary phenomenal conditions.

Question: How will the pasture, treasure and agricultural fields be affected? Isn't it necessary for the Parcel and Plate numbers of the wells to be opened and the estates to be utilized at the project to be known?

Answer: The project is currently in the stage of feasibility and the "certain" location of the project has not yet been determined. In this respect, it is not possible to determine the parcel numbers of the project site. However, before the commencement of the construction activities in the region, an application is to be made to the Ministry of Agriculture and Rural Affairs Agricultural Production and Development General Directorate (TUGEM) regarding the fact that whether the project site is included within the 4342 issued Pasture Law. In case the

area is a pasture, permission will be taken from TUGEM for allocation purpose modification before the commencement of the investment.

Question: Will the drinking water of the Sultanhani District be affected from the project?

Answer: All the water transmission and discharge lines will be transmitted with closed pipe system. Additionally, it has been researched by DSI whether the water to be necessary for the leaching is present in the region and approval has been given regarding the fact that the approximately annual 5 million m^3 water necessary for this project can be met from the underground water resources. In this respect, it is not expected for any negative effect to occur on the drinking water resources in the scope of the project.

Question: Can the brine obtained as a result of the leaching of the salt formation be used for irrigation purposes after treatment?

Answer: It is possible for to treat the brine and bring it to the irrigation water criteria. In this respect, the water taken from sea in the Arabian countries is treated. However, this is a very costly process. Since the water amount to arise at the end of the leaching process is very high, and due to the fact that the treatment of the arising brine being very costly, this is not a cost-effective method.

Question: Will the fact that groundwater being used for the project, negatively affect the agriculture in the region?

Answer: The utilization of ground water during the project will not be continuous and shall only be used during the period of opening the caverns (approximately 10 years). In this respect, the opinion of DSI has been taken regarding the ground water reserves in this area and the mentioned institution has allocated a total of approximately 5×10^6 m^3 of water for this project. Therefore, an approximate 10-year utilization of the ground water is not expected to negatively affect the irrigation activities of the region.

Due to the groundwater shortage of the region and the project revision (opening of 4 caverns simultaneously instead of 2), althougyh there exist no problem related to the allowance of this amount of water from groundwater resources, BOTAŞ decided to utilize Hirfanli Dam reservoir located 115 km from the project site as a fresh water source. DSI (State Hydraulic Works), the authority responsible for the water resources allocation in Turkey, provided their official approval for use of the required $10\text{-}12 \times 10^6$ m^3/yr water from Hirfanli Dam.

Question: What will be the effect of the brine arising as a result of the leaching of the salt formation?

Answer: Detailed explanations are present at section 5.2.5.4 of the EIA Report for this topic. Accordingly, the brine obtained as a result of leaching operation will be discharged to the Tuz Golu. For this aim, a Niggle Diagram has been prepared to clearly determine whether the Tuz Golu shows similar characteristics with the brine (brine). The mentioned diagram is being used for a long time by DSI for basin and irrigation water projects and by Bank of Provinces for drinking water projects, to determine whether different water are of the same

source or not. This diagram draws the anion and cation concentrations of the water sources on a single-sided logarithmic scale and the anion-cation changes of the water are observed. In the same-sourced waters, the anion-cation changes at the waters shows similarity.

In the scope of the Tuz Golu UNGSP (Underground Natural Gas Storage Project), the analysis results of the water sample taken from the Tuz Golu is compared with the analysis values of the salt cores via a Niggle Diagram. In the diagram where the anion and cation concentrations are taken into account, it has been seen that the salt cores and the anion-cation changes of the Tuz Golu show a similarity. In this respect, it can be drawn out that the Tuz Golu and the water to be obtained by leaching the salt cores are of the same source.

As a result, the discharge of the brine to be obtained as a result of the leaching of salt cores to Tuz Golu will not negatively affect the present quality of the lake. Additionally, as a consequence of the discharge of the brine to be obtained from the salt beds, which are a continuation of the salt beds located under the Tuz Golu and having the same composition with the Tuz Golu, to the lake will positively affect the lake, which is subject to continuous water loss.

In a similar in Germany, the fact that the discharge of the leaching waters for long years to a fresh water source (Fulda River) near the project site has not negatively affected the lake, gives a general idea regarding the environmental issues mentioned above.

Note: By the regional community of Bezirci Lake nearby the project site, it has been stated that *Kaisers* occur from time to time in the region.

Second Public Consultation

For the revision in Project and the fresh water pipeline 2 additional Public Consultation Meetings were held, the first one in Ağaçören Municipality, which is cn the way of fresh water pipeline route, the second one in Sultanhani Municipality as the previous one. The records of these 2 meetings are as follows:

Ağaçören Municipality

Announcement

The notification of the consultation was announced by announced by loudspeaker at several times along the week before meeting by Ağaçören Municipality to the local people.

Date of Consultation

24.03.2005

Location

Ağaçören Municipality Meeting Hall

Particpators

- BOTAŞ Representatives
  Ethem Tozlu/Project Manager, Faran Özer, Gamze Emre, Erdeşir İkizoğlu
- ENVY Inc.
  Ayşegül Korur
- Ağaçören Municipality **(Phone:0382 331 20 07)**
  Ahmet Aydın/ Acting Major
- Aksaray Provincial Directorate of Environment **(Phone: 0382 2129098)**
  Ahmet Çakmak (Director of Environmental Management and EIA)
  Mustafa Erbaş (Engineer)
- Aksaray Provincial Directorate of Agriculture **(Phone: 0382 213 1021)**
  Halil Özen (Engineer)
  Ahmet Koşan (Engineer)
  Kemal A.Kahraman (Engineer)
- Headman of GümüştepeDistrict
  Menderes Aydın
- Headman of Camii District
  Muammer Yeşilöz
- Headman of Yurtsever District
  Gürsel Göktaş
- Headman of Yenimahalle District
  Üçler Bekneviç
- Local people (11persons)

Kemal Yüksel, Hamit Görgülü, Adem Erbaş, İlhami Kaynak, Rüstem Görgülü, Hikmet Yalman, Bünyamin Yılmaz, Fazlı Göktaş, Yaşar Görgülü, Muharrem Aslihan, Tahsin Görgülü

Anyone who wants to contact these local people may contact with Headmans (muhtar) through contact with Ağaçören Municipality.

Meeting Program/Schedule

The Public Consultation Meeting was held at 11:00 a.m. at the Ağaçören Municipality Meeting Hall. Ethem Tozlu, Project Manager gave brief information to the attendees. During the presentation, the need for the project, how the EIA Report has been prepared, the project site, potential impacts of the project and the proposed mitigation measures as well as the results were described including the history of the project and the revisions made by BOTAŞ. The questions raised were answered by BOTAŞ representatives.

Summary Meeting Minutes

Question: How long will leaching operations last?

Answer: Leaching operation will last approximately 7,5 years, and the pipeline construction will last for 2,5 years. The fresh water pipeline will be given to the DSI after the project completion.

Question: What will happen incase a drought problem in Hirfanli Dam, especially during summer months?

Answer: Water intake location will be decided together with DSI representatives. Therefore no such problem is expected.

Sultanhani Municipality

Announcement

The notification of the consultation was announced by loudspeaker at several times along the week before meeting by Sultanhani Municipality to the local people.

Date of Consultation

24.03.2005

Location

Sultanhani Municipality Meeting Hall

Particpators

- BOTAŞ Representatives
  Ethem Tozlu/Project Manager, Faran Özer, Gamze Emre, Erdeşir İkizoğlu
- ENVY Inc.
  Ayşegül Korur
- Sultanhani Municipality
  Seyit Temel/ Major
- Aksaray Provincial Directorate of Environment **(Phone: 0382 2129098)**
  Ahmet Çakmak (Director of Environmental Management and EIA)
  Mustafa Erbaş (Engineer)
- Aksaray Provincial Directorate of Agriculture **(Phone: 0382 213 1021)**
  Halil Özen (Engineer)
  Ahmet Koşan (Engineer)
- Local people (51 persons)

Names of local people attended the meeting are ; Veli Kara, İsmail Öztürk, Fevzi Kara, Rasim Kara, Seyit Öztürk, Muhittin Akbaş, Fahri Solak, Ahmet Böge, Abuzer Solak, Cumali Turgut, Ömer Özuslu, Veli Kara, Ziya Pekmezci, İbrahşm Körük, Veli Yumuşak, Rasim Kara, Murat Solak, Hacı Ağır, İsmail Aydın, Ahmet Özuslu, Fevzi Yumuşak, İsmail Dölek, Ahmet Salman, İbrahim Atar, Muharrem Atar, Ahmet Neşeli, Hacı Mustafa Ağır, Mustafa Solak, Ahmet Tosun, Ömer Saman, Mehmet Neşeli, Ömer Solak, Mustafa Tahir Öztürk, Mümtaz Kara, İbrahim Altınsoy, Mustafa Altınsoy, Derviş Özdemir, Cuma Mutlu, Mehmet Ali, Kazım Kürkçü, Veysel Koyuncu, Veyis Dölek, Mehmet Pekmezci, Ömer Akarlı, Cumali Sarı

Meeting Program/Schedule

The Public Consultation Meeting was held at 03:00 p.m. at the Sultanhani Municipality Meeting Hall. Ethem Tozlu, Project Manager gave brief information to the attendees. During the presentation, the need for the project, how the EIA Report has been prepared, the project

site, potential impacts of the project and the proposed mitigation measures as well as the results were described including the history of the project and the revisions made by BOTAŞ. The questions raised were answered by BOTAŞ representatives.

Summary Meeting Minutes

Question: What will be dimensions of the storage facility?

Answer: One storage cavern will have a volume of 500,000 m^3. (approximately with a depth of 400 m, and with width of 80 m)

Question: Will there be any earthquake risk?

Answer: Earthquake risk analysis was done within the scope of the project. The project site (Aksaray) is located at one of the least seismic and most stable regions of Anatolia. In addition, the earthquakes of last 100 years were investigated within this study and no such problem is expected.

Question: What will happen to the fresh water pipeline after the project completion?

Answer: The pipeline will be given to DSI.

Question: When the construction of pipeline will start? How many people will work?

Answer: It will start on October or November 2005. Approximately 200 people will work during the construction. During the operation phase of the project 50 people will be working. Local people will be preferred.

Question: How much area will be fenced and the entrance will be forbidden?

Answer: At wellhead locations 20 m x 20 m area will be fenced. The pipelines will pass underground. In this respect, except for the surface facilities and wellheads, no area will be occupied to negatively affect the animal transit or the agricultural activities.

ANNEX

1. Water Pollution Control Regulation/Table 21.2

Table 1. Domestic Wastewater Discharge Standards

Parameters	Discharge Limits *	
	2 hours composite sample	24 hours composite sample
BOD_5 (mg/L)	50	45
COD (mg/L)	160	110
SPM (mg/L)	60	30
pH	6-9	6-9

BOD: Biochemical Oxygen Demand
COD: Chemical Oxygen Demand
SPM: Suspended Particulate Matter
Class 2: Pollutant load is 60-600 kg/day as raw BOD

2. Worker Health and Occupational Safety Act/Article 22

The noise levels, where heavy and dangerous activities are not performed, shall not exceed 80 dBA. At the areas, where the working activities, generating higher noise levels due to the requirements are conducted, the noise levels shall be 95 dBA maximum. However, in such a case, the workers shall be given protective equipments, i.e. special helmets, earphones or earplugs against noise.

3. Noise Control Regulation/Table 2,3&4

Table 2. Maximum Noise Level that workers can subject to

Noise Occurrence Period (hr/d)	Maximum Noise Level (dBA)
7.5	80
4	90
2	95
1	100
0.5	105
0.25	110
1/8	115

Table 3. Noise Limit Values

Region	Explanation	Leq (dBA)
I	Settlement area out of the city (far from traffic)	35 – 45
II	City side settlement	40 – 50
	City settlement area (100 m distance to traffic flow)	45 – 55
	Settlement area out of the city, main roads, workplaces (60 m	50 – 60

	distance to traffic flow)	
III	The city center settlement area, main roads, work places (20 m distance to traffic flow)	55 – 65
IV	Industrial Region or roads on which heavy vehicle and buses are operated	60 – 70

Table 4. Noise Limit Values

Source	L_{eq} (dBA)	
	Day (06.00-22.00)	Night (22.00-06.00)
Industrial Noise		
Continuous	65	55
Sudden	70	60
Work Site Noise		
Building construction (continuous)	70	-
Road construction (temporary)	75	-
Beat Noise	100 (L_{max})	-

4. Decisions of Central Hunting Commission

The protection status of species is defined by Article 2 of the Terrestial Hunting Law (dated 5.5.1937 no. 3167) and the pertaining decisions of the Central Hunting Commission are updated each year.

According to the 2000-2001 Hunting Season decision of the General Directorate of National Parks and Game-Wildlife, Central Hunting Commission;

"The species given permission to hunt in specified periods" in Appendix List I are the species in Appendix III of Bern Convention. According the Bern Convention, hunting of the species listed in Appendix II is prohibited every season.
The species, which are allowed to be hunted every season by the Central Hunting Commission, are the ones that are not under protection by the Bern Convention. According to the Bern Convention, the species "Under Definite Protection" are listed in Appendix II while the ones "Under Temporary Protection" is listed in Appendix III. The Central Hunting Commission decision was given considering these statements."

5. Bern Convention

In the context of Bern Convention, in Article 6, for the special protection of the wild fauna species specified in Appendix II, the following will in particular be prohibited for these species:

(a) all forms of deliberate capture and keeping and deliberate killing;
(b) the deliberate damage to or destruction of breeding or resting sites;
(c) the deliberate disturbance of wild fauna, particularly during the period of breeding, rearing and hibernation, insofar as disturbance would be significant in relation to the objectives of this Convention;
(d) the deliberate destruction or taking of eggs from the wild or keeping these eggs even if empty;
(e) the possession of and internal trade in these animals, alive or dead, including stuffed animals and any readily recognizable part or derivative thereof, where this would contribute to the effectiveness of the provisions of this article.

In Article 7, for the special protection of the wild fauna species specified in Appendix III measures to be taken shall include:

(a) closed seasons and/or other procedures regulating the exploitation;
(b) the temporary or local prohibition of exploitation, as appropriate, in order to restore satisfactory population levels;
(c) the regulation as appropriate of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals.

1 PROJECT DESCRIPTION AND OBJECTIVES

1.1 Project Description

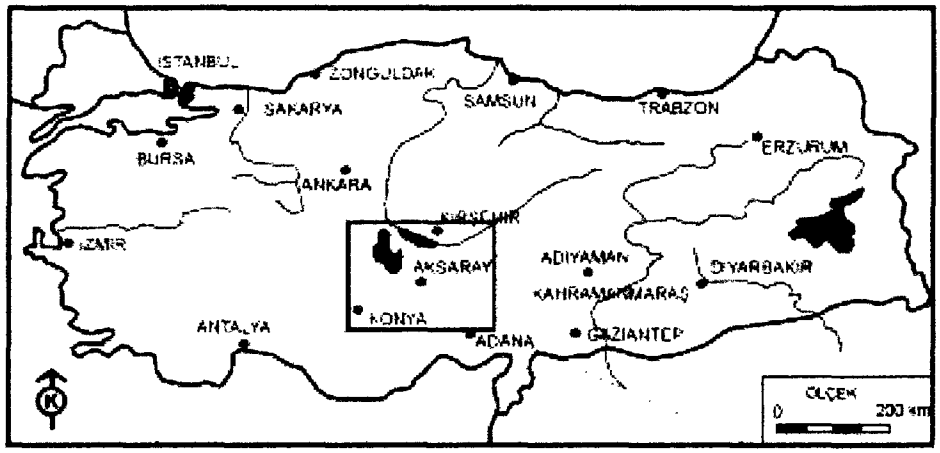
The objective of Tuz Golu (Salt Lake) Basin Underground Natural Gas Storage Project (UNGSP) is to meet the seasonal fluctuations to be occurred in the future depending on the increase in residential natural gas demand. In that content, it is planned to store natural gas between the salt layers, located at a depth of approximately 1150 m.

Tuz Golu Basin UNGSP is proposed to be realized about 17 km south of Sultanhani Municipality of the Central District of Aksaray Province by Petroleum Pipeline Corporation (BOTAŞ) (see Figure 1.1 and Figure 1.2). Proposed project site is located in the south of Tuz Golu and the closest distance between the site and the lake is approximately 40 km.

The project of concern will be one of the first investments in Turkey that will be carried out for the natural gas underground storage[1]. The seismic, drilling, feasibility, design and similar engineering studies related to the topic and environmental impact assessment were executed by a consortium established by Russian, German and Turkish companies; namely, PODZEMGAZPROM Limited (PGP), Pipeline Engineering GmbH (PLE) and ENVY Energy and Environmental Investments Inc. (ENVY), respectively. The Turkish Petroleum Corporation (TPAO) carried out the studies three-dimensional seismicity and drilling activities for this consortium.

Within the context of the Tuz Golu Basin UNGSP of concern, the underground salt layers, located at the Bezirci Lake locality, approximately 17 km south of the Sultanhani Municipality, will be utilized. In this regard, the excess natural gas, which is revealed especially in the summer months in the country scale, will be withdrawn via a branching from the Kayseri-Konya-Seydisehir section of the Eastern Anatolia Natural Gas Main Transmission Line situated approximately 14 km north of the project site, and will be stored in the caverns, that will be created in salt layers.

[1] *As per the agreement between BOTAS and TPAO to develop and operate the North Marmara and Degirmenkoy Natural Gas Sites as underground natural gas storage with the investments to be made by TPAO, the North Marmara and Degirmenkoy Sites Underground Gas Storage Project was realized. Pursuant to the Environmental Impact Assessment Regulation, which took effect having been published in the Official Gazette dated 06.06.2002 and numbered 24777, of the Ministry of Environment of the Republic of Turkey, "EIA Approved Certificate" has been obtained. In respect of the project, the drilling activities are continuing as of April 2003.*



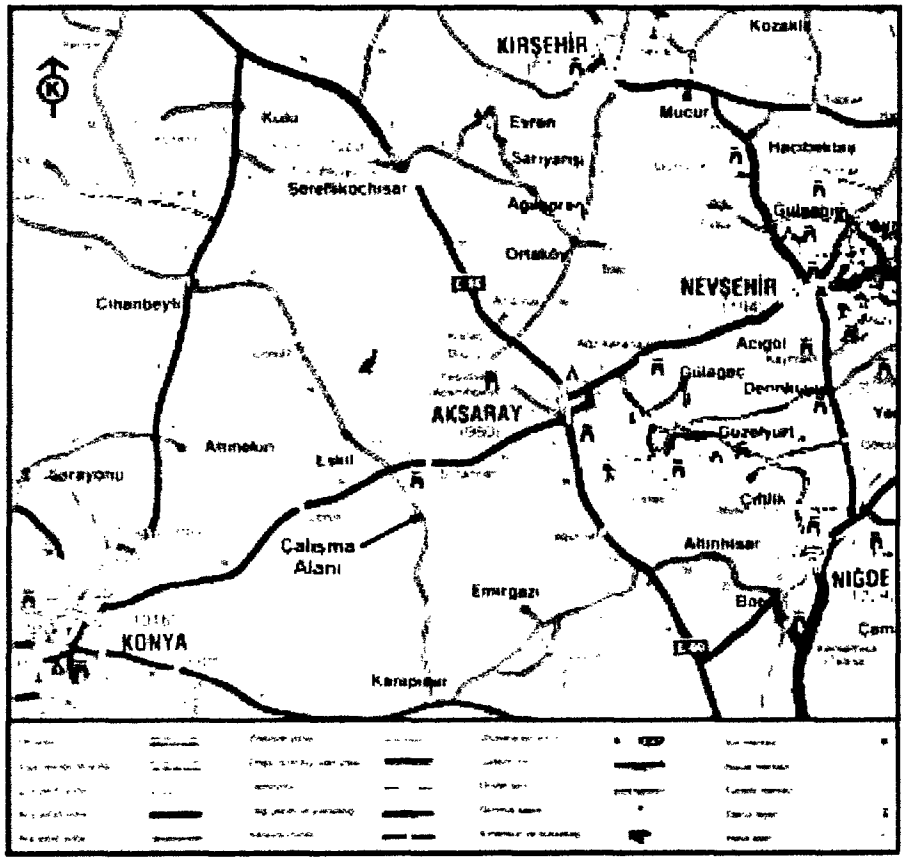


Figure 1.1 Location of the Proposed Project Site in Turkey

Figure 1.2 Proposed Project Site and Its Vicinity

On the country scale, in order to meet the increasing gas demand especially in the winter months, stored gas will be withdrawn from these caverns and again will be transmitted to the Kayseri-Konya-Seydisehir section of the Eastern Anatolia Natural Gas Main Transmission Line for usage.

In order to determine the seismic characteristics of the region, seismic studies, which began in November of the year 2000, were carried out within an area of about 80 km^2. The proposed project site was chosen within this study area and detailed information concerning its location is presented in Section 2.

The salt domes to be used in the project are located approximately 700 m and deeper in the surface and have a thickness of 700 to 1500 m. During the project, the leaching (dissolving of the salt domes) method, which is a commonly used method around the world, will be used for minimum 12,5-15 years, and 10 caverns, each having approximately 500,000 m^3 of volume, will be created. There will be approximately 42×10^6 m^3 cushion gas in each cavern and the process will be performed with approximately 70×10^6 m^3, over the cushion gas. Thus, approximately 112×10^6 m^3 of gas can be storable in each cavern[2]. The total cushion gas will be approximately 420×10^6 m^3. The total amount of gas that will be taken from the national network, stored and then returned to the network is stipulated to be 700×10^6 m^3.

Fresh water will be used to leach the underground salt domes and the present groundwater reserves in the region will be utilized for water demand. The brine (solution) arose following the leaching process, is planned to be discharged to Tuz Golu.

In the extent of the project, two caverns will be opened simultaneously and the required time for this process is approximately 30-36 months. In this regard, the time required for the opening of the 10 proposed caverns will be around 150-180 months (12,5-15 years). Within this period, the natural gas storage process will be commenced in the opened caverns. In other words, the construction and operation activities of Tuz Golu Basin UNGSP will be carried out concurrently.

The economic lifetime of the similar projects, which are still considered as projects with recent past in the world literature, is estimated as at least 50 years.

[2] *Since the natural gas will be stored under pressure (through compression), the amount of natural gas will be more than the volume of cavern.*

1.2 Objectives of the Project Activities

Within the scope of the proposed Tuz Golu Basin UNGSP, the natural gas transported via Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line will be stored when the national natural gas demand decreases, and it will be transmitted back to the line with the increase in demand, to obtain a balance in national natural gas supply and demand. The main objectives of the project are stated below:

- Since the project is the first application of underground storage of natural gas in Turkey, it will constitute an example to future implementations.
- The excess natural gas resulting from the low demand during summer months could be stored. Thus, when the natural gas shortage arise because of the increase in demand during winter months, stored gas will be withdrawn from these caverns and will be given back to the national network. As a result, the supply and demand equilibrium of the national natural gas will be ensured.
- In case if the project is realized, the natural gas transported from the foreign countries will be stored in order to supply a reserve for the country.
- The national resources used for electrical energy and heating purposes will be stabilized.
- Healthy and continuous energy source will be provided for the rapidly increasing number of industrial facilities.

1.3 Electrical Energy Policy of Turkey

The main goal of the energy policies in Turkey is defined as "to provide secure, cheap, high-quality, clean energy required for the country in time, in a way as to maintain progress and social development". The main principles of Turkish energy policy are to increase the efficiency in energy generation, to give the priority to the utilization of local resources to the maximum extent, and besides the utilization of the native resources, to draw attention to the usage of cleaner energy resources and to provide diversity in resources.

Hydraulic sources and fossil fuels are the main energy resources in Turkey. Lignite among the fossil fuels and natural gas, recently whose demand is increasing continuously, play an important role in the energy supply of the country.

Due to irregular precipitation regime in Turkey, in terms of time and place, as well as its variation owing to the meteorological conditions within frequent periods, the hydraulic

power plants are risky in terms of energy supply safety. In electricity (power) energy generation within thermal power plants, low quality domestic lignite which is not possible to be used in the industry and heating is consumed. Low thermal value and high ash and sulfur rates of these lignite coals increase the importance of environmental problems arising from the thermal power plants.

However, it can be possible to minimize the adverse environmental impacts by using advanced emission control and boiler-burning technologies and taking other necessary measures.

The data which have been published by the Foreign Trade Undersecretariat of the Republic of Turkey and which represent the growth, primary energy generation and consumption increases of Turkey between 1963-2000 are given in Table 1.1[3] According to this table, the primary energy consumption is higher than the energy generation. This situation has caused to increase the gap between the energy generation and consumption. In addition, delay in the energy investments in spite of rapid increase in the manufacturing industrial investments in Plan Periods II and III in particular has caused this gap to increase.

According to the data published by the Foreign Trade Undersecretariat of the Republic of Turkey, the domestic primary energy generation has increased from 25.1 Mtep to 27.6 Mtep by 9.8% during 1990 - 2004[4] (see Table 1.2). The biggest share in this increase is the natural gas generation, which increased 3,3 times, and lignite generation, which increased 1,35 times. The natural gas generation, which was only 0.7% of the total primary energy generation in 1990, increased up to 2.3% of the total generation following the activities in Thrace Region in the recent period.

Lignite and coal generation (production) was 14.6 Mtep in 2000, which constitutes 53% of the total production (see Table 1.2 and Figure 1.3). In the listing of the size of primary energy resources generation, petroleum and natural gas take the second place with the share of 12.9%. The remaining part is the share of geothermal and hydraulic energy, biomass and solar energy.

The primary energy consumption increased from 52.6 Mtep in 1990 up to the level of 79.6 Mtep in 2000, and hence the consumption increased by 51.3% (please refer to Table 1.2). The annual increasing rate became 3.9% in the consumption in 2000.

[3] *http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm*

[4] *tep: ton equivalent petroleum; Mtep: million ton equivalent petroleum*

There is slow-down in the last period in comparison to the high increasing rates in 1995-1996.

Table 1.1. Growth, Energy Generation and Consumption Increases in Different Periods

Periods	Increase in Gross National Income (%)	Increase in Primary Energy Generation (%)	Increase in Primary Energy Consumption (%)
1st Plan Period (1963 – 1967)	6.6	6.9	5.5
2nd Plan Period (1968 – 1972)	6.3	1.9	7.4
3rd Plan Period (1973 – 1977)	5.2	1.9	7.3
4th Plan Period (1979 – 1983)	1.7	2.7	3.8
5th Plan Period (1985 – 1989)	4.7	4.0	6.5
6th Plan Period (1990 – 1994)	3.5	0.9	4.4
7th Plan Period (1996 – 2000)	3.5	1.3	4.5
8th Plan Period (2001 – 2005)*	6.7	1.2	6.1

** Estimation of State Planning Organization (DPT)*
Reference: Foreign Trade Undersecretariat of the Republic of Turkey

The petroleum, which has the biggest share of energy consumption with 43.8% in 2000, is followed by natural gas with 17.6% and lignite with 16.1% (see Table 1.2). The natural gas consumption increased by approximately 3.5 times during 1999-2000 with the impact of acceleration in the construction of natural gas pipelines in recent years. With the increasing number of units of population where the natural gas is served in the future years, the share of natural gas in the total energy consumption is expected to increase.

When the sectoral distribution of 76.7 Mtep of primary energy consumed in 1999, it is observed that industrial sector is leading with 35% followed by residential and services sectors with 34% (please refer to Table 1.3 and Figure 1.4). While the energy consumption shares of the residential and service sectors decreased from 38% to 34% during 1990-1999, any change did not occur in the share of agricultural sector, and the biggest change occurred in the cycle sector, which increased from 21% to 25%. The energy consumption for 2000 of the cycle sector including the power plants, oil refineries and natural gas cycle plants is 19.2 Mtep.

The most significant share of industry sector in the energy consumption is petroleum with 31%, and the share of natural gas, which was 5% in 1990, reached up to 10.3% in 1999.

Table 1.2. Primary Energy Generation and Consumption (Btep)*

Years	Petroleum		Natural Gas		Lignite		Coal		Other		Total	
	Generation	*Consumption*	*Gen.*	*Cons.*	*Gen.*	*Cons.*	*Gen.*	*Con.*	*Gen.*	*Cons.*	*Gen.*	*Cons.*
1990	3.903	23.901	193	3.110	9.524	9.765	2.080	6.150	9.423	9.706	25.123	52.632
1991	4.674	23.315	185	3.827	9.117	10.572	1.827	6.501	9.335	9.700	25.138	53.915
1992	4.495	24.865	180	4.197	10.299	10.743	1.727	6.243	9.707	10.250	26.408	56.298
1993	4.087	28.412	182	4.630	9.790	9.918	1.722	5.834	10.240	11.051	26.021	59.845
1994	3.871	27.142	182	4.921	10.471	10.331	1.636	5.512	9.899	10.769	26.059	58.675
1995	3.692	29.324	166	6.313	10.735	10.570	1.319	5.905	10.343	11.068	26.255	63.180
1996	3.675	30.939	187	7.189	10.876	12.351	1.382	5.560	10.767	11.999	26.887	68.035
1997	3.630	30.515	230	9.165	11.759	12.280	1.347	8.495	10.721	10.912	27.687	71.367
1998	3.385	30.349	514	9.690	12.792	12.631	1.143	8.921	11.030	12.576	28.864	74.167
1999	3.087	33.166	665	11.740	12.242	12.314	1.030	7.708	10.035	11.775	27.059	76.703
2000	2.925	34.893	631	14.071	12.830	12.830	1.769	8.149	9.438	9.728	27.593	79.671

** Btep: Billion tons equivalent petroleum*
Source: Foreign Trade Undersecretariat of the Republic of Turkey

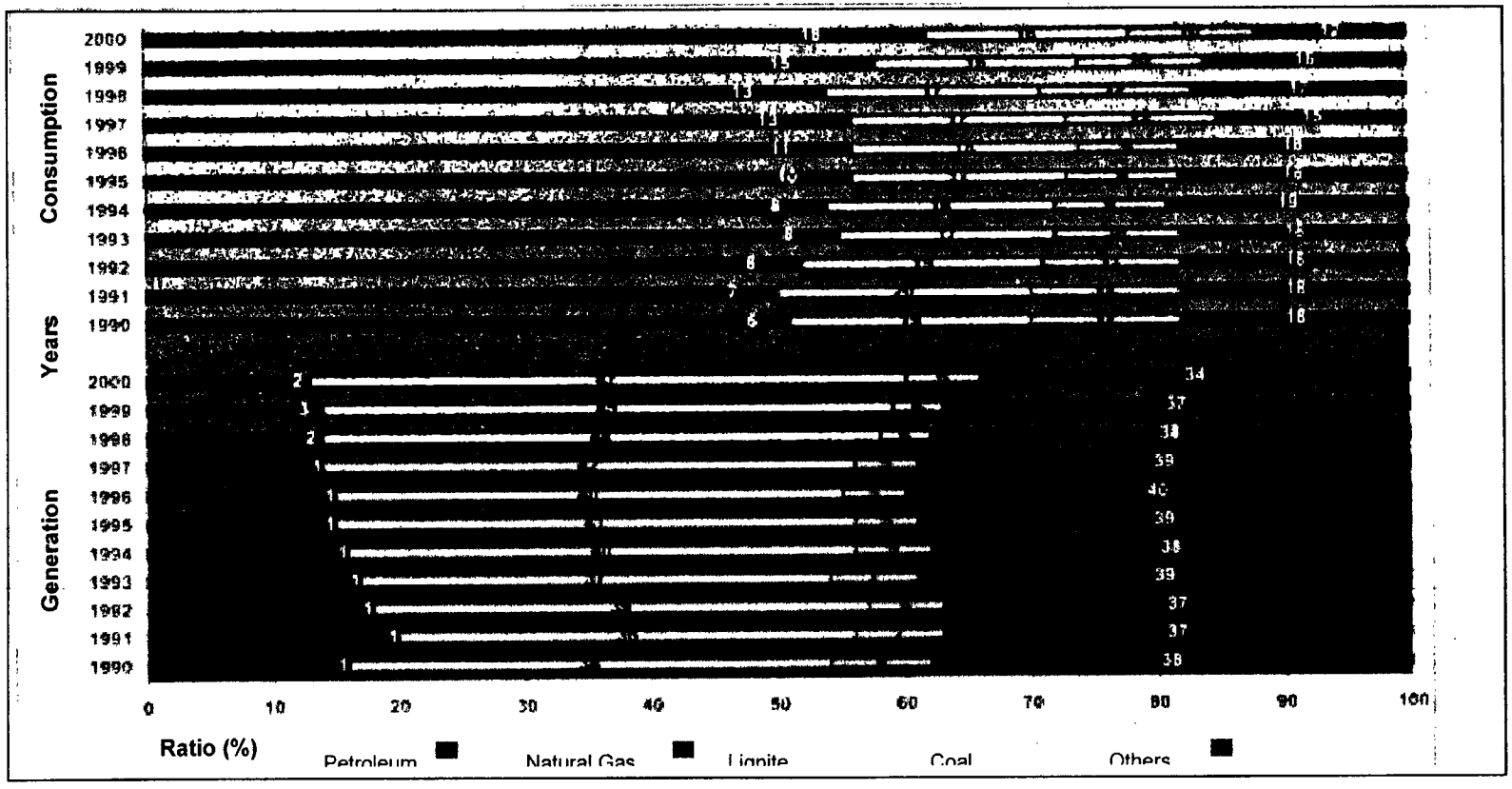


Figure 1.3. Primary Energy Generation and Consumption (%) (Foreign Trade Undersecretariat of the Republic of Turkey)

Table 1.3. Sectoral Energy Consumption (Thousand Tep)

Years	Industry	Residential	Transport	Agriculture	Other than Energy	Final Energy Consumption	Cycle Sector	Total Energy Consumption
1990	14.543	16.087	8.723	1.956	1.031	42.340	11.377	53.716
1991	15.181	16.646	8.304	1.976	1.203	43.310	11.698	55.009
1992	15.454	17.491	8.545	1.994	1.450	44.935	12.526	57.461
1993	16.333	17.734	10.419	2.450	1.743	48.679	12.386	61.065
1994	15.272	17.163	9.907	2.480	1.349	46.171	13.786	59.957
1995	17.372	18.469	11.066	2.556	1.386	50.849	13.703	64.552
1996	20.050	19.373	11.778	2.714	1.643	55.557	15.212	70.769
1997	21.790	20.672	11.338	2.823	1.788	58.412	16.335	74.747
1998	21.555	20.298	10.760	2.827	2.272	57.712	18.096	75.808
1999	20.894	20.228	13.322	2.923	1.881	59.249	19.262	78.511

Reference: Foreign Trade Undersecretariat of the Republic of Turkey

While the consumption increased by 51.3% during 1990-2000, the increase in primary energy consumption remained at 9.8%. Since the increase in consumption became higher than the generation (production), the compensation ratio of generation to consumption decreased from 47.7% to 34% in the last 10 years. The energy import reached up to 52 Mtep through increasing by 1.9 times (see Table 1.4).

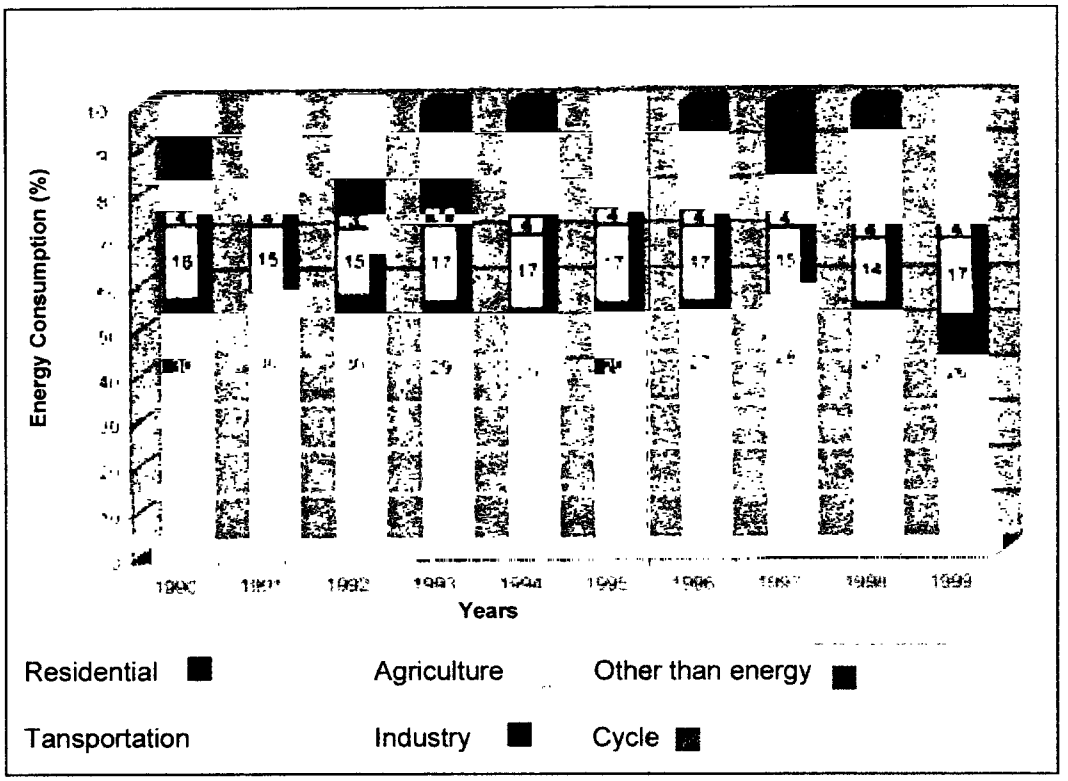


Figure 1.4. Sectoral Energy Consumption (%) (Foreign Trade Undersecretariat of the Republic of Turkey)

Approximately 61.2% of the total energy import in 2000 is constituted by crude oil and oil products, 26% by natural gas and 12.8% by coal and electricity. Although the electricity energy generation investments reached up to 6-7% of total investments during 1996-2000, the increase in annual consumption was around 8%. According to the Foreign Undersecretariat of the Republic of Turkey, it is estimated that the country electricity demand will continue to increase at a high rate until the saturation in consumption is reached5. However, the economic crisis experienced in 2001 caused a decrease in the demand for energy as in the case of crisis experienced in 1994.

Table 1.4. Energy Generation – Consumption and Import (Thousand tep)

Years	Generation	Consumption	Generation / Consumption (%)	Import
1990	25.123	52.632	47.73	27.509
1991	25.138	53.915	46.63	28.777
1992	26.408	56.298	46.91	29.890
1993	26.021	59.845	43.48	33.824
1994	26.059	58.675	44.41	32.616
1995	26.255	63.180	41.56	36.925
1996	26.887	68.035	39.52	41.148
1997	27.687	71.367	38.80	43.680
1998	28.864	74.167	38.92	45.303
1999	27.059	76.703	35.28	49.644
2000	27.593	79.671	34.63	52.078

Reference: Foreign Undersecretariat of the Republic of Turkey

1.4 Energy Generation and Consumption Expectations

According to the data of the Foreign Undersecretariat of the Republic of Turkey, the overall demand for energy, which was 79.7 Mtep in 2000 in the energy projections, is expected to reach up to 129.6 Mtep in 2005, 171.3 Mtep in 2010 and 298.4 Mtep in 2020 with an annual average increase of 6.8% (please refer to Table 1.5).

Table 1.5 Energy Generation and Consumption Expectations (Thousand tep)

Years	Consumption	Generation	Import	Generation / Consumption (%)
2000	79.671	27.593	52.078	34.6
2005	129.625	34.116	95.509	26.3
2010	171.339	47.329	124.010	27.6
2020	298.448	70.238	228.210	23.5

Reference: Foreign Undersecretariat of the Republic of Turkey

It is expected that the overall energy generation, which was 27.6 in 2000, will be 70.2 with an annual increase of 4.8% within the process until 2020. Only 34% of total primary energy demand could be met from local resources in 2000. Due to the increase in demand highly over than the generation, it is estimated that the ratio of generation to consumption will be 27% in 2010 and 23% in 2020.

In other words, the share of import in the energy generation will increase further in the near future. It is expected that the total energy import will reach up to 124 Mtep in 2010 and 228 Mtep in 2020. When the distribution of resources in the overall import is examined, it is anticipated that the share of natural gas will reach to 33% in 2020 while the share of petroleum will decrease from 60% to 33%.

While the overall energy consumption per capita was 1.259 kg-petroleum equivalent (pe) in 2000, it is expected that this value will be 2.076 kg-pe in 2010 and 3.445 kg-pe in 2020 with an average increase of 5.2% on annual basis[5].

1.5 Natural Gas and Recyclable Energy Resources

According to the data published by the Foreign Trade Undersecretariat of the Republic of Turkey, the share of petroleum was 43.8%, lignite and coal was 26.3%, natural gas was 17.6%, hydraulic energy was 33% and recyclable energy resources was 1% in 2000 when the distribution of consumption sources are examined. It is expected that the share of natural gas will be 32% in 2010. Although the shares of natural gas and recyclable energy resources increase, it is anticipated that there will be rapid decrease in the share of petroleum.

When the energy demands of the sectors are examined, it is estimated that the industrial sector will have the highest share with 59% and the shares of other sectors will drop while the share of cycle sector will reach up to 27% in 2020. Natural Gas Combined Cycle Plants that are being or will be put into operation in the future years will play a significant role in this increase[6]

1.6 Natural Gas Utilization in Turkey

The past of the natural gas utilization in Turkey is prolonged till the year 1976. The natural gas had been regarded as one of the energy sources of Turkey, since in some industrial facilities located at Thrace Region had started to use local natural gas; however, its share in primary energy consumption had been negligible until the year 1987. In 1987, together with the import of the natural gas from the former Soviet Union by BOTAŞ, the share of the import natural gas in the energy consumption began to increase rapidly and grew approximately 28 times, reaching up to 14.6 billion m^3 from 0.5 billion m^3 till the year 2000 (2001 Annual Report, BOTAŞ).

In parallel to the demands increasing gradually following 1987, the liquefied natural gas (LNG) purchases from Algeria and then Nigeria effective from 1994 commenced. In the

[5] *However, all these expectations must be revised taking into account the narrowing in economy, which was experienced in 2001 and reflected to 2002. Our economy retrogressed by 9.4% in 2001. As known, 1.8% of decrease in the demand for energy was observed besides the economy that retrogressed by 6.1% during economic crisis 1994. Furthermore, when the grow rate of 3% stipulated for 2002 is taken as basis, it is likely that the demand for energy will not be 298.4 Mtep, but 279.3 Mtep in 2020 with a correction of 6.4%. (Reference: http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm)*

[6] *http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm*

mean time, a second natural gas agreement on 8 billion cubic meters was concluded with the Russian Federation.

1.6.1 Natural Gas Transportation, Facilities and Trade

Within the framework of the policy to diversify resources, BOTAS undertook the construction and operation of natural gas pipelines which it started. Existing natural gas pipelines and related facilities of BOTAS are as written below:

- Russian Federation – Turkey Natural Gas Pipeline
- Marmara Eregli Liquefied Natural Gas (LNG) Importat Terminal
- Izmit – Black Sea Eregli Natural Gas Transmission Line
- East Anatolia Natural Gas Transmission Line
- Karacabey – Izmir Natural Gas Transmission Line
- Samsun – Ankara Natural Gas Transmission Line (the Blue Stream)

1.6.2 Natural Gas Trade

According to the Annual Report 2001 of BOTAS, the quantity of natural gas imported within 2001 is approximately 16.368x106 m^3. The natural gas utilization is increasing rapidly in our country. The highest share of natural gas utilization within the sectors is the electricity sector (see Figure 1.5). According to the supply–demand projections performed by BOTAS, the demand for natural gas is anticipated to be 55x 109 m^3 in 2010 and 82 x 109 m^3 in 2020 (BOTAS, 2002).

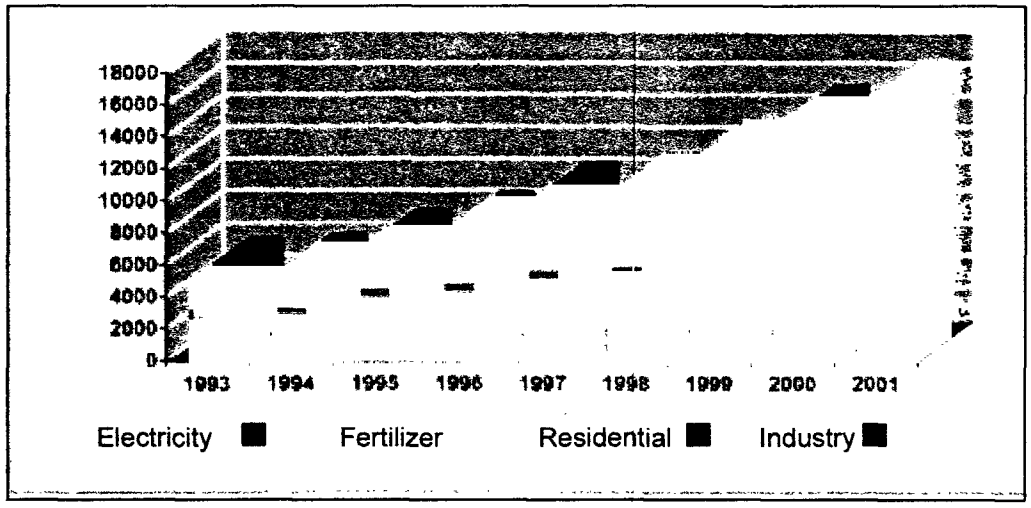


Figure 1.5. Natural Gas Sales Quantities in Different Years (Million m^3) (BOTAS, 2002)

1.6.3 Present Natural Gas and LNG Purchase – Sales Agreements

The present natural and LNG purchase–sales agreements are provided in Table 1.6 and represented on the graph in Figure 1.6.

Table 1.6 Present Natural Gas and LNG Import-Export Agreements

Present Agreements	Amount (Plateau) (Billion m^3/year)	Sign Date	Period (year)
Russian Federation (West)	6	February, 1986	25
Algeria (LNG)	4	April, 1988	20
Nigeria (LNG)	1.2	November, 1995	22
Iran	10	August, 1996	25
Russian Federation (Black Sea)	16	December, 1997	25
Russian Federation (West)	8	February, 1998	23
Turkmenistan	16	May, 1999	30

Reference: BOTAS, 2002

1.6.4 Investments

According to the Annual Report 2001 of BOTAS, BOTAS continues its activities to increase the capacities of Russian Federation – Turkey Natural Gas Pipeline and construct new transmission and distribution lines in addition to the existing lines already constructed in our country.

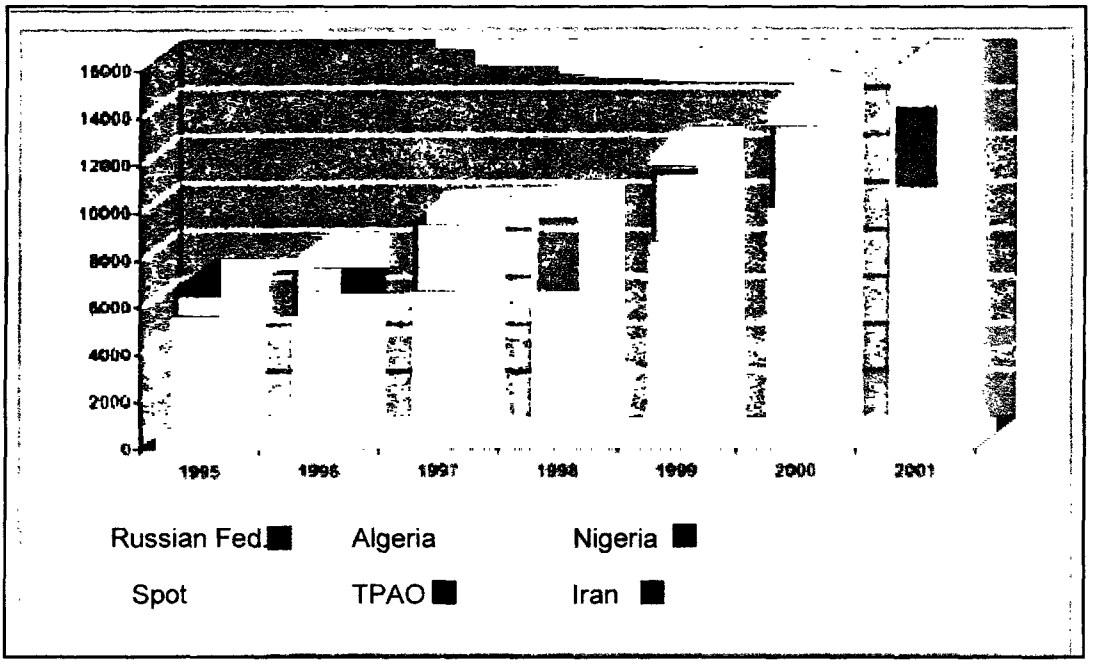


Figure 1.6. Natural Gas Purchase Quantities in Different Years (Million m^3) (BOTAS, 2002)

Furthermore, BOTAS is working on a variety of projects to expand the natural gas utilization throughout the country and diversify the natural gas supplies. Information about the investments and projects is as follows:

- Eastern Anatolia Natural Gas Main Transmission Line: It is aimed to transport the natural gas that will be purchased from the resources in the east including Iran to Turkey with this project. The line with the capacity of 10 x 109 m3 and approximately 1500 km long comprises of the following sections: Dogu Bayazit–Erzurum, Erzurum–Sivas, Sivas–Kayseri, Kayseri–Ankara, Kayseri–Konya–Seydisehir. The overall pipeline became capable of receiving gas as of the end of June 2001.
- Samsun – Ankara Natural Gas Transmission Line (the Blue Stream): It is aimed to transport the Russian gas to Turkey via the Black Sea with this project. The line with the capacity of 16 x 109 m3 and approximately 400 km (dual lines) long starts from Samsun and reaches to Ankara via Amasya, Corum and Kirikkale. Thus, natural gas shall be supplied to the provinces of Samsun, Amasya, Corum and Kirikkale on the route. The first gas was supplied at the end of December 2002.
- Karacabey – Izmir Natural Gas Transmission Line: It is planned to supply natural gas to the natural gas cycle plants in Manisa, Balikesir and Aliaga Region with the

extension of the existing Natural Gas Transmission Line. The line was commissioned in April 2002.

- South Natural Gas Transmission Line: It is aimed to meet the natural gas demand of South and Southeast Anatolian Regions with a branch line from the Eastern Anatolia Natural Gas Main Transmission Line around Sivas. The line, which is about 565 km long, shall start from Malatya and extend to Mersin via Kahramanmaras, Gaziantep, Osmaniye and Adana.
- Konya – Izmir Natural Gas Transmission Line: A branch line from the East Anatolia Natural Gas Main Transmission Line shall extend from Konya to Izmir. The line, which is approximately 618 km long, shall start from Konya and extend to Izmir via Burdur, Isparta, Denizli and Nazilli. Branch line shall be constructed for the cities such as Afyon and Antalya.
- Eastern Black Sea Region Natural Gas Pipeline: A branch line shall be constructed in Erzincan from the East Anatolia Natural Gas Main Transmission Line and the natural gas shall be supplied on this route with the extension of line to Gumushane, Bayburt, Hopa, Artvin, Rize, Trabzon, Giresun, Ordu and Samsun. The length of the line is approximately 233 km.
- West Black Sea Region Natural Gas Pipeline: A branch line from the Black Sea – Eregli shall supply natural gas to the industrial facilities and units of population on the route extending to Bartin via Zonguldak, Devrek and Caycuma. The length of the line is approximately 141 km.
- Georgian Border–Erzurum (Horasan) Natural Gas Transmission Line: The line of approximately 225 km long that is planned to transport the Azerbaijan and Turkmenistan natural gases within Turkey shall start from the Georgian border and extend to Erzurum / Horasan.
- Caspian Crossing Turkmenistan–Turkey–Europe Natural Gas Pipeline: It is aimed to transport the natural gas generated in the south section of Turkmenistan to Turkey and then to Europe via Turkey with a pipeline crossing the Caspian Sea.
- Azerbaijan Natural Gas Pipeline: It is aimed to transport the natural gas generation in Azerbaijan to Turkey via Georgia with this project.
- Egypt–Turkey Natural Gas Pipeline: This project has been developed to diversify the natural gas supplies.
- Iraq–Turkey Natural Gas Pipeline: It is aimed to develop the natural gas sites in Iraq and transport the natural gas generated to Turkey with a pipeline.
- Turkey–Greece Natural Gas Pipeline (Southeast European Gas Ring): Interconnection of Turkey and Greece natural gas systems as well as realization of Southeast European Gas Ring are aimed for the transportation of natural gas supplied from the Caspian Basin, Russia, Middle East, South Mediterranean countries and other international resources to the European markets.

The planned distribution pipelines are given below and the construction activities of these lines have started:

- Bilecik – Kutahya – Usak
- Izmir/ Kemalpasa Organized Industrial Zone – Pinarbasi – Torbali – Turgutlu
- Izmir – Aliaga – Ataturk Organized Industrial Zone
- Kirikkale – Kirsehir – Yozgat – Polatli
- Konya/ Eregli – Aksaray – Nigde
- Konya – Karaman/ Kazim Karabekir – Konya Organized Industrial Zone
- Manisa Organized Industrial Zone – Akhisar – Balikesir – Susurluk
- Kayseri – Sivas
- Corum – Samsun
- Adapazari Earthquake Buildings

1.7 Economic Importance of Project

As described under Section 1.6, Turkey has entered into a rapid development process and has achieved to be a large market in the energy sector. It is expected that Turkey will be an energy bridge between the Middle East, Middle Asia and Europe in the near future due to its geographical location. Because of great importance attached to the natural gas projects, the natural gas storage facilities should be increased in Turkey. Thus, the surplus natural gas could be stored and returned to the national grid if needed. In this context, it is important that there is a site where the natural gas can be stored in Turkey.

Important changes to the demand for the natural gas for heating of buildings in particular require the natural gas storage throughout Turkey. For example, 70% of the total annual energy consumption is realized in the four-month period between December – March while 90% is realized in the six-month period between November – April in respect of consumption for heating in Istanbul. There is not any demand for gas for heating in the period between June – September. In this case, it is of great importance that the natural gas transported from abroad to Turkey during the period including June – September is stored and returning the natural gas stored to the national grid during the period including November – April when the demand for natural gas increases (Satman, 2000).

Typical trend of natural gas supply and demand is represented in Figure 1.7. According to this figure, although the demands for natural gas change on seasonal basis, the natural gas procurement continues at certain extent. In this case, it is possible to store the gas when there is little demand for the natural gas and return the gas to the grid during the period when there is a great deal of demand.

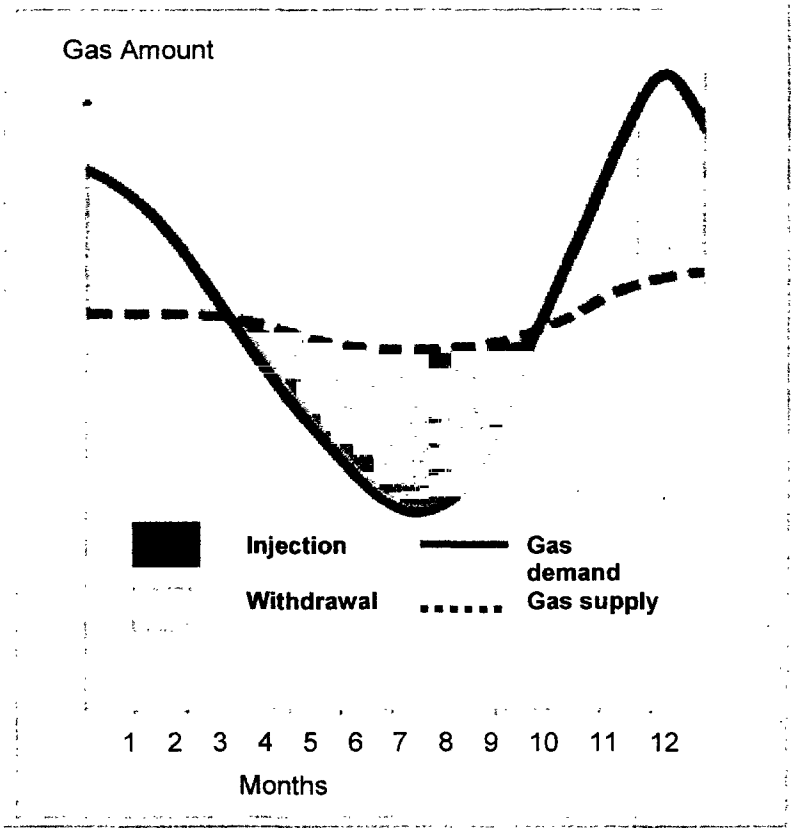


Figure 1.7. Supply–Demand Trend in Natural Gas

1.8 Social Importance of Project

It is planned to realize the proposed Lake Salt Basin UNGSP in Bezirci, Sultanhani Municipality, the Central District of the Province of Aksaray. Incase natural gas demand decreases; natural gas shall be taken from Kayseri – Konya – Seydisehir section of East Anatolia Natural Gas Main Transmission Line by means of a branch line and stored underground within the scope of the project. When the demand for natural gas increases in the country, the stored gas shall be transferred to the national grid again through the same line.

The most socially impacted areas of the project shall be the Province of Aksaray and the Central District as well as the District of Eskil. Total population of the Province of Aksaray in 1997 was 347.163 and rural and urban populations are 178.085 and 169.078

respectively. These population figures correspond to 51% and 49% of the whole province respectively (SSI, 2002).

Population figures for 1997 of the Central District and District of Eskil that are anticipated to be impacted by the proposed project are 200.338 and 25.689 respectively. The rural and urban populations in the Central District are 99.151 and 101.187 respectively and these figures are 6.433 and 19.256 respectively in the District of Eskil. In this context, although the population living in the rural and urban areas in the Central District is very close, a major part of the population in the District of Eskil live in the urban area (SSI (State Statistics Institute), 2002).

According to the information gathered during field trips, the public in some villages of the Province of Aksaray earn their lives by working abroad. In this context, it is estimated that direct and indirect opportunities of employment during the project as well as direct and indirect expenditures shall be beneficial with respect to preventing emigration that may occur in the region and supporting the industrial development in the region. Accordingly, the importance of the project covers the positive impacts on the economy (meeting natural gas shortage in the winter, indirect opportunities for jobs etc.) and enhancing the social life (incentive for natural gas utilization etc.).

1.9 Environmental Impact Assessment

This report is prepared by ENVY in a manner to fulfill the necessities of the EIA report, which will be presented to the Ministry of Environment concerning the proposed Tuz Golu Basin Underground Natural Gas Storage Project. The extent of the project is determined in respect to a special format given by the Ministry of Environment. The EIA format given by the Ministry is presented in Appendix-A.

1.9.1 EIA Team

The EIA report prepared for the proposed Tuz Golu UNGSP, is prepared by EIA team of ENVY, including environmental and mechanical engineers, environment management experts, experts who have specialization in various engineering topics such as ecology, social impacts, soil, air and water pollution, hydrology and meteorology, geology, geotechnics and geophysics. The curriculum vitae of the individuals, who worked in the preparation of the report, are presented in Appendix-B.

1.9.2 Impact Assessment Approach

The aim of constituting this EIA report is to define and to evaluate the probable impacts of the proposed project on biophysical and socio-economical environments. For this purpose, the project of concern covers the matters mentioned below:

- To define the alternatives of the proposed underground gas storage project,
- To determine the baseline characteristics of the environment, which can be affected by the project,
- To define the probable impacts of the project on the environment (to determine the present pollution load of Tuz Golu and to evaluate the impact of the brine water (solution) discharge, which can appear due to the proposed project),
- To determine the national and international control methods, which will be applied to prevent or minimize the potential environmental impacts,
- To develop suggestions about the precautions to be taken for the permanent impacts likely to exceed the related national and international standards.

The information about the baseline environmental condition of the proposed project site and its impact area is presented by using the data obtained from the detailed literature research and field studies undertaken by the EIA group. Impact assessment studies are realized after the determination the baseline characteristics of the project site and its vicinity. The determination of the areas, which can be affected by the project activities, is carried out by means of the studies concerning the definite design and technical contracts.

The probable impacts assessment phase of the proposed project includes the aspects presented below:

- *Duration Limits:* Probable impacts and the duration of these impacts are examined by taking various project phases into consideration like construction, operation and post-operation.
- *Site Limits:* Because that the project site is in the vicinity of Sultanhani Municipality of the Central District of Aksaray Province, it is thought that the most important area, which will be affected by the project, will be Aksaray Province and Sultanhani Municipality. In that context, Aksaray is assessed in terms of socio-economics and baseline condition. In order to study the biophysical impacts, the baseline condition of the project site and its vicinity is discussed in Section 4.
- *Sources:* The probable impacts of the whole project activities on the biophysical sources (air, water, soil etc.) are surveyed. Besides, the social, cultural and economical impacts on the neighboring settlement areas, positive or negative,

are also evaluated. During this evaluation, literature, field and laboratory studies are used effectively.

2 SELECTED SITE LOCATION

2.1 Site Selection

The proposed site for the Tuz Golu Basin Underground Natural Gas Storage Project (TUGSP) is close to Sultanhani Municipality, which is approximately 40 km west of Aksaray Province. The site, located approximately 17 km south of the mentioned sub-district, is in the Bezirci Locality (see Figure 2.1). In the content of the project, the natural gas being transported via the Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line (see Figure 2.1) will be commenced to be stored in the months (in summer) when the national natural gas demand lowers and with the increase in demand (in winter) it will be transmitted back to the same line and thus the supply-demand equilibrium will be attained nationwide.

Three dimensional seismic studies were carried out by TPAO in November 2000 within the site of about 80 km² determined in the area and considering the obtained results, the locations of ten caverns in which the natural gas will be stored and the surface facilities were determined (see Figure 2.1).

Accordingly, in the project, in which 10 caverns are intended to be utilized, the volume of each cavern will be around 500.000 m³. New caverns can be opened in the recent years together with the changes in the national natural gas policy. Considering the convenience in operation and the safety factors, the distance between the closest caverns is planned to be between 300 and 500 m.

Except for the compressor station, which will be constructed at the top of each cavern and which will cover a limited area, there will be an area for the surface facilities. Because of the safety criteria, it is required to plan this area at least 500 m far from the nearest cavern. In this regard, the distance of the surface facilities planned to be constructed in the scope of TUGSP to the closest cavern will be approximately 700 m and the area of concern will be outside the boundary of the salt layer determined by the seismic studies (see Figure 2.1).

The project site and its vicinity are mostly flat (slope %1-3), with an average altitude of 1000 m for the region (see Figure 2.2 and Figure 2.3). The site is near Bezirci Lake and this lake is presently dry (see Figure 2.4). Moreover, the wide area extending from west and north parts of Sultanhani to Tuz Golu is a marshland.

There are also small settlements in the vicinity of the project site and these areas are used as "plateaus" where the animals are grazed between April and October (see Figure

2.5). The most important ones are Bucak, Tomu, Rasimusagı, Nasuhusagı, Omeraga and Hacihuseyin plateaus. The distance of the project units to these areas are given in the Table 2.1.

Table 2.1 Approximate Distance of the Project Units to the Plateaus

Units In The Project	Bucak Plateau	Tomu Plateau	Rasimusagi Plateau	Nasuhusagi Plateau	Omeraga Plateau	Hacıhuseyin Plateau
Surface Facilities	4750 m	1750 m	1800 m	1200 m	1100 m	1850 m
Closest Cavern	2500 m	1375 m	850 m	200 m	150 m	800 m

Except for the settlement areas, agricultural areas are encountered as well within the site. The detailed information regarding the protection sites in the vicinity of the project site is discussed in Section 4.2.

For the determination of the project site, site survey studies were carried out at the proposed site by distinct institutions under the supervision of Provincial Directorate of Health/Environment of Aksaray Governorship on different dates and consequently, it is resolved that the proposed site shown in Figure 2.1 is appropriate. The official letters of the relevant institutions and foundations are presented in Appendix-C.

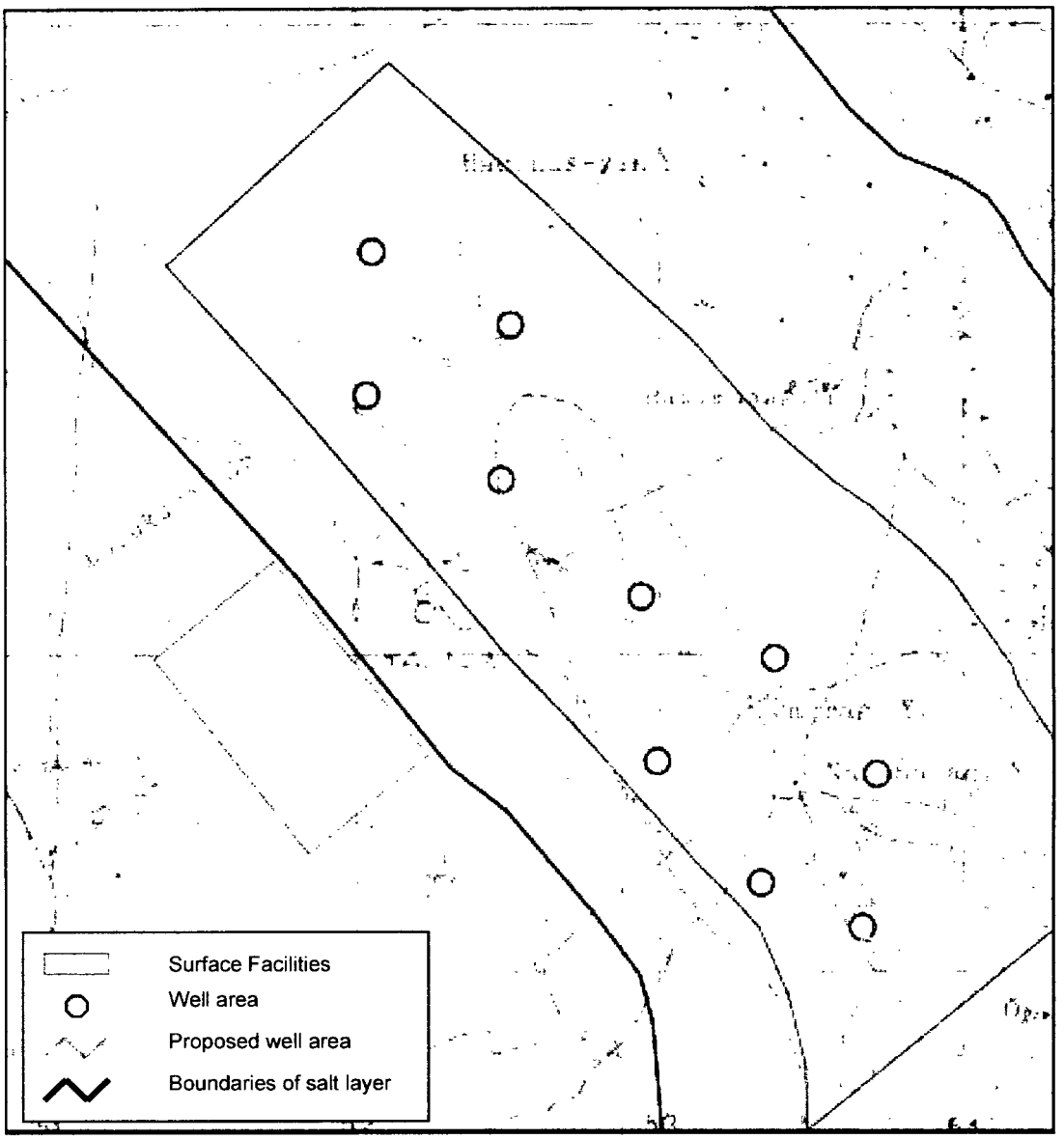


Figure 2.1 TUGSP Project Site and the Location of the Caverns

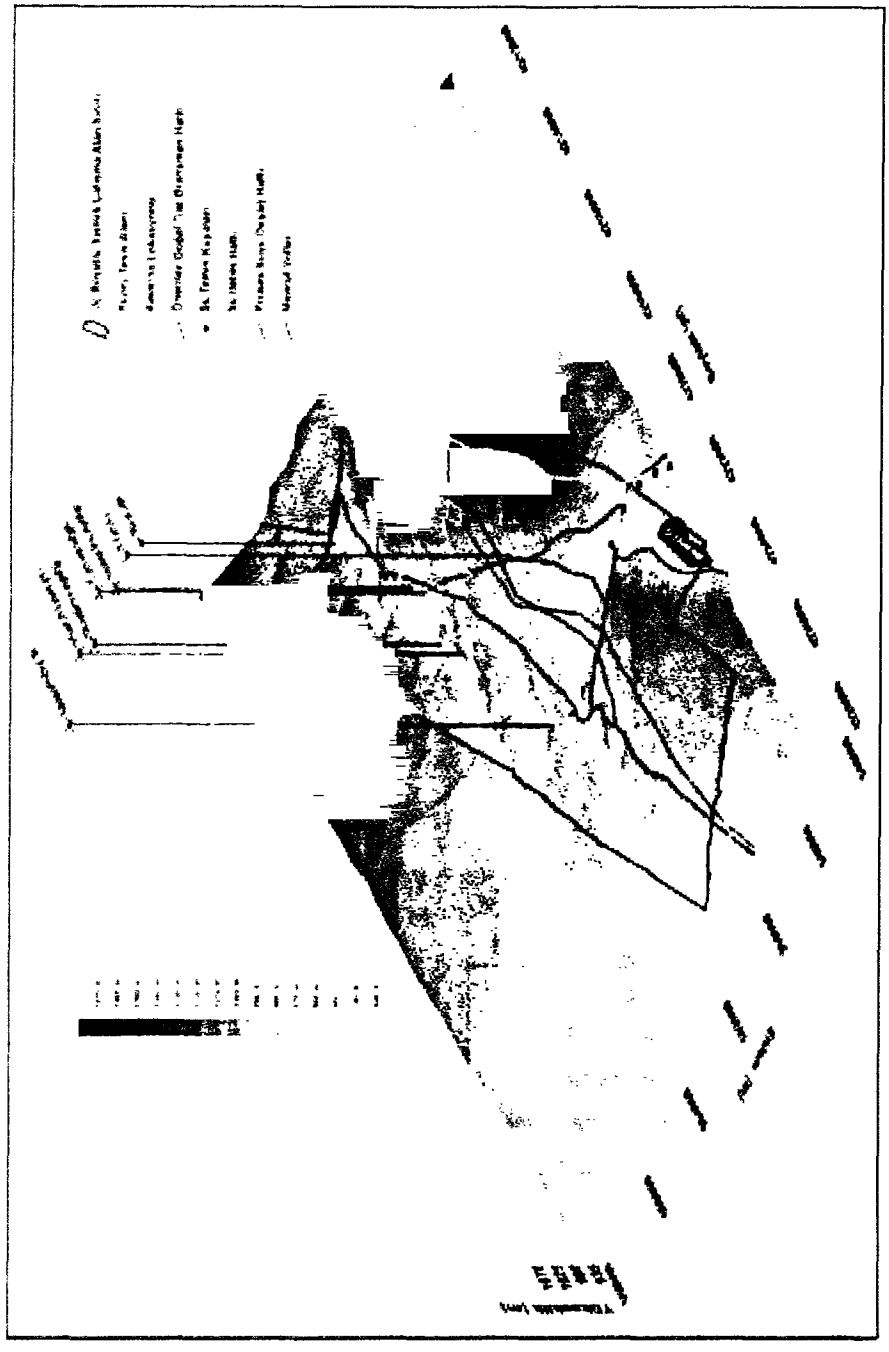


Figure 2.2 Three Dimensional Topographical Map of the Project Site and its Vicinity

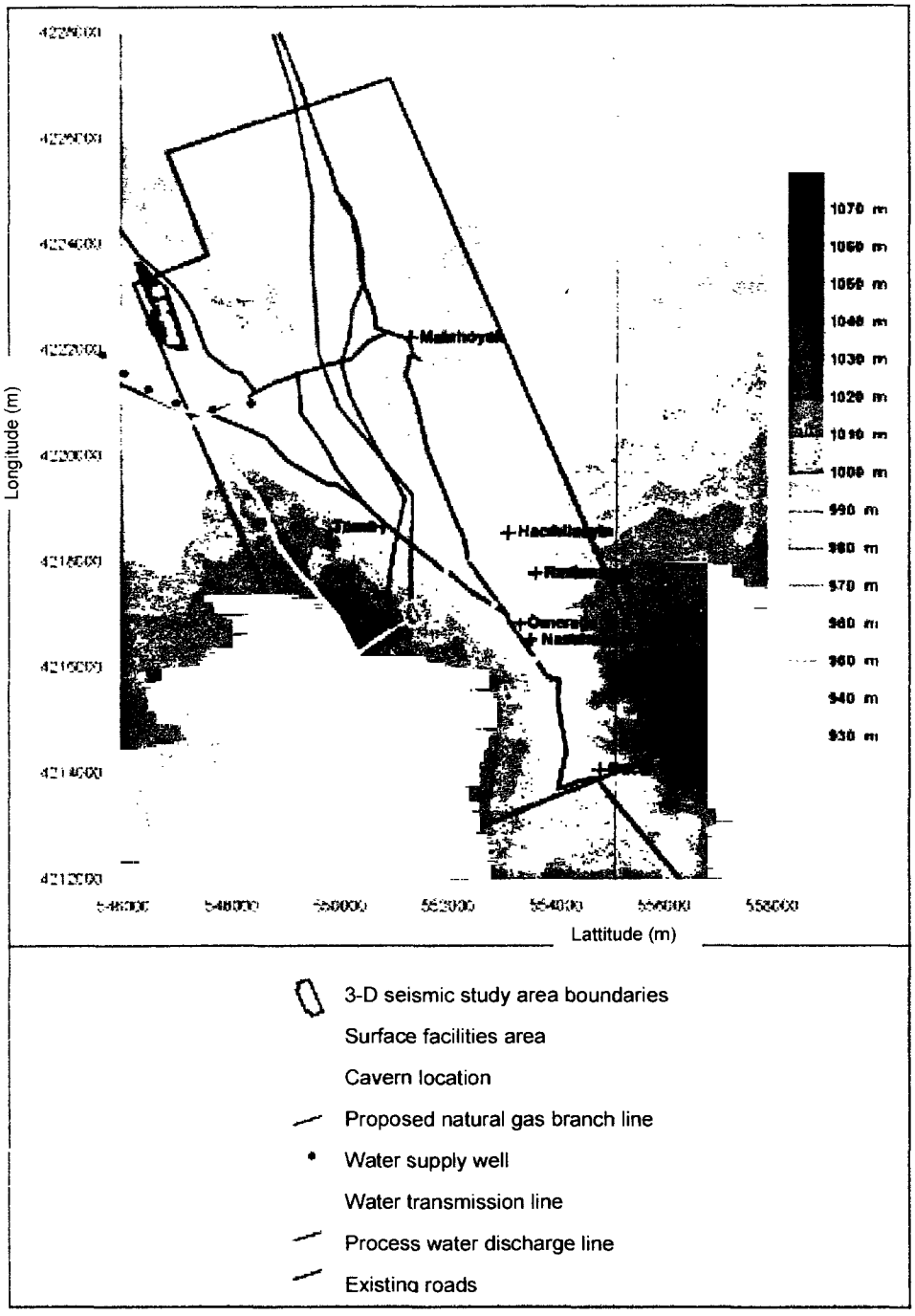


Figure 2.3 Two-Dimensional Topographical Map of the Project Site and its Vicinity

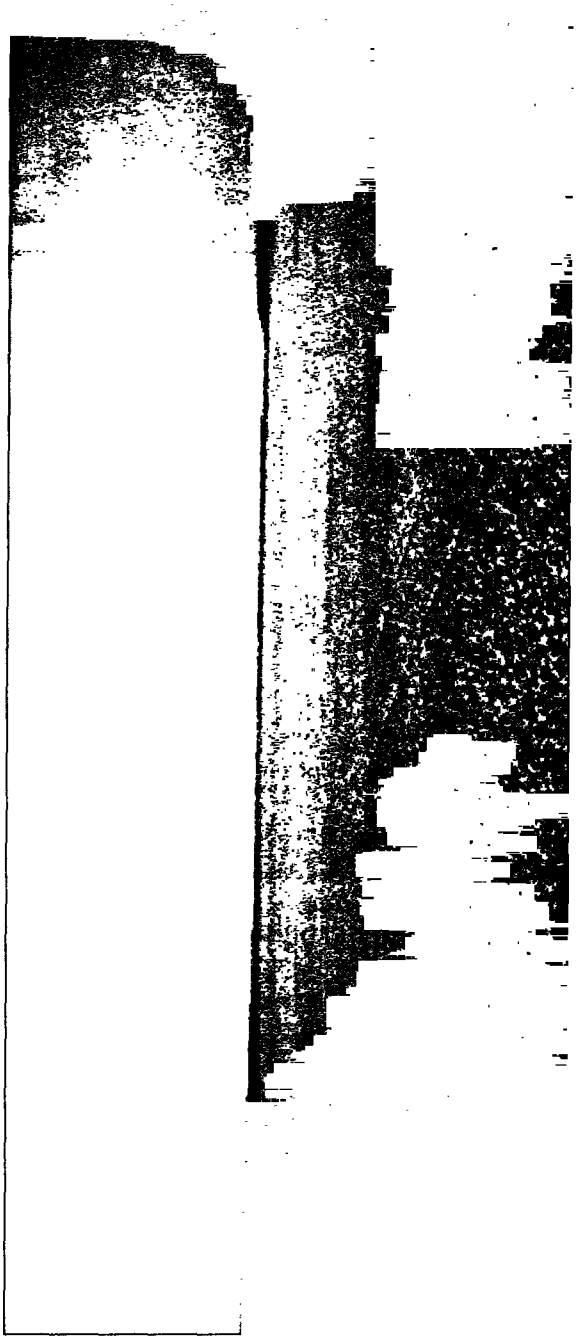


Figure 2.4 A View From Bezirci Lake

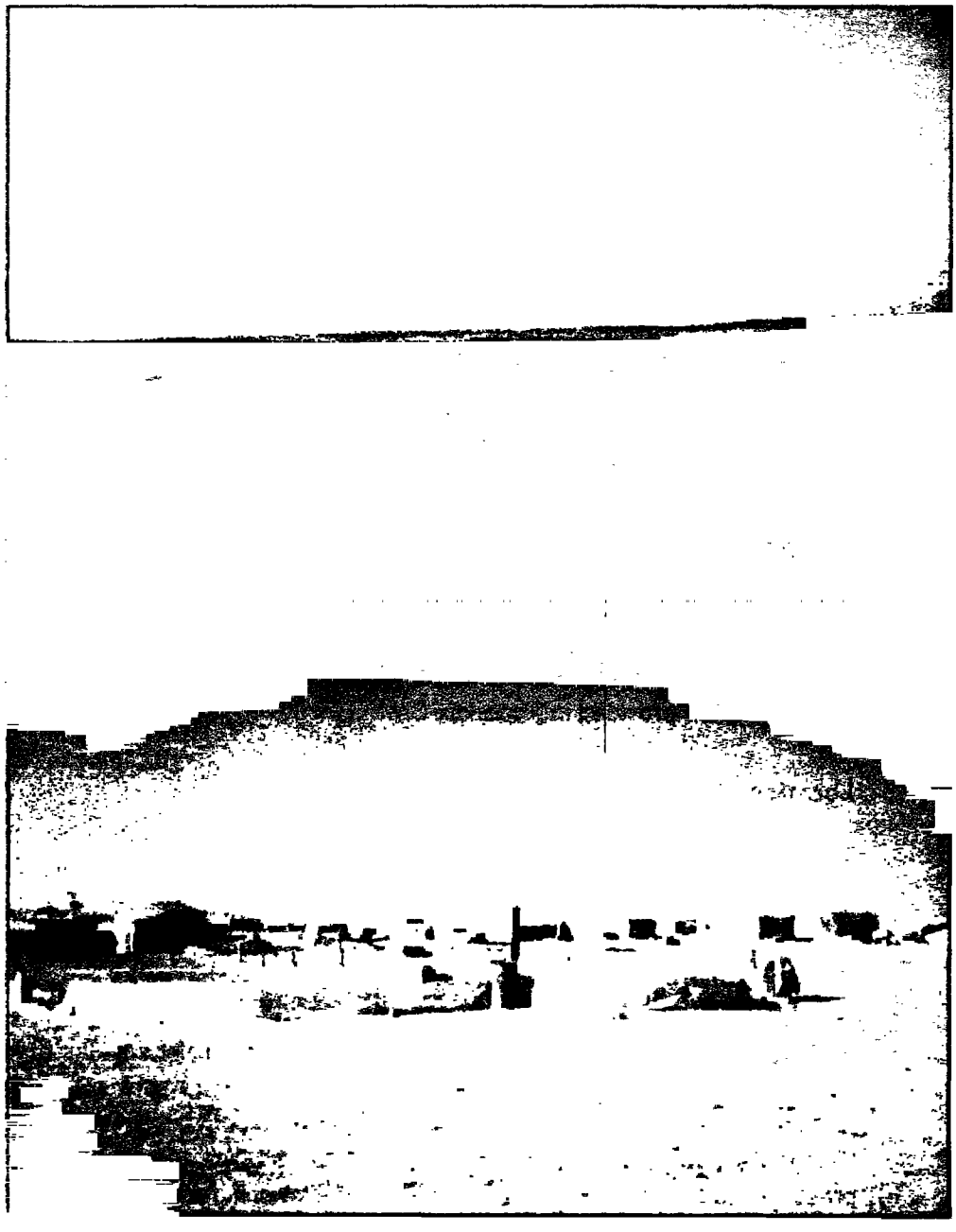


Figure 2.5 A View of the Settlements in the Vicinity of the Project Site (Bucak Plateau)

There are small units of population in the vicinity of the project site and these areas are used as the plateaus where the animals are herded during April – October (please refer to Figure 2.5). The most important ones include Bucak, Tomu, Rasimuşağı, Nasuhusagi,

Ömerağa and Hacihüseyin plateaus and the distance of project units to these areas are given in Table 2.2

Table 2.2. Approximate Distances of Project Units to Plateaus

Unit within the Project	Bucak Plateau	Tomu Plateau	Rasimusagi Plateau	Nasuhusagi Plateau	Omeraga Plateau	Hacihuseyin Plateau
Surface Facilities	4.750 m	1.750 m	1.800 m	1.200 m	1.100 m	1.850 m
Closest Cavern	2.500 m	1.375 m	850 m	200 m	150 m	800 m

There are occasionally agricultural fields besides the settlement areas within the site. Detailed information about the protection areas in the vicinity of the project area is given in Section 4.2.

The site investigation surveys were conducted on different dates by a variety of organizations under the presidency of Provincial Health / Environmental Management of the Governorship of Aksaray on the proposed area in order to determine the project site and it was decided that the project site represented in Figure 2.1 was proper consequently. The official letters of the related institutions and organizations concerning this subject are provided in Appendix-C.

2.2 Location of the Activity Units in the Project

In the content of TUGSP, except for the compressor station, which will be constructed at the top of the each cavern and which will cover a limited area, there will be an area for the surface facilities. The surface facilities to be constructed will cover an area of around 500 m × 800 m (40 hectare). The layout of the facility is presented in Appendix-C.

As to be a model for the layout, a view of the Krummhörn Natural Gas Storage Facility is presented in Figure 2.6. At the area there will be two distinct areas for the leaching process and gas. In this content, structures such as control room, compressor building, filter units, heating and cooling systems, units in which the oil separators are found, pressure reducers, regeneration units, dehydration unit, facility for waste water treatment package, offices, workshop and garages will be found within the area.

The construction and operation phases of the proposed TUGSP will be carried out concurrently. While the practice of creating caverns is carried out (construction activity), the practice of storing natural gas in the created caverns will be commenced (operation activity). In the course of the natural gas storage, the natural gas will be compressed by a compressor and transmitted to the underground caverns.

While withdrawing the gas, a portion of natural gas will be left in the cavern (cushion gas) and by decreasing the pressure; the gas will be drawn to the surface. Later on, the gas withdrawn from the store will be transmitted to Kayseri-Konya-Seydisehir Natural Gas Pipeline by a branching, in order to be conveyed to the network.

Leaching system will comprise of the units listed below:

- Six wells (five as main and one as standby) for water supply;
- Water pumping station;
- Rising main;
- Leaching unit;
- Blanket fluid unit; and
- Brine discharge line.

The units related to the surface operation complex are listed below:

- Compressor station;
- Preparation unit of the gas for transport and injection (separators, consumption measurement, gas heating and drying units, cooling equipment);
- Internal gas lines and collectors;
- Branching on the gas line and main gas line;
- Administrative and production facilities like boiler, dispatcher center, workshop, garage;
- Electrical energy system, potable water network, sewer system.

The creation of the underground caverns, where the natural gas will be stored, and the operation of these caverns will be realized by the help of the automatic control systems of the mechanical and technological processes and measurement techniques based on modern micro-processes.

Krummhorn Gaz Depolama ve Kompresor İstasyonu'ndan bir görüntü
Kaynak: First Latin American Gas and Electricity Congress (1. Latin Amerika Gaz ve Elektrik Kongresi), Bariloche, 1997

Figure 2.6 Model Layout for the Natural Gas Storage Facility

Natural Gas Branch Line

With the purpose of underground storage of the excess demand of natural gas in the national network by withdrawing it from the network and conveying it again to the national network in case of need, a branching will be constructed to the project site from the Kayseri-Konya-Seydisehir part of the Eastern Anatolia Natural Gas Main Transmission Line. It is planned to make the connection at 33rd km of the pipeline between Aksaray and Konya (see Figure 2.7) The length of the line of approximately 14 km and diameter will be 40". The estimated route of the natural gas pipeline of concern will be as shown in Appendix–E.

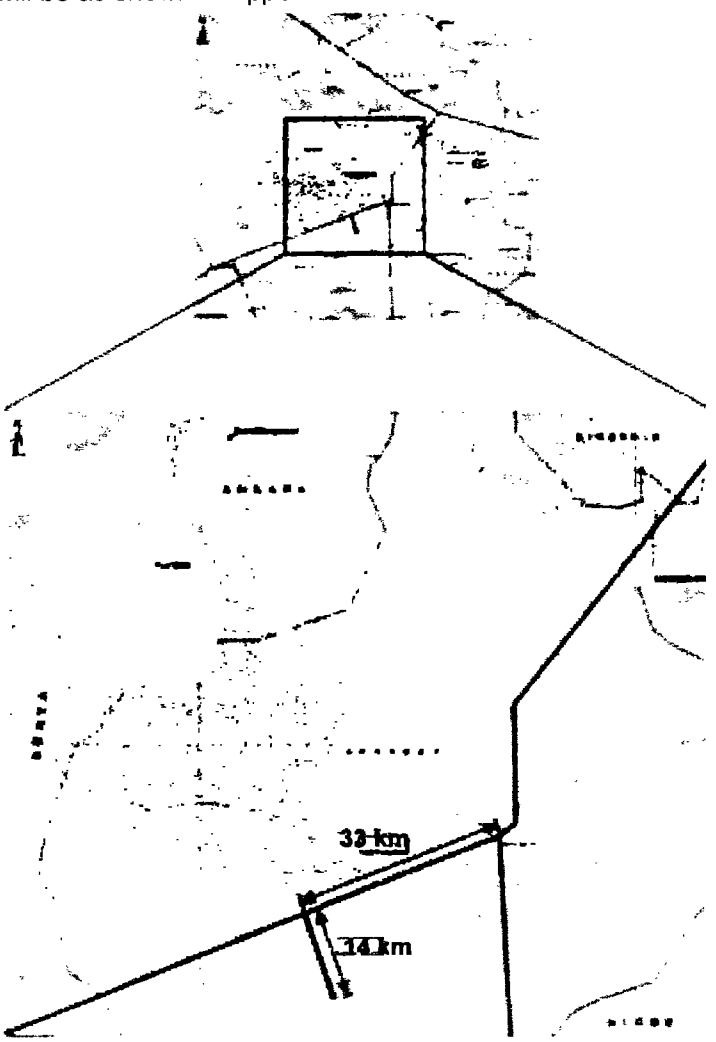


Figure 2.7. Proposed Natural Gas Branch Line

1 PROJECT DESCRIPTION AND OBJECTIVES

1.1 Project Description

The objective of Tuz Golu (Salt Lake) Basin Underground Natural Gas Storage Project (UNGSP) is to meet the seasonal fluctuations to be occurred in the future depending on the increase in residential natural gas demand. In that content, it is planned to store natural gas between the salt layers, located at a depth of approximately 1150 m.

Tuz Golu Basin UNGSP is proposed to be realized about 17 km south of Sultanhani Municipality of the Central District of Aksaray Province by Petroleum Pipeline Corporation (BOTAŞ) (see Figure 1.1 and Figure 1.2). Proposed project site is located in the south of Tuz Golu and the closest distance between the site and the lake is approximately 40 km.

The project of concern will be one of the first investments in Turkey that will be carried out for the natural gas underground storage[1]. The seismic, drilling, feasibility, design and similar engineering studies related to the topic and environmental impact assessment were executed by a consortium established by Russian, German and Turkish companies; namely, PODZEMGAZPROM Limited (PGP), Pipeline Engineering GmbH (PLE) and ENVY Energy and Environmental Investments Inc. (ENVY), respectively. The Turkish Petroleum Corporation (TPAO) carried out the studies three-dimensional seismicity and drilling activities for this consortium.

Within the context of the Tuz Golu Basin UNGSP of concern, the underground salt layers, located at the Bezirci Lake locality, approximately 17 km south of the Sultanhani Municipality, will be utilized. In this regard, the excess natural gas, which is revealed especially in the summer months in the country scale, will be withdrawn via a branching from the Kayseri-Konya-Seydisehir section of the Eastern Anatolia Natural Gas Main Transmission Line situated approximately 14 km north of the project site, and will be stored in the caverns, that will be created in salt layers.

[1] *As per the agreement between BOTAS and TPAO to develop and operate the North Marmara and Degirmenkoy Natural Gas Sites as underground natural gas storage with the investments to be made by TPAO, the North Marmara and Degirmenkoy Sites Underground Gas Storage Project was realized. Pursuant to the Environmental Impact Assessment Regulation, which took effect having been published in the Official Gazette dated 06.06.2002 and numbered 24777, of the Ministry of Environment of the Republic of Turkey, "EIA Approved Certificate" has been obtained. In respect of the project, the drilling activities are continuing as of April 2003.*

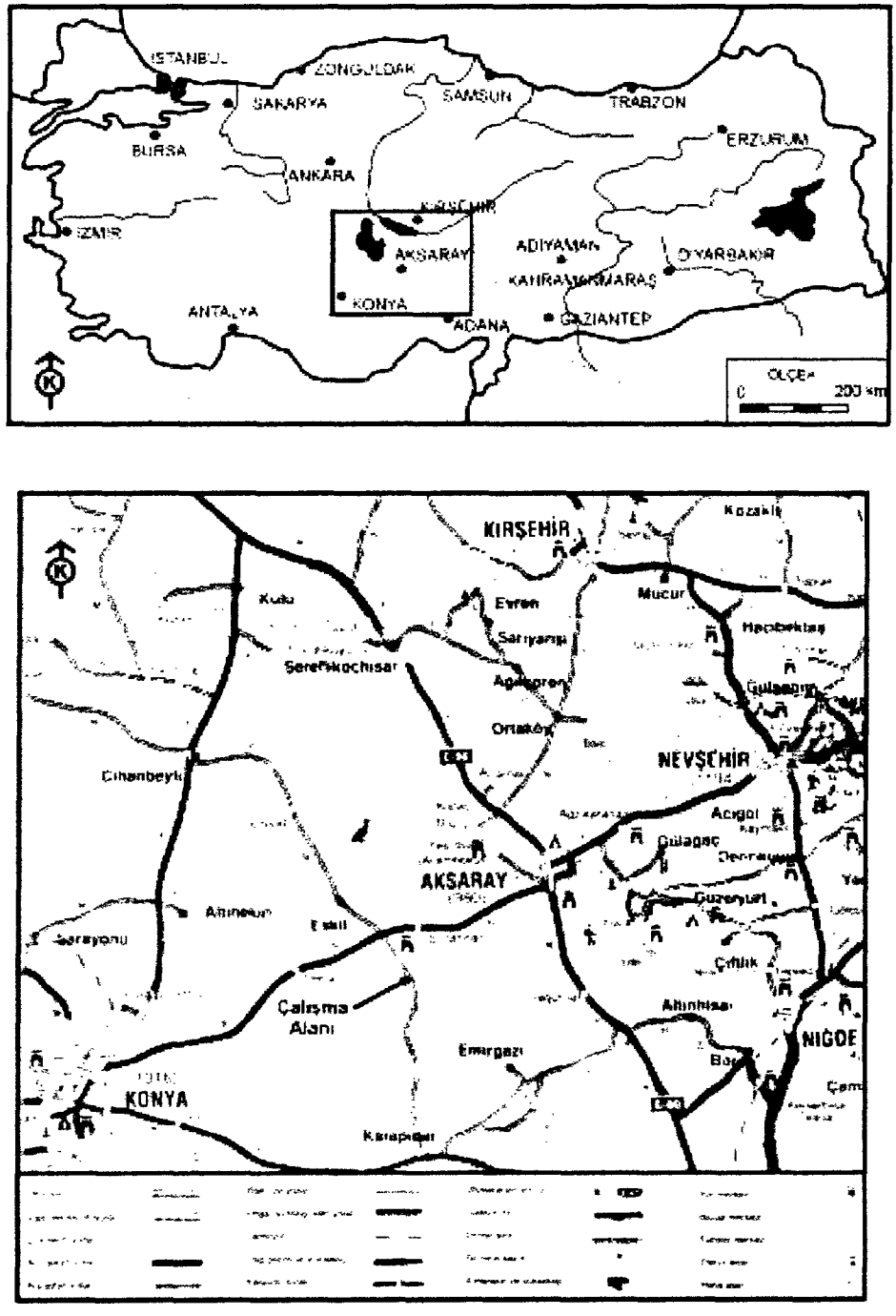


Figure 1.1 Location of the Proposed Project Site in Turkey

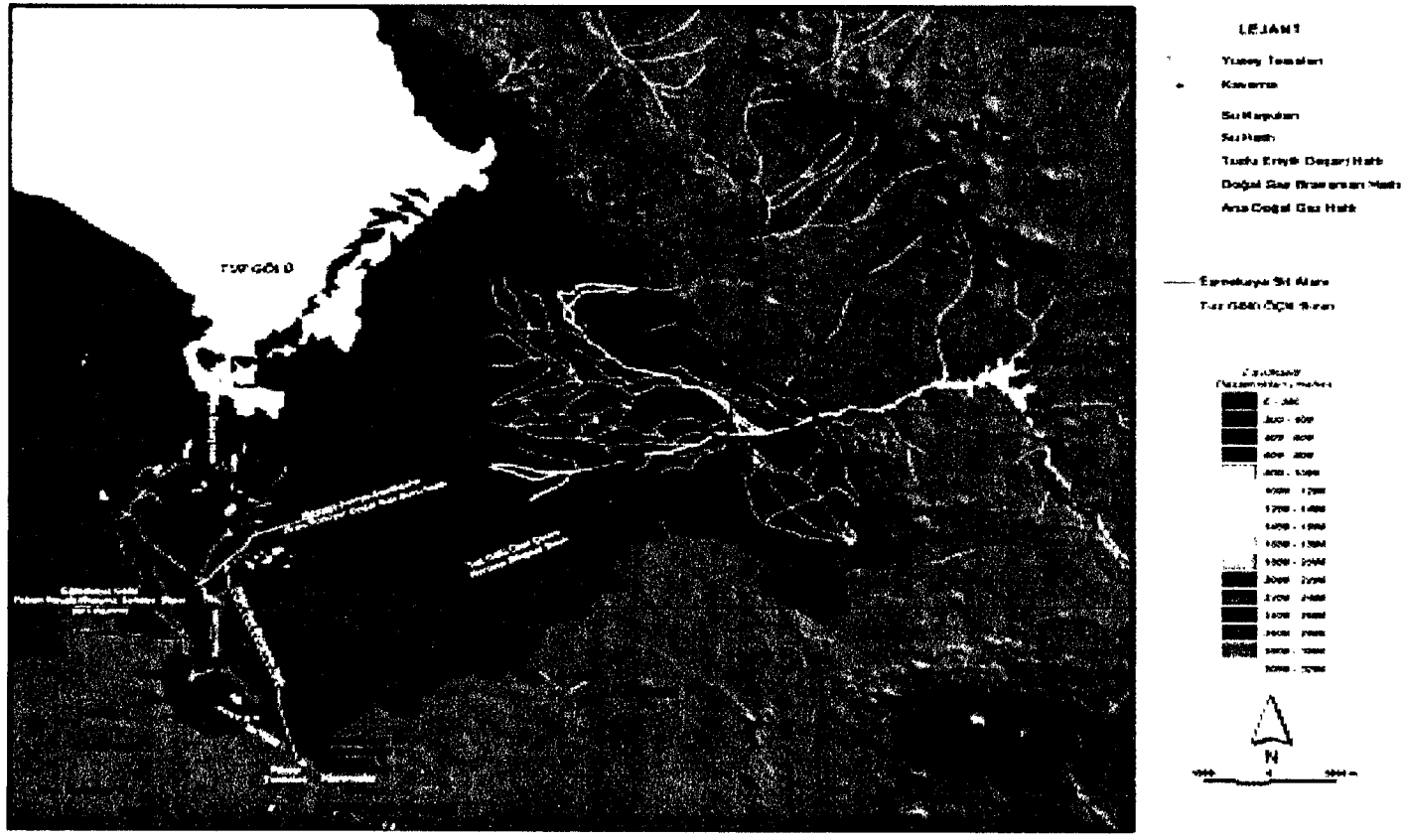


Figure 1.2 Proposed Project Site and Its Vicinity

On the country scale, in order to meet the increasing gas demand especially in the winter months, stored gas will be withdrawn from these caverns and again will be transmitted to the Kayseri-Konya-Seydisehir section of the Eastern Anatolia Natural Gas Main Transmission Line for usage.

In order to determine the seismic characteristics of the region, seismic studies, which began in November of the year 2000, were carried out within an area of about 80 km². The proposed project site was chosen within this study area and detailed information concerning its location is presented in Section 2.

The salt domes to be used in the project are located approximately 700 m and deeper in the surface and have a thickness of 700 to 1500 m. During the project, the leaching (dissolving of the salt domes) method, which is a commonly used method around the world, will be used for minimum 12,5-15 years, and 10 caverns, each having approximately 500,000 m³ of volume, will be created. There will be approximately 42×10^6 m³ cushion gas in each cavern and the process will be performed with approximately 70×10^6 m³, over the cushion gas. Thus, approximately 112×10^6 m³ of gas can be storable in each cavern[2]. The total cushion gas will be approximately 420×10^6 m³. The total amount of gas that will be taken from the national network, stored and then returned to the network is stipulated to be 700×10^6 m³.

Fresh water will be used to leach the underground salt domes and the present groundwater reserves in the region will be utilized for water demand. The brine (solution) arose following the leaching process, is planned to be discharged to Tuz Golu.

In the extent of the project, two caverns will be opened simultaneously and the required time for this process is approximately 30-36 months. In this regard, the time required for the opening of the 10 proposed caverns will be around 150-180 months (12,5-15 years). Within this period, the natural gas storage process will be commenced in the opened caverns. In other words, the construction and operation activities of Tuz Golu Basin UNGSP will be carried out concurrently.

The economic lifetime of the similar projects, which are still considered as projects with recent past in the world literature, is estimated as at least 50 years.

[2] *Since the natural gas will be stored under pressure (through compression), the amount of natural gas will be more than the volume of cavern.*

1.2 Objectives of the Project Activities

Within the scope of the proposed Tuz Golu Basin UNGSP, the natural gas transported via Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line will be stored when the national natural gas demand decreases, and it will be transmitted back to the line with the increase in demand, to obtain a balance in national natural gas supply and demand. The main objectives of the project are stated below:

- Since the project is the first application of underground storage of natural gas in Turkey, it will constitute an example to future implementations.
- The excess natural gas resulting from the low demand during summer months could be stored. Thus, when the natural gas shortage arise because of the increase in demand during winter months, stored gas will be withdrawn from these caverns and will be given back to the national network. As a result, the supply and demand equilibrium of the national natural gas will be ensured.
- In case if the project is realized, the natural gas transported from the foreign countries will be stored in order to supply a reserve for the country.
- The national resources used for electrical energy and heating purposes will be stabilized.
- Healthy and continuous energy source will be provided for the rapidly increasing number of industrial facilities.

1.3 Electrical Energy Policy of Turkey

The main goal of the energy policies in Turkey is defined as "to provide secure, cheap, high-quality, clean energy required for the country in time, in a way as to maintain progress and social development". The main principles of Turkish energy policy are to increase the efficiency in energy generation, to give the priority to the utilization of local resources to the maximum extent, and besides the utilization of the native resources, to draw attention to the usage of cleaner energy resources and to provide diversity in resources.

Hydraulic sources and fossil fuels are the main energy resources in Turkey. Lignite among the fossil fuels and natural gas, recently whose demand is increasing continuously, play an important role in the energy supply of the country.

Due to irregular precipitation regime in Turkey, in terms of time and place, as well as its variation owing to the meteorological conditions within frequent periods, the hydraulic

power plants are risky in terms of energy supply safety. In electricity (power) energy generation within thermal power plants, low quality domestic lignite which is not possible to be used in the industry and heating is consumed. Low thermal value and high ash and sulfur rates of these lignite coals increase the importance of environmental problems arising from the thermal power plants.

However, it can be possible to minimize the adverse environmental impacts by using advanced emission control and boiler-burning technologies and taking other necessary measures.

The data which have been published by the Foreign Trade Undersecretariat of the Republic of Turkey and which represent the growth, primary energy generation and consumption increases of Turkey between 1963-2000 are given in Table 1.1[3]. According to this table, the primary energy consumption is higher than the energy generation. This situation has caused to increase the gap between the energy generation and consumption. In addition, delay in the energy investments in spite of rapid increase in the manufacturing industrial investments in Plan Periods II and III in particular has caused this gap to increase.

According to the data published by the Foreign Trade Undersecretariat of the Republic of Turkey, the domestic primary energy generation has increased from 25.1 Mtep to 27.6 Mtep by 9.8% during 1990 - 2004[4] (see Table 1.2). The biggest share in this increase is the natural gas generation, which increased 3,3 times, and lignite generation, which increased 1,35 times. The natural gas generation, which was only 0.7% of the total primary energy generation in 1990, increased up to 2.3% of the total generation following the activities in Thrace Region in the recent period.

Lignite and coal generation (production) was 14.6 Mtep in 2000, which constitutes 53% of the total production (see Table 1.2 and Figure 1.3). In the listing of the size of primary energy resources generation, petroleum and natural gas take the second place with the share of 12.9%. The remaining part is the share of geothermal and hydraulic energy, biomass and solar energy.

The primary energy consumption increased from 52.6 Mtep in 1990 up to the level of 79.6 Mtep in 2000, and hence the consumption increased by 51.3% (please refer to Table 1.2). The annual increasing rate became 3.9% in the consumption in 2000.

[3] *http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm*

[4] *tep: ton equivalent petroleum; Mtep: million ton equivalent petroleum*

There is slow-down in the last period in comparison to the high increasing rates in 1995-1996.

Table 1.1. Growth, Energy Generation and Consumption Increases in Different Periods

Periods	Increase in Gross National Income (%)	Increase in Primary Energy Generation (%)	Increase in Primary Energy Consumption (%)
1st Plan Period (1963 – 1967)	6.6	6.9	5.5
2nd Plan Period (1968 – 1972)	6.3	1.9	7.4
3rd Plan Period (1973 – 1977)	5.2	1.9	7.3
4th Plan Period (1979 – 1983)	1.7	2.7	3.8
5th Plan Period (1985 – 1989)	4.7	4.0	6.5
6th Plan Period (1990 – 1994)	3.5	0.9	4.4
7th Plan Period (1996 – 2000)	3.5	1.3	4.5
8th Plan Period (2001 – 2005)*	6.7	1.2	6.1

** Estimation of State Planning Organization (DPT)*
Reference: Foreign Trade Undersecretariat of the Republic of Turkey

The petroleum, which has the biggest share of energy consumption with 43.8% in 2000, is followed by natural gas with 17.6% and lignite with 16.1% (see Table 1.2). The natural gas consumption increased by approximately 3.5 times during 1999-2000 with the impact of acceleration in the construction of natural gas pipelines in recent years. With the increasing number of units of population where the natural gas is served in the future years, the share of natural gas in the total energy consumption is expected to increase.

When the sectoral distribution of 76.7 Mtep of primary energy consumed in 1999, it is observed that industrial sector is leading with 35% followed by residential and services sectors with 34% (please refer to Table 1.3 and Figure 1.4). While the energy consumption shares of the residential and service sectors decreased from 38% to 34% during 1990-1999, any change did not occur in the share of agricultural sector, and the biggest change occurred in the cycle sector, which increased from 21% to 25%. The energy consumption for 2000 of the cycle sector including the power plants, oil refineries and natural gas cycle plants is 19.2 Mtep.

The most significant share of industry sector in the energy consumption is petroleum with 31%, and the share of natural gas, which was 5% in 1990, reached up to 10.3% in 1999.

Table 1.2. Primary Energy Generation and Consumption (Btep)*

Years	Petroleum		Natural Gas		Lignite		Coal		Other		Total	
	Generation	*Consumption*	*Gen.*	*Cons.*	*Gen.*	*Cons.*	*Gen.*	*Con.*	*Gen.*	*Cons.*	*Gen.*	*Cons.*
1990	3.903	23.901	193	3.110	9.524	9.765	2.080	6.150	9.423	9.706	25.123	52.632
1991	4.674	23.315	185	3.827	9.117	10.572	1.827	6.501	9.335	9.700	25.138	53.915
1992	4.495	24.865	180	4.197	10.299	10.743	1.727	6.243	9.707	10.250	26.408	56.298
1993	4.087	28.412	182	4.630	9.790	9.918	1.722	5.834	10.240	11.051	26.021	59.845
1994	3.871	27.142	182	4.921	10.471	10.331	1.636	5.512	9.899	10.769	26.059	58.675
1995	3.692	29.324	166	6.313	10.735	10.570	1.319	5.905	10.343	11.068	26.255	63.180
1996	3.675	30.939	187	7.189	10.876	12.351	1.382	5.560	10.767	11.999	26.887	68.035
1997	3.630	30.515	230	9.165	11.759	12.280	1.347	8.495	10.721	10.912	27.687	71.367
1998	3.385	30.349	514	9.690	12.792	12.631	1.143	8.921	11.030	12.576	28.864	74.167
1999	3.087	33.166	665	11.740	12.242	12.314	1.030	7.708	10.035	11.775	27.059	76.703
2000	2.925	34.893	631	14.071	12.830	12.830	1.769	8.149	9.438	9.728	27.593	79.671

** Btep: Billion tons equivalent petroleum*
Source: Foreign Trade Undersecretariat of the Republic of Turkey

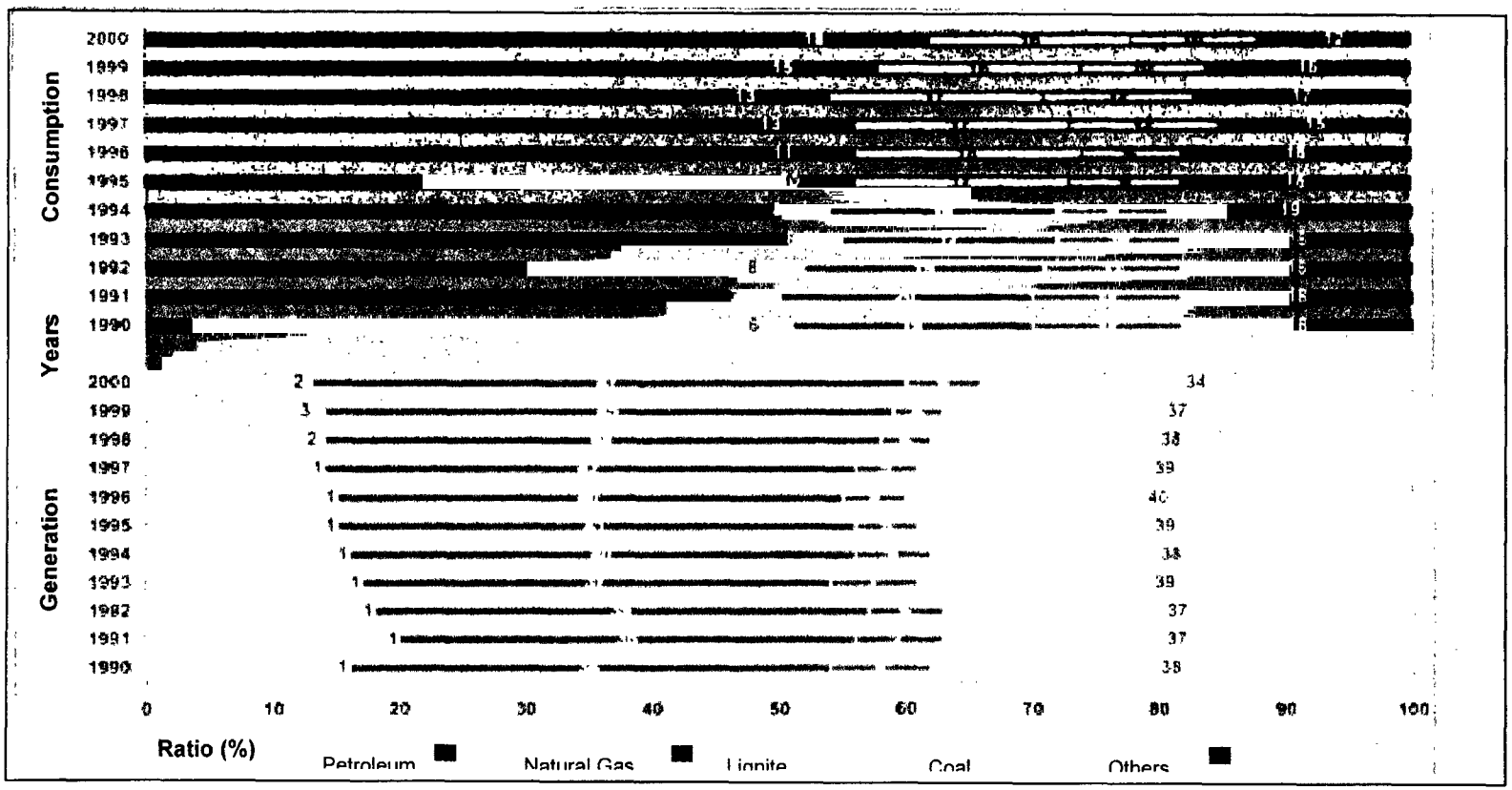


Figure 1.3. Primary Energy Generation and Consumption (%) (Foreign Trade Undersecretariat of the Republic of Turkey)

Table 1.3. Sectoral Energy Consumption (Thousand Tep)

Years	Industry	Residential	Transport	Agriculture	Other than Energy	Final Energy Consumption	Cycle Sector	Total Energy Consumption
1990	14.543	16.087	8.723	1.956	1.031	42.340	11.377	53.716
1991	15.181	16.646	8.304	1.976	1.203	43.310	11.698	55.009
1992	15.454	17.491	8.545	1.994	1.450	44.935	12.526	57.461
1993	16.333	17.734	10.419	2.450	1.743	48.679	12.386	61.065
1994	15.272	17.163	9.907	2.480	1.349	46.171	13.786	59.957
1995	17.372	18.469	11.066	2.556	1.386	50.849	13.703	64.552
1996	20.050	19.373	11.778	2.714	1.643	55.557	15.212	70.769
1997	21.790	20.672	11.338	2.823	1.788	58.412	16.335	74.747
1998	21.555	20.298	10.760	2.827	2.272	57.712	18.096	75.808
1999	20.894	20.228	13.322	2.923	1.881	59.249	19.262	78.511

Reference: Foreign Trade Undersecretariat of the Republic of Turkey

While the consumption increased by 51.3% during 1990-2000, the increase in primary energy consumption remained at 9.8%. Since the increase in consumption became higher than the generation (production), the compensation ratio of generation to consumption decreased from 47.7% to 34% in the last 10 years. The energy import reached up to 52 Mtep through increasing by 1.9 times (see Table 1.4).

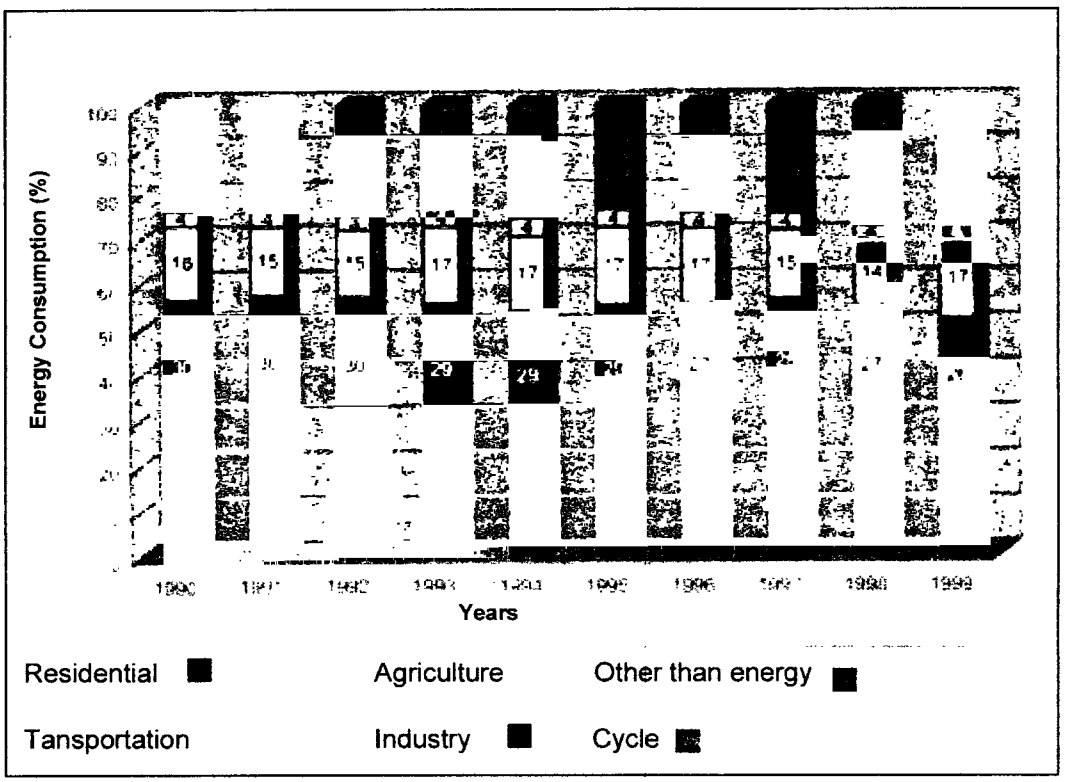


Figure 1.4. Sectoral Energy Consumption (%) (Foreign Trade Undersecretariat of the Republic of Turkey)

Approximately 61.2% of the total energy import in 2000 is constituted by crude oil and oil products, 26% by natural gas and 12.8% by coal and electricity. Although the electricity energy generation investments reached up to 6-7% of total investments during 1996-2000, the increase in annual consumption was around 8%. According to the Foreign Undersecretariat of the Republic of Turkey, it is estimated that the country electricity demand will continue to increase at a high rate until the saturation in consumption is reached5. However, the economic crisis experienced in 2001 caused a decrease in the demand for energy as in the case of crisis experienced in 1994.

Table 1.4. Energy Generation – Consumption and Import (Thousand tep)

Years	Generation	Consumption	Generation / Consumption (%)	Import
1990	25.123	52.632	47.73	27.509
1991	25.138	53.915	46.63	28.777
1992	26.408	56.298	46.91	29.890
1993	26.021	59.845	43.48	33.824
1994	26.059	58.675	44.41	32.616
1995	26.255	63.180	41.56	36.925
1996	26.887	68.035	39.52	41.148
1997	27.687	71.367	38.80	43.680
1998	28.864	74.167	38.92	45.303
1999	27.059	76.703	35.28	49.644
2000	27.593	79.671	34.63	52.078

Reference: Foreign Undersecretariat of the Republic of Turkey

1.4 Energy Generation and Consumption Expectations

According to the data of the Foreign Undersecretariat of the Republic of Turkey, the overall demand for energy, which was 79.7 Mtep in 2000 in the energy projections, is expected to reach up to 129.6 Mtep in 2005, 171.3 Mtep in 2010 and 298.4 Mtep in 2020 with an annual average increase of 6.8% (please refer to Table 1.5).

Table 1.5 Energy Generation and Consumption Expectations (Thousand tep)

Years	Consumption	Generation	Import	Generation / Consumption (%)
2000	79.671	27.593	52.078	34.6
2005	129.625	34.116	95.509	26.3
2010	171.339	47.329	124.010	27.6
2020	298.448	70.238	228.210	23.5

Reference: Foreign Undersecretariat of the Republic of Turkey

It is expected that the overall energy generation, which was 27.6 in 2000, will be 70.2 with an annual increase of 4.8% within the process until 2020. Only 34% of total primary energy demand could be met from local resources in 2000. Due to the increase in demand highly over than the generation, it is estimated that the ratio of generation to consumption will be 27% in 2010 and 23% in 2020.

In other words, the share of import in the energy generation will increase further in the near future. It is expected that the total energy import will reach up to 124 Mtep in 2010 and 228 Mtep in 2020. When the distribution of resources in the overall import is examined, it is anticipated that the share of natural gas will reach to 33% in 2020 while the share of petroleum will decrease from 60% to 33%.

While the overall energy consumption per capita was 1.259 kg-petroleum equivalent (pe) in 2000, it is expected that this value will be 2.076 kg-pe in 2010 and 3.445 kg-pe in 2020 with an average increase of 5.2% on annual basis[5].

1.5 Natural Gas and Recyclable Energy Resources

According to the data published by the Foreign Trade Undersecretariat of the Republic of Turkey, the share of petroleum was 43.8%, lignite and coal was 26.3%, natural gas was 17.6%, hydraulic energy was 33% and recyclable energy resources was 1% in 2000 when the distribution of consumption sources are examined. It is expected that the share of natural gas will be 32% in 2010. Although the shares of natural gas and recyclable energy resources increase, it is anticipated that there will be rapid decrease in the share of petroleum.

When the energy demands of the sectors are examined, it is estimated that the industrial sector will have the highest share with 59% and the shares of other sectors will drop while the share of cycle sector will reach up to 27% in 2020. Natural Gas Combined Cycle Plants that are being or will be put into operation in the future years will play a significant role in this increase[6]

1.6 Natural Gas Utilization in Turkey

The past of the natural gas utilization in Turkey is prolonged till the year 1976. The natural gas had been regarded as one of the energy sources of Turkey, since in some industrial facilities located at Thrace Region had started to use local natural gas; however, its share in primary energy consumption had been negligible until the year 1987. In 1987, together with the import of the natural gas from the former Soviet Union by BOTAŞ, the share of the import natural gas in the energy consumption began to increase rapidly and grew approximately 28 times, reaching up to 14.6 billion m^3 from 0.5 billion m^3 till the year 2000 (2001 Annual Report, BOTAŞ).

In parallel to the demands increasing gradually following 1987, the liquefied natural gas (LNG) purchases from Algeria and then Nigeria effective from 1994 commenced. In the

[5] *However, all these expectations must be revised taking into account the narrowing in economy, which was experienced in 2001 and reflected to 2002. Our economy retrogressed by 9.4% in 2001. As known, 1.8% of decrease in the demand for energy was observed besides the economy that retrogressed by 6.1% during economic crisis 1994. Furthermore, when the grow rate of 3% stipulated for 2002 is taken as basis, it is likely that the demand for energy will not be 298.4 Mtep, but 279.3 Mtep in 2020 with a correction of 6.4%. (Reference: http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm)*

[6] *http://www.foreigntrade.gov.tr/ead/ekonomi/sayi%2011/teut.htm*

mean time, a second natural gas agreement on 8 billion cubic meters was concluded with the Russian Federation.

1.6.1 Natural Gas Transportation, Facilities and Trade

Within the framework of the policy to diversify resources, BOTAS undertook the construction and operation of natural gas pipelines which it started. Existing natural gas pipelines and related facilities of BOTAS are as written below:

- Russian Federation – Turkey Natural Gas Pipeline
- Marmara Eregli Liquefied Natural Gas (LNG) Importat Terminal
- Izmit – Black Sea Eregli Natural Gas Transmission Line
- East Anatolia Natural Gas Transmission Line
- Karacabey – Izmir Natural Gas Transmission Line
- Samsun – Ankara Natural Gas Transmission Line (the Blue Stream)

1.6.2 Natural Gas Trade

According to the Annual Report 2001 of BOTAS, the quantity of natural gas imported within 2001 is approximately 16.368x106 m^3. The natural gas utilization is increasing rapidly in our country. The highest share of natural gas utilization within the sectors is the electricity sector (see Figure 1.5). According to the supply–demand projections performed by BOTAS, the demand for natural gas is anticipated to be 55x 109 m^3 in 2010 and 82 x 109 m^3 in 2020 (BOTAS, 2002).

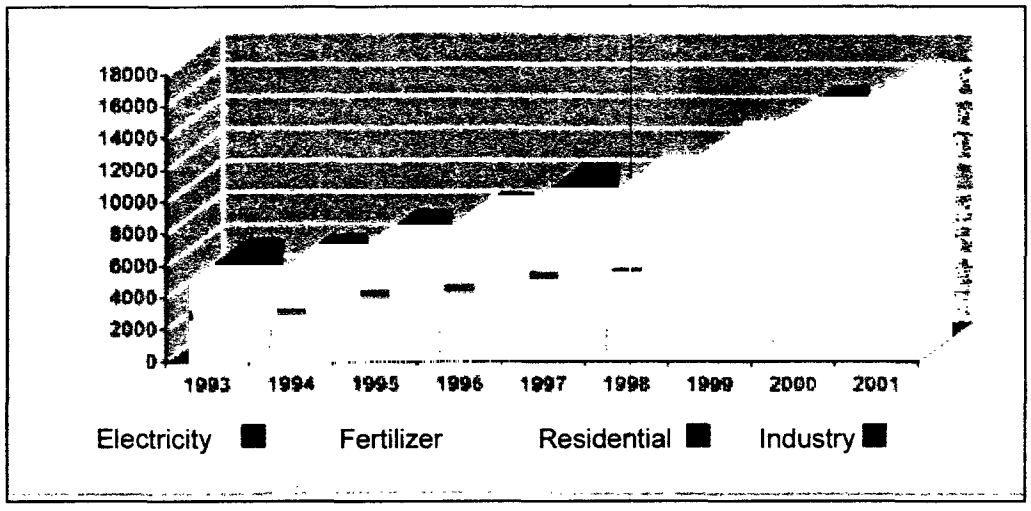


Figure 1.5. Natural Gas Sales Quantities in Different Years (Million m^3) (BOTAS, 2002)

1.6.3 Present Natural Gas and LNG Purchase – Sales Agreements

The present natural and LNG purchase–sales agreements are provided in Table 1.6 and represented on the graph in Figure 1.6.

Table 1.6 Present Natural Gas and LNG Import-Export Agreements

Present Agreements	Amount (Plateau) (Billion m^3/year)	Sign Date	Period (year)
Russian Federation (West)	6	February, 1986	25
Algeria (LNG)	4	April, 1988	20
Nigeria (LNG)	1.2	November, 1995	22
Iran	10	August, 1996	25
Russian Federation (Black Sea)	16	December, 1997	25
Russian Federation (West)	8	February, 1998	23
Turkmenistan	16	May, 1999	30

Reference: BOTAS, 2002

1.6.4 Investments

According to the Annual Report 2001 of BOTAS, BOTAS continues its activities to increase the capacities of Russian Federation – Turkey Natural Gas Pipeline and construct new transmission and distribution lines in addition to the existing lines already constructed in our country.

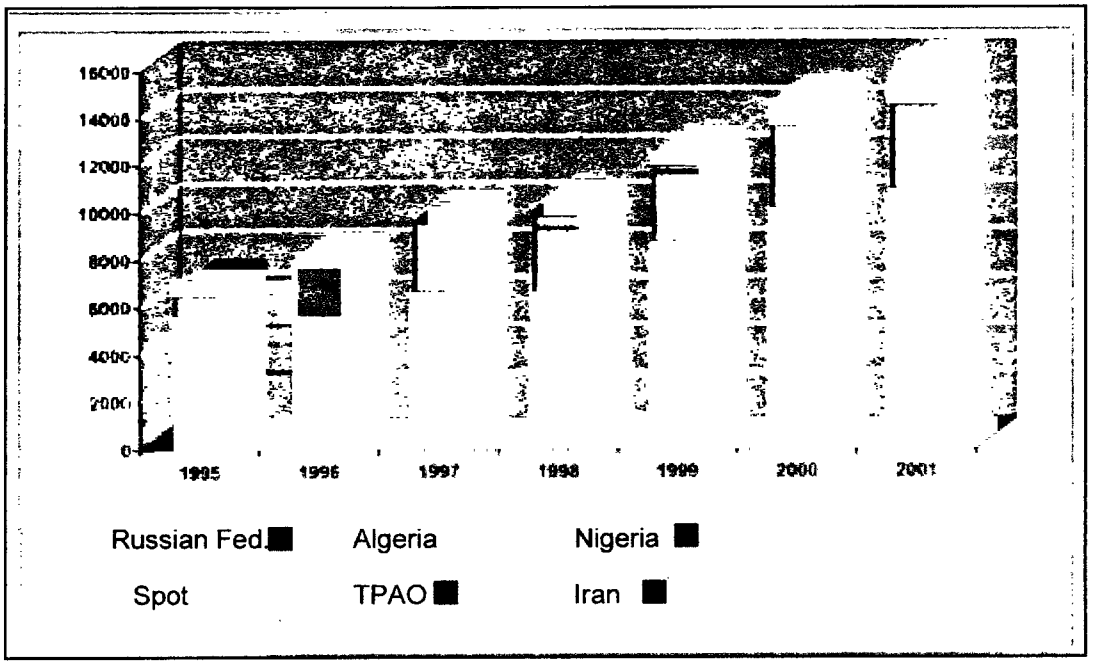


Figure 1.6. Natural Gas Purchase Quantities in Different Years (Million m^3) (BOTAS, 2002)

Furthermore, BOTAS is working on a variety of projects to expand the natural gas utilization throughout the country and diversify the natural gas supplies. Information about the investments and projects is as follows:

- Eastern Anatolia Natural Gas Main Transmission Line: It is aimed to transport the natural gas that will be purchased from the resources in the east including Iran to Turkey with this project. The line with the capacity of 10 x 109 m3 and approximately 1500 km long comprises of the following sections: Dogu Bayazit–Erzurum, Erzurum–Sivas, Sivas–Kayseri, Kayseri–Ankara, Kayseri–Konya–Seydisehir. The overall pipeline became capable of receiving gas as of the end of June 2001.
- Samsun – Ankara Natural Gas Transmission Line (the Blue Stream): It is aimed to transport the Russian gas to Turkey via the Black Sea with this project. The line with the capacity of 16 x 109 m3 and approximately 400 km (dual lines) long starts from Samsun and reaches to Ankara via Amasya, Corum and Kirikkale. Thus, natural gas shall be supplied to the provinces of Samsun, Amasya, Corum and Kirikkale on the route. The first gas was supplied at the end of December 2002.
- Karacabey – Izmir Natural Gas Transmission Line: It is planned to supply natural gas to the natural gas cycle plants in Manisa, Balikesir and Aliaga Region with the

extension of the existing Natural Gas Transmission Line. The line was commissioned in April 2002.

- South Natural Gas Transmission Line: It is aimed to meet the natural gas demand of South and Southeast Anatolian Regions with a branch line from the Eastern Anatolia Natural Gas Main Transmission Line around Sivas. The line, which is about 565 km long, shall start from Malatya and extend to Mersin via Kahramanmaras, Gaziantep, Osmaniye and Adana.
- Konya – Izmir Natural Gas Transmission Line: A branch line from the East Anatolia Natural Gas Main Transmission Line shall extend from Konya to Izmir. The line, which is approximately 618 km long, shall start from Konya and extend to Izmir via Burdur, Isparta, Denizli and Nazilli. Branch line shall be constructed for the cities such as Afyon and Antalya.
- Eastern Black Sea Region Natural Gas Pipeline: A branch line shall be constructed in Erzincan from the East Anatolia Natural Gas Main Transmission Line and the natural gas shall be supplied on this route with the extension of line to Gumushane, Bayburt, Hopa, Artvin, Rize, Trabzon, Giresun, Ordu and Samsun. The length of the line is approximately 233 km.
- West Black Sea Region Natural Gas Pipeline: A branch line from the Black Sea – Eregli shall supply natural gas to the industrial facilities and units of population on the route extending to Bartin via Zonguldak, Devrek and Caycuma. The length of the line is approximately 141 km.
- Georgian Border–Erzurum (Horasan) Natural Gas Transmission Line: The line of approximately 225 km long that is planned to transport the Azerbaijan and Turkmenistan natural gases within Turkey shall start from the Georgian border and extend to Erzurum / Horasan.
- Caspian Crossing Turkmenistan–Turkey–Europe Natural Gas Pipeline: It is aimed to transport the natural gas generated in the south section of Turkmenistan to Turkey and then to Europe via Turkey with a pipeline crossing the Caspian Sea.
- Azerbaijan Natural Gas Pipeline: It is aimed to transport the natural gas generation in Azerbaijan to Turkey via Georgia with this project.
- Egypt–Turkey Natural Gas Pipeline: This project has been developed to diversify the natural gas supplies.
- Iraq–Turkey Natural Gas Pipeline: It is aimed to develop the natural gas sites in Iraq and transport the natural gas generated to Turkey with a pipeline.
- Turkey–Greece Natural Gas Pipeline (Southeast European Gas Ring): Interconnection of Turkey and Greece natural gas systems as well as realization of Southeast European Gas Ring are aimed for the transportation of natural gas supplied from the Caspian Basin, Russia, Middle East, South Mediterranean countries and other international resources to the European markets.

The planned distribution pipelines are given below and the construction activities of these lines have started:

- Bilecik – Kutahya – Usak
- Izmir/ Kemalpasa Organized Industrial Zone – Pinarbasi – Torbali – Turgutlu
- Izmir – Aliaga – Ataturk Organized Industrial Zone
- Kirikkale – Kirsehir – Yozgat – Polatli
- Konya/ Eregli – Aksaray – Nigde
- Konya – Karaman/ Kazim Karabekir – Konya Organized Industrial Zone
- Manisa Organized Industrial Zone – Akhisar – Balikesir – Susurluk
- Kayseri – Sivas
- Corum – Samsun
- Adapazari Earthquake Buildings

1.7 Economic Importance of Project

As described under Section 1.6, Turkey has entered into a rapid development process and has achieved to be a large market in the energy sector. It is expected that Turkey will be an energy bridge between the Middle East, Middle Asia and Europe in the near future due to its geographical location. Because of great importance attached to the natural gas projects, the natural gas storage facilities should be increased in Turkey. Thus, the surplus natural gas could be stored and returned to the national grid if needed. In this context, it is important that there is a site where the natural gas can be stored in Turkey.

Important changes to the demand for the natural gas for heating of buildings in particular require the natural gas storage throughout Turkey. For example, 70% of the total annual energy consumption is realized in the four-month period between December – March while 90% is realized in the six-month period between November – April in respect of consumption for heating in Istanbul. There is not any demand for gas for heating in the period between June – September. In this case, it is of great importance that the natural gas transported from abroad to Turkey during the period including June – September is stored and returning the natural gas stored to the national grid during the period including November – April when the demand for natural gas increases (Satman, 2000).

Typical trend of natural gas supply and demand is represented in Figure 1.7. According to this figure, although the demands for natural gas change on seasonal basis, the natural gas procurement continues at certain extent. In this case, it is possible to store the gas when there is little demand for the natural gas and return the gas to the grid during the period when there is a great deal of demand.

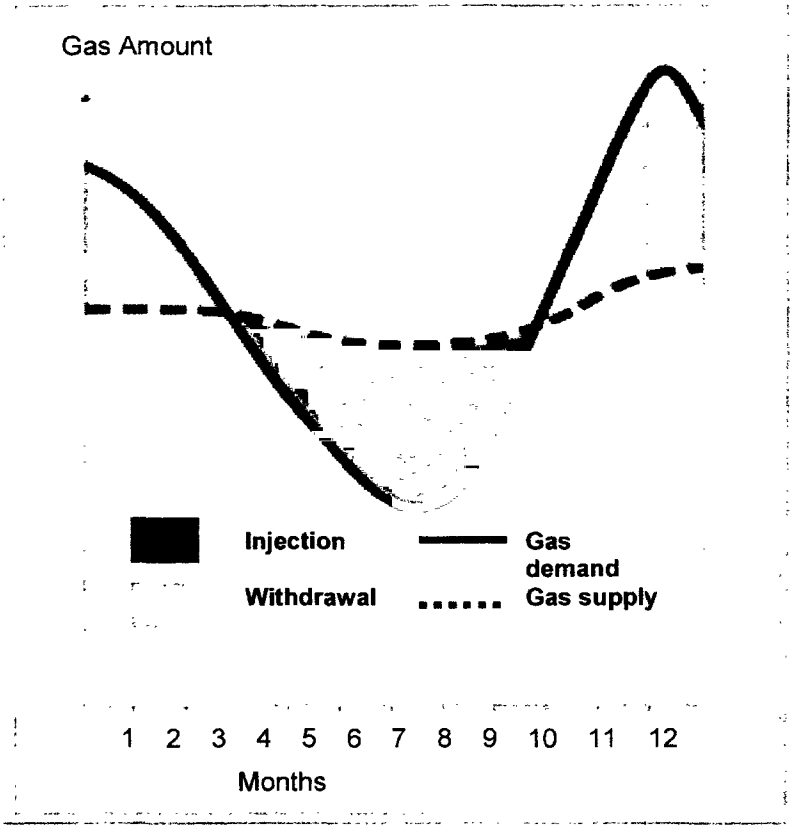


Figure 1.7. Supply–Demand Trend in Natural Gas

1.8 Social Importance of Project

It is planned to realize the proposed Lake Salt Basin UNGSP in Bezirci, Sultanhani Municipality, the Central District of the Province of Aksaray. Incase natural gas demand decreases; natural gas shall be taken from Kayseri – Konya – Seydisehir section of East Anatolia Natural Gas Main Transmission Line by means of a branch line and stored underground within the scope of the project. When the demand for natural gas increases in the country, the stored gas shall be transferred to the national grid again through the same line.

The most socially impacted areas of the project shall be the Province of Aksaray and the Central District as well as the District of Eskil. Total population of the Province of Aksaray in 1997 was 347.163 and rural and urban populations are 178.085 and 169.078

respectively. These population figures correspond to 51% and 49% of the whole province respectively (SSI, 2002).

Population figures for 1997 of the Central District and District of Eskil that are anticipated to be impacted by the proposed project are 200.338 and 25.689 respectively. The rural and urban populations in the Central District are 99.151 and 101.187 respectively and these figures are 6.433 and 19.256 respectively in the District of Eskil. In this context, although the population living in the rural and urban areas in the Central District is very close, a major part of the population in the District of Eskil live in the urban area (SSI (State Statistics Institute), 2002).

According to the information gathered during field trips, the public in some villages of the Province of Aksaray earn their lives by working abroad. In this context, it is estimated that direct and indirect opportunities of employment during the project as well as direct and indirect expenditures shall be beneficial with respect to preventing emigration that may occur in the region and supporting the industrial development in the region. Accordingly, the importance of the project covers the positive impacts on the economy (meeting natural gas shortage in the winter, indirect opportunities for jobs etc.) and enhancing the social life (incentive for natural gas utilization etc.).

1.9 Environmental Impact Assessment

This report is prepared by ENVY in a manner to fulfill the necessities of the EIA report, which will be presented to the Ministry of Environment concerning the proposed Tuz Golu Basin Underground Natural Gas Storage Project. The extent of the project is determined in respect to a special format given by the Ministry of Environment. The EIA format given by the Ministry is presented in Appendix-A.

1.9.1 EIA Team

The EIA report prepared for the proposed Tuz Golu UNGSP, is prepared by EIA team of ENVY, including environmental and mechanical engineers, environment management experts, experts who have specialization in various engineering topics such as ecology, social impacts, soil, air and water pollution, hydrology and meteorology, geology, geotechnics and geophysics. The curriculum vitae of the individuals, who worked in the preparation of the report, are presented in Appendix-B.

1.9.2 Impact Assessment Approach

The aim of constituting this EIA report is to define and to evaluate the probable impacts of the proposed project on biophysical and socio-economical environments. For this purpose, the project of concern covers the matters mentioned below:

- To define the alternatives of the proposed underground gas storage project,
- To determine the baseline characteristics of the environment, which can be affected by the project,
- To define the probable impacts of the project on the environment (to determine the present pollution load of Tuz Golu and to evaluate the impact of the brine water (solution) discharge, which can appear due to the proposed project),
- To determine the national and international control methods, which will be applied to prevent or minimize the potential environmental impacts,
- To develop suggestions about the precautions to be taken for the permanent impacts likely to exceed the related national and international standards.

The information about the baseline environmental condition of the proposed project site and its impact area is presented by using the data obtained from the detailed literature research and field studies undertaken by the EIA group. Impact assessment studies are realized after the determination the baseline characteristics of the project site and its vicinity. The determination of the areas, which can be affected by the project activities, is carried out by means of the studies concerning the definite design and technical contracts.

The probable impacts assessment phase of the proposed project includes the aspects presented below:

- *Duration Limits:* Probable impacts and the duration of these impacts are examined by taking various project phases into consideration like construction, operation and post-operation.
- *Site Limits:* Because that the project site is in the vicinity of Sultanhani Municipality of the Central District of Aksaray Province, it is thought that the most important area, which will be affected by the project, will be Aksaray Province and Sultanhani Municipality. In that context, Aksaray is assessed in terms of socio-economics and baseline condition. In order to study the biophysical impacts, the baseline condition of the project site and its vicinity is discussed in Section 4.
- *Sources:* The probable impacts of the whole project activities on the biophysical sources (air, water, soil etc.) are surveyed. Besides, the social, cultural and economical impacts on the neighboring settlement areas, positive or negative,

are also evaluated. During this evaluation, literature, field and laboratory studies are used effectively.

3 ECONOMICAL AND SOCIAL ASPECTS OF THE PROJECT

3.1 Investment Program and Finance Sources for the Realization of the Project

The proposed Tuz Golu Basin UNGSP financing comprises of two different groups including: (i) investment and (ii) operation costs (GEOSTOCK, 2002). The cost stipulated for this project is approximately USD 155.5×10^6 for investment and USD 664.9×10^6/year for operation. Detailed description of these costs is given under the following titles.

3.1.1. Investment Cost

The investment cost comprises of the following items:

- Activities to be performed underground,
- Activities to be performed within the content of surface facilities,
- Activities to be performed during the construction of branch line.

Underground Activities

The underground activities include opening wells, costs concerning the leaching process and cost of cushion gas. The total financing required for these works is stipulated to be USD 112.5 x 106. The items in this total price and costs of these items are as follows (GEOSTOCK, 2002):

Opening Wells	: USD 30.5×10^6
Leaching Process	: USD 50×10^6
Cushion Gas	: USD 42×10^6
TOTAL	: USD 122.5×10^6

Surface Activities

The activities to be performed on the surface include the costs associated with the supply of fresh water necessary for leaching process, erecting the leaching station and discharging the brine to Tuz Golu. It is anticipated that the total financing necessary for these works shall be USD 27×10^6. The items and costs of these items in the total price are given in the table below (GEOSTOCK, 2002):

Water Supply	: USD 7×10^6
Leaching Station	: USD 22×10^6
Brine Discharging	: USD 8×10^6
Surface Facilities	: USD 70×10^6
Storage of Gas	: USD 43×10^6
TOTAL	: USD 150×10^6

Branch Line

The total cost of activities associated with the branch line is USD $16x10^6$, and the work items and estimated costs of these items are given below (GEOSTOCK, 2002):

Project Management	: USD 196×10^3
Engineering / Design	: USD 196×10^3
Field Survey	: USD 70×10^3
Consultation Services	: USD 252×10^3
Insurance	: USD 314×10^3
Right of Way	: USD 420×10^3
Site Preparations	: USD 168×10^3
Roads	: USD 140×10^3
Pipe	: USD 3.990×10^3
Pipe Coating	: USD 700×10^3
Valves	: USD 75×10^3
Cathodic Protection	: USD 11.2×10^3
Advance	: USD 14×10^3
Handling	: USD 720×10^3
Pipe Laying	: USD 7.406×10^3
Mobilization / Demobilization	: USD $1.140.9 \times 10^3$
TOTAL	: USD $15.813.1 \times 10^3$

General Assessment

As given in the sections above, the total investment cost stipulated for Tuz Golu Basin UNGSP is USD $288.5x10^6$. The distribution of this cost in different years is represented in Figure 3.1. According to this Figure, it is anticipated, with the assumption that the project activities are initiated in 2003, the highest expenditure shall be made within 2006 and the natural gas shall be continued to be stored by opening 10 caverns in 2020 (GEOSTOCK, 2002).

3.1.2 Operation Cost

The operation costs comprise of the following items and costs associated with these items:

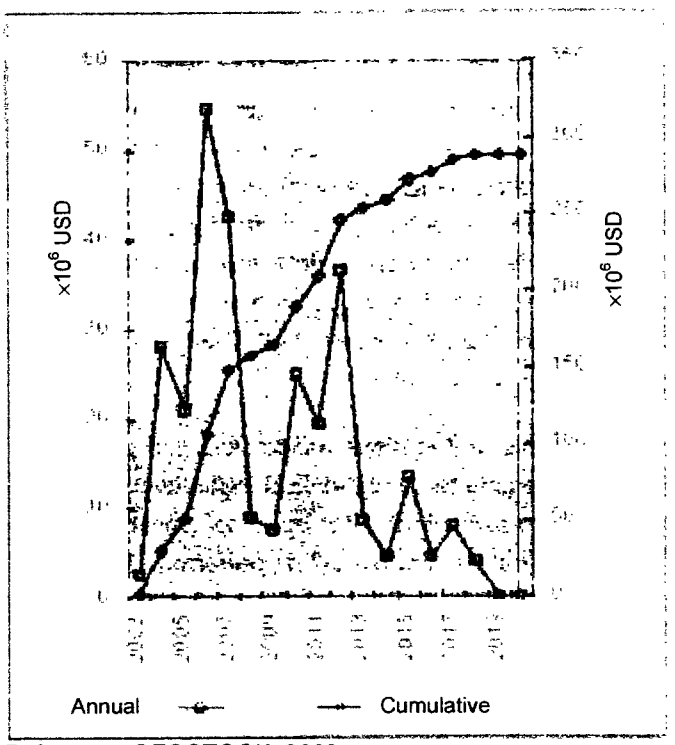
Personnel Expenses	: USD 0.6×10^6
Maintenance	: USD 0.02×10^6/year/cavern
Special Works	: USD 0.08×10^6/year
Electricity	: USD 0.9×10^6/year

Energy / Gas : USD 3.7 x 10^6/year
Chemicals, communication etc. : USD 0.2 x 10^6/year

When it is considered that the operation continues during 2008–2020, it is stipulated that the annual operational cost during these years shall vary between USD 4.9x10^6/year and USD 8.3x10^6/year. Average annual operation cost during these years is calculated to be approximately USD 6.6x10^6/year (GEOSTOCK, 2002).

3.1.3 Financing Sources

The financing source of the proposed Tuz Golu Basin UNGSP has not become certain yet in the present situation. However, since the investment and operation costs of the project are high, it is likely that this project shall be tendered in build–operate–transfer (BOT) model instead of allocating equities for this project.



Reference: GEOSTOCK, 2002

Figure 3.1. Annual Flow of Investment Costs of the Project

3.2 Work Flow Chart or Time Table Concerning the Realization of the Project

The salt domes that will be used within the content of the project are located at approximately 700 m and lower layers of the ground and their thickness varies between 700 mm and 1500 mm. Within the frame of the project, it is planned to leach the salt domes during 12.5-15 years using a common method prevailing in the world and creating a total of 10 caverns, each with an approximate volume of 500.000 m^3.

As a result of this process that will be realized for 12.5–15 years at the first stage, a total of 10 caverns, each with an approximate volume of 500.000 m^3 shall be created. There shall be approximately $42x10^6$ m^3 of cushion gas within each cavern and the working gas volume shall be approximately $70x10^6$ m^3. Thus, approximately $112x10^6$ m^3 of natural gas shall be able to be stored in each cavern. With a simple calculation, the total cushion gas in 10 caverns shall be approximately $420x10^6$ m^3. The total quantity of gas to be stored by taking from the national grid and returned to the grid is stipulated to be approximately $700x10^6$ m^3.

Within the scope of the project, two caverns shall be opened at the same time and the duration for this process is approximately 30–36 months. In this context, the duration required to open caverns, which are planned to be 10, shall be about 150–180 months. It shall be commenced to store natural gas into the caverns opened in this duration. When the studies that will be conducted before the caverns are opened are considered, the total duration for completing the project is anticipated to be approximately 15 years. The important activities that are estimated to be carried out within the scope of the project during this period are listed below:

- Geological surveys and surveys associated with projecting the underground natural gas store shall be able to be completed within two years.
- The processes associated with opening drilled wells and the construction of underground natural gas store shall be performed between 3rd and 14th years.
- The construction activities of the discharge facilities including the fresh water supply wells, water and brine lines, pump stations etc. shall be realized within third and fourth years.
- The cavern opening activities shall be carried out following the fourth year. In parallel to these activities, the surface facilities that will be activated before injecting gas into the two caverns shall be constructed in the eighth year.
- Third and fourth caverns shall be commissioned in 10th year; fifth and sixth caverns shall be commissioned in the 11th year; seventh and eighth caverns shall be commissioned in the 12th year while the ninth and tenth caverns shall be commissioned in the 14th year of the project.

The project activities were commenced in the first months of 2000 and the proposed work flow chart for the project is given in Figure 3.2.

3.2.1. Caverns Formation Plan

Within the scope of Tuz Golu Basin UNGSP, the plan to be applied in order to form caverns at approximately 1150 m below the surface is given in Table 3.1. According to this plan, the first three years were allocated for surveys, engineering studies and design phase and leaching process shall be commenced in the caverns following the completion of these activities. In this context, the natural gas shall be able to be stored only seven years after the commencement of activities.

Table 3.1 Cavern Creation Plan in the Content of TUGSP

Year	Volume of Cavern (10^3 m³)	Number of Cavern	Total Volume of Stored Gas (10^6 m³)	Active Gas Volume (10^6 m³)	Cushion Gas Volume (10^6 m³)	Maximum Withdraw (10^6 m³)
1 2 3	Geological research studies, projecting of the underground gas store, activities for drilling of the wells, commencement of the underground gas store construction, construction of the surface facilities					
4	60					
5	372					
6	900					
7	1469					
8	2031	2	246.4	160	86.4	6.6
9	2593	4	320	320	172.8	13.2
10	3155	4	320	320	172.8	13.2
11	3717	6	480	480	259.2	19.8
12	4279	8	640	640	345.6	26.4
13	4840	8	640	640	345.6	26.4
14	5000	10	800	800	432.0	33.0

NOTE 1: While preparing the plan for commissioning of the caverns, it is accepted that the first loading processes of gas will be realized in the summer season.

NOTE 2: Following the commissioning of the pipeline, which supplies gas to the underground gas store, it is proposed that the natural gas will be used as the non-solvent gas (cushion gas) in the cavern opening process.

MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
TOTAL PROJECT																	
Detailed Engineering																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	
Procurement																	
Long Lead Items																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	
Construction																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	

Figure 3.2 Work Flow Chart for the Proposed TUGSP

3.3 Benefit-Cost Analysis of the Project

For the benefit-cost analysis realized for any project, the owner of the business (if getting an exterior financial support is in question, together with the investor), country or state which are in the content of the proposed project, and regional and local communities, which will be directly affected by the project, should be discussed individually. Discrete criteria are used for each element in the analysis. Moreover, the results of different analyses can be distinct from each other.

3.3.1 National Benefit-Cost Analysis

Generally in Turkey, the important variations in the natural gas demand for the domestic heating during the year makes the natural gas storage compulsory. In this regard, in order to meet the seasonal fluctuations, which will occur in the future depending on the increase in the natural gas demand of residences, storage of the natural gas between the salt layers, which have a depth of approximately 1150 m, is planned in the content of TUGSP.

The natural gas, transported by Kayseri-Konya-Seydisehir part of the Eastern Anatolia Natural Gas Main Transmission Line, will be started to be stored in the months (summer season), when the national natural gas demand decreases, and together with the demand increase (winter season), it will be given back to the same line in order to obtain a nationwide supply-demand balance. Another significance of the project is to supply a reserve for the country by storing the natural gas imported from foreign countries.

Accordingly, the importance of the project covers the positive impacts on the economy (meeting the natural gas shortage in winter, indirect opportunities for job etc.) and enhancing the social life (encourage to use natural gas etc.).

In addition to all, the activities associated with making natural gas connections for various provinces within the scope of the projects in the near future are important as well (please refer to Section 1.6.). In this context, the fluctuations in the natural gas supply and demand will increase. Consequently, it is compulsory to store the natural gas.

3.3.2 Regional Benefit-Cost Analysis

It is planned to realize the proposed Lake Salt UNGSP in Bezirci Location, Sultanhani Municipality, the Central District of the Province of Aksaray. The area where the social

impacts of the project will be experienced is the Province of Aksaray as well as the Central District and District of Eskil.

According to the information gathered during the field surveys, the people living in some villages of the Province of Aksaray earn their lives by working abroad. In this context, it is estimated that direct and indirect opportunities of employment during the proposed Lake Salt Basin UNGSP as well as direct and indirect expenditures shall be beneficial with respect to preventing emigration that may occur in the region and supporting the industrial development in the region.

3.4 Other Economic, Social and Infrastructure Activities Not Found in the Content of the Project But Planned to be Realized by Investor Firm Or Other Firms Depending on the Realization of the Project

3.4.1 Water Supply and Wastewater Treatment Systems

The water in the proposed TUGSP will be used for the purposes determined below:

- To open caverns for the storage of the natural gas by dissolving the salt layers during the leaching process;
- To meet the water need (e.g. water for drinking and using) of personnel;
- During the activities of the construction of surface facilities; and
- Later on for the irrigation of green-fields.

The water required for all the activities, which will be carried out within the project of concern, will be supplied from the underground water reserve in the vicinity of Bezirci Lake. Regarding this purpose, it is planned to open six wells, five as main and one as standby, and to withdraw the required water from the wells by pumps.

The water withdrawn from the wells under consideration will initially be transmitted to the service store, which has a capacity of 1500 m^3 and will be constructed near the wells and then to the surface facilities. Prior to the transmission of the water to the surface facilities, it will be subjected to chemical dosing against corrosion via a unit placed at the outlet of the store.

The flow rate of the water withdrawn from the wells will be maximum 660 m^3/hour and in order for the water to be transmitted to the site, steel pipes of 6 km in length and 400 mm in diameter will be utilized. The detailed information concerning the water supply is presented in Section 5.1.11.

The brine water (solution), which will be formed at the end of the leaching process, will be discharged to Tuz Golu. The domestic wastewater will be treated at the facility for wastewater treatment package. The treated water will be used for the irrigation of the green-fields at the facility or will be connected to the solution discharge line. For the solution to be discharged to Tuz Golu, it is planned to use a discharge line of 39 km in length and 500 mm in diameter. The detailed information concerning the topic is presented in Section 5.2.5.

3.4.2 Electrical Connections

The electrical energy, required for the construction and operation activities to be carried out at the proposed project site, will be supplied from the electrical line drawn to the site. Total energy need to be required for the operation of the facility will be 5 MVA. For the required amount, it is planned to purchase one of the pylons located within the provincial boundaries of Aksaray and found on the Sultanhani-Eskil transmission line of 34.5 kW pertaining to the Turkish Electricity Distribution Corporation (TEDAŞ).

Regarding the project, in the consequence of the negotiations realized with TEDAŞ authorities in the region, it is stated verbally that the issue could be resolved by means of an application to TEDAŞ. In this regard, following the verification of the transmission line route required official procedures would be commenced.

3.4.3 Protection System Against Fire

In the content of TUGSP, in order to prevent probable fire events, a protection system containing various equipments will be provided. As the main element of this system, an advanced fire alarm system will be set up. Fire detectors susceptible to heat, smoke and flame will be present on site. These detectors will be arranged as to give alarm and additionally, a manually controlled fire alarm system will be found and control switches will be placed.

Moreover, there will be non-automatic fire extinguisher systems on site. Fire hydrants, fire extinguishers with carbon-dioxide, manual fire extinguishers, fire blankets, fire extinguishing powder generators, fire extinguishing foam generator, carbon-dioxide tank and sand buckets will be found at the facility to be used against fire.

3.4.4 Lighting System

Within the project, there will be a system for both interior and exterior illumination of the site. In case of emergencies, the illuminated constructions will be connected to the emergency power line.

3.4.5 Security System

All required arrangements for the security control would be realized at the surface facility area and the compressor buildings, which will be constructed at the top of each cavern. For this purpose, areas will be surrounded with wire fence, security guards will be provided for the main entrance and exit points.

3.4.6 Communication

The required telecommunication infrastructure will be set up at the facilities to be constructed.

3.4.7 Accommodation

In the project, both leaching process and the construction of the surface facilities will be carried out concurrently. Furthermore, following the completion of the surface facilities and the opening of the two caverns, leaching process and storage of the natural gas will be carried out together.

It is planned that the number of the personnel during the construction works of the surface facilities will be 100. With the completion of the construction of the facilities and with the commencement of the natural gas storage, the number of the personnel will be reduced to around 25-30. The personnel to be worked for the construction activities will be provided from the residents in the vicinity and the accommodation at the project site in the content of the activities of concern will be applicable for a limited number of personnel.

3.4.8 Access Roads

The existing roads in the vicinity of the region will be utilized for the proposed TUGSP. Prior to the construction activities, the restoration activities will be carried out for the required roads.

3.4.9 Storm Water Collection System

There is no surface water resource in the vicinity of the proposed project site. Therefore, no flood problem is accepted to be occurred at the construction site. Nevertheless, all

required measures will be taken against the surface waters by connecting the drainage system to be built at the foundation level of the buildings to the grid channels and flues to be formed at all construction sites and the water to be collected at these channels will be discharged to the open field with a suitable topography.

3.4.10 Natural Gas Branch Line

In order to withdraw the excess natural gas found in the national network and to store it underground and again to transmit it to the national network when required, a branching will be drawn from Kayseri-Konya-Seydisehir part of the Eastern Anatolia Natural Gas Main Transmission Line to the project site. The line under consideration will be approximately 19 km in length and 40" in diameter (see Appendix-E). Since the exact route of the branching is not determined yet, the environmental impacts of the mentioned line are not assessed in this report.

3.5 Supplementary Economic, Social and Infrastructure Activities Not Found in the Content of the Project But Required for the Realization of the Project and Planned to be Realized By Investor Firm Or Other Firms

Except for the activities stated in Section 3.4 to be realized in the content of the proposed TUGSP, there is no need for any other infrastructure facility.

3.6 Other Aspects

No other aspect is required to be assessed in this section.

3 ECONOMICAL AND SOCIAL ASPECTS OF THE PROJECT

3.1 Investment Program and Finance Sources for the Realization of the Project

The proposed Tuz Golu Basin UNGSP financing comprises of two different groups including: (i) investment and (ii) operation costs (GEOSTOCK, 2002). The cost stipulated for this project is approximately USD $155.5x10^6$ for investment and USD $664.9x10^6$/year for operation. Detailed description of these costs is given under the following titles.

3.1.1. Investment Cost

The investment cost comprises of the following items:

- Activities to be performed underground,
- Activities to be performed within the content of surface facilities,
- Activities to be performed during the construction of branch line.

Underground Activities

The underground activities include opening wells, costs concerning the leaching process and cost of cushion gas. The total financing required for these works is stipulated to be USD 112.5 x 106. The items in this total price and costs of these items are as follows (GEOSTOCK, 2002):

Opening Wells	: USD 30.5×10^6
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Cushion Gas	: USD 42×10^6
TOTAL	: USD 122.5×10^6

Surface Activities

The activities to be performed on the surface include the costs associated with the supply of fresh water necessary for leaching process, erecting the leaching station and discharging the brine to Tuz Golu. It is anticipated that the total financing necessary for these works shall be USD $27x10^6$. The items and costs of these items in the total price are given in the table below (GEOSTOCK, 2002):

Water Supply	: USD 7×10^6
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Branch Line

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Mobilization / Demobilization	: USD 1.140.9 x 10^3
TOTAL	: USD 15.813.1 x 10^3

General Assessment

As given in the sections above, the total investment cost stipulated for Tuz Golu Basin UNGSP is USD $288.5x10^6$. The distribution of this cost in different years is represented in Figure 3.1. According to this Figure, it is anticipated, with the assumption that the project activities are initiated in 2003, the highest expenditure shall be made within 2006 and the natural gas shall be continued to be stored by opening 10 caverns in 2020 (GEOSTOCK, 2002).

3.1.2 Operation Cost

The operation costs comprise of the following items and costs associated with these items:

Personnel Expenses	: USD 0.6 x 10^6
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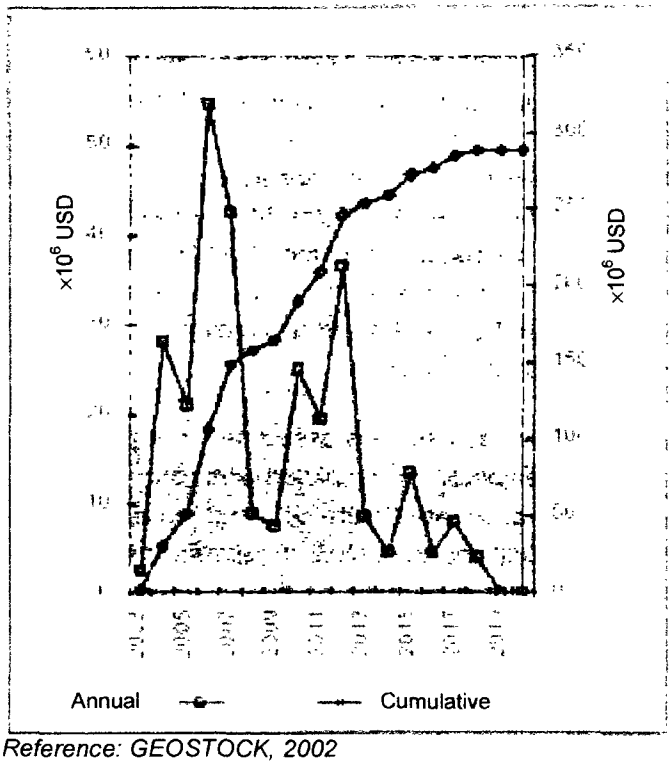
Electricity	: USD 0.9 x 10^6/year

Energy / Gas : USD 3.7 x 10^6/year
Chemicals, communication etc. : USD 0.2 x 10^6/year

When it is considered that the operation continues during 2008–2020, it is stipulated that the annual operational cost during these years shall vary between USD 4.9x10^6/year and USD 8.3x10^6/year. Average annual operation cost during these years is calculated to be approximately USD 6.6x10^6/year (GEOSTOCK, 2002).

3.1.3 Financing Sources

The financing source of the proposed Tuz Golu Basin UNGSP has not become certain yet in the present situation. However, since the investment and operation costs of the project are high, it is likely that this project shall be tendered in build–operate–transfer (BOT) model instead of allocating equities for this project.



Reference: GEOSTOCK, 2002
Figure 3.1. Annual Flow of Investment Costs of the Project

3.2 Work Flow Chart or Time Table Concerning the Realization of the Project

The salt domes that will be used within the content of the project are located at approximately 700 m and lower layers of the ground and their thickness varies between 700 mm and 1500 mm. Within the frame of the project, it is planned to leach the salt domes during 12.5-15 years using a common method prevailing in the world and creating a total of 10 caverns, each with an approximate volume of 500.000 m^3.

As a result of this process that will be realized for 12.5–15 years at the first stage, a total of 10 caverns, each with an approximate volume of 500.000 m^3 shall be created. There shall be approximately $42x10^6$ m^3 of cushion gas within each cavern and the working gas volume shall be approximately $70x10^6$ m^3. Thus, approximately $112x10^6$ m^3 of natural gas shall be able to be stored in each cavern. With a simple calculation, the total cushion gas in 10 caverns shall be approximately $420x10^6$ m^3. The total quantity of gas to be stored by taking from the national grid and returned to the grid is stipulated to be approximately $700x10^6$ m^3.

Within the scope of the project, two caverns shall be opened at the same time and the duration for this process is approximately 30–36 months. In this context, the duration required to open caverns, which are planned to be 10, shall be about 150–180 months. It shall be commenced to store natural gas into the caverns opened in this duration. When the studies that will be conducted before the caverns are opened are considered, the total duration for completing the project is anticipated to be approximately 15 years. The important activities that are estimated to be carried out within the scope of the project during this period are listed below:

- Geological surveys and surveys associated with projecting the underground natural gas store shall be able to be completed within two years.
- The processes associated with opening drilled wells and the construction of underground natural gas store shall be performed between 3rd and 14th years.
- The construction activities of the discharge facilities including the fresh water supply wells, water and brine lines, pump stations etc. shall be realized within third and fourth years.
- The cavern opening activities shall be carried out following the fourth year. In parallel to these activities, the surface facilities that will be activated before injecting gas into the two caverns shall be constructed in the eighth year.
- Third and fourth caverns shall be commissioned in 10th year; fifth and sixth caverns shall be commissioned in the 11th year; seventh and eighth caverns shall be commissioned in the 12th year while the ninth and tenth caverns shall be commissioned in the 14th year of the project.

The project activities were commenced in the first months of 2000 and the proposed work flow chart for the project is given in Figure 3.2.

3.2.1. Caverns Formation Plan

Within the scope of Tuz Golu Basin UNGSP, the plan to be applied in order to form caverns at approximately 1150 m below the surface is given in Table 3.1. According to this plan, the first three years were allocated for surveys, engineering studies and design phase and leaching process shall be commenced in the caverns following the completion of these activities. In this context, the natural gas shall be able to be stored only seven years after the commencement of activities.

Table 3.1 Cavern Creation Plan in the Content of TUGSP

Year	Volume of Cavern (10^3 m³)	Number of Cavern	Total Volume of Stored Gas (10^6 m³)	Active Gas Volume (10^6 m³)	Cushion Gas Volume (10^6 m³)	Maximum Withdraw (10^6 m³)
1 2 3	Geological research studies, projecting of the underground gas store, activities for drilling of the wells, commencement of the underground gas store construction, construction of the surface facilities					
4	60					
5	372					
6	900					
7	1469					
8	2031	2	246.4	160	86.4	6.6
9	2593	4	320	320	172.8	13.2
10	3155	4	320	320	172.8	13.2
11	3717	6	480	480	259.2	19.8
12	4279	8	640	640	345.6	26.4
13	4840	8	640	640	345.6	26.4
14	5000	10	800	800	432.0	33.0

NOTE 1: While preparing the plan for commissioning of the caverns, it is accepted that the first loading processes of gas will be realized in the summer season.

NOTE 2: Following the commissioning of the pipeline, which supplies gas to the underground gas store, it is proposed that the natural gas will be used as the non-solvent gas (cushion gas) in the cavern opening process.

MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
TOTAL PROJECT																	
Detailed Engineering																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	
Procurement																	
Long Lead Items																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	
Construction																	
Leaching Units																	
Processing																	
Mechanical Works and Pipe Laying																	
Electrical Works																	
Check and Installation of Tools																	
Construction Works																	
Installation of Pipelines for Water, Brine & Units																	
Well and Well Area Activities																	

Figure 3.2 Work Flow Chart for the Proposed TUGSP

3.3 Benefit-Cost Analysis of the Project

For the benefit-cost analysis realized for any project, the owner of the business (if getting an exterior financial support is in question, together with the investor), country or state which are in the content of the proposed project, and regional and local communities, which will be directly affected by the project, should be discussed individually. Discrete criteria are used for each element in the analysis. Moreover, the results of different analyses can be distinct from each other.

3.3.1 National Benefit-Cost Analysis

Generally in Turkey, the important variations in the natural gas demand for the domestic heating during the year makes the natural gas storage compulsory. In this regard, in order to meet the seasonal fluctuations, which will occur in the future depending on the increase in the natural gas demand of residences, storage of the natural gas between the salt layers, which have a depth of approximately 1150 m, is planned in the content of TUGSP.

The natural gas, transported by Kayseri-Konya-Seydisehir part of the Eastern Anatolia Natural Gas Main Transmission Line, will be started to be stored in the months (summer season), when the national natural gas demand decreases, and together with the demand increase (winter season), it will be given back to the same line in order to obtain a nationwide supply-demand balance. Another significance of the project is to supply a reserve for the country by storing the natural gas imported from foreign countries.

Accordingly, the importance of the project covers the positive impacts on the economy (meeting the natural gas shortage in winter, indirect opportunities for job etc.) and enhancing the social life (encourage to use natural gas etc.).

In addition to all, the activities associated with making natural gas connections for various provinces within the scope of the projects in the near future are important as well (please refer to Section 1.6.). In this context, the fluctuations in the natural gas supply and demand will increase. Consequently, it is compulsory to store the natural gas.

3.3.2 Regional Benefit-Cost Analysis

It is planned to realize the proposed Lake Salt UNGSP in Bezirci Location, Sultanhani Municipality, the Central District of the Province of Aksaray. The area where the social

impacts of the project will be experienced is the Province of Aksaray as well as the Central District and District of Eskil.

According to the information gathered during the field surveys, the people living in some villages of the Province of Aksaray earn their lives by working abroad. In this context, it is estimated that direct and indirect opportunities of employment during the proposed Lake Salt Basin UNGSP as well as direct and indirect expenditures shall be beneficial with respect to preventing emigration that may occur in the region and supporting the industrial development in the region.

3.4 Other Economic, Social and Infrastructure Activities Not Found in the Content of the Project But Planned to be Realized by Investor Firm Or Other Firms Depending on the Realization of the Project

3.4.1 Water Supply and Wastewater Treatment Systems

The water in the proposed TUGSP will be used for the purposes determined below:

- To open caverns for the storage of the natural gas by dissolving the salt layers during the leaching process;
- To meet the water need (e.g. water for drinking and using) of personnel;
- During the activities of the construction of surface facilities; and
- Later on for the irrigation of green-fields.

The water required for all the activities, which will be carried out within the project of concern, will be supplied from the underground water reserve in the vicinity of Bezirci Lake. Regarding this purpose, it is planned to open six wells, five as main and one as standby, and to withdraw the required water from the wells by pumps.

The water withdrawn from the wells under consideration will initially be transmitted to the service store, which has a capacity of 1500 m^3 and will be constructed near the wells and then to the surface facilities. Prior to the transmission of the water to the surface facilities, it will be subjected to chemical dosing against corrosion via a unit placed at the outlet of the store.

The flow rate of the water withdrawn from the wells will be maximum 660 m^3/hour and in order for the water to be transmitted to the site, steel pipes of 6 km in length and 400 mm in diameter will be utilized. The detailed information concerning the water supply is presented in Section 5.1.11.

The brine water (solution), which will be formed at the end of the leaching process, will be discharged to Tuz Golu. The domestic wastewater will be treated at the facility for wastewater treatment package. The treated water will be used for the irrigation of the green-fields at the facility or will be connected to the solution discharge line. For the solution to be discharged to Tuz Golu, it is planned to use a discharge line of 39 km in length and 500 mm in diameter. The detailed information concerning the topic is presented in Section 5.2.5.

3.4.2 Electrical Connections

The electrical energy, required for the construction and operation activities to be carried out at the proposed project site, will be supplied from the electrical line drawn to the site. Total energy need to be required for the operation of the facility will be 5 MVA. For the required amount, it is planned to purchase one of the pylons located within the provincial boundaries of Aksaray and found on the Sultanhani-Eskil transmission line of 34.5 kW pertaining to the Turkish Electricity Distribution Corporation (TEDAŞ).

Regarding the project, in the consequence of the negotiations realized with TEDAŞ authorities in the region, it is stated verbally that the issue could be resolved by means of an application to TEDAŞ. In this regard, following the verification of the transmission line route required official procedures would be commenced.

3.4.3 Protection System Against Fire

In the content of TUGSP, in order to prevent probable fire events, a protection system containing various equipments will be provided. As the main element of this system, an advanced fire alarm system will be set up. Fire detectors susceptible to heat, smoke and flame will be present on site. These detectors will be arranged as to give alarm and additionally, a manually controlled fire alarm system will be found and control switches will be placed.

Moreover, there will be non-automatic fire extinguisher systems on site. Fire hydrants, fire extinguishers with carbon-dioxide, manual fire extinguishers, fire blankets, fire extinguishing powder generators, fire extinguishing foam generator, carbon-dioxide tank and sand buckets will be found at the facility to be used against fire.

3.4.4 Lighting System

Within the project, there will be a system for both interior and exterior illumination of the site. In case of emergencies, the illuminated constructions will be connected to the emergency power line.

3.4.5 Security System

All required arrangements for the security control would be realized at the surface facility area and the compressor buildings, which will be constructed at the top of each cavern. For this purpose, areas will be surrounded with wire fence, security guards will be provided for the main entrance and exit points.

3.4.6 Communication

The required telecommunication infrastructure will be set up at the facilities to be constructed.

3.4.7 Accommodation

In the project, both leaching process and the construction of the surface facilities will be carried out concurrently. Furthermore, following the completion of the surface facilities and the opening of the two caverns, leaching process and storage of the natural gas will be carried out together.

It is planned that the number of the personnel during the construction works of the surface facilities will be 100. With the completion of the construction of the facilities and with the commencement of the natural gas storage, the number of the personnel will be reduced to around 25-30. The personnel to be worked for the construction activities will be provided from the residents in the vicinity and the accommodation at the project site in the content of the activities of concern will be applicable for a limited number of personnel.

3.4.8 Access Roads

The existing roads in the vicinity of the region will be utilized for the proposed TUGSP. Prior to the construction activities, the restoration activities will be carried out for the required roads.

3.4.9 Storm Water Collection System

There is no surface water resource in the vicinity of the proposed project site. Therefore, no flood problem is accepted to be occurred at the construction site. Nevertheless, all

required measures will be taken against the surface waters by connecting the drainage system to be built at the foundation level of the buildings to the grid channels and flues to be formed at all construction sites and the water to be collected at these channels will be discharged to the open field with a suitable topography.

3.4.10 Natural Gas Branch Line

In order to withdraw the excess natural gas found in the national network and to store it underground and again to transmit it to the national network when required, a branching will be drawn from Kayseri-Konya-Seydisehir part of the Eastern Anatolia Natural Gas Main Transmission Line to the project site. The line under consideration will be approximately 19 km in length and 40" in diameter (see Appendix-E). Since the exact route of the branching is not determined yet, the environmental impacts of the mentioned line are not assessed in this report.

3.5 Supplementary Economic, Social and Infrastructure Activities Not Found in the Content of the Project But Required for the Realization of the Project and Planned to be Realized By Investor Firm Or Other Firms

Except for the activities stated in Section 3.4 to be realized in the content of the proposed TUGSP, there is no need for any other infrastructure facility.

3.6 Other Aspects

No other aspect is required to be assessed in this section.

4 DETERMINATION OF THE AREA TO BE IMPACTED BY THE PROJECT AND EXPLANATION OF ITS BASELINE ENVIRONMENTAL CHARACTERISTICS

In this section, a general assessment of the project site, its vicinity, the provinces and districts to be surveyed within the content of the proposed TUGSP is presented. In this regard, bio-physical and socio-economical data and literature researches were utilized and field surveys were carried out. In this regard, Aksaray Province is assessed socio-economically and in terms of its baseline conditions.

4.1 Determination of the Area to be Impacted by the Project

As the project site is located close to the Sultanhani Municipality of the Central District of Aksaray Province, it is thought that the most important impact area is Central District of Aksaray Province and Sultanhani. The proposed site for the TUGSP is close to Sultanhani which is approximately 40 km west of Aksaray Province. The site, located approximately 17 km south of the mentioned municipality, is in the Bezirci Locality (see Figure 1.1 and Figure 1.2).

The determined impact area includes the plateaux in the vicinity of the project site, Sultanhani Sub-district, the route of the discharge line of the brine and the discharge point on Tuz Golu.

4.2 Characteristics of the Physical and Biological Environment and Utilization of Natural Resources

Information concerning the characteristics of physical and biological environment and the utilization of the natural resources are evaluated under sub-titles and presented in the following sections as it is requested in the EIA format of the T.R. Ministry of Environment.

4.2.1 Meteorological and Climatic Characteristics

For the determination of the meteorological characteristics of the project site and its vicinity proposed in TUGSP, the average-extreme temperature and precipitation data and the wind regime for long years (1980-1999) pertaining to Aksaray and Karapinar (Konya) meteorological stations are obtained from the General Directorate of State Meteorological Service (DMI) and evaluated.

4.2.1.1 General Climatic Conditions of the Region

The proposed project site is within the boundaries of Aksaray Province (see Figure 1.1 and Figure 1.2). In this province, the continental climate is dominant, where winter months are cold with high precipitation, while summer months are hot and arid. The coldest month is January and the hottest is July.

4.2.1.2 Local Climate and Meteorology

It is rather important that the meteorological data to be used for the determination of the local meteorological conditions should represent the region. In this regard, the data recorded at the closest meteorological station to the project site, which is considered to best represent the site and its vicinity, are used.

For this study, the nearest stations to the proposed project site are Aksaray and Karapinar meteorological stations (see Figure 4.1) Aksaray Meteorological Station is approximately 60 km northeast of the project site, while Karapınar Meteorological Station is located approximately 80 km south of the project site. Since there are no major topographic elevations between the Aksaray Meteorological Station and the proposed project site, it is predicted that the data received from this station will be the best to represent the meteorological characteristics of the region.

The data of 1980-1999 recorded by DMI in Aksaray and Karapinar Meteorology Stations have been used in order to determine the meteorological characteristics of the region such as temperature and precipitation as well as the wind regime (see Appendix-F).

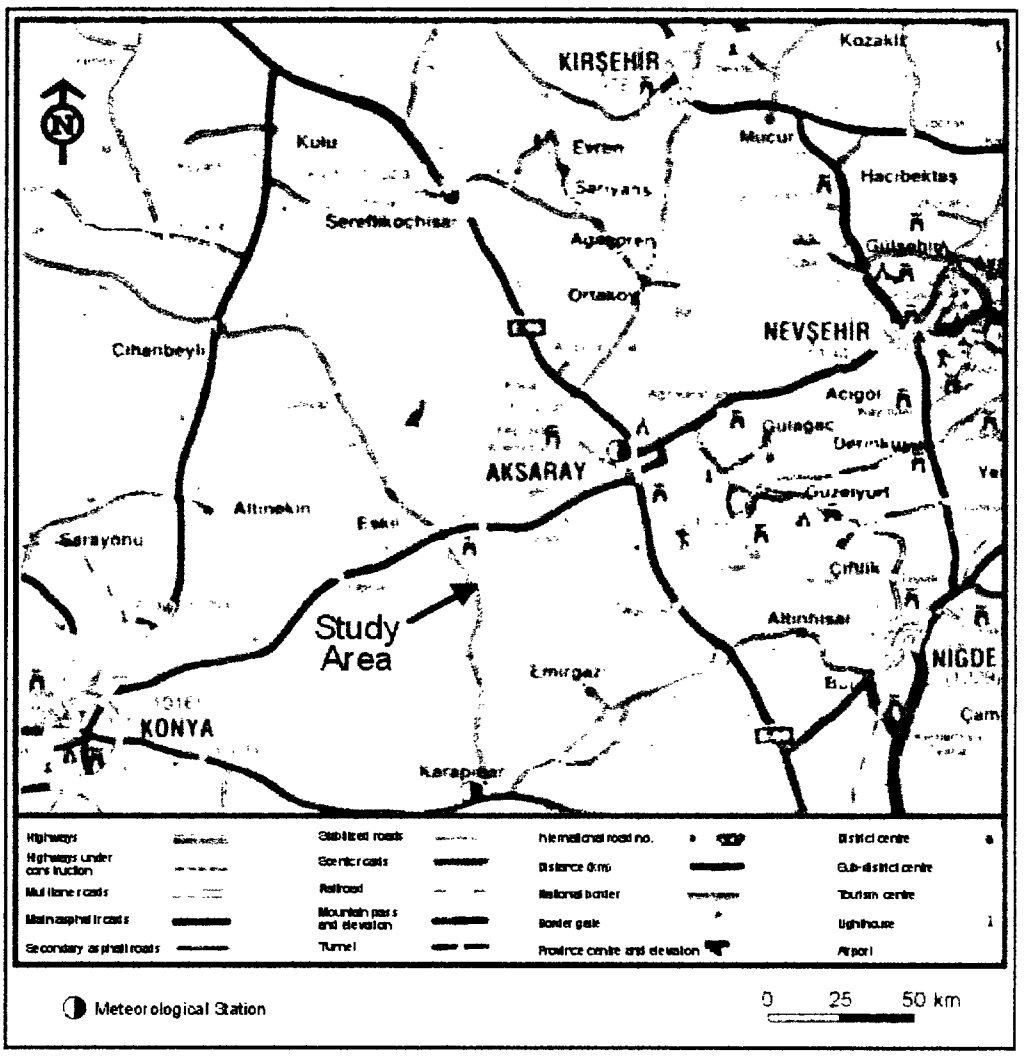


Figure 4.1 Locations of Aksaray and Karapinar (Konya) Meteorological Stations

4.2.1.3 Temperature Regime

The monthly maximum, average and minimum temperature values recorded at Aksaray and Karapinar meteorological stations are given in Table 4.1 and Table 4.2, respectively. The temperature values recorded between the years 1980-1999 at these stations of concern are presented in Figure 4.2 and Figure 4.3, respectively.

Table 4.1 Temperature Normals Recorded at Aksaray Meteorological Station (1980-1999)

Months	Maximum (°C)	Average (°C)	Minimum (°C)
January	16.2	0.6	-19.3
February	21.6	1.4	-29.0
March	24.6	5.6	-19.0
April	30.5	11.5	-7.5
May	33.8	16.1	-0.2
June	35.8	20.2	3.5
July	37.8	23.5	7.0
August	38.4	23.0	5.9
September	36.5	18.5	1.6
October	32.8	12.9	-5.2
November	25.8	6.5	-14.0
December	20.6	2.6	-14.6
Annual	**38.4**	**11.9**	**-29.0**

Source: DMI (1980-1999)

Table 4.2 Temperature Normals Recorded at Karapinar Meteorological Station (1980-1999)

Months	Maximum (°C)	Average (°C)	Minimum (°C)
January	19.6	-0.5	-21.6
February	20.3	0.0	-26.8
March	24.2	4.3	-22.8
April	31.4	10.6	-7.8
May	36.0	15.4	-3.1
June	37.3	19.6	3.1
July	40.1	22.7	5.0
August	38.5	22.1	4.5
September	36.0	17.5	-3.3
October	33.2	11.6	-6.2
November	25.3	5.2	-17.7
December	18.5	1.7	-19.4
Annual	**40.1**	**10.9**	**-26.8**

Source: DMI (1980-1999)

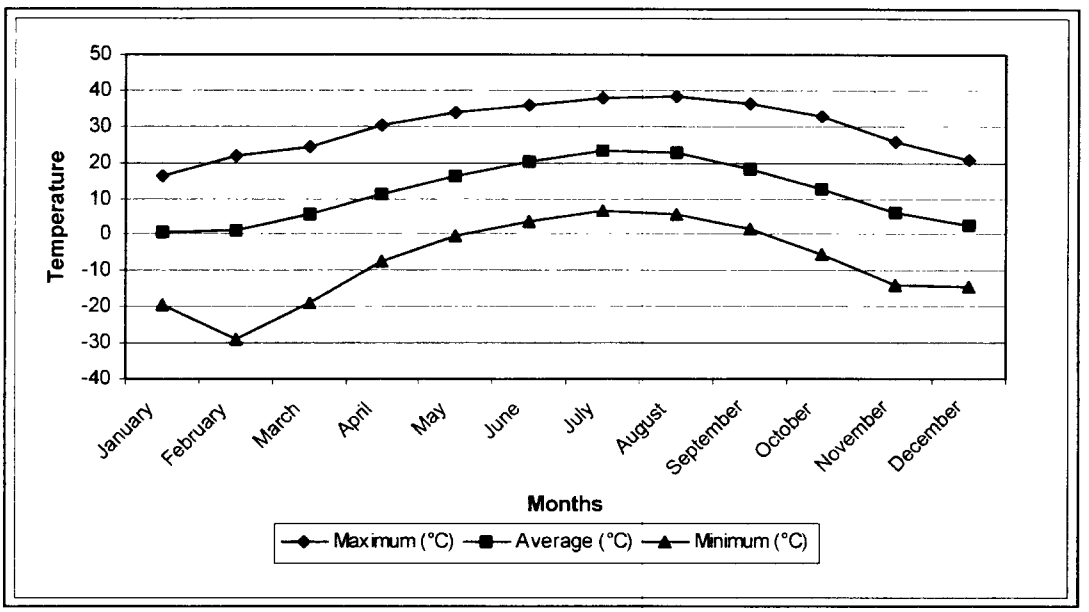


Figure 4.2 Temperature Normals Recorded at Aksaray Meteorological Station (DMI,1980-1999)

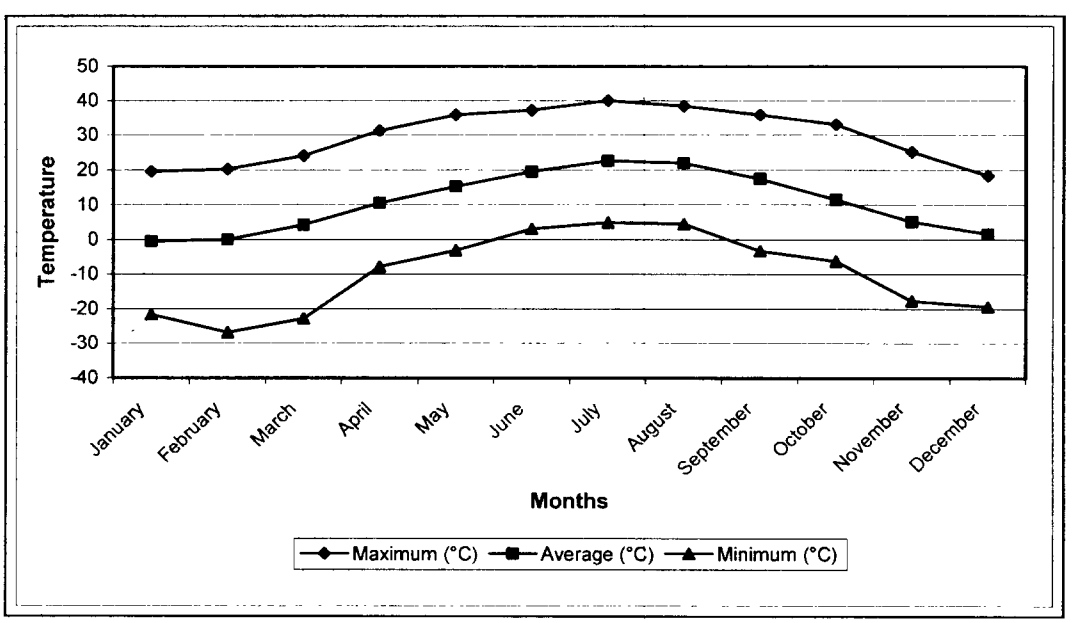


Figure 4.3 Temperature Normals Recorded at Karapinar Meteorological Station (DMI, 1980-1999)

As it can be seen from Table 4.1 and Table 4.2, the annual average temperature values recorded at Aksaray and Karapinar meteorological stations are close (11.9°C and 10.9°C, respectively). According to the both stations, while temperature values increase between the months January and July, they show a systematic decrease from August to December.

The lowest temperature value recorded at both stations is in February and is -29°C and -26.8°C for Aksaray and Karapinar meteological stations, respectively. The maximum temperature value recorded at the Aksaray station is 38.4°C in August and for Karapinar, this value is 40.1°C in July.

4.2.1.4 Precipitation Regime

In order to evaluate the precipitation regime of the region, the long-term data (1980-1999) of Aksaray and Karapinar Meteorological Stations have been utilized. The precipitation normals and evaporation values of the region, recorded at the stations of concern, are presented respectively in Table 4.3 and Table 4.4, and shown in Figure 4.4 and Figure 4.5.

Table 4.3 Precipitation Normals Recorded at Aksaray Meteorological Station (1980-1999)

Months	Average Total Precipitation (mm)	Maximum Daily Precipitation (mm)	Days with Precipitation≥0.1	Average Evaporation(mm)
January	35.6	33.0	9.4	-
February	31.8	20.6	9.7	-
March	38.7	28.5	10.4	-
April	49.9	28.5	10.9	105.7
May	46.1	32.1	10.7	165.6
June	25.5	42.5	6.3	217.7
July	10.4	24.0	2.8	279.0
August	6.6	31.5	2.0	270.1
September	6.4	19.9	2.6	189.5
October	27.8	65.8	6.5	101.4
November	35.7	29.4	7.7	22.3
December	45.8	33.6	10.8	-
Annual	**360.3**	**65.8**	**89.8**	**1351.3**

Source: DMI (1980-1999)

Table 4.4 Precipitation Normals Recorded at Karapinar Meteorological Station (1980-1999)

Months	Average Total Precipitation (mm)	Maximum Daily Precipitation (mm)	Days with Precipitation ≥ 0.1	Average Evaporation (mm)
January	30.7	30.5	9.7	-
February	23.3	25.0	8.9	-
March	27.7	17.4	10.3	-
April	36.9	26.7	9.3	76.0
May	36.2	55.9	10.0	155.4
June	25.0	34.5	5.6	198.4
July	10.1	19.0	2.7	267.4
August	6.5	16.1	1.7	249.2
September	7.2	28.3	2.1	175.0
October	22.5	31.7	5.8	82.7
November	27.1	31.7	8.0	15.3
December	36.9	28.4	10.9	-
Annual	**290.1**	**55.9**	**85.0**	**1219.4**

Source: DMI (1980-1999)

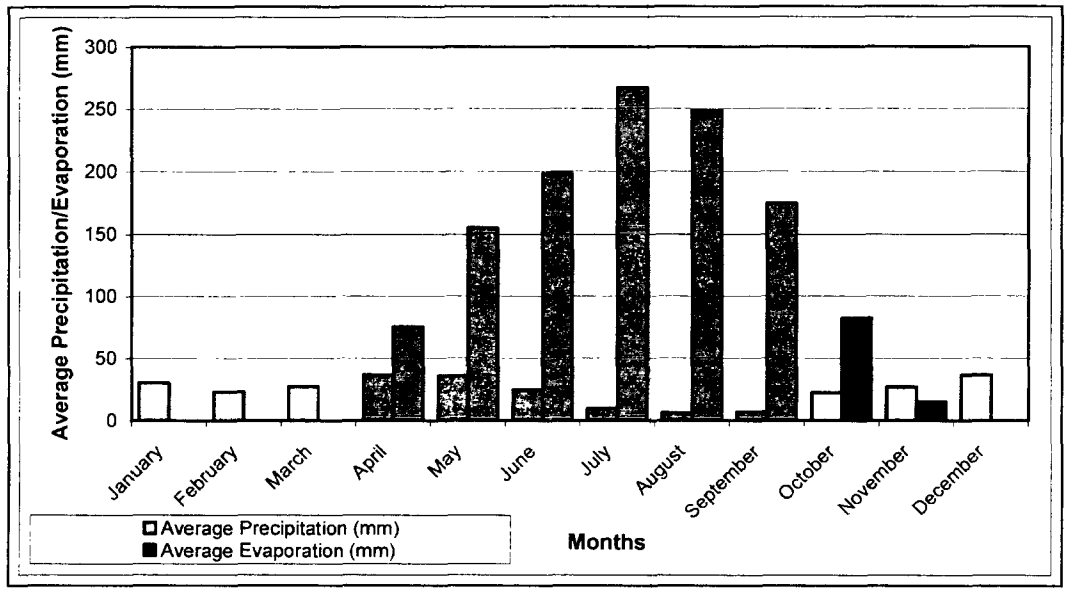


Figure 4.4 Monthly Average Precipitation and Evaporation Values Recorded at Aksaray Meteorological Station (DMI, 1980-1999)

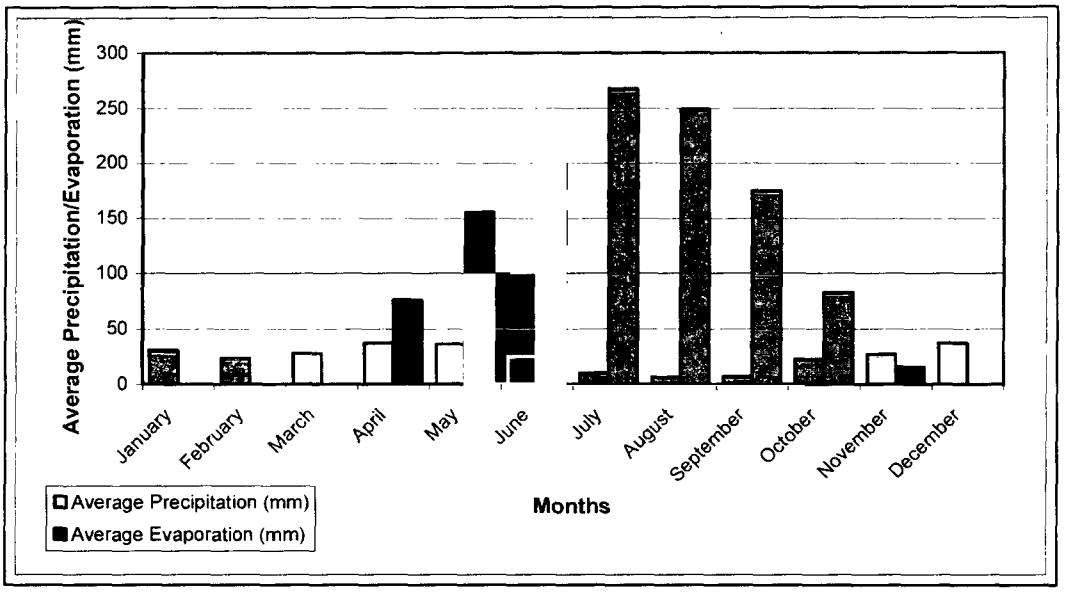


Figure 4.5 Monthly Average Precipitation and Evaporation Values Recorded at Karapinar Meteorological Station (DMI, 1980-1999)

The average total annual precipitation recorded at Aksaray Meteorological Station is 360.3 mm, whereas it is recorded as 290.1 mm at Karapinar Meteorological Station. The highest precipitation values are recorded in winter and spring. According to both stations, 31% of the annual total precipitation is recorded in winter. The ratio of precipitation recorded in spring to the annual precipitation is 37.3% for Aksaray and 34.7% for Karapinar meteorological stations. According to the data recorded at both stations between 1980-1999, the highest precipitation is recorded in April, while the lowest is recorded in August.

The snow, fog and hail data recorded at Aksaray and Karapinar meteorological stations between 1980-1999 are presented in Table 4.5 and Table 4.6. According to the data, the number of days with snow annually at both stations are nearly the same and is 59.3 and 62.7, respectively. The highest snow cover value is the same for both stations of concern and is recorded as 41 cm.

Table 4.5 Snow, Fog and Hail Data Recorded at Aksaray Meteorological Station (1980-1999)

Months	Average Number of days with Snow	Average Number of days with Snow Cover	Highest Snow Cover Thickness (cm)	Average Number of days with Fog	Average Number of days with Hail
January	13.3	10.3	20.0	8.4	-
February	13.7	8.4	41.0	4.9	0.1
March	11.4	3.8	29.0	3.4	0.6
April	2.3	0.6	16.0	0.8	0.4
May	0.3	0.1	1.0	0.1	0.3
June	-	-	-	-	0.3
July	-	-	-	-	-
August	-	-	-	-	-
September	-	-	-	0.3	-
October	0.3	0.1	5.0	1.6	-
November	5.3	1.9	17.0	5.4	0.1
December	12.7	8.1	26.0	12.8	0.1
Annual	**59.3**	**33.3**	**41.0**	**37.7**	**1.9**

Source: DMI (1980-1999)

Table 4.6 Snow, Fog and Hail Data Recorded at Karapinar Meteorological Station (1980-1999)

Months	Average Number of days with Snow	Average Number of days with Snow Cover	Highest Snow Cover Thickness (cm)	Average Number of days with Fog	Average Number of days with Hail
January	13.1	9.0	26.0	15.4	0.1
February	16.2	9.1	41.0	9.5	0.6
March	11.7	4.2	30.0	4.4	0.3
April	2.0	0.6	7.0	0.9	1.2
May	0.5	-	-	0.1	0.4
June	-	-	-	-	0.6
July	-	-	-	-	-
August	-	-	-	-	-
September	-	-	-	-	-
October	0.3	0.1	-	1.8	0.2
November	6.0	1.9	14.0	11.3	-
December	12.9	7.3	26.0	21.8	0.1
Annual	**62.7**	**32.2**	**41.0**	**65.2**	**3.5**

Source: DMI (1980-1999)

4.2.1.5 Wind Direction and Speed

The monthly average and strongest wind speeds recorded at Aksaray and Karapinar meteorological stations are presented in Table 4.7 and Table 4.8, respectively. Additionally, the average wind speeds according to wind directions for Aksaray and Karapinar meteorological stations are given in Table 4.9 and Table 4.10, respectively.

Table 4.7 Monthly Wind Speeds Recorded at Aksaray Meteorological Station (1980-1999)

Months	Average Wind Speed (m/s) at 07:00	Average Wind Speed (m/s) at 14:00	Average Wind Speed (m/s) at 21:00	Average Wind Speed (m/s)	Direction of Strongest Wind	Strongest Wind Speed (m/s)
January	2.1	2.8	2.0	2.3	S	24.3
February	2.3	3.3	2.2	2.6	SSW	25.0
March	2.1	3.6	2.4	2.7	SSE	26.3
April	1.9	3.7	2.1	2.6	SSW	31.4
May	1.9	3.4	2.0	2.4	WSW	20.6
June	1.9	3.3	2.2	2.5	SSW	22.3
July	2.7	3.2	3.2	3.1	SW	19.8
August	2.6	3.0	2.9	2.8	WSW	20.5
September	1.8	3.0	2.1	2.3	WSW	20.0
October	1.7	2.8	1.9	2.1	NW	19.3
November	1.8	2.7	1.8	2.1	WNW	20.6
December	2.1	2.6	2.0	2.2	S	25.5
Annual	**2.1**	**3.1**	**0.0**	**2.5**	**SSW**	**31.4**

Source: DMI (1980-1999)

The wind regime of the region was revealed by utilizing the statistics of average wind speed and direction values recorded at Aksaray and Karapinar meteorological stations between 1980-1999. The seasonal long-years (1980-1999) wind roses for these two stations are presented in Figure 4.6 and Figure 4.7, respectively.

According to the data recorded at Aksaray Meteorological Station, the dominant wind direction is east-northeast (ENE) with 19%. The annual distribution of winds blowing from northeast (NE) and north-northeast (NNE) are 12.8% and 7.9%, respectively.

As for the data recorded at Karapinar Meteorological Station, the dominant wind direction is north-northeast (NNE) with 20%. The annual distribution of winds blowing from north (N) and northeast (NE) are 12.4% and 8.5%, respectively.

Table 4.8 Monthly Wind Speeds Recorded at Karapinar Meteorological Station (1980-1999)

Months	Average Wind Speed (m/s) at 07:00	Average Wind Speed (m/s) at 14:00	Average Wind Speed (m/s) at 21:00	Average Wind Speed (m/s)	Direction of Strongest Wind	Strongest Wind Speed (m/s)
January	2.0	3.1	2.3	2.5	NNW	25.2
February	2.1	3.6	2.5	2.8	S	23.2
March	2.0	3.8	2.6	2.8	SSW	25.2
April	1.9	4.1	2.7	2.9	WSW	22.5
May	1.6	3.6	2.2	2.5	NNW	23.1
June	1.8	3.6	2.4	2.6	W	30.2
July	2.3	3.7	2.9	3.0	NW	21.6
August	1.9	3.4	2.7	2.6	NNW	19.7
September	1.4	3.0	2.2	2.2	WSW	21.6
October	1.3	2.9	1.9	2.1	NNW	21.3
November	1.8	3.2	2.1	2.4	NNW	20.1
December	2.0	3.1	2.3	2.5	SSW	23.2
Annual	**1.9**	**3.4**	**0.0**	**2.6**	**W**	**30.2**

Source: DMI (1980-1999)

Table 4.9 Average Wind Speed According to Wind Direction (m/s) (Aksaray Meteorological Station, 1980-1999)

Wind Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
N	1.8	1.3	1.7	1.9	1.6	2.2	2.5	2.3	2.1	1.3	2.0	1.4
NNE	1.9	2.5	2.4	2.0	1.9	2.2	2.8	2.9	2.5	1.9	2.2	2.3
NE	2.6	3.2	2.8	2.2	2.6	2.7	3.7	3.5	3.0	2.7	2.1	2.4
ENE	2.6	2.8	2.8	2.4	2.6	3.1	3.9	3.9	2.8	2.4	2.2	2.3
E	1.7	1.7	2.0	1.7	2.1	2.4	3.0	2.5	1.8	1.5	1.3	1.5
ESE	1.4	1.2	1.5	1.5	1.2	1.2	1.6	1.8	1.1	1.1	1.1	1.2
SE	1.3	1.2	1.6	1.4	1.7	1.2	1.3	1.3	1.2	1.0	1.0	1.2
SSE	1.7	2.0	2.2	1.7	1.6	1.4	1.6	1.3	1.1	1.4	1.9	1.8
S	4.0	3.7	3.6	3.0	2.4	1.7	1.8	1.7	1.4	2.2	3.4	3.6
SSW	3.5	3.6	3.8	3.7	2.9	2.3	2.2	1.4	2.3	3.3	3.3	3.1
SW	2.2	3.2	3.4	3.6	3.6	2.9	2.1	2.2	2.8	3.1	2.9	2.6
WSW	2.0	2.2	3.0	3.2	3.1	2.9	2.7	2.6	2.4	2.2	1.9	2.0
W	1.6	2.4	2.9	3.2	2.9	2.9	2.7	2.6	2.5	2.4	2.1	1.8
WNW	2.1	2.3	2.6	2.7	2.7	2.6	2.9	2.7	2.6	2.3	1.8	1.9
NW	2.1	2.4	2.8	3.3	3.1	2.8	2.8	2.5	2.3	2.2	2.3	2.1
NNW	1.4	1.6	1.6	2.1	2.1	1.9	2.3	1.9	1.9	1.4	1.5	1.6

Source: DMI (1980-1999)

Table 4.10 Average Wind Speed According to Wind Direction (m/s) (Karapinar Meteorological Station, 1980-1999)

Wind Direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
N	3.4	3.9	3.3	3.5	2.8	3.2	3.5	3.5	3.0	2.9	3.5	3.2
NNE	2.2	2.5	2.6	2.4	2.4	2.6	3.2	2.9	2.4	2.2	2.1	2.0
NE	1.5	1.6	1.7	1.8	1.8	1.9	2.1	1.8	1.9	1.6	1.4	1.3
ENE	1.3	1.3	1.4	1.6	1.6	1.6	1.5	1.6	1.5	1.3	1.3	1.1
E	1.1	1.3	1.5	1.3	1.5	1.6	1.7	1.3	1.1	1.4	1.2	1.0
ESE	1.4	1.2	1.6	1.7	1.7	2.1	1.4	1.2	1.1	1.1	1.1	1.6
SE	1.9	2.0	2.1	3.1	2.3	2.3	1.7	1.1	1.9	1.7	2.1	1.8
SSE	3.2	3.6	3.6	3.0	2.9	2.1	2.3	2.0	2.1	2.3	3.3	3.2
S	5.0	4.7	4.7	4.6	3.8	3.2	3.7	2.5	2.8	3.7	4.6	4.6
SSW	2.9	3.7	3.5	3.8	3.2	2.7	2.9	2.6	2.3	2.7	3.1	3.3
SW	2.0	1.8	2.3	2.7	2.3	2.1	2.5	2.2	1.9	2.0	1.9	1.7
WSW	1.5	1.7	2.3	2.6	2.2	2.4	1.8	2.0	2.0	1.6	1.5	1.4
W	1.8	1.9	2.3	3.5	3.2	2.8	3.1	3.1	2.7	1.9	1.8	1.5
WNW	1.2	1.6	1.8	2.3	2.7	2.7	2.2	1.9	1.9	1.8	1.3	1.7
NW	2.2	2.9	3.1	2.8	2.5	2.9	3.4	2.5	2.3	2.0	1.9	2.3
NNW	3.2	3.4	3.6	3.1	2.7	2.8	3.2	3.0	2.6	2.2	2.9	3.0

Source: DMI (1980-1999)

4.2.2 Geologic Properties

4.2.2.1 Geology of the Region

Field surveys were undertaken between 15.09-01.10.2000 by ENVY specialists to carry out geological and geophysical studies of the proposed project site and its vicinity. Within the mentioned studies, the geological formations of the proposed project site and its vicinity were determined. The geological map of the project site and its vicinity is presented in Figure 4.8.

The project site and its vicinity located in an area where Pliocene aged sediments are spread (see Figure 4.8). Pliocene aged series are formed of gravel; lentically aligned, cross bedded, loosely-cemented, medium-thin layered sandstone; marl and siltstone, which is partially interlayered with tuffite. The thickness of the unit is c.150 m and is not important by means of groundwater carrying capacity.

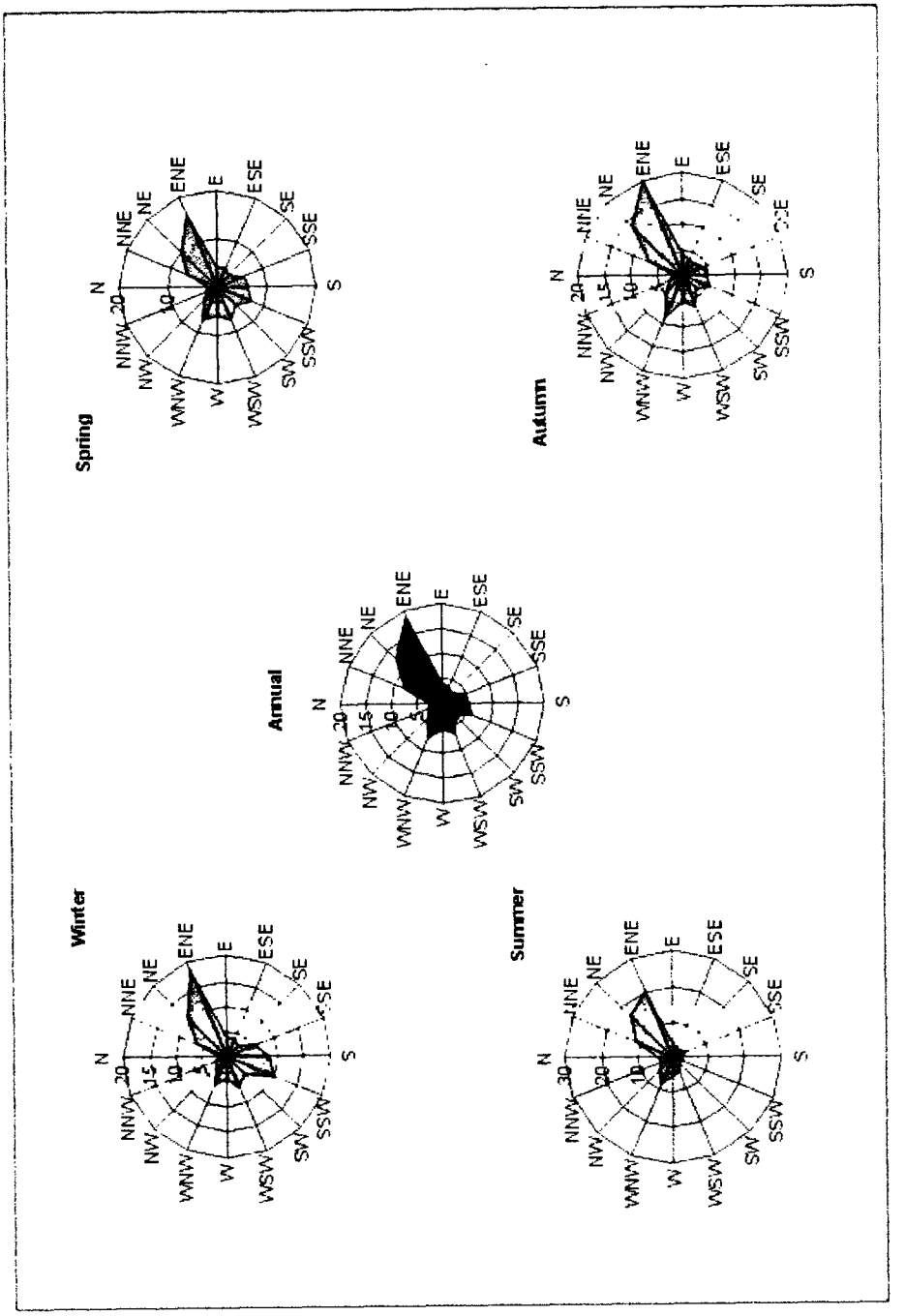


Figure 4.6 Seasonal Long-Years Wind Roses For Aksaray Meteorological Station (DMI, 1980-1999)

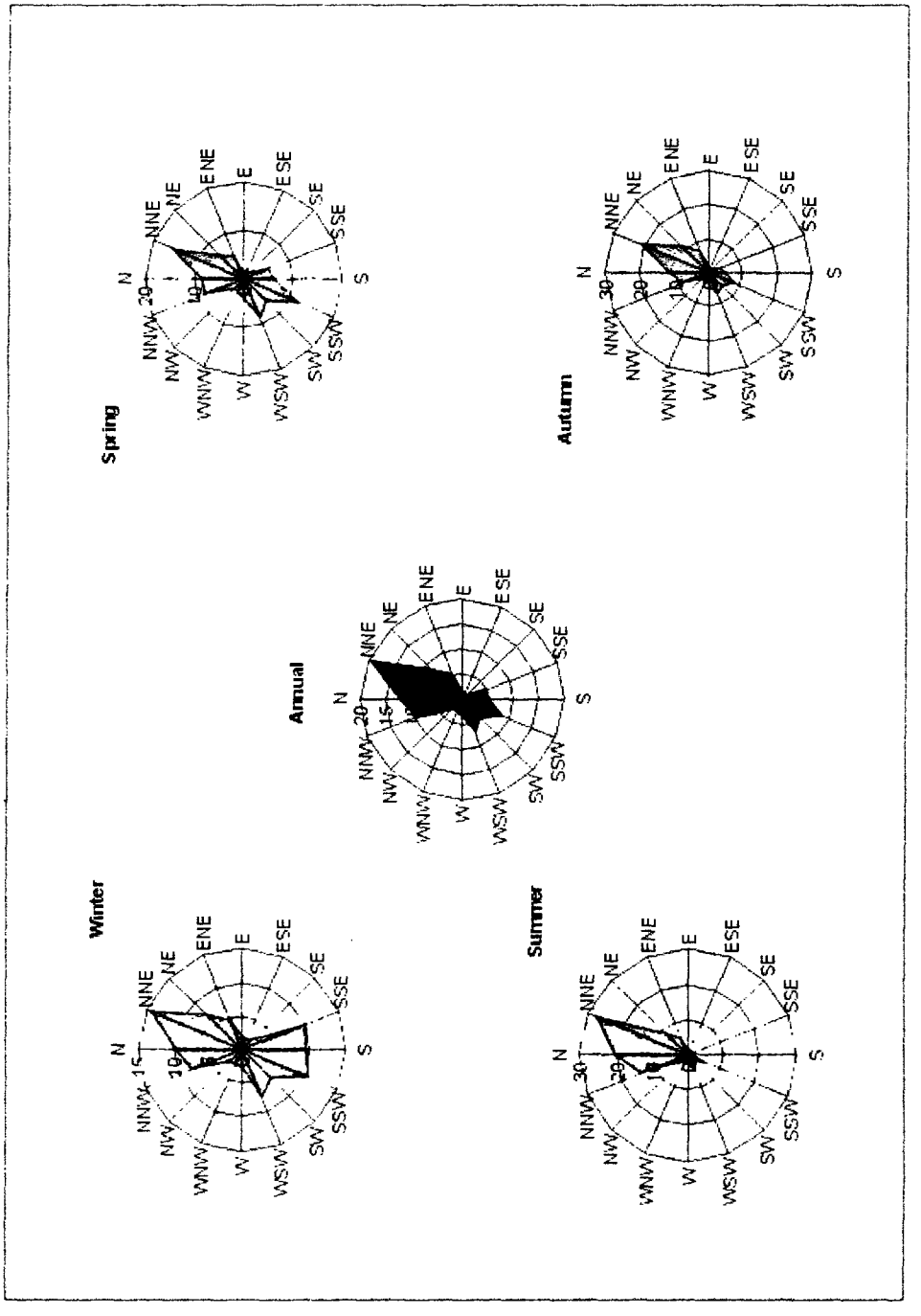


Figure 4.7 Seasonal Long-Years Wind Roses For Karapinar Meteorological Station (DMI, 1980-1999)

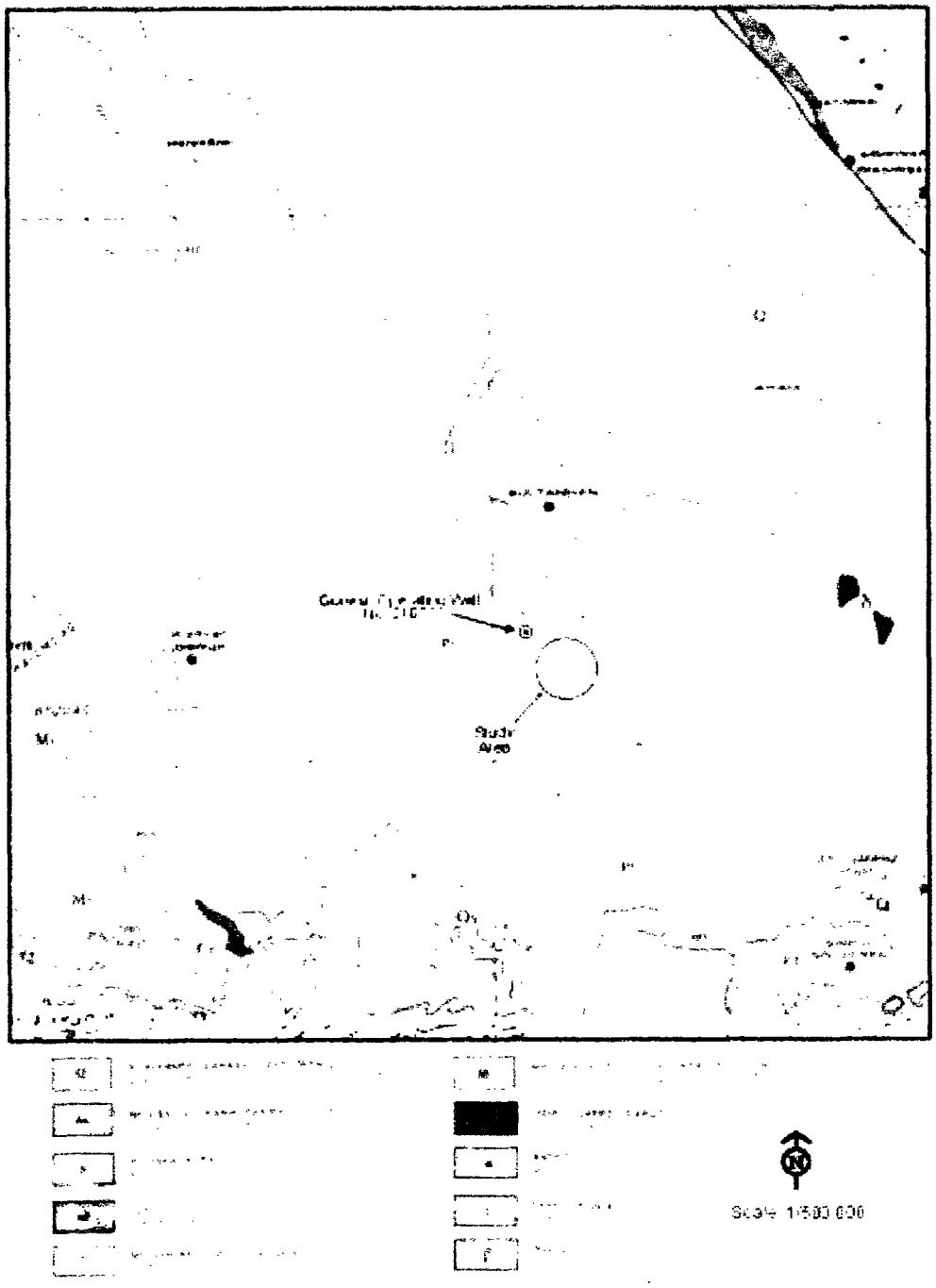


Figure 4.8 1:500,000 Scaled Geological Map of the Proposed TUGSP Site and its Vicinity

The geological formations surfaced within the region, where the project site is located, are given below, together with their characteristics, in the order from oldest to youngest (MTA, 1989). The stratigraphical cross-section of the region is presented in Figure 4.9.

Cenozoic

The geological formations of this period belong to the Tertiary. There exists a sedimentation unconformity before Tertiary.

Paleozoic (Mr, Cr, Pcr)

The bottom section of Palaeozoic aged formations, which are subjected to metamorphism, are formed of micaschists while top sections are formed of crystalline limestone. These formations are spread in the southwest of Obruk region. There is no sedimentation after the constitution of these formations forming the old basin. There is an unconformity in the stratigraphical sequence until the Upper Cretaceous.

Tertiary

Upper Cretaceous

The typical examples of the formations representing this age can be encountered in the vicinity of Aksaray. The Maastrichtian-Campanian aged units are formed of red wine coloured, loosely-cemented gravelstone, sandstone, siltstone and mudstone, partly containing gypsum and coal layers. The gravelstone found at the base is comprised of gravels of magmatic and metamorphic origin. The unit is overlain by loosely-cemented, well-rounded and indefinitely layered sandstone with cross bedded siltstone interbeds parti-ally. This formation is formed by river sediments deposited in a wide coastal plain impacted by the sea from time to time. The thickness of the formation is about 250 m.

Another member of the Upper Cretaceous Period is Maastrichtian-aged, medium-fine sand grain sized, yellowish-grey coloured, medium-thin layered sandstones with Orbitoides and medium-thin layered, grey coloured sandy limestones with Rudist. It is referred as Asmabogazi Formation since the typical example was encountered in Asmabogazi region.

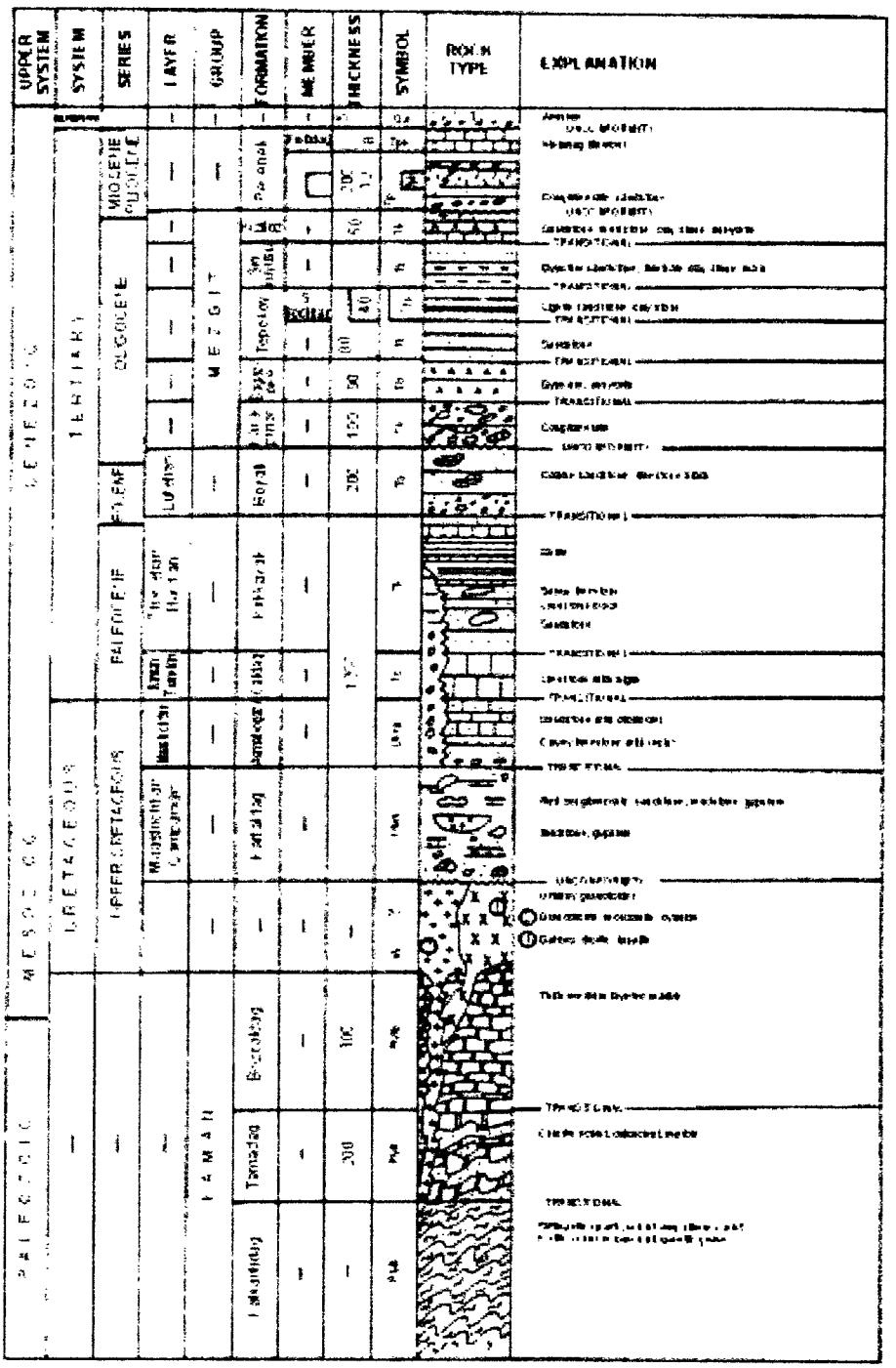


Figure 4.9 Stratigraphical Cross-section of the Area

Paleocene

Thanetian-Danian

The formations that represent this age are the yellowish-grey, whitish coloured, thick-medium layered, partly unlayered, hard, reddish, brittle surfaced limestones with Alg, that are in complex series in the east contact of Tuz Golu Plain. The base is conformable with Asmabogazı formation with c.30 m thickness. They have been named as Caldag Formation by the geologists working on the formation.

Ilerdian-Thanetian

The formation, which is in Aksaray complex and is formed by sandy limestone, sandstone and shales, represent this age. The unit consists of material generally derived from ophiolitic material, thin-medium layered, greenish coloured sandstone and laminated shale. The sandstones and shales are interbedded by medium-thin layered, graded, carved-filled structured, hard, sandy limestones with Alg. The formation, which is a product of the reefal environment, is referred as Kirkkavak Formation by geologists.

Eocene

Lutetian

Formations comprising by thick layered, poorly sorted, medium-thin sand grain sized, loosely-cemented, porous structured, yellowish-grey coloured sandstones represent this age. Within the sandstones on the base, there are gravels, which are derived from magmatic and metamorphic rocks. Shallow sea originated sandstones consist continental additives towards the top. At the base of this formation, the limestones of Caldag Formation is found, while Kirkkavak Formation exists on the top of it. It's thickness is c.200 m and named as Boyali Formation by Uygun *et.al.* (1982).

Oligocene

The formations of this epoch are named as Mezgit Group. The sequence of Mezgit Group from bottom to top, together with their given names, are as follows:

- Karapinar Formation, conglomerate, 100 m thickness;
- Bogazdere Formation, anhydrite, gypsum, 90 m thickness;
- Tepekoy Formation, sandstone, 80 m thickness;
- SerefliKochisar Member, lignite, sandstone, claystone, 40 m thickness;
- Sihkuyusu Formation, sandstone with gypsum, laminated claystone, marl, 100 m thickness;
- Kiziloz Formation, sandstone, claystone, gravelstone, anhydrite, 50 m thickness.

Pliocene (Pl) - Miocene

Pecenek Formation is the representative for these ages. It is formed by gravelstone, lentically aligned, cross bedded, loosely-cemented, medium-thin layered sandstone, marl and siltstone, which are partially interlayered with tuffite. Pecenek formation is formed by the transformation of the Sereflikochisar-Pecenek Valley to a basin by vertical faulting in Lower Pliocene and by filling of the basin with carried materials of the massive. The approximate thickness of the unit is 150 m.

Named as Kavak member (typical example of naming in Urgup Basin), this unit consists of pink-white coloured ignimbrites with pumice fragments and has a thickness of around 10 m.

As for the Kısladagi member (typical example of naming in Urgup Basin), it is formed of gastropoda cavc fragmented, thick and indefinitely layered, white-grey coloured, porous, gravelled limestone. This unit has a chalk-like appearance and is about 8 m thick.

Quaternary (Q)

The units that represent this age are alluvium which are creeps of detritic material that are wide-spread in Tuz Golu Plain. They are cross bedded deposits of gravel, sand, silt and soil.

4.2.2.2 Geology of the Study Area

Although explained in detail in the geology of the region section, the geology of the study area is presented below in line with the age order.

Pliocene (Pl) - Miocene

Pecenek Formation is the representative for these ages. It is formed by gravelstone, lentically aligned, cross bedded, loosely-cemented, medium-thin layered sandstone, marl and siltstone, which are partially interlayered with tuffite. Pecenek formation is formed by the transformation of the Sereflikochisar-Pecenek Valley to a basin by vertical faulting in Lower Pliocene and by filling of the basin with carried materials of the massive. The approximate thickness of the unit is 150 m.

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Studies Carried Out In The Project Site

In the content of the proposed TUGSP, in order to determine the definite location of the natural gas storage area, three-dimensional seismic studies were carried out in an area of around 80 km² (see Figure 2.3) between October-November 2000. The obtained results of the studies carried out by TPAO, are evaluated by Schlumberger and ISI firms in Germany (ENVY-PGP-PLE, 2001a). The results of the studies are summarized below with their outlines:

- The salt quality in the region is rather good for the storage of the natural gas.
- The salt layer extends along north-northwest/south-southeast (NNW/SSE) direction.
- The width of the salt layer is around 2-2.5 km and the total length is 15 km within the corners of the study area.
- The area of the salt layer determined in the study area is approximately 36 km² and this area is wide enogh for 10 caverns, that are planned to be opened.
- The salt layer in the region is mapped till around 1,500-2,000 m depth (see Figure 4.10 and Figure 4.11).
- It is determined that the salt layer in the region is at around 400-500 m deep in the surface. Above the layer, anhydrite formation having around 70-80 m thickness is found.
- In the area, where the caverns will be opened, the thickness of salt layer is approximately 1900 m.

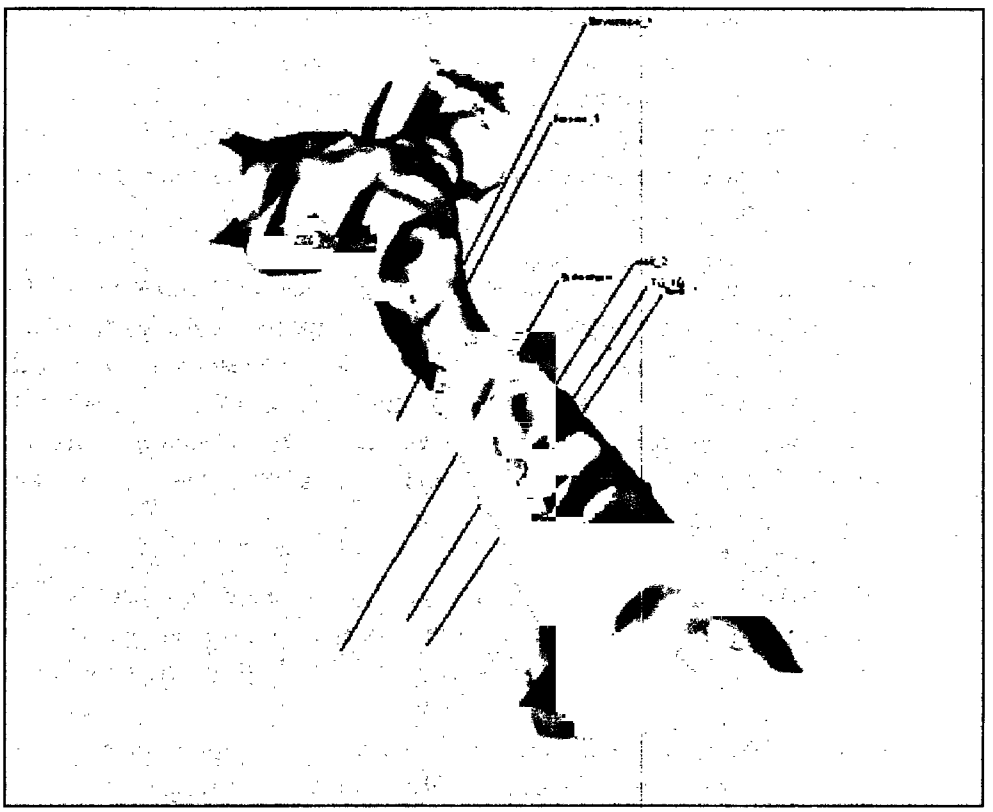


Figure 4.10 Three Dimensional Projection of Salt Layer

There are fractures and cracks on macro scale within the formations in association with the salt stratum in the project site. It is possible that such fractures and cracks may cause gas leakage. Therefore, all necessary measures shall be taken against these fractures and cracks.

The rock unit where the surface facilities is planned to be installed consists of sandstone, pebble, clay and limestone. The formation has a cracked and leached lacuna structure at the levels where there is intense limestone from these types of rocks interconnected to each other laterally and vertically. There may be underground lacunas (spaces) of leaching origin that does not reflect on the surface on the areas with the defined characteristics. When the facilities are installed, it shall be taken into consideration that there may be spaces of carstic origin and that may not be observed on the surface.

4.2.2.3 Seismicity of the Region

The maps prepared by the Ministry of Public Works and Settlement in 1996 were used, to determine the seismicity of Turkey and Aksaray Province (see Figure 4.12 and Figure 4.13). Even though Aksaray is located in a region with no earthquake risk, there are settlements within the boundaries of the province, which have suffered from floods and rock fall. However, the proposed projct site is located in the fifth degree earthquake area (see Figure 4.12).

The active fault map of the region is given in Figure 4.14 and Figure 4.15. According to the map, there is a distance of around 53 km between the study area of concern and Tuz Golu Fault Line. 48 earthquakes were recorded between the years 1881 and 1986 in Aksaray Province and its vicinity. Among these earthquakes, the intensity of 13 were 4.3; 12 were 4.6; 14 were 5.0; 4 were 5.3; two were 5.7; one was 6.0; one was 6.4 and one was 6.7. The distribution of these earthquakes and the determined faults in the region are shown in Figure 4.15 (TMMOB, 1990).

Additionally, seismicity studies were carried out by ENVY on October 2001. "Seismicity Report (ENVY-PGP-PLE, 2001b)" and "Seismic Hazard Assessment Report (ENVY-PGP-PLE, 2001c)" prepared concerning the topic are given in Appendix -G.

In the studies of concern, the active faults in the region were researched and the earthquakes, which were experienced formerly and will take place in the future on the faults of concern, were determined. In line with the information obtained, evaluations regarding the relation between the active faults of the region and earthquake and the largest earthquake expected in the region were realized. In addition, the active faults, on which large earthquakes were observed, were evaluated although they are distant to the region considering the probable earthquakes and their impact on the region.

Figure 4.11 Map Showing the Outset of the Salt Layer

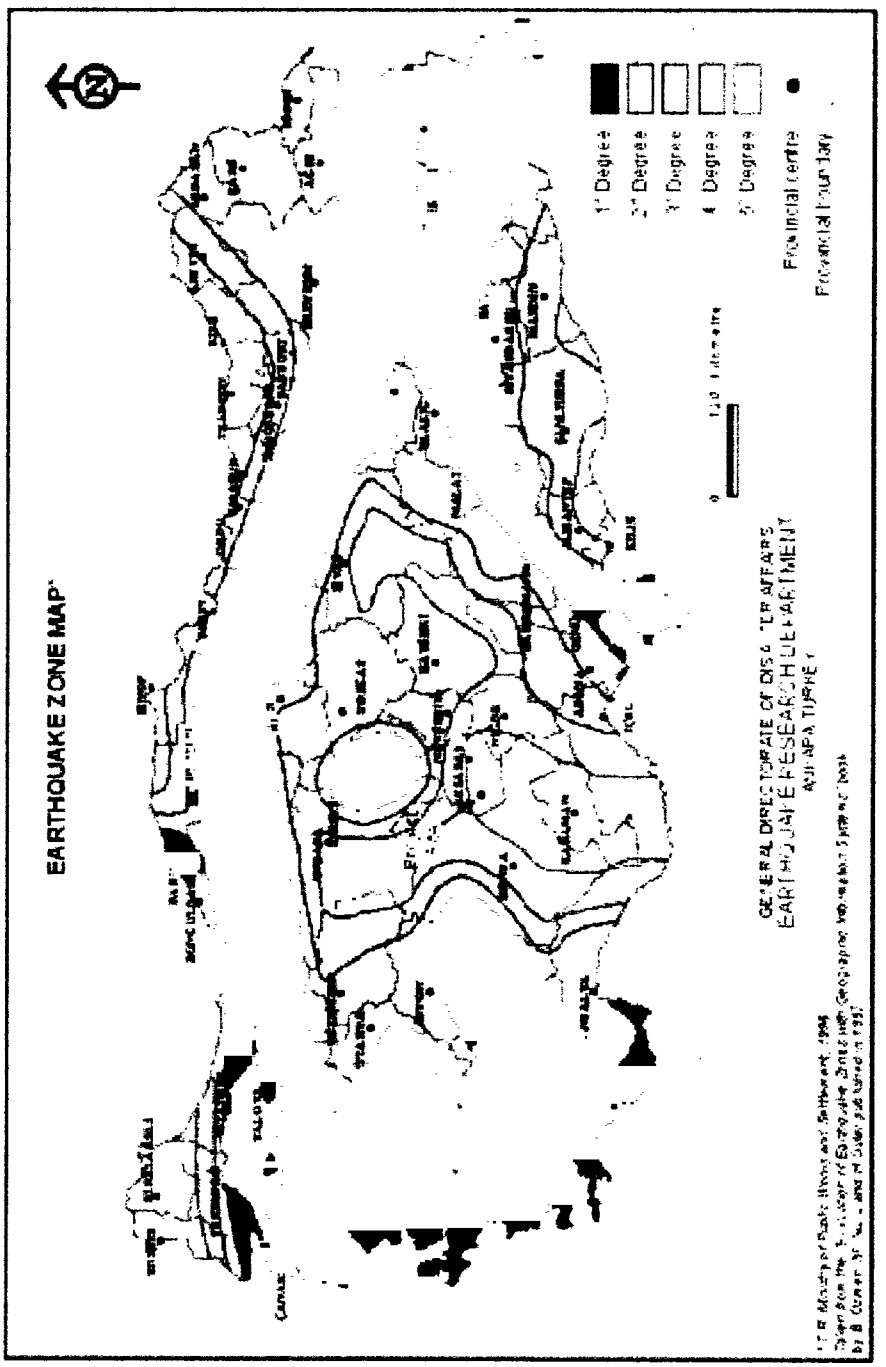


Figure 4.12 Earthquake Zone Map of Turkey

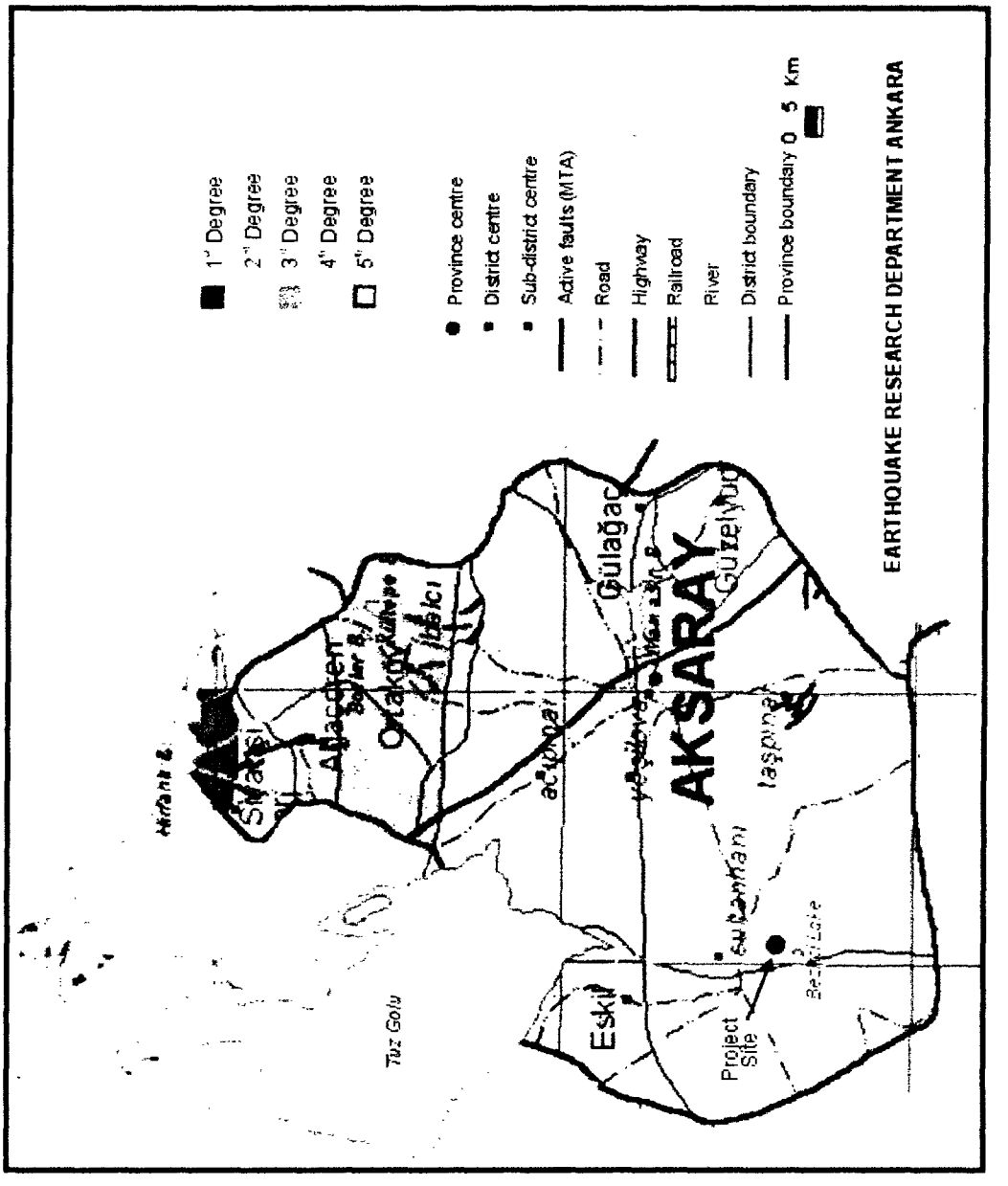


Figure 4.13 Earthquake Zone Map of Aksaray Province and the Project Site

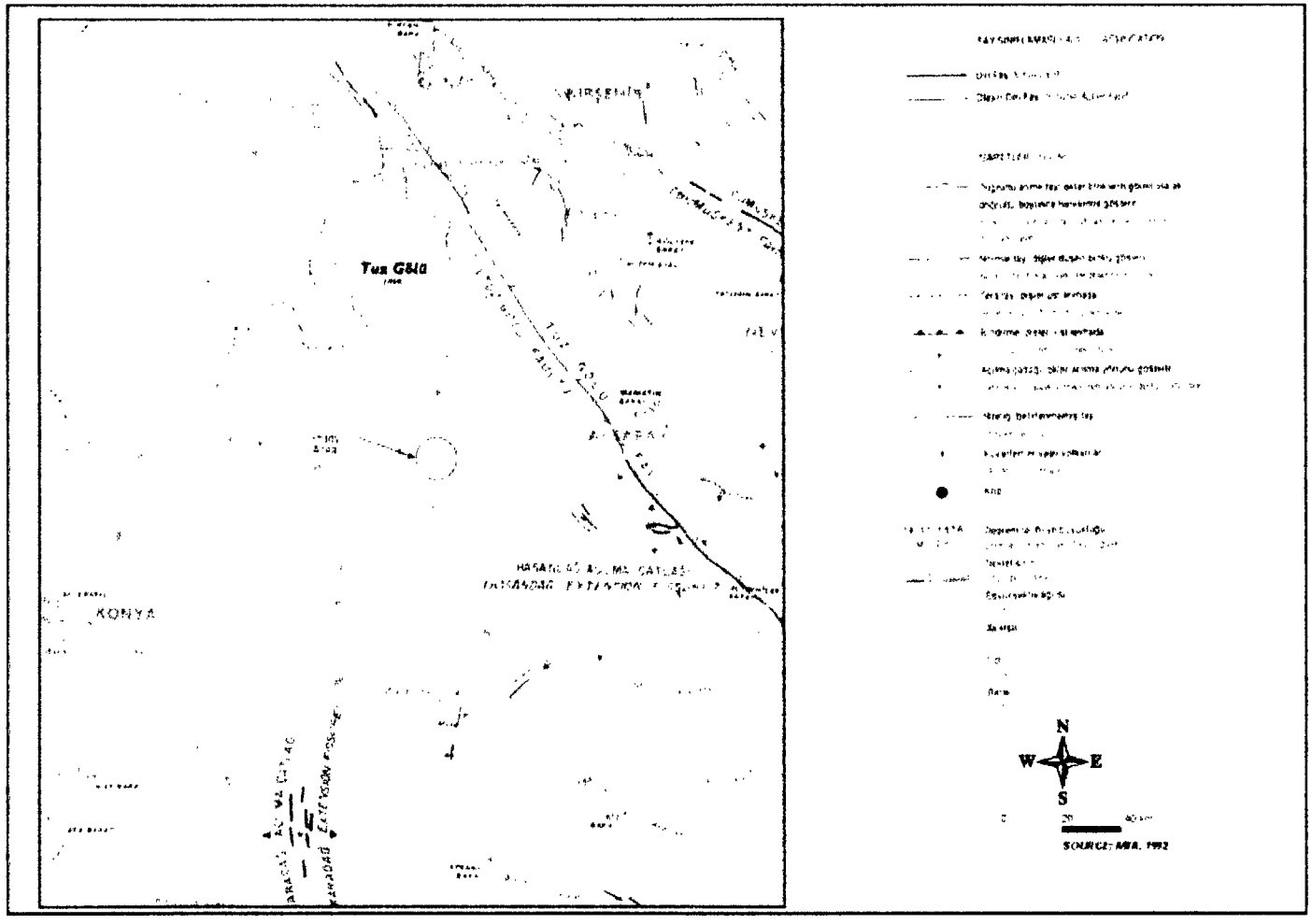


Figure 4.14 Active Fault Map of the Region

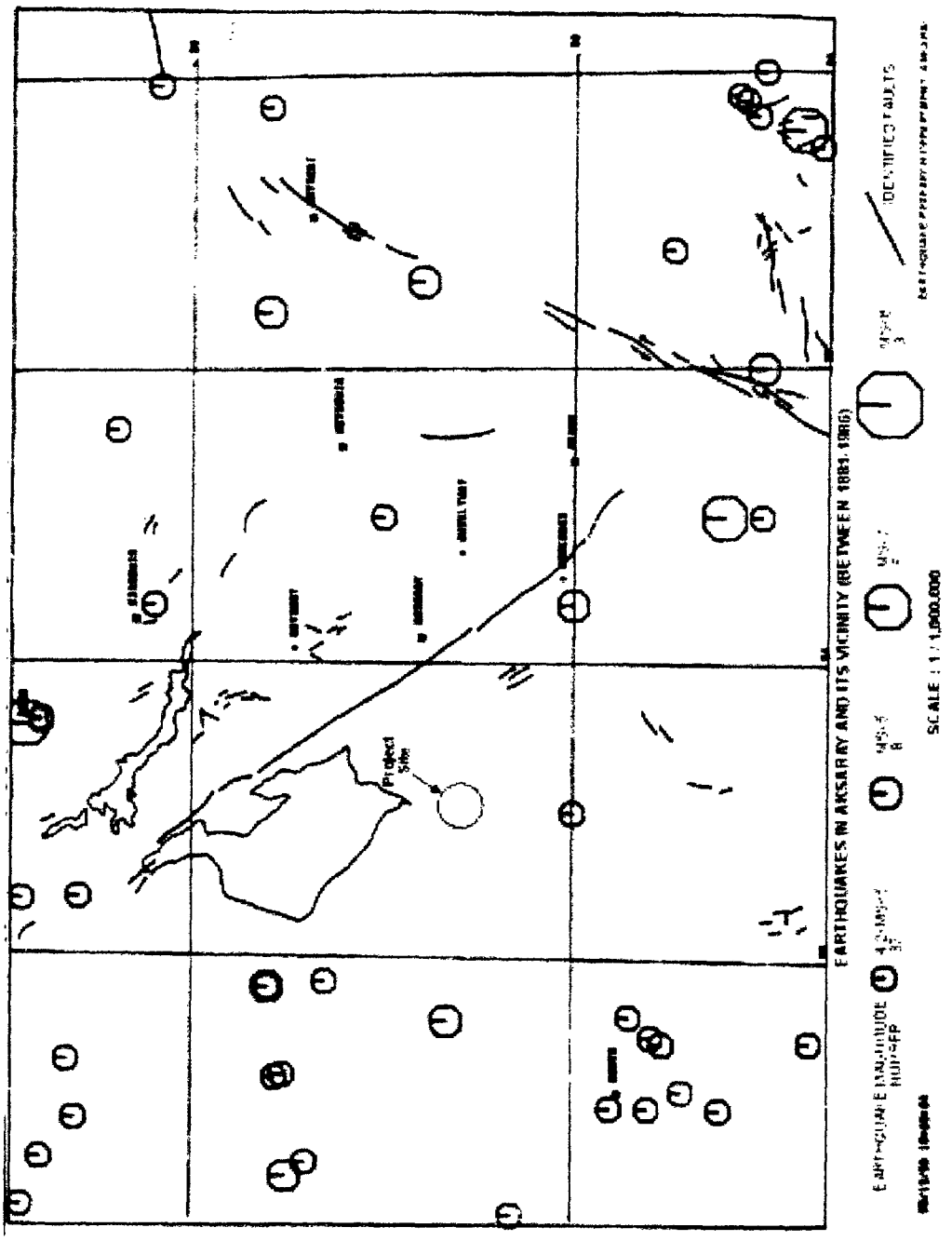


Figure 4.15 Faults Located in the Region and Distribution of the Earthquakes with M>4 Between 1881-1986

In the course of the research on the active faults in the region, Active Fault Map of Turkey, aerial photographs and satellite images were utilized. According to the information obtained, required site investigations were realized and the study was completed.

In order to determine the seismicity risk of the project site, the probabilistic and deterministic methods were used. With the deterministic approach, two critical earthquakes were determined for the project site. First of all, it is foreseen that an earthquake having a magnitude of 7.5 will take place depending on a reverse fault at a location 50 km far from the project site on Tuz Golu Fault known to be the closest active fault. Secondly, considering the historical facts indicating that intra-plate earthquakes having a magnitude of 6.5 such as 19.4.1938 Kırsehir earthquake can occur in all regions of Turkey, it is decided that the epicentre of an earthquake having a magnitude of 6.5 will be placed 5 km far away to the project site.

Consequently, the project site is located at one of the most stable regions in Turkey that has the least seismicity.

4.2.3 Hydrogeological Characteristics of Ground and Thermal Water Resources

The information obtained by the field trips (15 September-1 October 2000), which are carried out to determine the hydrogeological characteristics of the project site, are presented in sub-titles below (ENVY, 2000).

4.2.3.1 Formations Bearing Groundwater

Certain amount of groundwater can be obtained via private public wells from the Quaternary aged alluvium, gravel and clayey-sand alternating formations in the groundwater basin found in the south of Tuz Golu. The alluvium formations showing shallow unconfined aquifer characteristics are convenient formations for water supply through common and casing wells as they are not too thick.

Pliocene limestone, limestone-marl formations bear little amount of water; whereas the important aquifer formations are Neocene limestone. Tuff, granite, andesite and basalt formations pertaining to this era, which carry less amount of water, are encountered within the project site. On the other hand, gre, marl, conglomerate and particularly gypsum formations do not possess aquifer characteristics.

There are plenty wells in the vicinity of the project site drilled by State Hydraulic Works (DSI) on the behalf of irrigation cooperatives. In this regard, these wells posses many information regarding the available groundwater in the region. As a result of examining the data gathered from the boring wells, the groundwater table level is at c.30 m depth. However, the level can be even at 50 m depending on the location,especially its altitude. The yield of the wells is generally good; about 30 L/s of water can be obtained per well in the site. From these data, it can be concluded that the wells to be drilled have to penetrate the Neocene limestone.

Under the control of the Authority for the Protection of Special Areas of Ministry of Environment, a study concerning Tuz Golu Basin was carried out on the year 2001 (T.R. Ministry of Environment, 2001). A part of the study of concern, also refered as Tuz Golu Integrated Environment Project, is on the subject of the utilization of groundwater in the basin.

The hydrology and groundwater in the natural regime of the basin were modelled mathematically and in order to evaluate the impacts of the changes to be observed in the natural regime due to the utilization of groundwater and the water transmission among the basins various simulations were realized. Accordingly, the results obtained are given below:

- External Water Access: Even though the changes on the external water access is significant, there will be no permanent impacts on the water level or salinity rate of Tuz Golu.
- Water Withdrawal: The changes in the aquifers, groundwater withdrawals to be performed over the secure groundwater reserve of the basin can bring about declines in the base water level of the lake.

4.2.3.2 Common, Casing and Boring Wells

Within the Aksaray-Sultanhani-Obruk Region, which is found in the vicinity of the project site, the aquifer formations are generally sandy, gravely, calcareous layers of Neocene and sandy, gravely layers of Quaternary.

There exist the research and operation wells drilled by DSI, General Directorate of Rural Services (GDRS), the Bank of Provinces, etc., as well as private public wells.

Research and operation wells drilled by deep-drilling techniques (other than the common and casing wells) provided useful information on the regional aquifer characteristics. It was understood that the significant aquifer formation is the Neocene aged limestone. Despite the high yield of the wells, due to the characteristics of the site, different chemical parameters are encountered within the water quality at different locations.

According to the wells and the hydrogeological studies, the direction of the groundwater flow is from south to north, i.e. towards Tuz Golu. The groundwater is used to irrigate farmlands in the region via pumps.

4.2.3.3 Thermal and Geothermal Water Resources

There are no thermal and geothermal water resources in the project site and its vicinity of the proposed TUGSP. However, in Guzelyurt District of Aksaray, Ziga Thermal Spring and Ihlara Waters, and in Central District Hamambogazi Saltwater Thermal Spring are present. The thermal water potential of Aksaray Province is 101 hm^3/year. The Ihlara Waters is located approximately 64 km east of the project site.

The General Directorate of Mineral Research and Exploration had undertaken various studies in Ziga-Belisirma Geothermal Area, located c.75 km east of the project site. According to the results of the studies, the total flow rate of the Ziga hot water (32-51°C) spring is about 4 L/s (MTA, 1996). Results of the analysis carried out by MTA on the samples taken from the spring waters in the Geothermal Area of Aksaray Province are given in Table 4.11.

Table 4.11 Chemical Composition of Spring Waters in Geothermal Areas of Aksaray Province

Parameter	Ihlara Spring	Aksaray Spring	Ziga Thermal Spring
Date of Analysis	1986	1986	1983
Temperature (°C)	34.0	31.0	51.0
pH	6.2	6.5	6.8
Electrical Conductivity	-	4,300.0	6,800.0
Evaporation Residue	590.0	3,280.0	4,270.0
K^+ (mg/L)	20.0	30.0	150.0
Na^+ (mg/L)	71.0	630.0	1,160.0
NH_4^+ (mg/L)	-	0.1	1.9
Ca^{++} (mg/L)	48.0	380.0	309.0
Mg^{++} (mg/L)	24.0	158.0	49.0
Total As (mg/L)	-	0.1	1.8
Total B (mg/L)	-	5.4	32.0

Li^+ (mg/L)	-	0.5	6.8
SiO_2 (mg/L)	88.0	3.0	47.0
CO_2 (dissolved, mg/L)	-	-	-
HCO_3^- (mg/L)	336.0	1,452.0	1,244.0
$CO_3^=$ (mg/L)	0.0	0.0	0.0
$SO_4^=$ (mg/L)	18.0	309.0	65.0
Cl^- (mg/L)	65.0	1,120.0	1,900.0
I^- (mg/L)	-	0.5	-
F^- (mg/L)	-	0.1	0.9
NO_2^- (mg/L)	-	0.1	0.0
NO_3^- (mg/L)	-	1.0	0.0

Source: MTA, 1996

4.2.4 Hydrologic and Ecologic Characteristics

There are no surface water resources within the proposed project site and its vicinity. However, the important surface waters in Aksaray Province are given under the following sub-headings.

4.2.4.1 Rivers

Even though there are no surface water resources in the vicinity of the proposed project site, in order to evaluate the environmental baseline of the region, the information about the surface water resources in the vicinity of the study area are given under the following sub-headings.

Melendiz River

Melendiz River, one of the most important water resources of the region, is located c.62.5 km east of the project site (see Figure 4.16). The altitude of the creek is about 1060 m. According to the observations carried out between 1945-1958, the highest flow rate was measured as 11.28 m^3/s (in 1957) and the lowest instant flow was measured as 1160 m^3/s (in 1955). The average flow rate of the river is 4658 m^3/s (EIE, 2000).

Pecenekozu Creek

Pecenekozu Creek, located approximately 58 km northeast of the project site, discharges its waters to Tuz Golu (see Figure 4.16). The altitude of the creek is approximately 958 m. During 33 years of observation carried out till 1996, the highest instant flow was measured in 1967 as 77.0 m^3/s; whereas the lowest instant flow was

recorded in 1964. However, the creek has completely dried up. The average flow of the creek in these 33 years were 1760 m^3/s (EIE, 1999).

4.2.4.2 Lakes

The nearest lake to the proposed project site is Bezirci Lake, which is located c.8 km northwest of the site, and it is completely dry (see Figure 2.4). The other important lake is Tuz Golu, which is located c.40 km north of the proposed project site. Tuz Golu is of importance, as the solution formed in the content of the project will be discharged to this lake. Except for these lakes, even though there are no lakes in the project site and its vicinity, in order to evaluate the environmental baseline of the region, the information about the lakes in the region are given under the following sub-titles.

Bezirci Lake

Bezirci Lake, which is c.8 km northwest of the project site and c.2.5 km east of Gunesli Village (see Figure 2.4 and Figure 4.16), is located c.1 km north of Bezirci high plateau. The lake covers an area of around 1 km^2 and the water level of the lake is the same with the groundwater level.

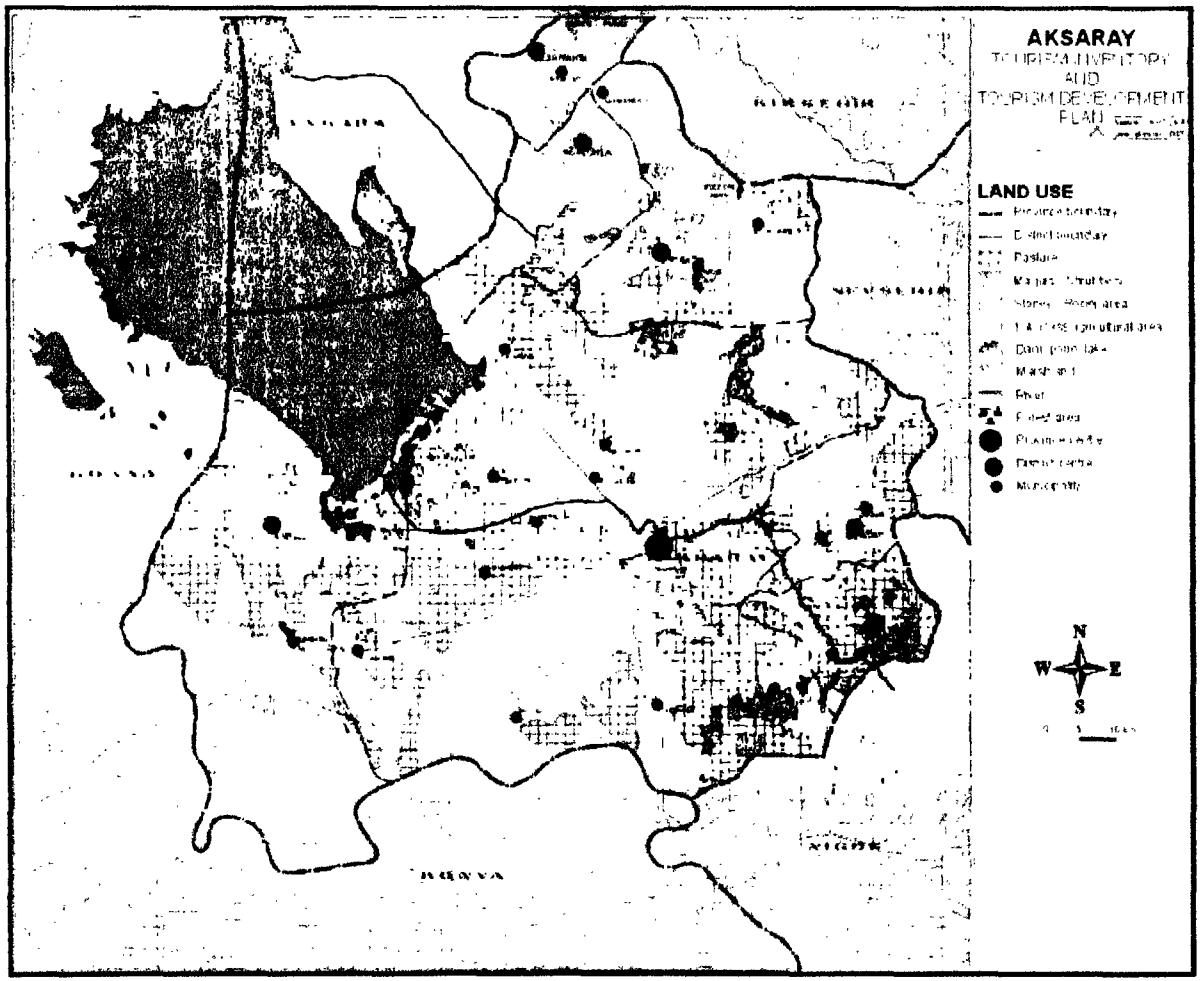


Figure 4.16 Surface Waters in Aksaray Province

Tuz Golu

Tuz Golu is the second large lake in Turkey after Van Lake. The lake, which is located c.40 km north of the proposed project site, is generally barren (see Figure 4.16). The water in the lake which is filled in the winter season only regresses to a great extent and there is only a water layer near Kochisar in the center and a little water in the south part of the lake, and other parts (90%) are completely dry during summer.The lake has 899 m altitude, a surface area of c.1620 km² and a depth of 5.0 m at most. Approximately 400 km² part of the lake is within the boundaries of Aksaray Province. The most important characteristics of the lake is its salt waters. In summer season, because of the evaporation, the depth of lake decreases up to 2 m and hard layers of salt , which has thickness ranging between 2.0 cm and 2.0 m, forms.

The altitude of the tectonic formation lake is 899 m. Melendiz Creek and streams within the province discharge to the lake. An unnatural constant water discharge is the wastewater transported via Konya Main Discharge Line with a length of 150 km. There are little salty marshes at the points where the canal and salts enter into the Lake.

Tuz Golu is located in the least rainy part of Turkey. The feeding basin of the lake has an alluvion, gypsum and calcerrous structure. The lake impacts the climate in this region and the solar rays reflecting in the lake which turns into a luminous salt layer after drying in summers prevent over temperatures in the region. Strong winds blow over the lake towards Aksaray in winters.

Mamasun Dam Lake

The Mamasun Dam Lake is c.62.5 km northeast of the project site and although it is located on Uluirmak c.12 km east of Aksaray (see Figure 4.16), its location is far from the project site. The height of the dam from the river bed, which was established in 1962 and is of rock-fill type, is 44.90 m and its storage volume is 165.8 hm³.

Esmekaya Lake

Esmekaya Lake is located in Esmekaya Village of Eskil District and is c.30 km northwest of the project site (see Figure 4.16). 4,500 ha area, in which the mentioned lake is found, was proclaimed as Protected Area in 1992 and Wild Life Protection Area in 1994 under the name of Esmekaya Reed bed. Also 11,250 ha area was determined as Important Bird Area (see Section 4.2.10) (DHKD, 1997).

Helvadere Pond

Helvadere Pond, located c.65 km east of the project site, was put into operation in 1987 in Helvadere Village of Central District (see Figure 4.16). The homogeneous-fill type dam has 10.5 m height from the river bed and 0.9 hm^3 storage volume.

Guzelyurt Pond

Guzelyurt Pond, located c.70 km east of the project site, was put into operation in 1995 in Guzelyurt District (see Figure 4.16). The zone-fill type dam has 21.0 m height from the river bed and 0.9 hm^3 storage volume.

Balci Pond

Balci pond, located c.85 km northeast of the project site, was put into operation in 1975 in Balci Village of Ortakoy District (see Figure 4.16). The homogeneous-fill type dam has15.5 m height from the river bed and 1.8 hm^3 storage volume.

Ciftevi Pond

Ciftevi Pond, located c.95 km northeast of the project site, was put into operation in 1993 in Ciftevi Village of Ortakoy District (see Figure 4.16). The homogeneous-fill type dam has 24 m height from the river bed and 1.5 hm^3 storage volume.

4.2.5 Present and Planned Utilization of Surface Water Resources

There are no surface water resources within the proposed project site and its vicinity. However, the important surface waters in Aksaray Province are given under the following sub-headings. Since Tuz Golu shores, which are one of the shores found within the boundaries of the province, are marsh and barren, utilization is unfeasible. Bezirci Lake[1] shores, also named as Kus Golu (Kus Lake), within Sultanhani settlement, are reedy. However, beach and swimming opportunities are present in shallow parts of Mamasun Dam Lake, c. 62.5 km northeast of the study area.

[1] *According to the information obtained through the field surveys, there has been no water in Bezirci Lake in the last two years , refer to Figure 2.4.*

4.2.5.1 Rivers

Even though there are no surface water resources in the vicinity of the proposed project site, in order to evaluate the environmental baseline of the region, the information about the surface water resources in the vicinity of the study area are given under the following sub-headings.

Melendiz River

Melendiz River, which is one of the most important water resources of the region, is located approximately 62.5 km east of the project site (see Figure 4.16). Melendiz River sources from Sultan Spring at the slopes of Melendiz Mountain and is enriched by the spring waters from Asmasiz and Ramat. It passes through Melendiz Plain and forms a valley between Ihlara and Selime. The creek, flows towards northwest taking some spring water along with itself. The creek enters the Kirecik Strait with the name of Uluirmak and ends in Karatepe reeds at the east of Eskil found in the vicinity of Tuz Golu.

Pecenekozu Creek

Pecenekozu Creek, located c.58 km northeast of the project site, discharges its waters to Tuz Golu (see Figure 4.16). The creek has completely dried up.

4.2.5.2 Lakes

The nearest lake to the proposed project site is Bezirci Lake, which is located c.8 km northwest of the site, and it is completely dry (see Figure 2.4). The other important lake is Tuz Golu, which is located c.40 km north of the proposed project site. Tuz Golu is of importance, as the solution formed in the content of the project will be discharged to this lake. Except for these lakes, even though there are no lakes in the project site and its vicinity, in order to evaluate the environmental baseline of the region, the information about the lakes in the region are given under the following sub-titles.

Bezirci Lake

Bezirci Lake, which is completely dry, is c.8 km northwest of the project site and c.2.5 km east of Gunesli Village (see Figure 2.4 and Figure 4.16). The 11,250 ha, area which the

mentioned lake is present within, is among the Important Bird Areas (see Section 4.2.12) (DHKD, 1997).

Tuz Lake

Tuz Golu is the second large lake in Turkey after Van Lake and is located c.40 km north of the proposed project site (see Figure 4.16).

The surface waters of the Konya Plain, which is considered as closed basin as it has no exterior flow, are discharged by the Konya Plain Main Discharge Canal constructed by DSİ. The canal waters, which also carries domestic and industrial wastewaters, are discharged to Tuz Golu. Therefore, it is determined that rather serious results are arised regarding the quality of Tuz Golu as a result of these wastewater discharges.

The great part of the salt production in Turkey is obtained from Tuz Golu, but after the opening of the canal, it is determined that a decrease has been encountered both in the production and the quality of the salt (EMF, 1998).

Tuz golu, located within the boundaries of Aksaray Province, is proclaimed as Special Environmental Protection Area by the decision of the Council of Ministers dated 14.09.2000 (see Section 4.2.10)

The unrefined salt production in Turkey is realized in 30 saltpans totally, including two marine, three lakes, five rocks and 20 rock saltpans, by TEKEL, General Directorate of Tobacco, Tobacco Products, Salt and Alcohol Enterprises, as stipulated by the Salt Law numbered 3078.

The salt production capacity is limited by area in marine salts, by machinery and equipment in lake and rock salts, and by flow rate of the flowing water in the source saltpans. 91% of the unrefined salt production capacity belongs to marine and lake saltpans. The rock and especially rock saltpans are minor enterprises.

An average of 200 million tons of salt is formed every year in Tuz Golu. The annual salt production in the world is approximately 180 million tons. Despite the high salt potential in Tuz Golu, the amount of salt produced from the lake is limited by interior and exterior demands. A major part of public in the region make their living economically from Tuz Golu. In only Sereflikochisar District of Ankara Province and Cihanbeyli District of Konya Province, a total of 6408 people depends on this sector to make a living (Baran, 2000).

Mamasun Dam Lake

The Mamasun Dam Lake is located on Uluirmak c.12 km east of Aksaray and c.62,5 km northeast of the project site (see Figure 4.16). The dam was established in 1962 with irrigational purposes. It irrigates an area of 24,854 ha of the Aksaray Plain by its left and right channels. Fishing activities are still being carried on in the Mamasun Dam Lake which is rather far from the study area. Perch and carpy are being bred in the dam lake.

Esmekaya Lake

Esmekaya Lake is located in Esmekaya Village of Eskil District and is c.30 km northwest of the project site (see Figure 4.16). The studies to convert the lake into a reservoir were started in1995 by DSI. The lake, which will be used for irrigational purposes, will have a net capacity to irrigate an area of 19,554 ha.

4,500 ha area, in which the mentioned lake is found, was proclaimed as Protected Area in 1992 and Wild Life Protection Area in 1994 under the name of Esmekaya Reed bed. Also 11,250 ha area was determined as Important Bird Area (see Section 4.2.10) (DHKD, 1997).

Helvadere Pond

Helvadere Pond, located c.65 km east of the project site, was put into operation in 1987 in Helvadere Village of Central District (see Figure 4.16). The pond, which is used for irrigation and flood prevention, irrigates an area of 253 ha.

Guzelyurt Pond

Guzelyurt Pond, located c.70 km east of the project site, was put into operation in 1995 in Guzelyurt District (see Figure 4.16). The pond which is used for irrigation, irrigates an area of 160 ha.

Balcı Pond

Balci pond, located c.85 km northeast of the project site, was put into operation in 1975 in Balci Village of Ortakoy District (see Figure 4.16). The pond, which is used for irrigation, irrigates an area of 150 ha.

Ciftevi Pond

Ciftevi Pond, located c.95 km northeast of the project site, was put into operation in 1993 in Ciftevi Village of Ortakoy District (see Figure 4.16). The pond, which is used for irrigation, irrigates an area of 211 ha.

4.2.6 Species in Inland Waters

The wetlands near the three-dimensional seismic study area and its vicinity, except for Tuz Golu, are not very rich and genuine in aquatic life. The main reason is that the present wetlands almost dry out in the summer season. The scarcity of precipitation and high evapotranspiration (the total of evaporation on inorganic surfaces and transpiration on plants), impedes the continuity of the aquatic life. There are only a few areas with water during summer.

Since a big proportion of Tuz Golu dries up and that the salt ratio increases, a weak halophytic vegetation has developed near the lake. This vegetation shows great similarity with the halophytic vegetation studied in the summer of 1998 in Caucasia. Nevertheless, there are some differences since the isolation between the two regions has materialized ten thousands of years ago. In this regard, there are no endemic species of narrow distribution in the vicinity of Tuz Golu.

4.2.6.1 Vegetation

No aquatic vegetation is present in the project site. Typical aquatic vegetation (see Figure 4.17) has developed in Esmekaya Marsh. The information about the "Plant Community" that form this vegetation are given in the sub titles below. Furthermore, halophytic plant communities that are present in the vicinity of Tuz Golu are determined in the following paragraphs.

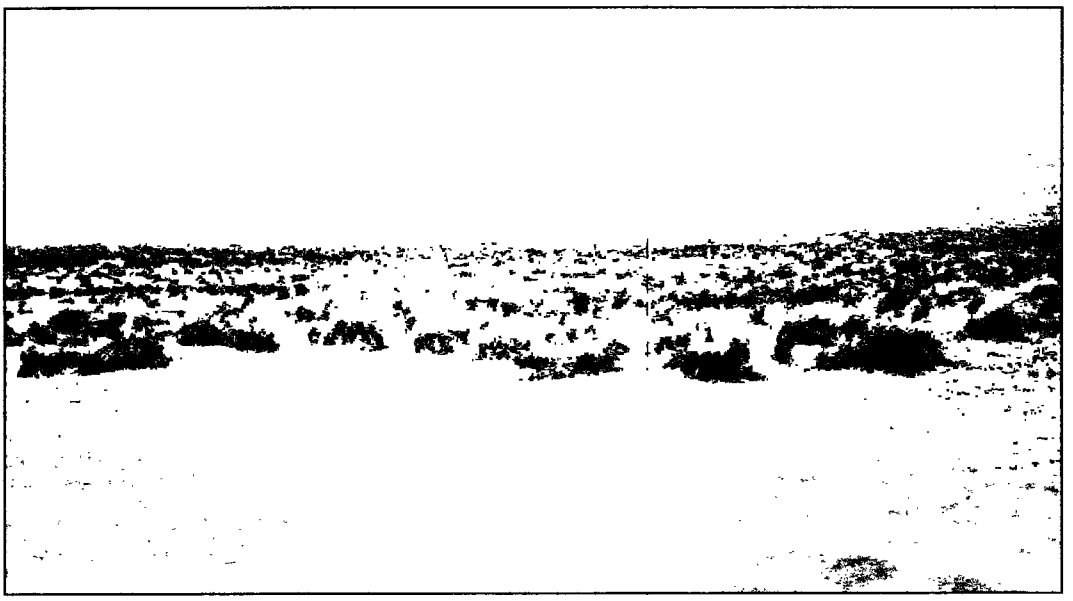


Figure 4.17 Vegetation Type on the Shores of Bezirci Lake

Phragmites australis Plant Community

This community is widespread in Esmekaya wetlands. The water depth shows significant differences seasonally. Although it exceeds 0.5 m in the winter, it totally dries up in the summer The coverage ratio of the dominant species *Phragmites australis* is usually c.100%, while the average height changes between 2-3 m. The main species which join the composition of the community are *Schoenoplectus lacustris* ssp. *tabernaemontani, Lythrum salicaria, Veronica anagalloides* and *Mentha aquatica.*

Typha domingensis Plant Community

It is widespread in Esmekaya wetlands. Although the water depth shows significant differences seasonally, it is mostly developed in muddy areas. The dominant species is *Typha domingensis* but it also co-exists with *Phragmites australis.* The coverage ratio differs between 60-90% and has an average height of 1.5-2 m. The main species which join the composition of the community are *Schoenoplectus lacustris* ssp. *tabernaemontanii, Lythrum salicaria, Veronica anagalloides* and *Mentha aquatica.*

Juncus maritimus Plant Community

It is found in Esmekaya wetlands. They develop in muddy areas. The dominant species *Juncus maritimus* has an average height of 80-100 cm and the coverage ratio is between 70-90%. Compared to *Phragmites australis* and *Typha domingensis* plant communities, its floristic composition is richer and the most common species are *Typha domingensis, Phragmites australis, Juncus articulatus, Schoenus nigricans, Schoenoplectus lacustris* ssp. *tabernaemontanii* and *Bulboschoenus maritimus* var. *maritimus*.

4.2.6.2 Halophytic Plant Communities in the Vicinity of Tuz Golu

The halophytic vegetation developed in the vicinity of Tuz Golu is also given in details by Çetik (1985). The communities that are defined in the association level and classified as sintacsonomic by Çetik (1985) are determined as "plant community" by us. Since the salinity is very high, the vegetation is poorly developed. Nevertheless, it is of importance as it possesses endemic and rare halophytic plants which grow only in the vicinity of Tuz Golu.

While a part of the barren plant community found in the Tuz Golu and its vicinity is covered with water for a long time, the ones that are found in the rear plan are generally found within the plain steppe transition zone. Owing to this, these latter ones co-exist frequently with Sea Wormwood (*Artemisia santonicum*), which is a typical plant for Central Anatolian plain steppe.

***Salsola inermis* Plant Community**

It is found in the areas with low salinity. It marks a transition between halophytic vegetation and Sea Wormwood. Even though its coverage ratio differs between 30-90%, it is generally around 40-50%. The number of species encountered in the model area of 1000 m² is low and it is between 3-10 and generally 6-8. Although *Salsola inermis* is not endemic, it is known only from the vicinity of Tuz Golu (Sereflikochisar and Sultanhani) in Turkey.

The dominant species in this community are Sea Wormwood, *Halanthium kulpianum, Apera intermedia, Camphorosma iconicum, Suaeda prostrata, Aeluropus littoralis,* Hairy Sea-heath (*Frankenia hirsuta*), Mediterranean Saltwort (*Salsola vermiculata* var. *villosa*), *S. laricina,* Sea Barley (*Hordeum marinum*), Common stargrass (*Cynodon dactylon*), Prostrate Summercypress (*Kochia prostrata*), *Atriplex lasiantha.*

In addition, many aridic species peculiar to the plain steppe are also developed in this community.

Hairy Sea-heath and *Limonium iconicum* Plant Communities

They are encountered in the north and south of Tuz Golu and in the east of Esmekaya. They develop on high areas with high salinity, which are covered with water in winter and spring. Its coverage ratio is between 20-40%. While Hairy Sea-heath is widely distributed in our country, *Limonium iconicum* is an endemic peculiar to the Central Anatolia. The community is poor in diversity of species and the species that are enountered frequently are given below:

Reaumeria alternifolia, Limonium gmelinii, Artemisia santonicum, Taraxacum farinosum, Plantage crassifolia, Salsola inermis, Camphorosma monspeliaca, Puccinellia distans, Halimione portulacoides, Juncus maritimus, Aeluropus littoralis, Holochnomum strobulaceum, Petrosimonia brachiata, Limpnium globuliferum, Suaeda birandii, Inula ducheriana, Crepis aculeata, Atriplex tatarica, Achillea wilhelmsii, Festuca arundinacea, Cynodon dactylon, Poa bulbosa.

***Limonium gmelinii* Plant Community**

They are observed in small dry ponds and water accumulations, in areas with relatively high salt rate. It has a coverage ratio of 20-40%. *Puccinellia distans* and *Limonium gmelinii* are the dominant species. Other species encountered frequently are listed below:

Spherophus divaricatus, Plantago crassifolia, Petrosimonia thandra, Salicomia europaea, Plantago maritima, Spergularia marina, Trifolium resupinatum. Italimione portulacoides, Itordeum maritimum, Itolocnemum strobulaceum, Limonium flobuliforum, Aelurapis littoralis, Suaeda prostrata, Frankenia hirsuta, Spergularia media, Salsola vermiculata, Reaumur/a alternifelia, Cynodon dactylon, Gypsophila linearifolia, Lotus gebelia, Allium stamineum, Petrosimonia brachiata, Agropyron elongatum, Lepidium latifolium, Alopecurus geniculatus, Panderisa pilosa.

***Halimione verrucifera* Plant Community**

They are present in salty areas in the east of Esmekaya Marshland. Its dominant species is *Halimione verrucifera*. The area, where the community is widespread, is invaded by

the waters of Tuz Golu in spring. The coverage ratio can reach up to 80% in some parts of the area. The community is poor in the variety of species. Those species are given below:

Limonium iconicum, Puccinellia distans, Salicomia europea, Halimione portulacoides, Camphorosma monspeliaca, Aleuropus littoralis, Frankenia hirsuta.

***Halanthium kulpani* Plant Community**

It is found in the northern part of Tuz Golu and in the east of Esmekaya in south. The dominant species is *Halanthium kulpiani.* They develop on the areas, which are covered with water in winter and spring. The other species found in this community are given below:

Apera intermedia, Petrosimonia triandra, Salsola anatolica, Halocharis sulphurous, Salicomia europea, Camphorosma monspeliaca, Aeluropus littoralis, Frankenia hirsuta, Hordeum maritimum, Salsola vermicula var. villosa, Tripleurospermum precox, Papaver dubium, Stipa hohenackeriana, Bromus squarosus, Halophyllum pumilium, Bromus tectorum, Stipa lagascae, Lepidium perfoliatum, Matricaria chamomilla, Agropyron orientate, Trigonella durantica, Valerianella vesicaria, Cynenctum acutum.

4.2.6.3 Fauna Species in Inland Waters

The most important inland water resource is Tuz Golu, located c.40 km north of the project site. The typical characteristic of the lake is that it is an ornithologic area. The lake, which is one of the most important Bird Areas in Turkey, is also an important wetland. The most important characteritic of the lake ornithologically, is being the incubation area for the biggest flamingo colony in our country (EMF, 1993).

The wetlands around the vicinity of the project site have an importance, especially for the "winter immigrant or trespassing" bird species in terms of aquatic fauna. In that context, Tuz Golu is a "1. Degree Natural Protection Area", besides being a "Special Environmental Protection Area". The bird species that emphasize the importance of Tuz Golu do not have a high population density in the wetlands situated around the project site. They are found either individually or in small colonies.

The immigration to Tuz Golu takes place in October-November. The immigrant birds are Ruddy Shelduck, Common Shelduck, Mallard, Teal, European Wigeon, Northern Pintail,

Common Shoveller, Merlin, Coot, Lapwing, Plover and Sandpiper, while the incubating species are Avocet, Greater Sand Plover, Stone Curlew, Slender-billed Gull, Yellow-legged Gull and Collared Pratincole (EMF, 1993).

Since the other wetlands in the vicinity almost totally dries during the summer, no fish species exist. The fauna inventory given in Section 4.2.14 contains detailed and comprehensive information on bird species. In the following paragraphs, the aquatic fauna species other than birds are mentioned only by names. Amphibians, reptiles and mammals are given in Table 4.12, Table 4.13 and Table 4.14, respectively.

Table 4.12 Amphibians (Amphibia)

Scientific Name	Common Name
Anura	**Frogs and Toads**
Pelobatidae	**Spadefoots**
Pelobates syriacus	Eastern Spadefoot
Bufonidae	**True Toads**
Bufo bufo	Common Toad
Bufo viridis viridis	Green Toad
Hylidae	**Tree Frogs**
Hyla arborea	Tree Frog
Ranidae	**True Frogs**
Rana ridibunda ridibunda	Marsh Frog

Table 4.13 Reptiles (Reptilia)

Scientific Name	Common Names
Emydidae	**Turtles**
Emys orbicularis	European Pond Turtle
Scincidae	**Skinks**
Typhlopidae	**Blind Snakes**
Colubridae	**Colubrids**
Natrix natrix persa	Grass Snake
Natrix tessellata tessellata	Dice Snake

Table 4.14 Mammals (Mammalia)

Scientific Name	Common Name
Cricetidae	**Hamsters**
Arvicola terrestris	European Water Vole

Fishes

The waters of Tuz Golu almost totally dries up in the summer and besides, the connected creeks generally can not reach the lake in summer months. Because of the high salinity of the lake, there is no convenient habitat for fishes. Nevertheless, two species of *Aphanius* species in the lake are of importance. A decision for the protection for both species is present in the content of Bern Agreement. Additionally, *Phoxinellus crassus* is an endemic fish species, which only habit in Tuz Golu throughout the world. The information about the species are given in the following paragraphs.

Aphanius anatolias

It is an endemic species, peculiar to the Central Anatolia. It lives in the regions from Elazig Hazer Lake to Afyon Acigol and Burdur Lake. It has no economic importance. It is interesting that this species habit in brine and brakish waters, as well as freshwater.

Eastern Anatolian Killie (*Aphanius chandrei*)

It is widespread from the Central Anatolia to the shores of Central Black Sea. It has a wide ecological tolerance including brine and brakish water to even spring waters. It is an endemic species, peculiar to Anatolia.

Phoxinellus crassus

This species is first recorded at Cihanbeyli (Insuyu) in 1960 by a researcher named Ladiges. Its typical habitat is accepted to be this locarion. In latter times, researchers named Geldiay, Kahsbauer (1975) and Karaman (1982) had informed that this species is also present in Aksaray.

There is not enough information on the biological and ecological characteristics of this species; however, it is known that it has no economic importance by means of human food. Its length is about 30 cm.

According to the meeting carried out with Dr. Aydın Akbulut who is among the lecturers of Hacettepe University, Science Faculty, Department of Biology, a study carried out by the Hacettepe University, Science Faculty, Department of Biology with Prof. Dr. Ali Demirsoy as the project manager on the biodiversity of this area has recently been completed. Sampling studies from many creeks and lakes within the basin regarding the

fishes were also undertaken within the context of the study, but despite the presence of *Phoxinellus crassus* was known, no sample could have been obtained.

4.2.7 Minerals and Fossil Fuel Resources

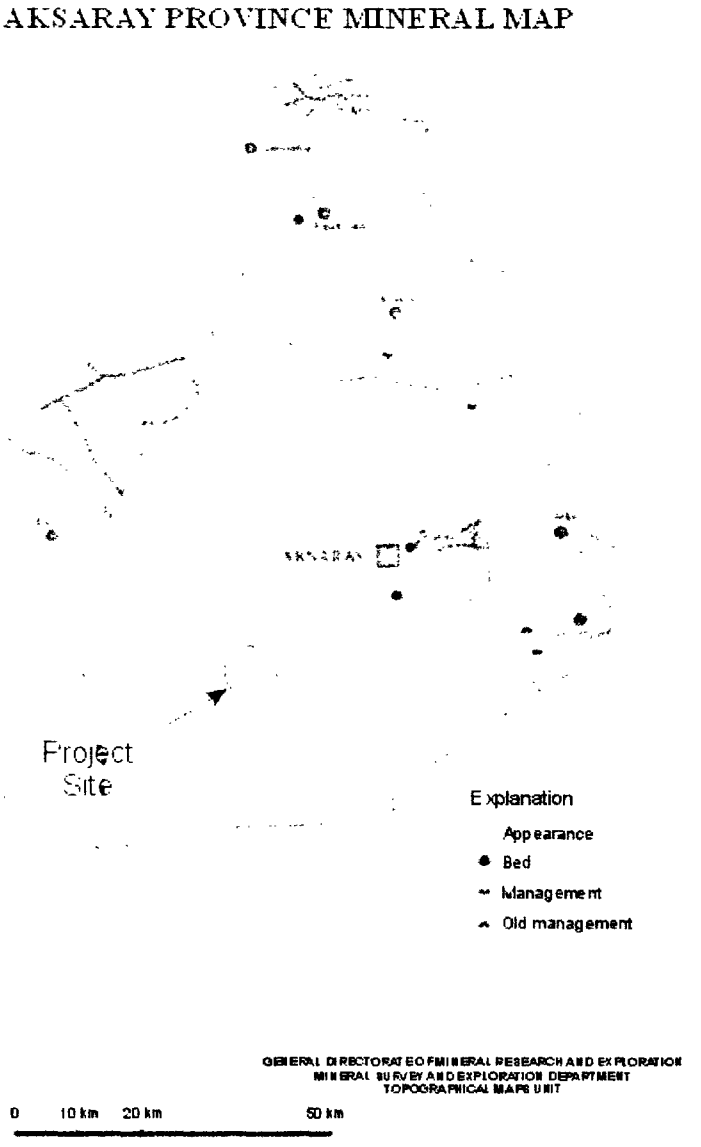
Although the province is poor in underground resources, there are kaolin and marble beds around Guzelyurt District, which can be used in the ceramic industry. There are also mercury resources in Sariyahsi District, bims in tuff formations around Hasan Mountain within the boundaries of Helvadere District that can be used in the tile, white brick and paper industry.

The map of mine beds present in Aksaray Province is shown in Figure 4.18 and the detailed information about the mineral resources are presented in Table 4.15. Accordingly, there are no mine beds within the project site and its vicinity.

4.2.8 Soil Characteristics and Utilization Condition

4.2.8.1 Major Soil Groups

In order to determine the major soil groups of the region covering the project site and the process water discharge line, the land use maps, prepared by the General Directorate of Rural Services were used (GDRS, 1993). According to the information obtained by digitizing of the maps of interest, the major soil groups were determined (see Table 4.16 and Figure 4.19). Detailed information about the major soil groups are presented in Appendix-H. Accordingly, brown soils are dominant at the project site and its vicinity (42.80%). It is followed by the alluvial soils with a ratio of 24.24%. The map of the major soil groups within the project site and its vicinity is presented in Appendix-H.



Source: www.mta.gov.tr

Figure 4.18 Mineral Map of Aksaray Province

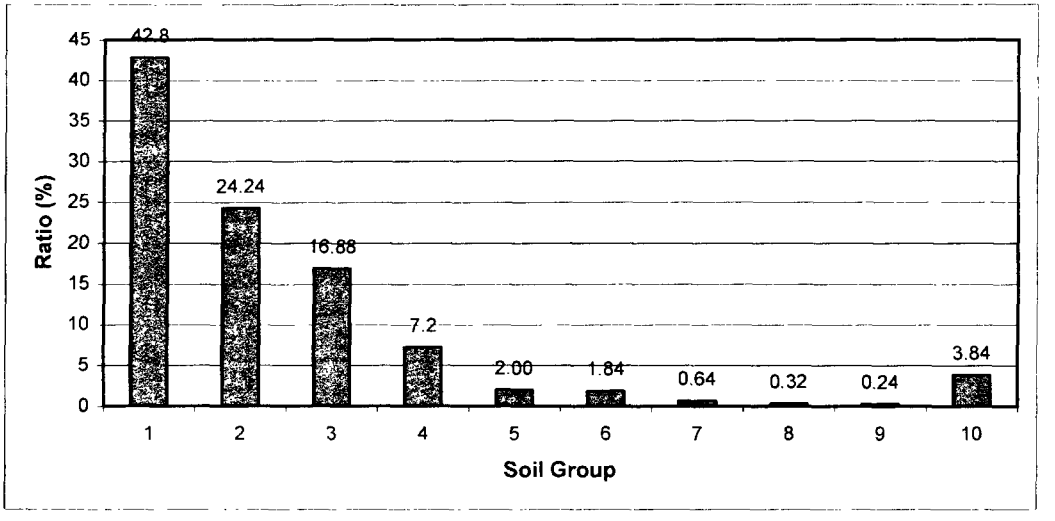
Table 4.15 Mineral Resources in Aksaray Province

Mineral	Reserve Area	Grade/Quality	Reserve Quantity
Mercury	Guzelyurt (Gelveri)	Grade: In form of pockets and veins	6-7 appearances
Diatomite	Ihlara and Belisirma Beds	Medium Quality	Production has been made in the past years
Feldspar	granite arenes of Panlı and Yenisabanlı Towns	Grade: Original Total alkali value 8%, iron oxide content 2,8% dir. Alkali increases up to 12% after enrichment, Fe_2O_3 content decreases to 0.17%.	There is a great feldspar potential that has the characteristic of being used as coloured cooked ceramic raw material in the vicinity
Kaolin	Seylik-Kukurtdere Bed	23-25% Al_2O_3	629,200 tons visible+probable
	Guzelyurt-Mekedere Bed	Grade:15-30% Al_2O_3, 0,3-2,8 % Fe_2O_3	841,217 tons visible+probable, 1,860,000 ton probable. Kaolin with alunite are used as raw material in the paper industry.
Sulphur	Genedela appearance	25% S	-
Manganese	Gucunkaya and Gostuk appearances	-	-
Marble	Ortakoy-Gokkaya Bed	Good quality granite	The bed is being operated
Brick-Tile	Centre-Hirkatol Village Bed	Quality: Good	2,000,000 tons

Source: www.mta.gov.tr

Table 4.16 Major Soil Groups in the Region

Major Soil Group	Area (km²)	Ratio (%)
Brown soils	535	42.80
Alluvial soils	303	24.24
Hydromorphic alluvial soils-Alluvial shore marshlands	211	16.88
Barren (brine-sodic) soils	90	7.20
Regosols	25	2.00
Organic soils-Red yellow podzolic soils	23	1.84
Hydromorphic alluvial soils-Vertisols-Reddish brown soils	8	0.64
Red yellow podzolic soils	4	0.32
Colluvial soils	3	0.24
Lake	48	3.84
TOTAL	**1,250**	**100.00**



1: Brown soils
2: Alluvial soils
3: Hydromorphic alluvial s. Alluvial shore mar.
4: Barren (brine-sodic) soils
5: Regosols
6: Organic soils-Red yellow podzolic soils
7: Hydromorphic alluvial s.-Vertisols-Reddish brown s.
8: Red yellow podzolic soils
9: Colluvial soils
10:Lake

Figure 4.19 Major Soil Groups in the Region

4.2.8.2 Land Use Capability

In order to determine the present land use capability of the region covering the project site and the process water discharge line, the land use maps, prepared by the General Directorate of Rural Services were used (GDRS, 1993). According to the information obtained by digitizing of the maps of interest, the land use capabilities were determined (see Table 4.17 and Figure 4.21) Accordingly, soils of class IV are dominant at the project site and its vicinity (27.60%). It is followed by soils of class VII with a ratio of 19.04%. (see Table 4.17, Figure 4.21 and Figure 4.22)

Table 4.17 Land Use Capability in the Region

Land Use Capability	Area (km²)	Ratio (%)
I	144	11.52
II	143	11.44
III	200	16.00
IV	107	8.56
V	23	1.84
VI	345	27.60

VII	238 b	19.04
VIII	50	4.00
TOTAL	**1,250**	**100.00**

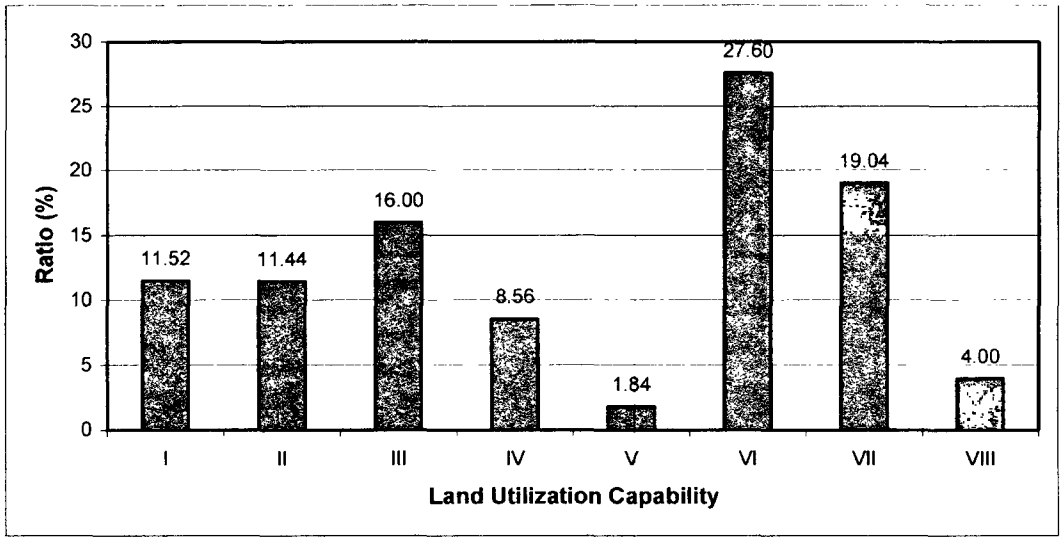


Figure 4.21 Land Use Capability of the Region

4.2.8.3 Land Use Pattern

In order to determine the present land use pattern of the region covering the project site and the process water discharge line, the land use maps, prepared by the General Directorate of Rural Services were used (GDRS, 1993). According to the information obtained by digitizing of the maps of interest, the land use pattern of the region was determined (see Table 4.18, Figure 4.22)

Accordingly, the dominant land use pattern at the project site and its vicinity is rain-fed agriculture with fallow (35.68%). It is followed by pastures with a ratio of 29.68%.

Table 4.18 Land Use Patterns of the Region

Land Use Pattern	Area (km²)	Ratio (%)
Rain-fed agriculture (with fallow)	446	35.68
Pasture	371	29.68
Meadow	191	15.28
Irrigated agriculture	185	14.80
Irrigated agriculture (insufficient)	9	0.72
Lake area	48	3.84
TOTAL	**1,250**	**100.00**

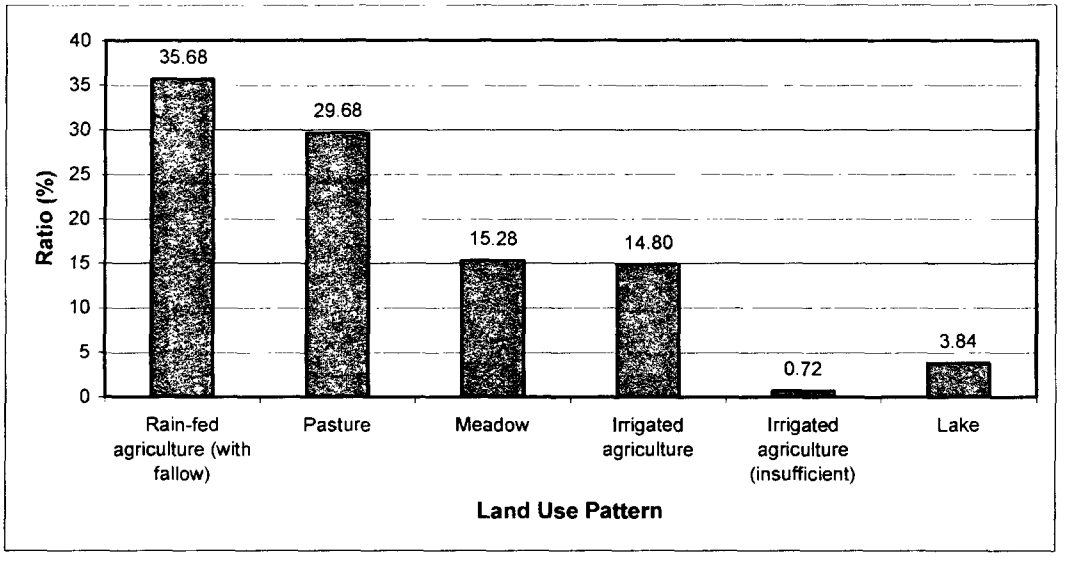


Figure 4.23 Land Use Pattern in the Region

4.2.8.4 Erosion

In order to determine the erosion conditions within the region covering the project site and the process water discharge line, the land use maps, prepared by the General Directorate of Rural Services were used (GDRS, 1993). According to the information obtained by digitizing of the maps of interest, the erosion conditions of the region was determined (see Table 4.19 and Fiigure 4.23) Accordingly, the lands subjected to "no or very low" erosion are dominant in the vicinity of the project site (80.40%). It is followed by lands subjected to "medium" degree erosion with a ratio of 12.80%.

Table 4.19 Erosion Conditions of the Region

Erosion Degree	Area (km²)	Ratio (%)
1	1005	80.40
2	160	12.80
3	37	2.96
Lake	48	3.84
TOTAL	**1,250**	**100.00**

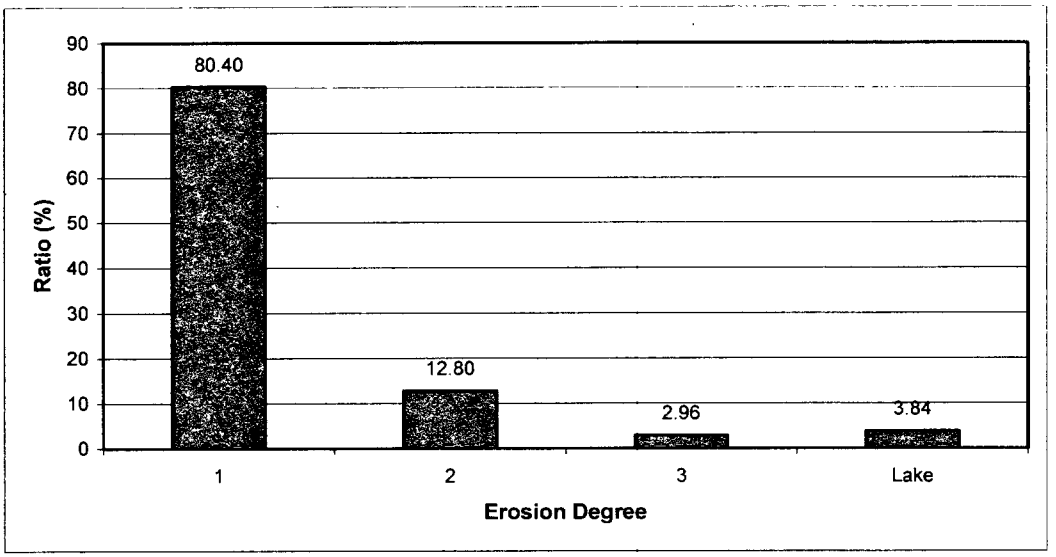


Figure 4.25 Erosion Conditions of the Region

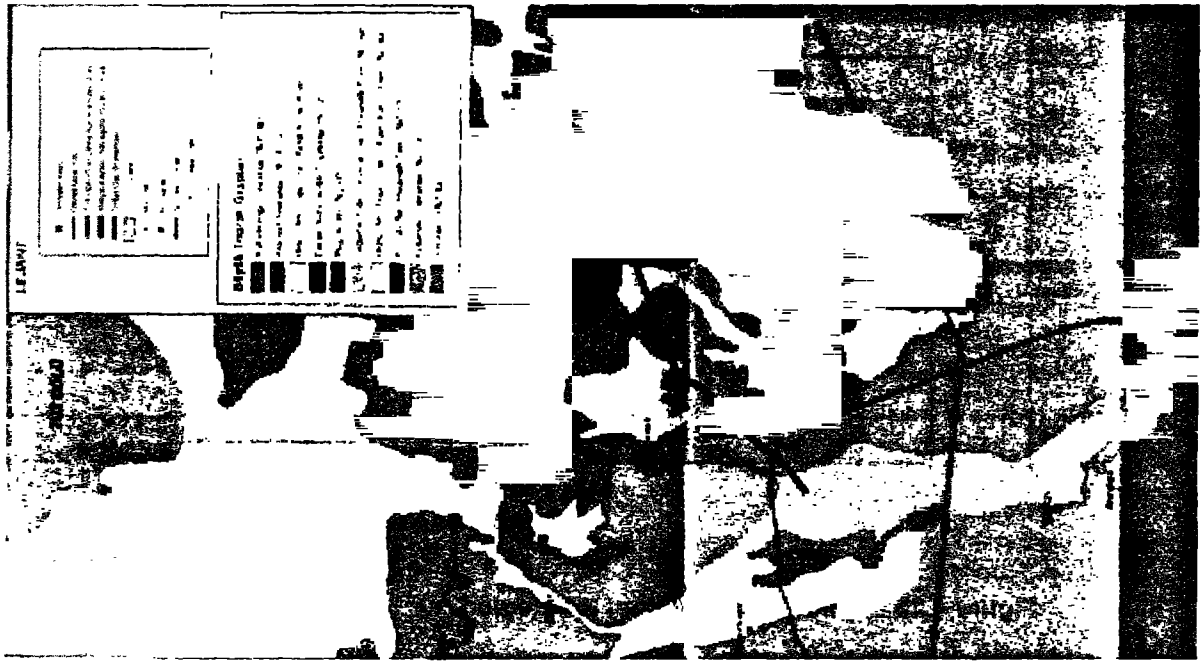


Figure 4.20 Major Soil Groups in the Region

Figure 4.22 Land Use Capabilities in the Region

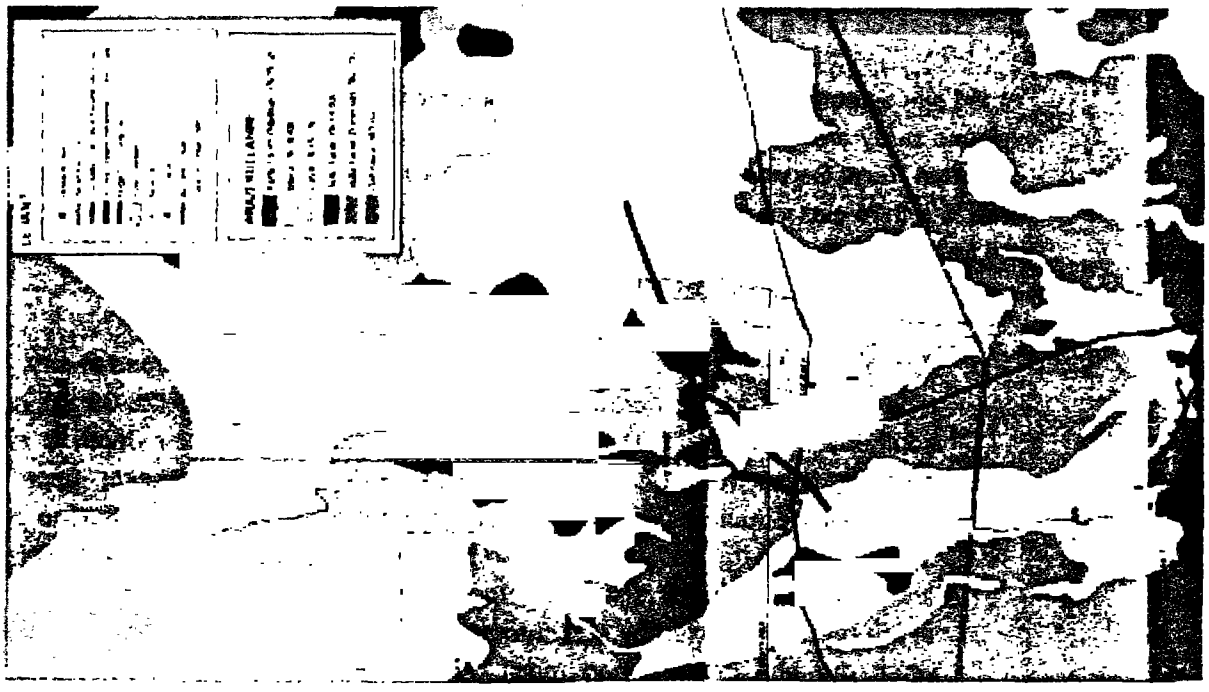


Figure 4.24 Land Use Patterns

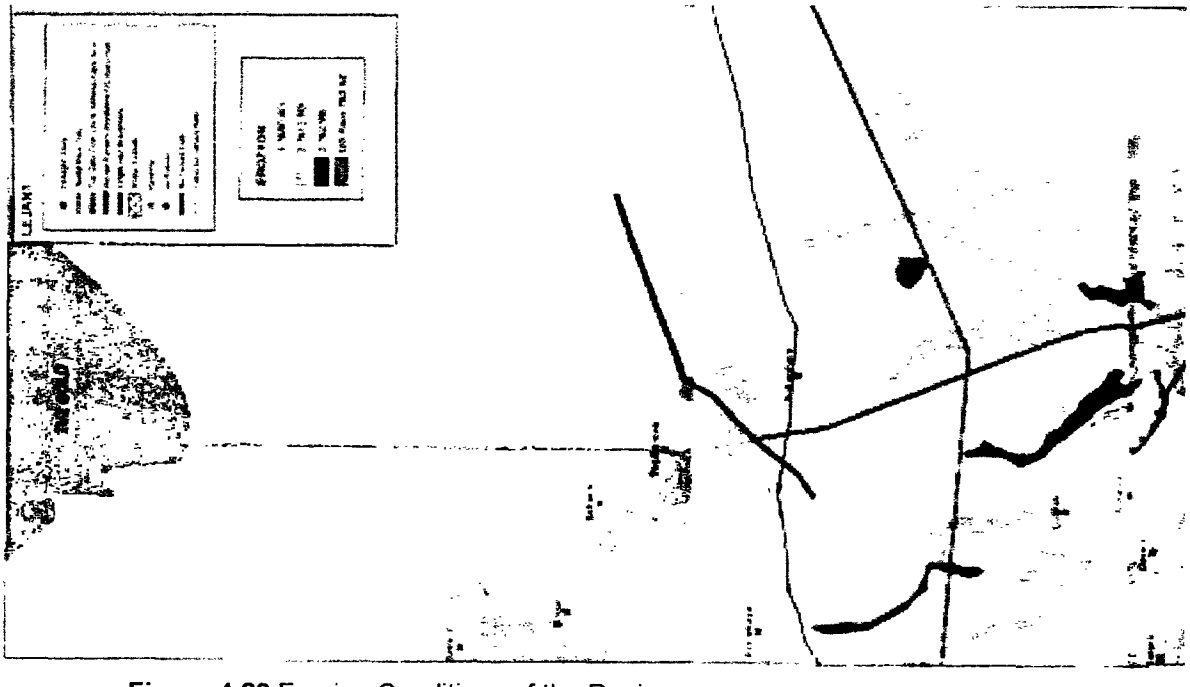


Figure 4.26 Erosion Conditions of the Region

4.2.8.5 Soil Research of the Three Dimensional Seismic Study Area

At the site selection phase in the content of the proposed TUGSP, the three dimensional seismic study area of c.400 ha is examined by the authorities of II. Regional Directorate of Konya Rural Services (see Appendix-C). According to the prepared report, the study area is a third class land with brown soils formed *in-situ*, which are shallow layered and are found over the marl, along with limestone. The information obtained by the research is summarized above:

- The soil of the study area belongs to the brown soil group formed *in-situ*. The lands, located at the north and east slopes of low elevated (20-30 m) hill in southeast, are flat (Z0-1) and mildly inclined (Z1-6), and their depth is either medium deep (80-90 cm) and shallow (40-45 cm) depending upon the topographic structure. The main substances are marl along with limestone and it is observed on the surface and in the profile in small pieces (3-5-7 cm) at slopes and hills, also bed rock is seen as outcrops in the land. The soil depth (30-90 cm) at the bottom is limited by soft chrome colored marl. Its color is brownish yellow when dry and brown when moist. At the land, where the wind erosion is dominant, erosion has medium intensity. In the sandy-loam and loam structured soil, agragate formation is weak.
- Study area is a rain-fed agricultural land and there are settlements (high plateau) in the vicinity. The productivity of the lands, where irrigation is done depending on the precipitation, is medium and low due to the soil depth.
- Except for the salty area located at the bottom of Bezirci Lake, the study area is covered with lands of class VI where low sloped bed rock is surfaced and class II (because of the salinity at the bottom) which is located at the bottom and has a deep profile. As for the general land structure, the lands of class III, with shallow soil layer, formed over the main material with marl is dominant.

4.2.8.6 Soil Sampling Study

In order to determine the soil characteristics of the proposed project site and its vicinity, soil sampling studies were carried out at November 11, 2000 and December 19, 2000.

The study dated December 19, 2000 was realized with the participation of experts of the II. Regional Directorate of Konya Rural Services. The coordinates of the 15 soil samples taken from the project site and its vicinity are given in Table 4.20 and their locations are shown in Figure 4.27. The samples are analized by the Directorate of Soil and Fertilizer

Research Institute of the General Directorate of Rural Services (see Appendix-I). The results of the analyses are presented under the following sub-titles.

Table 4.20 Soil Sampling Locations

Sample No.	Explanation	Sampling Date	Coordinate	
			Latitude	*Longtiude*
1	Bezirci Lake	19.12.2000	0545239	4226640
2	Bezirci Lake	19.12.2000	0546563	4223529
3	Shallow	19.12.2000	0549448	4219602
4	Shallow	19.12.2000	0550854	4218657
5	From 60-120 cm depth	19.12.2000	0551847	4217952
6	From the surface	19.12.2000	0553027	4216886
7	From the surface	19.12.2000	0553680	4217111
8	From 20-30 cm depth	19.12.2000	0552370	4221916
9	4 (from 30-60 cm depth)	19.12.2000	0550854	4218657
10	Well 2 (From the surface)	19.12.2000	0552692	4217232
11	Between Bucak High Plateau-Well 2 (From the surface)	29.11.2000	0553873	4215744
12	Tomu High Plateau (From the surface)	29.11.2000	0550748	4218778
13	Malir Hoyuk (northeast) (From the surface)	29.11.2000	0551448	4222344
14	Malir Hoyuk (southwest) (From the surface)	29.11.2000	0551418	4221957
15	Emirler Yurdu (Sultanhani) (From the surface)	29.11.2000	0551363	4225827

Salinity Analyses

The results obtained through the salinity analyses carried out on soil samples are presented in Table 4.21. Additionally, the report of the Directorate of Soil and Fertilizer Research Institute of the General Directorate of Rural Services is given in Appendix-I.

Table 4.21 Resuls of Salinity Analyses on Soil Samples

Sample No.	pH	EC** (dS/m)	Exchangeable Cations (%)				CEC*** (me/100 g)	Boron (ppm)
			Na	K	Ca	Mg		
2	8.24	57,350	7.55	5.71	71.31	13.01	31.65	1.701
3	8.16	2,638	1.23	4.84	82.47	11.19	18.58	0.034
4	8.21	0,906	1.32	10.57	85.40	2.33	21.85	0.082
5	8.08	5,735	3.92	1.54	77.39	0.65	26.62	0.430
6	8.20	1,066	1.15	6.16	73.60	4.97	32.77	0.073
7	8.15	0,871	8.38	0.90	64.41	22.61	16.58	0.127
8	8.12	1,771	1.75	4.32	53.76	30.36	15.94	0.028
9	7.89	6,882	1.33	7.86	68.00	18.48	12.72	0.060

10	8.15	0,802	1.82	4.39	69.70	20.13	17.53	0.047
11	8.16	1,720	1.58	5.34	78.61	11.68	20.20	0.039
12	8.17	1,261	1.25	11.17	69.06	9.76	24.79	0.045
13	8.19	0,963	1.03	6.22	68.95	14.78	20.23	0.065
14	8.20	1,491	1.93	10.97	80.71	4.54	19.13	0.019
15	8.23	4,014	4.65	3.65	67.64	18.33	15.05	0.061

** As soil sample no.1 is in insufficient amount, no analyses were carried out.*
*** EC: Electrical Conductivity*
**** CEC: Cation Exchange Capacity*

Soil Physics

The results obtained from the soil physics analyses of soil samples are presented in Table 4.22. Additionally, the report of the Directorate of Soil and Fertilizer Research Institute of the GDRS is given in Appendix-I.

Table 4.22 Soil Physics Analyses in Soil Samples

Sample No.*	Sand %	Silt %	Clay %	Structure Class
1	42.81	44.03	13.16	L
4	32.01	36.57	31.42	CL
6	25.55	35.06	39.39	CL
7	88.45	1.69	9.86	LS
11	49.59	25.66	24.75	SCL
12	30.87	38.85	30.28	CL

L: Loamy *CL: clayey-loamy*
LS: loamy-silty *SCL: silty-clayey-loamy*
** As soil samples no.2, 3, 5, 8, 9, 10, 13, 14, 15 contain more than 45% lime, the structure analyses for these samples could not be carried out.*

Total Nitrogen Analysis

The results obtained from the total nitrogen analyses of soil samples are presented in Table 4.23. Additionally, the report of the Directorate of Soil and Fertilizer Research Institute of the General Directorate of Rural Services is given in Appendix-I.

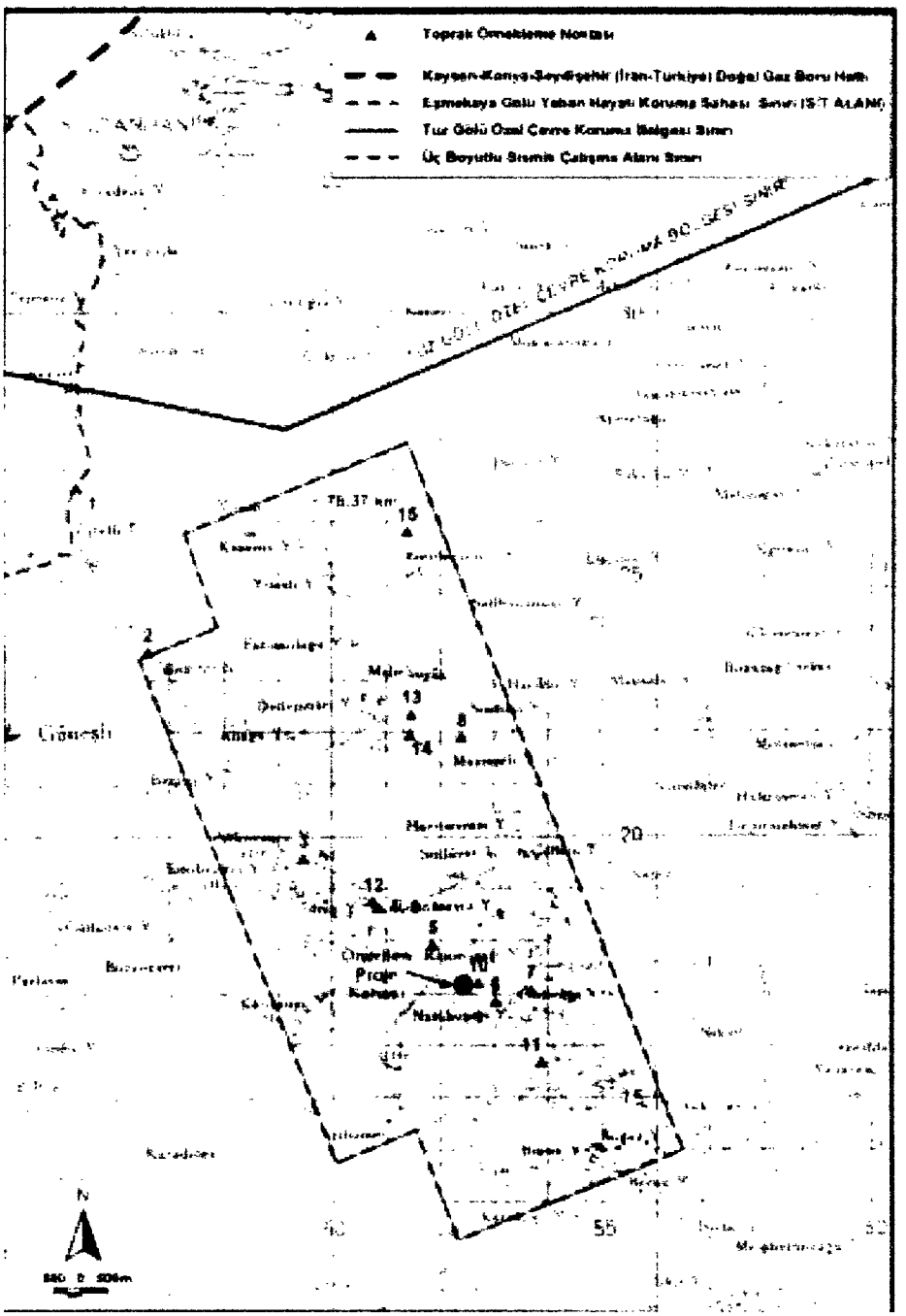


Figure 4.27 Soil Sampling Locations

Table 4.23 Total Nitrogen Analyses in Soil Samples

Sample No.	Total Nitrogen (%)
1	0.550
2	0.190
3	0.160
4	0.170
5	0.130
6	0.150
7	0.039
8	0.067
9	0.072
10	0.050
11	0.130
12	0.250
13	0.170
14	0.160
15	0.120

Productivity Analysis

The results obtained from the total nitrogen analyses of soil samples are presented in Table 4.24. Additionally, the report of the Directorate of Soil and Fertilizer Research Institute of the GDRS is given in Appendix-I.

Table 4.24 Productivity Analyses of Soil Samples

Sample No.	Saturation with water (%)	Total salt (%)	pH of soil saturated with water	Lime ($CaCO_3$%)	Nutritional Substances Useful for Plants (kg/dekar)		Organic substance (%)
					Phosphorus (P_2O_5)	Potassium (K_2O)	
1	73 C	0.390	7.86	31.9	90.6	143	6.08
2	65 CL	2.450	8.15	65.2	12.5	21	1.95
3	51 CL	0.107	7.47	48.9	11.4	127	1.79
4	57 CL	0.045	7.58	42.2	13.7	266	1.95
5	62 CL	0.335	7.69	48.9	2.2	51	1.46
6	50 L	0.041	7.68	27.4	7.62	232	1.94
7	44 L	0.035	8.34	28.2	3.23	19	0.33
8	44 L	0.055	7.42	43.3	3.23	105	1.26
9	67 CL	0.400	7.31	70.0	2.71	290	0.65
10	36 L	TRACE	7.74	45.6	10.2	113	1.13
11	41 L	0.073	7.46	34.1	12.5	133	1.39
12	60 CL	0.054	7.68	41.5	25.8	337	2.72
13	52 CL	0.035	7.78	50.4	15.2	156	1.79

14	45 L	0.048	7.70	46.7	25.5	241	1.79
15	70 CL	0.181	7.52	58.5	21.4	96	1.78

4.2.9 Agricultural Areas

According to the results of the agricultural operations (household) performed in the Census 1991 on Agriculture, the total agricultural land cultivated in Turkey is 214.494.821 thousand m^2. 4.623.901 thousand m^2 (2%) of this amount is within the province of Aksaray (see Table 4.25). Other than the agricultural land cultivated in this region, there is the land of 301.077 thousand m^2, which is not cultivated though suitable for agriculture (SIS, 2002).

As seen in Table 4.25, major part of the total land in the Province of Aksaray is the cultivated area (91%), which is followed by the land that is not cultivated though suitable for agriculture with the percentage of 6% and permanent meadow and pasture with 2% and land not suitable for agriculture with 2%. (SIS,2002)

Table 4.25 Land Utilization Type in the Province of Aksaray

Means of Utilization	Area (decare)	Distribution (%)
Cultivated land	4.623.901	91
Land not used though suitable for agriculture	301.077	6
Permanent Pasture and Meadow	103.816	2
Land not suitable for agriculture	81.655	2
Grove and forest	56	-
TOTAL	5.110.505	100

Reference: SSI, 2002.

Sizes of Agricultural Enterprises

According the results of survey on agricultural enterprises (households) conducted in the Agricultural Census in 1991, the sizes and numbers of agricultural lines are given in Table 4.26 (SSI, 2002). According to this data, majority of the families in the province belong to the agricultural households that may be assumed to be small scale varying between 20-49 thousand m^2. The number of medium and large scale ($\geq$ 100 thousand m^2) agricultural households has the rate of 26.7%, which is higher than the average rate of 15.0% applicable for Turkey.

Table 4.26 Sizes and Numbers of Enterprises in Aksaray Province

Enterprise Size (decare)	Number of Enterprises (%)	Area (%)
< 5	1.3	0.0
5- 9	3.7	0.3

10- 19	12.0	1.9
20- 49	30.8	12.1
50- 99	25.5	20.8
100- 199	17.0	26.4
200- 499	9.0	30.7
500- 999	0.7	5.8
1.000- 2.499	0.0	0.1
2.500- 4.999	0.0	0.1
> 5.000	0.0	1.8

Reference: SIS, 2002.

Irrigated and Dry Agricultural Areas

According the results of survey on agricultural enterprises (households) conducted in the Agricultural Census in 1991, the sizes of irrigated and dry lands in the Province of Aksaray are given in Table 4.27. According to this data, approximately 7% of the total cultivated land is irrigated. This value is rather lower than the average rate of 14% in Turkey (SIS, 2002).

Table 4.27 Irrigated and Dry Agricultural Fields in the Province of Aksaray (10^3 m^2)

Land Cultivated	Total Land	Land Irrigated	Land Not Irrigated
Field	2.700.592	250.559	2.450.033
Vegetable and Flower Gardens	19.312	18.549	763
Fruits and other long lived flora	73.509	65.411	8.098
TOTAL	4.623.901	334.519	4.289.382

Source: SIS, 2002.

The annual agricultural crop patterns of the Province of Aksaray, the Middle Anatolian Region and the overall country are given in Table 4.28. According to the data of 1998, the productivity values of the field crops and fruits grown in the province are provided in Table 4.29 and Table 4.30 respectively. According to these tables, the productivity values of cereals, industrial plants and round plants cultivated in the Province of Aksaray are higher than the national values (SSI, 2002).

Major part of the cereals, which constitute the most important part of the production in the Province of Aksaray is processed in Soil Yields Office (TMO) and the sugar beet, which is another important crop, are sold to Konya and Kayseri sugar factories. The sunflower produced as hors d'oeuvres is sold to the merchants and the vegetables and fruits produced are sold in the surrounding provinces. The sugar beet has got a significant role among the industrial plants.

Sultanhani has got a flat and wide land, 3/5 of which is used as the agricultural land. One fourth of the land allocated for agriculture is wetlands. Sugar beets and cereals are cultivated on the wetlands while barley, rye and wheat are cultivated on the arid land (Sultanhani Municipality, 1996).

Agricultural Lands in the Project Site and Its Vicinity

According to the soil surveys conducted by the authorities of Konya IIth District Management of Rural Services within the 3-D seismic survey area and in the vicinity, the project site and its vicinity are dry agricultural land and there are units of population (plateaus) around it. The productivity in the lands where the cultivation is made depending upon the rain is medium and low depending upon the soil depth.

According to the information from the field surveys, the main agricultural crops in the region include wheat, barley and rye.

Table 4.28 Crop Patterns

Crop	*Province of Aksaray*		*Turkey*	
	Production (ton)	*Value (Million TL)*	*Production (ton)*	*Value (Million TL)*
Cereals	529.516	23.704.356	33.060.972	1.572.084.532
Leguminosae	18.126	2.421.996	1.559.360	228.867.554
Industrial Plants	1.723.479	28.869.997	23.485.669	972.102.601
Fatty Seeds	4.894	902.331	2.391.105	169.529.954
Round Plants	165.104	12.067.233	7.720.000	597.676.831
TOTAL	2.441.119	67.965.913	68.257.106	3.540.261.472

Reference: SIS 2002.

Table 4.29 Productivity rates of Agricultural Crops

Crop	*Province of Aksaray*			*Turkey*		
	Cultivated Land (hectare)	*Production (ton)*	*Productivity (ton / hectare)*	*Cultivated Land (hectare)*	*Production (ton)*	*Productivity (ton / hectare)*
Cereals	210.227	529.516	3	14.074.700	33.060.972	2
Leguminosae	21.905	18.126	1	1.657.770	1.559.360	1
Industrial Plants	31.238	1.723.479	55	1.660.190	23.485.669	14
Fatty Seeds	3.269	4.894	2	713.190	2.391.105	3
Round Plants	6.590	165.104	25	321.600	7.720.000	24

Reference: SIS 2002.

Table 4.30 Fruit Productivity Rates of Aksaray Province

Crop	*Province of Aksaray*			*Turkey*		
	Number of Trees	*Production (ton)*	*Productivity (kg / tree)*	*Number of Trees*	*Production (ton)*	*Productivity (kg / tree)*
Soft Seeds	477.864	15.115	32	55.549.300	2.921.500	53
Stone Seeds	188.307	4.666	25	147.585.000	3.109.600	21
Hard Shells	19.015	844	44	346.366.000	826.000	2

Grapy Fruits	***5.070***	***51.782***	***10.213***	***16.603.400***	***4.153.870***	***250***

Reference: SSI, 2002.
Source: Aksaray Economical and Social Indicators, SIS. 1999.

4.2.10 Protected Areas

Various areas are under protection by the current laws of Turkey, due to their ecological, historical, natural etc. importance. According to field and literature surveys, the protected areas within the proposed project site and its vicinity are explained under the following sub titles.

Malir (Marul) Hoyuk (Tumulus)

Malir Hoyuk, which is located at approximately 7 km north of the project site, is at the distance of approximately 100 m in the east – west and north – south direction and has the height of 40 m (see Figure 4.28). The photo of the said tumulus is given in Figure 4.29. There are the settlements of B.C. 2000, Iron Age, Hellenistic, Roman and Seljuk Eras. Pots and pans, glass pots and bracelet pieces are still encountered near the Tumulus.

The said Tumulus was registered pursuant to the Resolution dated 24.06.1988 / numbered 217 of Konya Board of Protecting the Cultural and Natural Assets. In addition, it was resolved that the same areas would be the Grade I and III Archeological Sites and Resolution dated 05.11.1999 / numbered 658 of the High Board of Protecting the Cultural and Natural Assets would be applicable for these areas (please refer to Appendix-C). The said resolution no. 658 is associated with the "Archeological Sites, Protection and Utilization Conditions", and the related details are presented in the following subtitles.

Grade I Archeological Site

This means the sites that shall duly be protected other than the scientific studies for protection. Any construction shall not be allowed in these areas and they shall be referred as the sites that shall duly be protected in the settlement plans and any excavation other than the scientific excavations shall not be made, however;

a. The subject shall be considered by the Protection Board upon the approval of the museum management and chief of excavation with respect to the compulsory infrastructural applications by official and private bodies.

b. New agricultural lands shall not be opened, only limited seasonal agricultural activities shall continue, and greenhouse applications shall continue if approved by the protection boards.
c. The agricultural activities including the soil cultivation shall absolutely be prohibited in the mounds and tumulus, the afforestation shall not be carried out, but only the crops shall be taken from the present trees.
d. Stones, soils, sands etc. shall not be taken; lime, stone, brick, marble, sand, mineral pits etc. shall not be opened; soil, sludge, rubbish, industrial waste and similar materials shall not be disposed.
e. Trip way arrangement in the ruins, square arrangement, outdoor car park, WC, ticket office, watchman hut etc. may only be constructed within these areas upon permission from the protection board.
f. Only the burials shall be made in the public graveyards that are located within these areas and still used.
g. Unification and separation may be made with prior permission from the board of protection in a way not to impact the content of the immovable cultural assets.

Grade III Archeological Site

This means the archeological areas where new arrangements may be allowed according to the protection – utilization decisions. In these areas,

a. The construction conditions in the transitional period shall be determined. In the mean time,

- Density of the proposed structure should not exceed the density determined with the present settlement plan.
- The functions in the area must be compatible.
- Necessary infrastructural applications must be made.
- Importance must be attached to the proposed structural patterns.
- The construction technique and material must be taken care of.
- Solutions must be found for protecting and evaluating the present and possible archeological assets.

b. The settlement plans respecting protection must be developed by protecting the archeological assets in the sections opened to the settlement pursuant to the approved environmental arrangement and arrangement plans.
c. At places where the Protection Purpose Settlement Plans are developed before this resolution is taken, applicability of the requirements of the plan must be accepted.

d. The drilling must be performed by the related museum authorities before the construction permit is given by the municipality and governorship in these areas, and the drilling results must be submitted to board of protection by the museum management together with opinions of the chief of excavation in this field if any, and the application must be initiated following the decision of the board of protection.

e. The boards of protection in the archeological sites determined as Grade III archeological sites may take the general drilling resolutions concerning the areas to be drilled.

f. Unification and separation may be made with prior permission from the board of protection in a way not to impact the content of the immovable cultural assets.

g. Stones, soils, sands etc. shall not be taken; lime, stone, brick, marble, sand, mineral pits etc. shall not be opened; soil, sludge, rubbish, industrial waste and similar materials shall not be disposed.

h. Wind power plants may be constructed in these areas if approved by the board of protection provided that the same contributes to the energy generation of the country and is for the public benefit.

i. The resolution in force shall be applicable for the aqueous products production and breeding facilities in the protection areas.

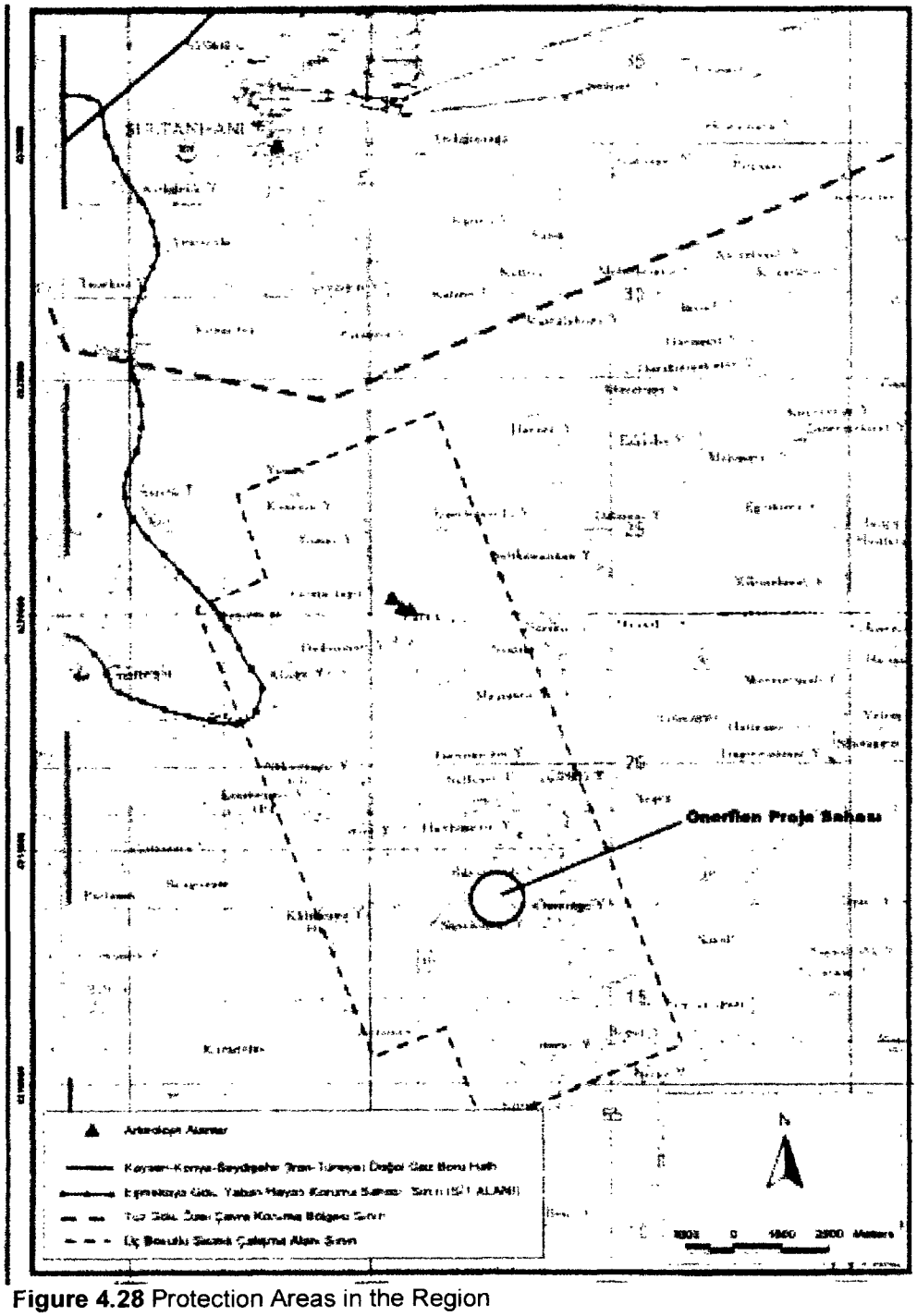


Figure 4.28 Protection Areas in the Region

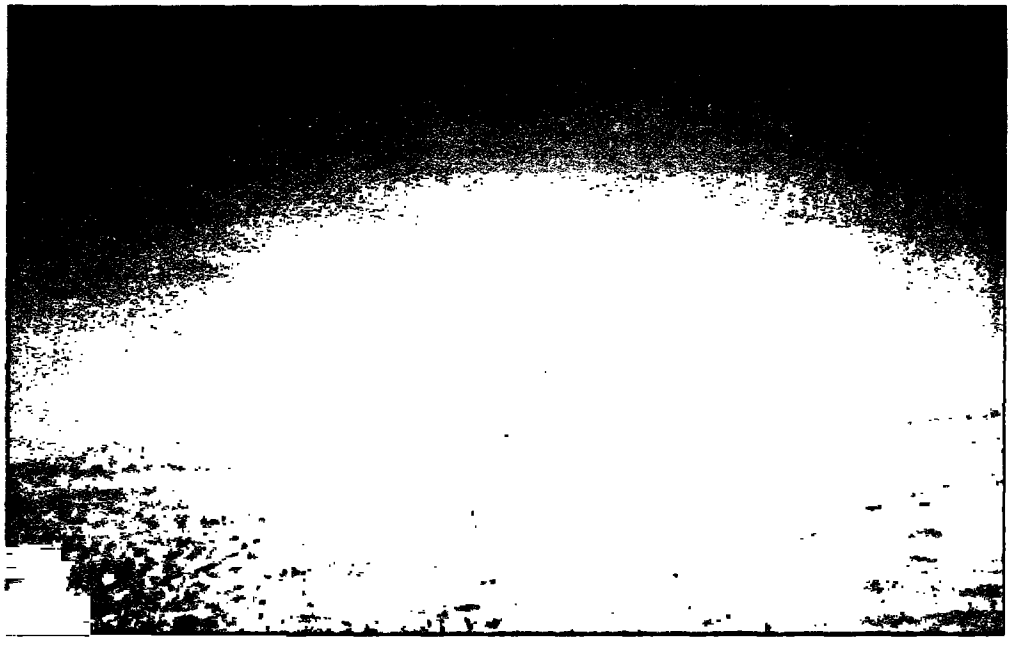


Figure 4.29 Malir (Marul) Hoyuk (Tumulus)

Kral (Bagdat) Yolu (King's Road)

Kral Yolu, which is located c.7 km north of the project site (see Figure 1.2), advances parallel to the village roads to Malir Figure 4.30) The stone floored road has a width of 3-5 m. It is believed that Kral Yolu belongs to the Middle Age.

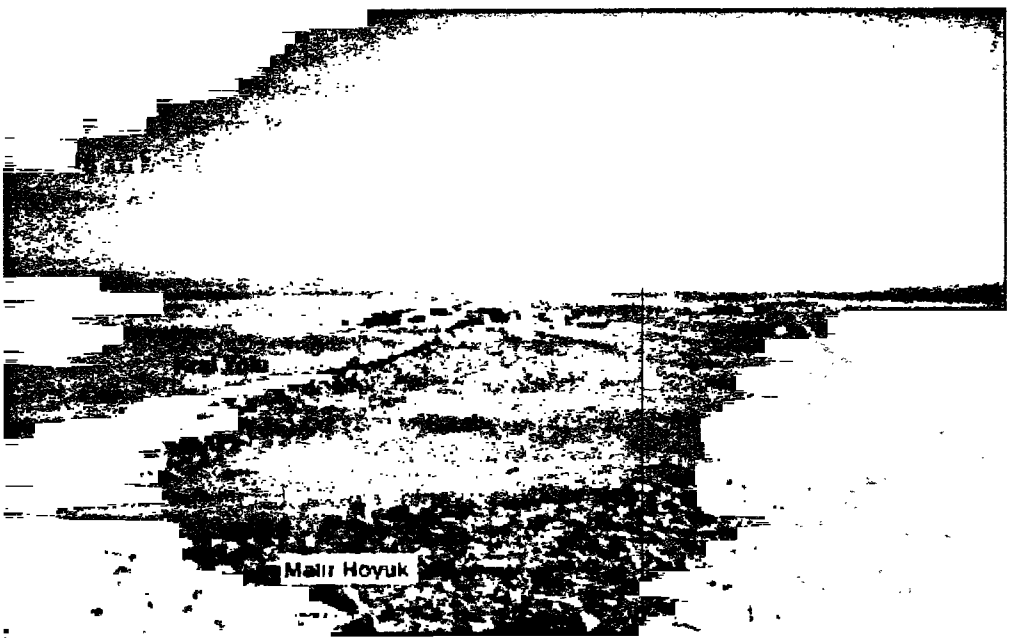


Figure 4.30 Kral (Bagdat) Yolu (King's Road)

Kullutepe (Flat Settlement)

The dimensions of this flat settlement located c.7 km north of the project site and northwest of the Malir Hoyuk is 500 m in east-west direction and 100 m in the north-south direction. The height of the hillside settlement is 5 m and remains belonging to the Seljuk are evident.

Lake Bezirci

Lake Bezirci, which is located at approximately 2.5 km northwest of the project site and called as Lake Gunesli, was proclaimed as the Grade I Natural Protection Site pursuant to the Resolution dated 01.07.1992 / numbered 1368 of Konya Board of Protecting the Cultural and Natural Assets.

The Resolution dated 05.11.1999 / numbered 659 of the Senior Board of Protecting the Cultural and Natural Assets is related to the "Natural Protection Sites, Protection and Utilization Conditions". Detailed information about the Grade I Natural Protection Sites is given under the following subtitles.

Grade I Natural Protection Site

This means the sites that shall be duly protected except for the scientific studies for protection, which has universal value in respect of conservation, and which must be conserved owing to interesting characteristics and beauties and as they are found rare. Any action shall not be performed in these areas to corrupt the vegetation, topography and landscape and cause destruction. However;

a. Although there is absolute prohibition against construction, the technical infrastructural services (sewerage, open car park, cable transmission, cable railway, potable water, power transmission line, communication line and etc.) that are compulsory to be rendered by the official and private bodies may be provided in a manner approved by the board of protection.

b. Public recreation facilities (restaurants, kiosks, cafeterias, dressing cabins, WC, trip paths, open car parks etc.) upon permission from the related board of protection according the project developed in compliance with the Environmental Arrangement Plan of 1/25.000 scale and General Settlement Plan of 1/5000 scale as well as the structures for protecting and enhancing the activities arising from the characteristics of the site and its vicinity may be constructed.

c. It may be allowed for afforestation by the board of protection according to an approved opinion from the related unit of the General Directorate of Forests without changing the vegetation of the site.

d. Chopping the trees may be permitted by the board of protection (conservation) according to the technical report issued by the related unit of the General Directorate of Forests in order maintain the trees overturned due to snow and wind as well as the trees that may be affected, got sick due to natural disasters or the trees without any economic value and the forests and conserve the ecological balance.

e. The necessary protection measures against fire in the forests may be obtained by the relevant bodies.

f. Stones, soils, sands etc. shall not be taken; lime, stone, brick, marble, sand, mineral pits etc. shall not be opened; soil, sludge, rubbish, industrial waste and similar materials shall not be disposed, but the site may be rehabilitated and the works may be terminated within the legally prescribed period in the case of enterprises that obtains license prior to the resolution of proclaiming the conservation site.

g. The activities arising from the nature of the site may be continued with prior permission of the board of protection according to the opinions of the public agencies and organizations in order to ensure sustainability of the ecological balance.

h. All informatory warning boards shall be placed and the protection measures within these sites shall be taken by the relevant authorities and local governments in order to protect this site.
i. The repair and maintenance of the present registered and unregistered may be performed according to the relevant resolutions in force.

Tuz Golu (Salt Lake)

Tuz Golu Special Protection Area, whose nearest border is c.9 km north of the project site (see Figure 1.2), has been a Natural Site Area since 1992 and was proclaimed as Special Environmental Protection Area by the 14.09.2000 dated decision of the Cabinet. The Special Protection Area boundaries of the lake is presented in Figure 4.31.

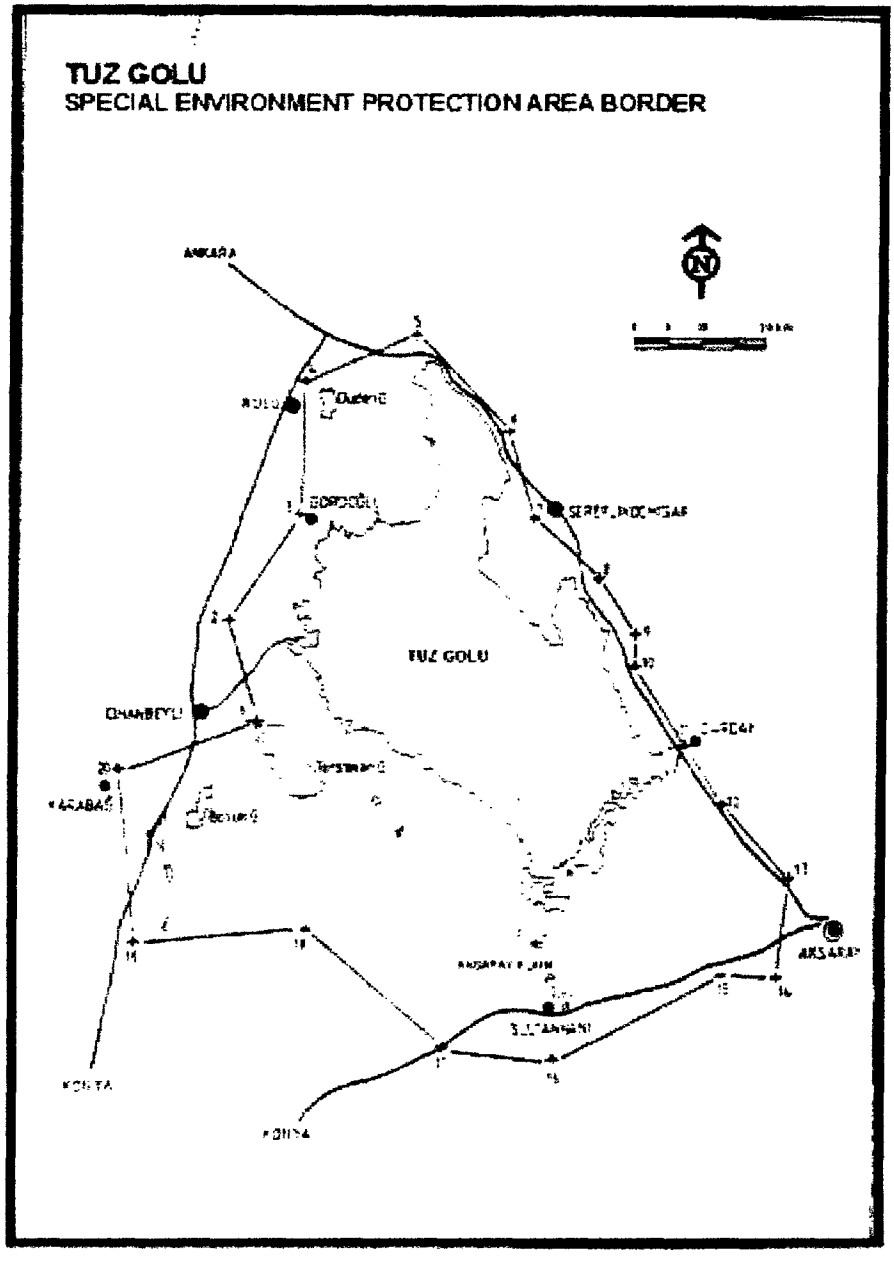


Figure 4.31 Boundaries of Tuz Golu Special Protection Area

Esmekaya Reed Bed

Esmekaya Reed Bed, located c.17 km northwest of the study area is among the important bird areas of Turkey (see Figure 4.32) The Esmekaya Reed Bed (4,500 ha) which was proclaimed as Natural Site Area in 1992 was given the status of Wild Life Reserve in 1994.

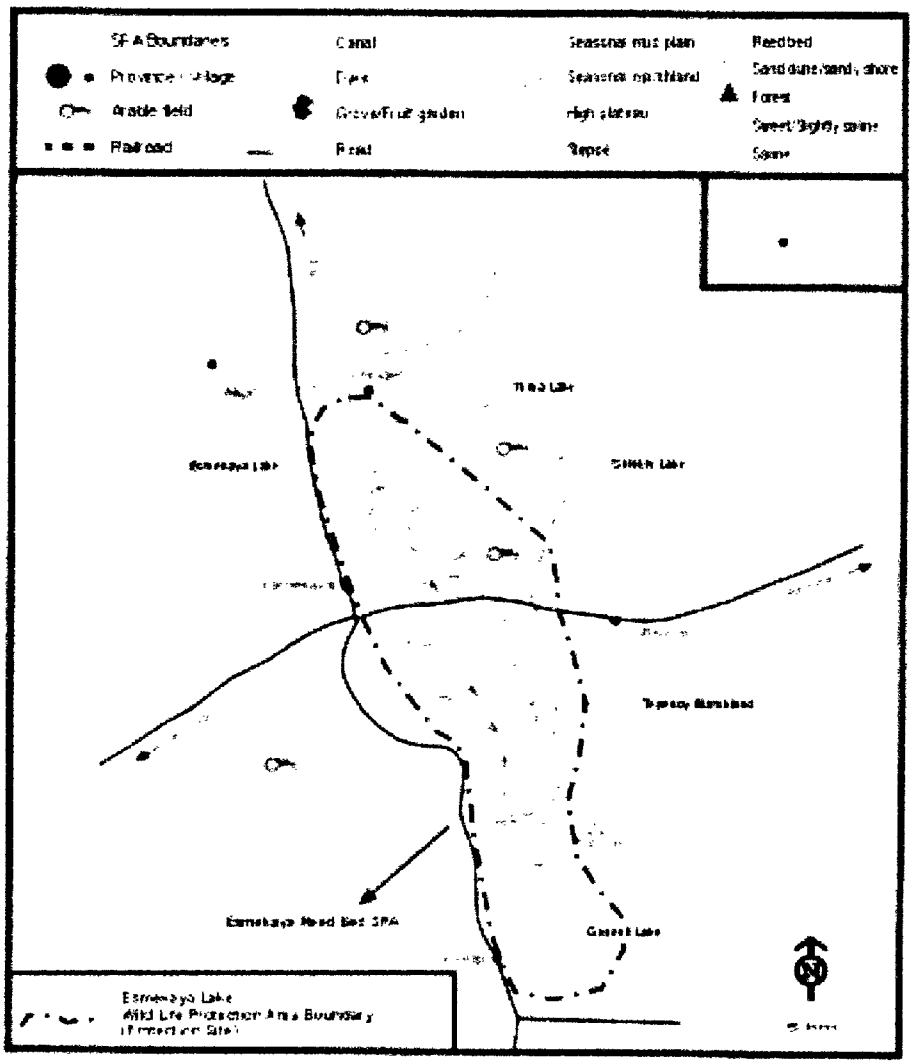


Figure 4.32 Esmekaya Reed Bed Protection Area

Figure 4.28 Protection Areas in the Vicinity of Project Site

Sultanhani Caravanserai

The nearest historical building to the project site is the caravanserai in Sultanhani Village and is located c.15 km north to the mentioned site. The caravanserai was built in 1229 by Alaaddin Keykubat the First. The photographs of the this caravanserai is presented in Figure 4.33.

Since the province is rather rich in historical and natural assets, some places in Aksaray have been proclaimed as Natural Site Area by the Protection Committee for the Cultural and Natural Assets. The Acemkoy Archaeological Site Area has been proclaimed 1st and 3rd degree archaeological site area in 1978. Remains of Asur Trade Colonies dating back to 3000 BC are present. Guzelyurt Village was proclaimed as urban and natural site area in 1988. There are 115 officially registered buildings in the urban site area. Ihlara Valley has been declared 1st, 2nd and 3rd degree archaeological, urban and natural site area in 1991. Apart these, there are 39 officially registered buildings within the boundaries of the Central District of Aksaray.

The most important tourism centres of Aksaray are Ihlara-Guzelyurt Tourism Centre and Hasan Mountain Winter Sports Tourism Centre. On November 21, 2000 within the Ihlara-Guzelyurt Tourism Centre, an area including Ihlara Village, Yaprakhisar, Selime and Belisirma settlements was declared as Ihlara (Cappadocia) Special Environmental Protection Area.

Information about the ruins within Aksaray Province are given below:

Asikli Hoyuk: The tumulus is settled close to a water body in Kizilkaya Village, 25 km southeast of Aksaray Province, facing Melendiz River on one side and fields convenient for agriculture on the other. The tumulus is c.35 km east of the project site.

Ancient Nora City: Ancient Nora City is within the boundaries of Helvadere Village of Central District. There are ancient city remains of Roman and Byzantine Period in the slopes of Hasan Mountain (Argaios) and on the Kral Yolu (King's Road). The ancient city is c.55 km east of the project site.

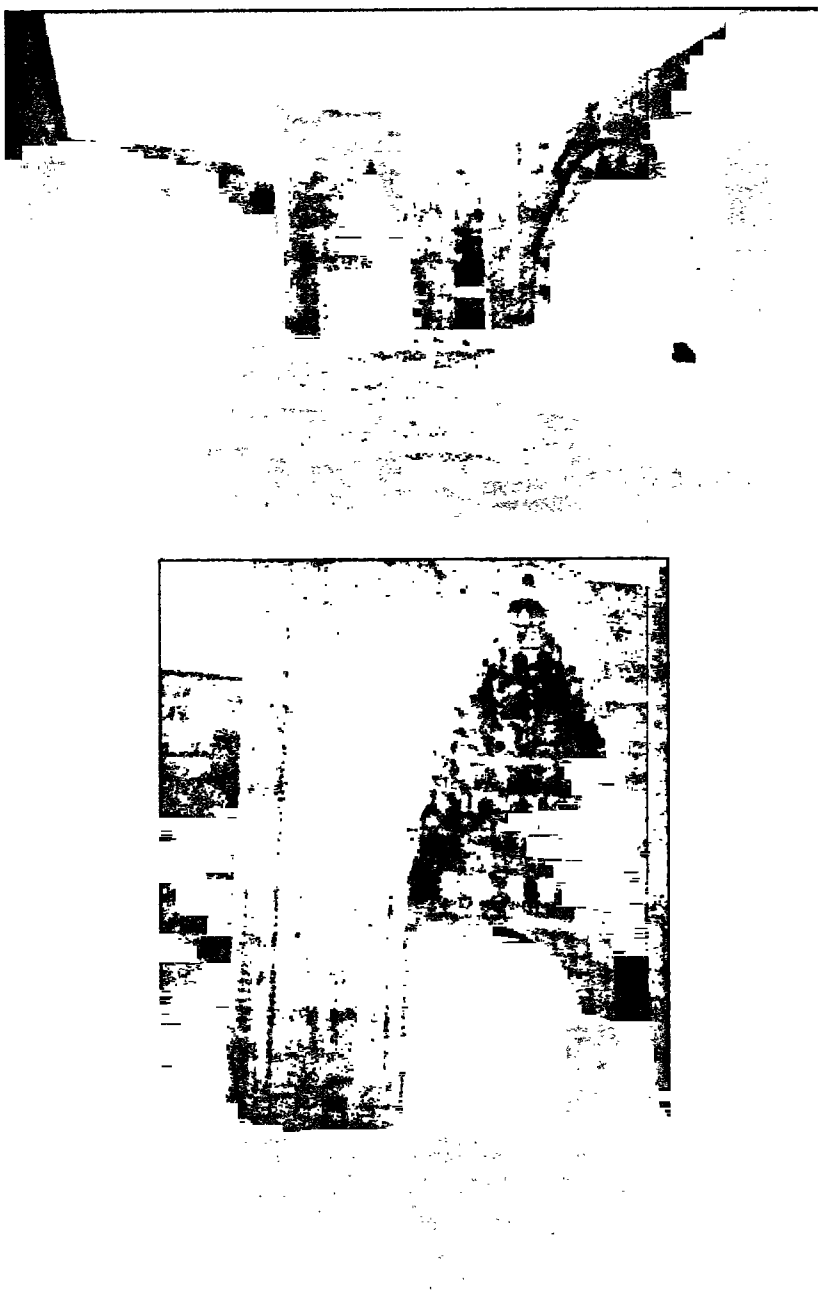


Figure 4.33 Sultanhani Caravanserai

Acemhoyuk: It is located 13 km northwest of Aksaray, in Yesilova Village. The tumulus is oval-shaped with dimensions of 700 × 600 m. It is one of the largest tumuli in Anatolia, together with Asagisehir. The archaeological studies have revealed that the tumulus has been settled since 3000 BC and that its most luminous era was in 1800 BC during the Asur Trade Colonies Age. During the Colony Age, Asagisehir was also another place for settlement. It was the centre of one of the most important kingdoms in Anatolia. At the end of this age, both Asagisehir and the tumulus was abandoned. However, in the early Hellenistic and Roman periods, some parts of the tumulus were resettled again. The tumulus was totally deserted in the beginning of the third century AC. Three groups of nomads coming from the city of Hoy in Iran Azerbaijan in 1517 were settled in the feet of the tumulus and founded Today's Yesilova. The two palace structures brought out to the open, belonging to the Colony age in which the city had its most luminous period, has great importance not only for Acemhoyuk but for the Anatolian architectural history. The palace in the south of the tumulus is named as Sarikaya, while the one in northwest is called Hatipler Palace. The tumulus is c.20 km north of the project site.

Manastir Valley: The valley is 50 km east of Aksaray within the boundaries of Guzelyurt District, which is a natural beauty site, and has a length of 4-5 km. With 28 rock carved churches and underground cities, which represent the characteristics of the era, it resembles Ihlara. Sivisli Church, Buyuk Kilise Mosque, Papaz Evi, Kalburlu Church and Komurlu Church, which are located along the valley, are important cultural and natural assets. The valley is c.70 km east of the project site.

Ihlara Valley: The valley is located to the northeast of Hasan Mountain, in Ihlara Village of Aksaray Province. Melendiz River, whose former name was "Peristremma", has formed a canyon with a depth of 100-200 m after crossing through the Ihlara Valley of 14 m long, heads toward Selimiye Village in the northwest and then Yaprakhisar, Belisirma Villages and the wide valley, which the Ziga Thermal Spring is located and finally to Tuz Golu. Rather than being a settlement area, Ihlara Valley has a great importance a religious centre. The Valley describes the religious comprehension of the era with its architecture. Partly with fresco, single and couple closed naves or open Grecian cross planned and chapel shaped churches carved into rocks are located in the left and right of the steep sides of the valley where they unite with the waters of Melendiz River. Because of its natural structure, the valley has been used for seclusion and worshipping by the monks and priests ever since the IX. Century, and as a hiding and protection place during the war period. The churches in the valley have frescos which reflect events like the Birth of Jesus, Good Tidings, Visit, Escape to Egypt and the Last Meal. The Valley is c.49 km east of the project site. (http://www.kultur.gov.tr)

4.2.11 Forest Areas

As a result of literature studies and field surveys conducted within the scope of EIA studies, it has been revealed that there is not any forest or forestry area within and in the vicinity of the project site. When the ecological characteristics of the project site and its vicinity are taken into consideration in the general sense, it can be said that the forest development is not possible.

In addition, the Village of Bezirci is within the scope of Law No. 6831 on Forest pursuant to the Letter dated 20.11.2001 / numbered 05.KD.1/537 of Aksaray Chief of Operation, Konya Forestry Management, General Directorate of Forestry of the Ministry of Forestry of the Republic of Turkey (please refer to Appendix-C). The forestry area that is the closest area to the project site is Esentepe Afforestration Area, which is located at approximately 65 km northeast of the project site.

4.2.12 Flora and Fauna

4.2.12.1 Vegetation Types in the Study Area and its Vicinity

The project site and its vicinity is Grade III dry agricultural land to a great extent. The steppe vegetation is dominant in the sections not suitable for agriculture in the land. Furthermore, the road bank and border vegetation is discussed in this section due to its special importance. The aqueous vegetation is discussed in Section 4.2.8. The vegetation map related to the project site and its vicinity is presented in Appendix-C.

Agricultural Areas

The agricultural lands in the project site and its vicinity are generally used for the production of cereals. The main crops include barley, wheat and rye. The sugar beet is grown at the sections that can be irrigated. Furthermore, the local people grow the fruits and vegetables in order to meet their own needs, but these crops do not have any economic importance.

The dominant flora species observed in the agricultural lands include Cynodon dactylon, Carlina corymbulosa, Amaranthus albus, Sonchus asper, Erodium cicutarium, Rumex crispus, Cichorium, intybus, Portulacca oleracea, Datura stramonium, Solanum nigrum, Raphanus raphanistrum, Chenopodium album, Heliotropium suaveolens, Hirschfeldia incana, Sinapis arvensis, Eruca sativa, Polygonum cognatum, P. Lapathifolium, P.

Aviculare, Hypericum triquetrifolium, Papaver rhoeas, Fumaria parviflora, F. Asepala, Hypeceum imberbe, H. Pendulum, Consolida orientalis and Geranium collium. These species have a common ecosystem.

Steppe Vegetation

This vegetation is seen within the entire Central Anatolian Plateau. Even though there are differences between dominant and characteristic species according to bedrock, soil characteristics and anthropogenic effects, this difference is not clear in appearance.

This vegetation mostly consists of meadows and short bushes with an average height of 30 cm. The dominant types of steppe vegetation mostly encountered over calcareous rocks like marl and shallow steppe soil with A-C horizon are *Astragalus microcephalus, Acantholimon acerosum* ssp. *acerosum,* Tree-leafed greenweed (*Genista sessilifolia*), *Stipa lessingiana, Thymus sipyeus,* Wallis fescue (*Festuca valesiaca*), Squarrose knapweed (*Centaurea virgata*), *Noaea mucronota, Artemisia santolina,Salvia cryptantha.*

The species with high frequencies that join the composition are listed below:

Helianthemum salicifolium, Alyssum sibiricum, Alyssum sthgosum, Alyssum desortorum, Ziizphora tenuior, Bromus sguarosus, Bhza humilis, Taeniatherum caput-medusae, Cousinia iconica, Eryngium bithynicum, Bromus tomentellus, Scabiosa argentea, Sisymbrium loeselii, Teuchum pollum, Xeranthemum annuum, Sangusorba minör, Astragalus vuinehae, Stipa holosericea, Ononis adenotricha, Bambyciaena erecta, Phleum bertelonii, Minuartia anatolica var. arachnoidea, Phlomis pungens, Bolanthus minîartioides, Fumana aciphyila, Achillea setacea, Astragalus lydkıs, Leontodon crispus var. crispus, Carduus nutans ssp. nutans, Centaurea kotschy var. persica, Stachys annua ssp. annua, Lactuca serriola, Marrubium pan/iflorum, Rhamnus thymifolius.

Ruderal and Boundary Vegetation

The term boundary vegetation is used for the vegetation at the boundaries of agricultural areas. On the other hand, ruderal and boundary vegetation includes vegetation along the road side. The boundary vegetation is not important in the region and the ruderal vegetation is at very low levels. Thus, these ecosystems are not appropriate for the fauna types that can not tolerate human intervention including chemicals.

The species that are encountered during the field survey are Yellow star-thistle (*Centaurea solstitialis*), London-rocket (*Erysimum irio*), Mountain dog-daisy (*Anthemis cretica*), *Carlina corymbulosa*, Saffron thistle (*Carthamus lanatus*), Glaucous star thistle (*Carthamus glaucus*), Spiny cocklebur (*Xanthium spinosum*), Common cocklebur (*Xanthium strumarium*), Wild fennel (*Nigella arvensis*), Prickly lettuce, *Hordeum murium*, Prickly lettuce, Tatarian sea kale (*Crambe tataria*), Jerusalem-oak (*Chenopodium botrys*), White pigweed, Chicory, Curly Dock, Buchan weed, Charlock mustard and Wild carrot (*Daucus carota*).

4.2.12.2 Flora

The plant species in the project site and its vicinity are determined by field studies and literature research, and general information about the dominant flora species is given in this section. The informations in this section are based on the field surveys realized within the last 10 years (minimum) and the last field study was carried out between 22-23 April 2001 for the verification of these infomations. The flora species found in the project site and its vicinity are researched by the field surveys and these studies are combined with the literature studies (Davis, 1965-1988).

Seedless Plants

A detailed and comprehensive information on seedless plants of the project site are presented in Appendix-K. Especially the lichen species that are indicators of air pollution are listed in this chapter. The most important seedless plants in the project site and its vicinity are lichens and mosses. In this context, *Grimnia trichophlla* and *Tortula pulvinata* are the mostly encountered species in the region.

Lichens, which are recognized as the indicators of air pollution, are Crustose lichen (*Buellia punctata*), *Caloplaca boulyi*, Gray-rimmed firedot lichen (*Caloplaca cerina*), *Caloplaca holocarpa*, Firedot lichen (*Caloplaca saxicola*), Goldspeck lichen (*Candelariella coralliza*), *Candelariella reflexa*, Common goldspeck lichen (*Candelariella vitellina*), *Catinaria atropurpurea*, Golden moonglow lichen (*Dimelaena oreina*), Cartilage lichen (*Ramalina polymorpha* var. *capitata*), *Lecanora hageni*, Stonewall rim-lichen (*Lecanora muralis*), *Squamarina cartiwginea*, *Xanthoria candeleria*, Maritime sunburst lichen (*Xanthoria parietina*), *Rhizoplaca peltata*, Map lichen (*Rhizocarpon geographicum*), *Rhizocarpon riparum*, *Parmelia pokoryni*, *Parmelia pulla*, *Parmelia taractica*, *Parmelia tiliacea*, *Parmelia tinctina*, *Phaeophyscia orbicularis*, *Physcia adscendens*, *Physcia stellsris*, *Physconia enteroxantha* and *Physconia muscigena*. These species are widely spread in

the area and are not endangered. Thus, these species can be used as bio-indicators in long term.

4.2.12.3 Fauna

The fauna species within the proposed project site and its vicinity are determined by field studies and literature research, and informations in this section are based on the field surveys realized within the last 10 years (minimum) and the last field study was carried out between 22-23 April 2001 for verification. Additionally, the observations of the inhabitants in the region were used.

Amphibians

Amphibians are animals that can live both in water and on land. Five amphibian species were found within the project site and its vicinity, which are listed in Appendix-L.

Reptiles

20 reptile species have been encountered within the project site and its vicinity. Among these, three are turtle, six are lizard and 11 are snake species. There are also endangered species according to the international conventions within the study area. However, since all other turtle, lizard and snake species are abundant in Turkey in general, there is no extinction risk for these species. According to the field and literature surveys, two endemic reptile species (*Lacerta trilineata* ssp. *galatiensis* and *Ophisops elegans ssp. centranatoliae*) can survive within the study area.

Birds

There are 115 bird species that are observed and estimated to habit within the project site and its vicinity. The mentioned bird species are given in Appendix-K, together with their risk categories according to Kiziroglu (1993).

Mammals

There are 15 mammal species in the project site. The mostly encountered species are hedgehog, rabbit, wolf and badger. Since the study area is mostly composed of arable fields, these species are rather few in number. The mammals living in the area are listed in Appendix-K. Most of the vertebrates in this list are under protection by national and/or

international laws and conventions (i.e., Bern Convention) due their temporary or permanent risk status.

4.2.12.4 Flora and Fauna Species that are Under Protection by National Legislation and International Conventions

Flora Species

The most important convention related to the subject is the BERN Convention and CITES. The appendices of CITES and BERN Convention signed by Turkey are legal and the species listed in these conventions are under protection in Turkey. Any of the flora species determined in the project site and its vicinity (at approximately 2 km vicinity of the project site) are not included in the BERN Convention and CITES, but some of them are endemic and rare (that must be taken care of) flora species as per the national legislation.

In the event that the species that must be protected are found out as per the convention during the construction and operation activities, the seeds of these species shall be taken and these species shall be moved to the similar habitats or protected ex-situ in botanic gardens and greenhouses under the control of universities. If the species included in these conventions are found out "in the vicinity" of the project area, these species shall in no way be collected, chopped and taken off their roots.

In general, the Middle Anatolian Territory is one of the most critical areas of Turkey in respect of endemic species. Totally 85 endemic and/or rare species have been found in the region as a consequence of studies.

According to these studies, the ratio of endemic species within the site to the endemic species in the whole region is 18%. This figure is lower than 30%, which is the average value for Turkey. This can be explained with the fact that the project site and its vicinity is the agricultural land. In this context, the physical environment in the site has not remained stable, but subjected to modifications.

In addition, the region does not have the characteristics of important flora area except for Lake Salt. The endemic species are given in Table 4.31 in IUCN (1994) risk categories and in Appendix-K according to the EIA format. There are five endemic species under low risk (LR(lc)) according to the Red Data Book of Turkey Flora in the project area and its vicinity (Thymus sipyleus var. sipyleus, Eryngium bithynicum, Minuartia anatolica var. arachnoidea, Astrgalus lydius and Rhammus thymifolius). The densities of these endemics under low risk and that are widespread are low according to other areas.

Table 4.31 Endemic Flora Species

Species	Common Name	Probability of Impact	IUCN Risk Category
ANGIOSPERMAE	**FLOWERING PLANTS**		
MAGNOLIOPSIDA	**DICOTYLEDONS**		
Acenthaceae	**Maple Family**		
Acanthus hirsutus	Hairy bears breeches	Low	LR-lc
Apiaceae (Umbelliferae)	**Carrot Family**		
*Bupleurum heldreichii**	-	Low	LR-lc
B. sulphureum	-	Low	LR-lc
*B.turcicum**	-	Low	LR-lc
Eryngium bithynicum	-	Low	LR-lc
Ferulago pauciradiata	-	Low	LR-lc
Asteraceae (Compositae)	**Thistle Family**		
Achillea aleppica ssp. *zederbaueri*	-	Low	LR-lc
Centaurea bommuelleri	-	Low	LR-lc
C. kotschyi var. *kotschyi*	-	Low	LR-lc
Crepis macropus	-	Low	LR-lc
Jurinea pontica	-	Low	LR-lc
Scorzonera eriophora	-	Low	LR-lc
S. tomentosa	-	Low	LR-lc
Taraxacum farinosum	-	Low	LR-lc
Tripleurospermum callosum	-	Low	LR-lc
Boraginaceae	**Borage Family**		
Moltkia aurea	-	Low	LR-lc
Myosotis sicula	Jersey forget-me-not	Low	LR-lc
Nonea macrosperma	-	Low	LR-lc
Onosma armenum	-	Low	LR-lc
O. isauricum	-	Low	LR-lc
O. tauricum var. *brevifolium*	Golden flowered onosma	Low	LR-lc
Paracaryum ancyritanum	-	Low	LR-lc
P. calycinum	-	Low	LR-lc
P. racemosum var. *racemosum*	-	Low	LR-lc
Brassicaceae	**Mustard Family**		
Alyssum pateri	-	Low	LR-lc
Lepidium caespitosum	-	Low	LR-lc
Campanulaceae	**Bellflower Family**		
Asyneuma limonifolium ssp. *pestalozzae*	Southern rampion	Low	LR-lc
Campanula argaea	-	Low	LR-lc
C. lyrata ssp. *lyrata*	Bellflower	Low	LR-lc
Caryophyllaceae	**Pink Family**		
Bolanthus minuartioides	-	Low	LR-lc
Gypsophila arrostii var. *nebulosa*	Arrost's babysbreath	Low	LR-lc

G. eriocalyx	-	Low	LR-lc
Minuartia anatolica var. *arachnoidea*	Anatolian sandwort	Low	LR-lc
Saponaria prostrata ssp. *prostrata*	-	Low	LR-lc
F. paphlagonica	-	Low	LR-lc
Chenopodiaceae	**Goosefoot Family**		
Kalidiopsis wagenitzii	-	High	VU
Cyathobazis fruticosa	-	High	VU
Salsola stenoptera	-	High	VU
S. anatolica	-	High	VU
S. prostrata ssp. *anatolica*	-	High	VU
Clusiaceae (Guttiferae)	**St. John's-wort Family**		
Hypericum avicullariifolium ssp. *depilatum* var. *Depilatum*	-	Low	LR-lc
Convolvulaceae	**Morning-glory Family**		
Convolvulus assyricus	-	Low	LR-lc
C. galaticus	-	Low	LR-lc
Euphorbiaceae	**Spurge Family**		
Euphorbia anacampseros var. *anacampseros*	-	Low	LR-lc
Fabaceae	**Pulse Family**		
Astragalus baibutensis	-	Low	LR-lc
A. condensatus	-	Low	LR-lc
A. eriophyllus	-	Low	LR-lc
A. brachypterus	-	Low	LR-lc
A. lycius	-	Low	LR-lc
A. lydius	-	Low	LR-lc
A. melanophrurius	-	Low	LR-lc
A. podperae	-	Low	LR-lc
A. pisidicus	-	Low	LR-lc
A. tmoleus var. *bounacanthus*	-	Low	LR-lc
A. vulnerariae	-	Low	LR-lc
A. wiedemannianus	-	Low	LR-lc
A. xylobasis var. *angustus*	-	Low	LR-lc
Ebenus hirsuta	-	Low	LR-lc
Hedysarum cappadocicum	-	Low	LR-lc
Melilotus bicolor	-	Low	LR-lc
Onobrychis armena	-	Low	LR-lc
O. tournefortii	-	Low	LR-lc
Trifolium pannonicum ssp. *elongatum*	Hungarian clover	Low	LR-lc
Hypericaceae	**St. John's-wort Family**		
*Hypericum salsogineum**	-	Low	LR-lc
Illecebraceae	-		
Paronychia chionaea	-	Low	LR-lc
Lamiaceae (Labiatae)	**Mint Family**		

Ballota nigra ssp. *anatolica*	Black horehound	Low	LR-lc
Phlomis armeniaca	-	Low	LR-lc
Salvia cadmica	-	Low	LR-lc
S. cryptantha	-	Low	LR-lc
S. cyanescens	-	Low	LR-lc
S. hypargeia	-	Low	LR-lc
S. wiedemannii	-	Low	LR-lc
Stachys cretica ssp. *anatolica*	Mediterranean woundwort	Low	LR-lc
Thymus sipyleus ssp. *sipyleus*	-	Low	LR-lc
Linaceae	**Flax Family**		
Linum flavum ssp. *scabrinerve*	Golden flax	Low	LR-lc
L. hirsutum ssp. *anatolicum* var. *anatolicum*	Hairy flax	Low	LR-lc
L. hirsutum ssp. *anatolicum* var. *pseudoanatolicum*	Hairy flax	Low	LR-lc
Papaveraceae	**Poppy Family**		
Glaucium grandiflorum var. *grandiflorum*	-	Low	LR-lc
Plumbaginaceae	**Leadwort Family**		
Limonium iconicum *	-	Low	LR-lc
*Limonium anatolicum**	-	Low	LR-lc
Ranunculaceae	**Crowfoot Family**		
Delphinium venulosum	-	Low	LR-lc
Ranunculus reuterianus	-	Low	LR-lc
Rhamnaceae	**Buckthorn Family**		
Rhamnus thymifolius	-	Low	LR-lc
Rosaceae	**Rose Family**		
Crataegus tanacetifolia	Tansy-leaved hawthorn	Low	LR-lc
Rubiaceae	**Madder Family**		
Asperula bommuelleri	-	High	VU
Crucianella disticha	-	Low	LR-lc
Rutaceae	**Rue Family**		
Haplophyllum myrtifolium	-	Low	LR-lc
Scrophulariaceae	**Figwort Family**		
Linaria corifolia	-	Low	LR-lc
L. iconia	-	Low	LR-lc
Veronica multifida	-	Low	LR-lc
Verbascum ancyritanum	-	Low	LR-lc
V. cheiranthifolium var. *asperulum*	-	Low	LR-lc
V. vulcanicum var. *vulcanicum*	-	Low	LR-lc
Solanaceae	**Potato Family**		
Lycium anatolicum	-	Low	LR-lc
Iridaceae	**Iris Family**		
G. halophilus	-	Low	LR-lc
Liliaceae	**Lily Family**		

Allium phrygium	-	Low	LR-lc
A. scabriflorum	-	Low	LR-lc

LR : "Lower Risk" A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa included in the Lower Risk catagory can be seperated into three subcatagories.

lc : "Least Concern" Taxa that do not qualify for Conservation Dependent or Near Threatened (One of the subcatagories of LR)

VU : "Vulnerable" A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

Fauna Species

All amphibia and reptilia living in the region are under protection as per BERN Convention. The turtle, snake and lizard species included in the project site and environmental fauna and under protection in our country according to the Resolution of Central Hunting Commission in 2002-2003 Hunting Period by the General Directorate of National Parks and Hunting-Wildlife, the Ministry of Forestry of the Republic of Turkey are as follows: Testudo graeca, Agama stellio, Agama ruderata, Lacerta parva, Lacerta trilineata, Ophisos elegans, Eumeces schneiderii, Typlops vermicularis, Eryx jaculus, Coluber caspius, Coluber najadum, Eirenis modestus, Elaphe quatuorlineata, Natrix natrix, Natrix tesellata, Maipolon monspessulana and Vipera xanthina. The Resolutions of the Central Hunting Commission shall be complied with during the project activities.

All birdspecies other than *Larus argentatus*, *Garrullus glandarius*, *Pica pica, Corvus monedula*, *Corvus frugilegus*, *Corvus corone*, *Corvus corax* and *Passer domesticus* are under protection as per BERN Convention."Species Allowed for Hunting at Specified Times", "Species That May Be Hunted At All Times" and "Species Under Protection", which are included in the project site and environmental fauna and under protection in our country according to the Resolution of Central Hunting Commission in 2002-2003 Hunting Period by the General Directorate of National Parks and Hunting-Wildlife, the Ministry of Forestry of the Republic of Turkey are given in Appendix-L (Table L.3). There is not any endemic fauna specie. The species given in Table 4.32 are the species located in the project site and its vicinity and that are under protection as per BERN Convention. These species shall be protected during the project activities.

Table 4.32 Mammalia Under Protection As Per Bern Convention

Scientific Name	Turkish Name	Bern Convention
SORİCIDAE		
-	Kir sivrifaresi	Appendix III
RHINOLOPHİDAE		
Rhinolophus ferrumequinum	Buyuk nalburunlu yarasa	Appendix II
Rhinolophus hipposideros	Kuçuk nalburunlu yarasa	Appendix II
Rhinolophus mehelyi	Nalburunlu yarasa	Appendix II
VESPERTİLIONİDAE		
Myotis mystacinus	Kuçuk sakalli yarasa	Appendix II
Myotis biythi	Farekulakli kuçuk yarasa	Appendix II
Eptesicus serotinus	Genis kanatli yarasa	Appendix II
Pipistrellus pipistrellus	Cuce yarasa	Appendix III
Pipistrellus nathusii	Purtuklu derili yarasa	Appendix II
Pipistrellus savii	Pipistrellus sp.	Appendix II
Miniopterus schreibersi	Uzun kanatli yarasa	Appendix II
MOLOSSiDAE		
Tadanda teniotis \ Kuyruklu yarasa		Appendix II
LEPORiDAE		
Lepus *europaeus*	Yabani tavsan	Appendix III
SCIURİDAE		
Spermophilus (Citellus)	Tarla sincabi, Gelengi	Appendix II
MUSTELIDAE		
Mustella nivalis	Gelincik	Appendix III
Meles meles	Porsuk	Appendix III

According to the Resolution of Central Hunting Commission in 2002-2003 Hunting Period by the General Directorate of National Parks and Hunting-Wildlife, the Ministry of Forestry of the Republic of Turkey;

The Mammalian Species Allowed for Hunting At Specified Times include Lepus *capensis, Oryctolagus cuniculus, Vulpes vulpes, Martes foina* and *Martes martes*. The species that can be hunted at all times include *Canis lupus, Canis aureus, Sus scrofa* and *Herpestes ichneumon*. The resolutions of the Central Hunting Commission shall be complied with during the project activities.

The species observed at approximately 2 km outside the project site and taken under protection as per the BERN Convention are Kalidiopsis vvageniitzii, Microcnemum coralloides, Salsola anatolica and Limonium anatolicum.

4.2.13 Animal Husbandry and Aquatic Products

Stock breeding, especially sheep/goat breeding, is carried out in all the regions of Aksaray. The animals are usually marketed within the province and districts in the vicinity.

According to the data of 1998, the animal availability and breeding in the province are given in Table 4.33 and Table 4.34 respectively in comparison to the breeding in the country. As seen in Table 4.33, the sheep and chicken breeding is the most common animal husbandry in the province and the sheep and chicken breeding constitutes 1.5% and 0.2% respectively of the total breeding in the country. Though the cattle breeding are common in the province, it constitutes only 0.6% of the total cattle breeding in the country. The milk and egg production is very high in the province with respect to the animal products. The spring wool production is 1.24% of the average value of the country (see Table 4.34).

Table 4.33 Animal Presence in Aksaray Province

Type	Aksaray (Quantity)	Turkey (Quantity)	Share of Aksaray (%)
Sheep	425.580	29.435.000	1,5
Bristle Goat	14.650	7.523.000	0,2
Angora Goat	3.930	534.000	0,7
Cattle	69.440	11.031.000	0,6
Water Buffalo	1.390	+76.000	0,8
Horse	2.470	330.000	0,8
Donkey	7.010	603.000	1,2
Hen	387.900	236.997.651	0,2
Goose	20.000	1.771.327	1,1
Beehive	10.807	4.199.351	0,3

Table 4.34. Animal Products in Aksaray Province

Type	Aksaray (ton)	Turkey (ton)	Share of Aksaray (%)
Milk	62.541	9.970.531	0,6
Meat	3.223	532.504	0,6
Spring Wool	614	44.368	1,4
Bristle	7	2.981	0,2
Angora Wool	3	608	- 0,5
Egg*	4.650	867.992	0,5
Honey	170	67.490	0,3

** 16.000 eggs are accepted as 1 ton.*
Reference: SIS, 2002

Sultanhani, is one of the most developed husbandry centres of the region. Meat, milk and spring wool are some of the animal products that are produced in the municipality (Sultanhani Municipality, 1996). Another husbandry activity that is carried out traditionally in the province is apiculture. Apiculture is undertaken in the high plateaus especially in the vicinity of Hasandagi (Hasan Mountain).

Aquatic products production in Aksaray Province is carried out in specific areas. In Mamasun, Hirfanli and Kultepe dam lakes, fresh water sea bass and mirror carp are bred. As for the lagoons, sea bass, common carp, brown trout and wels catfish are

being produced. There is abundant red coral in Uluirmak River. Freshwater lobsters raised in Mamasun Lake are exported to foreign countries (Tourism Inventory of Aksaray Province, 1992).

4.2.14 Recreational Areas and Areas with High Landscape Value

The areas for daily public use are limited since there is a weak vegetation and poor forest wealth in the project site and its vicinity. The areas used for recreational purposes in Aksaray Province are listed below:

- Mamasun Dam picnic area,
- Tuzlusu Thermal Spring picnic area,
- Ziga Thermal Spring picnic area,
- Ihlara Valley picnic area,
- Manastir Valley picnic area.

The province has an important tourism potential; however, the tourism sector is not much developed. Tourism and recreation centres in the province are not adequate. The number of trees in the study area are rather low. The site, where wheat, barley and sugar beet are cultivated as the main agricultural crops, has no importance in terms of its landscape and visual worth and also recreationally. Protected areas and locations which are of importance recreationally were presented in Section 4.2.12.

4.2.15 Lands Under Control and Responsibility of Authorized Governmental Agencies

Bezirci Lake Natural Site Area, Malir Tumulus, Kullutepe (flat settlement) and Kral Yolu (King's Road), which are close to the project site, are under protection. As for the vicinity, Esmekaya Reed Bed and Tuz Golu Special Protection Area are present (see Section 4.2.12). Kayseri-Konya-Seydisehir (Iran-Turkey) natural gas pipeline passes 20 km north of the study area (see Figure 1.2). Besides, there are no other areas that belongs to the public.

4.2.16 Determination of Present Air, Water, Soil and Noise Quality

4.2.16.1 Present Air Quality

There are no significant emission resources within the project area and its vicinity. Since the region is a rural area, the present air quality depends upon the emissions that

originate from the sources used for heating purposes (i.e., coal) and soil. Sulphur dioxide (SO_2) and particulate matter (PM) concentrations in Sultanhani are expected to be high, owing to the pollutant sources (i.e., stacks) related to the local coal consumption. However, since there are not many settlements within the project site and its vicinity, and the plateau houses of the local people are not used during the winter, there is no pollution related with coal. The only existing problem is the dust emission during dry and windy days. This problem is due to the dispersion of clayey soil when dried up.

The most practical way of determining the air quality in the region is by comparing the long-term measurement values provided from the existing monitoring stations with the "limit values" stipulated in Regulation on Prevention of Air Quality[2] (RPAQ). However, as no monitoring station, where the long-term air quality values can be provided, is present within the proposed project site and its vicinity, the local air quality was evaluated from the 1998-1999 winter season (October-March) records of the State Institute of Statistics (SIS) (see Table 4.35)

Table 4.351998-1999 Winter Season (October-March) Air Quality Records

Parameter	SO_2	PM
Average ($\mu g/m^3$)	71	66
Alteration Ratio (%)	48	106
Number of Days STL* Value was Exceeded	-	-

** STL: Short Term Limit*

4.2.16.2 Present Surface Water Quality

There are no surface water resources in the vicinity of the project site. Hence, it is not possible to mention about the surface water quality of the study area. However, drainage water sourcing from the irrigation of Cumra Plain and all domestic and industrial wastewaters of Konya is discharged to Tuz Golu via a 185 km long pipeline. When the annual pesticide (1105 tons) and fertilizer (415 tons) consumption in Cumra Plain and the industrial wastes (food, cement, paper, metal and metal products) are taken into consideration, it can easily be seen that the pollutant load of the discharged water is at a level that can negatively effect the ecological balance. Algal blooms are observed in Tuz Golu due these wastes.

On February 18, 2002, water samples were taken from the Uluirmak River and Tuz Golu, which are close to the Yesilova Village located c.30 km northwest of Sultanhani for the determination of surface water quality. These samples were analysed by Düzen-Norwest

[3] *02.11.1986 dated and 19269 numbered Official Gazette*

Environmental and Health Services Education and Consulting Co. The results of these analysis are presented in Appendix-L.

The analysis results of the samples taken from Uluirmak River and Tuz Golu are presented in Table 4.36 and Table 4.37, respectively. These results were also compared with the "Table 1. Quality Criteria of Inland Water Resources According to Quality Classes" of the Water Pollution Control Regulation, which was published in the September, 4, 1988 dated and 19919 numbered Official Gazette. According to this table, the surface waters are of quality class IV (extremely polluted water).

Table 4.28 Uluirmak River Surface Water Quality

Parameter	Water Quality Criteria				Uluirmak River Water Sample	
	Class I	*Class II*	*Class III*	*Class IV*	*Analysis Results*	*Water Quality Class*
pH	6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0	8.25	I
Fe (mg/L)	0.3	1.0	5.0	>5.0	0.380	II
Cu (mg/L)	0.02	0.05	0.20	>0.20	<0.002	I
Zn (mg/L)	0.2	0.5	2.0	>2.0	0.010	I
Cr (mg/L)	0.02	0.02	0.05	>0.05	<0.002	I
Hg (mg/L)	0.0001	0.0005	0.002	>0.002	<0.002	III
Pb (mg/L)	0.01	0.02	0.05	>0.05	<0.002	I
Ni (mg/L)	0.02	0.05	0.20	>0.20	0.010	I
Cd (mg/L)	0.003	0.005	0.010	>0.010	<0.002	I
As (mg/L)	0.02	0.05	0.10	>0.10	0.136	IV
Na (mg/L)	125	125	250	>250	220	III
Se (mg/L)	0.01	0.01	0.02	>0.02	0.006	I
Mn (mg/L)	0.1	0.5	3	>3	0.352	II
B (mg/L)	1	1	1	>1	0.001	I
Al (mg/L)	0.3	0.3	1	>1	0.500	III
Li (mg/L)	-	-	-	-	0.360	-
Br (mg/L)	-	-	-	-	0.287	-
F^- (mg/L)	1.0	1.5	2.0	> 2.0	0.390	I
Co (mg/L)	0.01	0.02	0.2	>0.2	0.001	I
Total CN^- (mg/L)	0.01	0.05	0.10	> 0.10	0.050	II
SO_4^{-2} (mg/L)	200	200	400	> 400	142	I
Oil and grease (mg/L)	0.02	0.3	0.5	>0.5	155	IV
Cl^- (mg/L)	25	200	400	>400	197	II
Ammonium nitrate (mg/L)	0.2	1	2	>2	3.40	IV
NO_3^--N (mg/L)	5	10	20	>20	0.75	I
Total PO_4^{-3}-P	0.02	0.16	0.65	>0.65	0.87	IV

(mg/L)						
Total dissolved solids (mg/L)	500	1500	5000	>5000	1183	II
Chemical Oxygen Demand (COD) (mg/L)	25	50	70	>70	13.50	I
Biochemical Oxygen Demand (BOD) (mg/L)	4	8	20	>20	0	I
Suspended Solids (SS) (mg/L)	-	-	-	-	16.20	-
Total Organic Carbon (TOC) (mg/L)	5	8	12	>12	2.85	I
Fecal coliform (MPN/100 mL)	10	200	2000	>2000	0	I
Total coliform (MPN/100 mL)	100	20,000	100,000	>100,000	32	I

Class I: High Quality Water
Class II: Slightly Polluted Water
Class III: Polluted Water
Class IV: Extremely Polluted Water

Table 4.37 Tuz Golu Surface Water Quality

Parameter	Water Quality Criteria				Uluirmak River Water Sample	
	Class I	*Class II*	*Class III*	*Class IV*	*Analysis Results*	*Water Quality Class*
pH	6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0	7.92	I
Fe (mg/L)	0.3	1.0	5.0	>5.0	4.7	III
Cu (mg/L)	0.02	0.05	0.20	>0.20	0.4	IV
Zn (mg/L)	0.2	0.5	2.0	>2.0	0.2	I
Cr (mg/L)	0.02	0.02	0.05	>0.05	<0.002	I
Hg (mg/L)	0.0001	0.0005	0.002	>0.002	<0.002	III
Pb (mg/L)	0.01	0.02	0.05	>0.05	0.235	III
Ni (mg/L)	0.02	0.05	0.20	>0.20	0.017	I
Cd (mg/L)	0.003	0.005	0.010	>0.010	1.41	IV
As (mg/L)	0.02	0.05	0.10	>0.10	0.037	II
Na (mg/L)	125	125	250	>250	85.000	IV
Se (mg/L)	0.01	0.01	0.02	>0.02	0.0094	I
Mn (mg/L)	0.1	0.5	3	>3	0.03	I
B (mg/L)	1	1	1	>1	43	IV
Al (mg/L)	0.3	0.3	1	>1	0.8	III
Li (mg/L)	-	-	-	-	17	-
Br (mg/L)	-	-	-	-	<0.1	-
F^- (mg/L)	1.0	1.5	2.0	> 2.0	0.09	I
Co (mg/L)	0.01	0.02	0.2	>0.2	0.0075	I
Total CN^- (mg/L)	0.01	0.05	0.10	>0.10	<0.05	II
SO_4^{-2} (mg/L)	200	200	400	> 400	5329	IV
Oil and grease (mg/L)	0.02	0.3	0.5	>0.5	50	IV
Cl^- (mg/L)	25	200	400	>400	124,590	IV
Ammonium nitrate (mg/L)	0.2	1	2	>2	1.05	III
NO_3^--N (mg/L)	5	10	20	>20	0.21	I
Total PO_4^{-3}-P (mg/L)	0.02	0.16	0.65	>0.65	0.45	III
Total dissolved solids (mg/L)	500	1500	5000	>5000	227,930	IV
Chemical Oxygen Demand (COD) (mg/L)	25	50	70	>70	1821	IV
Biochemical Oxygen Demand (BOD) (mg/L)	4	8	20	>20	0	I
Suspended Solids (SS) (mg/L)	-	-	-	-	28.2	-
Total Organic Carbon (TOC) (mg/L)	5	8	12	>12	9.64	III

Fecal coliform (MPN/100 mL)	10	200	2000	>2000	0	I
Total coliform (MPN/100 mL)	100	20,000	100,000	> 100,000	0	I

Class I: High Quality Water
Class II: Slightly Polluted Water
Class III: Polluted Water
Class IV: Extremely Polluted Water

4.2.16.3 Present Groundwater Quality

To determine the groundwater quality, the analysis results of the samples taken from the existing wells were used. The values obtained from the 21075 numbered Gunesli operating well (see Figure 4.8), which was drilled by DSI and the nearest well to the location where the fresh water will be provided for the project, were utilized. The data obtained from this well are presented in Table 4.38.

Table 4.38 Groundwater Quality Values (DSI, 21075 numbered Gunesli Well)

Parameter	Value	Groundwater Class (GWC)*	Irrigation Water Class**
pH	7.8	I	I
EC	1,240×10^6 µmhos/cm	-	III
Hardness	50°Fr	-	-
Free CO_2	10.00 ppm	-	-
Dissolved Oxygen (DO)	6.4 mg O_2/L	II-III	-
Nitrate	0.011 mg/L	Nitrite nitrate – 0.033 mg/L (I-II)	I
Ammonium (NH_4^+)	2.11 mg/L	Ammonium nitrate – 1.64 mg/L (III)	I
Boron	2.2 mg/L	III	IV
Organic substance (as $KmnO_4$)	-	-	-
Sodium carbonate residue (SCR)	21.2%	-	I
Exchangeable sodium ratio (Na%)	1.2I	-	II
Sodium absorbtion ratio (SAR)	-	-	I
Cations			
Na^+	2.7 mg/L	I	-
K^+	0.03 mg/L	-	-
Ca^{++}	6.2 mg/L	-	-
Mg^{++}	3.8 mg/L	-	-

Total	**12.73 mg/L**	-	-
Anions			
HCO_3^-	5.5 mg/L	-	-
Cl^-	3.7 mg/L	I	I
SO_4^-	3.5 mg/L	I	I
Total	**12.7 mg/L**	-	-

GWC I: high quality groundwater
GWC II: medium quality groundwater
GWC III: poor quality groundwater
** Classified according to the Table 1 of the Water Pollution Control Regulation*
*** Classified according to the Notice on Technical Technical Procedures of the Water Pollution Control Regulation*

The groundwater is of Class III, according to Table 1 (Quality Criteria According to Inland Water Resources Classes) of Water Pollution Control Regulation (see Table 4.38). As the groundwater is currently used for irrigational purposes, these values of the water resource were compared with the criteria given in the Notice on Technical Procedures[3] of the Water Pollution Control Regulation.

According to the analysis results, the sodium absorption rate (SAR) in groundwater was determined as 1.2 and electrical conductivity (EC) as $1,240 \times 10^6$ µmhos/cm (see Table 4.38) In this regard, according to Notice on Technical Procedures of the Water Pollution Control Regulation, the mentioned water resource is within C_3S_1 irrigation class (III. Class water-usable). However, most parameters indicate that the water is of high quality (I. Class water- very good) (see Appendix-M).

The boron concentration of the groundwater was determined as 2.2 mg/L. According to Table-9 of the Notice, with a water resource with this amount of boron, plants like barley, wheat, maize, oat, olives, cotton, sugar beet, trefoil, broad been, onion, lettuce and carrots can be irrigated (see Appendix-M).

4.2.16.4 Present Noise Level

In order to determine present noise levels, for to be used in the determination of well locations, that will be drilled for the natural gas storage in the content of TUGSP, 5-minute equivalent noise level (L_{eq}) measurements were carried out at 12 distinct spots, which were determined by taking the regional settlements in the vicinity of the project site into consideration, on October 29, 2000 and at Sultanhani and Bucak, Omeraga, Rasimusagi and Hacihuseyin plateaus on February 17-19, 2002, by using CEL 480

[3] *07.01.1991 dated and 20748 numbered Official Gazette*

model noise measurement apparatus. The noise measurement locations are presented in Figure 4.34.

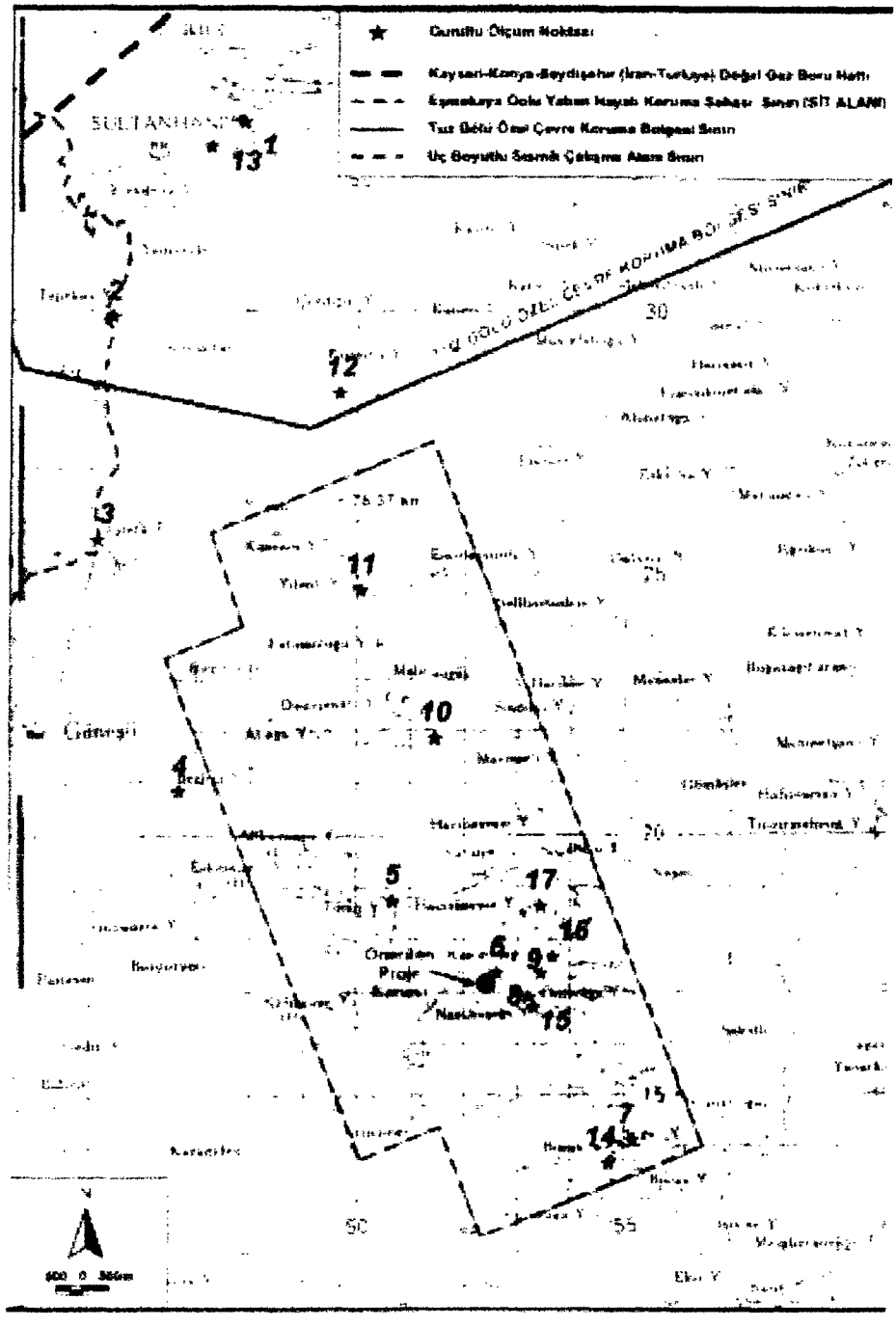


Figure 4.34 Noise Measurement Locations

CEL 480 Model Noise Measurement Apparatus

The apparatus is suitable for the International Electrotechnical Commission (IEC) 651 and IEC 804 type 1 categories. The apparatus has three different measurement intervals: i) 20-90 ii) 40-110 and iii) 70-140 dB. By using A and C weighted sound variation curves, it can measure the Sound Pressure Level (SPL) linearly.

It can also realize noise measurements in three different frequencies: i) constant noise (*fast mode*), ii) noise showing slow variation (*slow mode*) and iii) momentary noise (*impulsive mode*). It is possible either to make measurements directly or to determine SPL, L_{max} (maximum noise level), L_{min} (minimum noise level), L_{avg} (average noise level), L_{eq} (equivalent noise level) and L_n (relative noise level) by using measurement values by CEL 480, which is an integrated equipment. The measurement time interval can be arranged as 1,5,10,15, 30 and 60 minutes and can be automatically measured in six different sets by setting it up. The calibration of the apparatus is done at the production stage and once every following year. Before every measurement, a set-up, which can be explained as zero setting, is undertaken with again a CEL brand (282) and 114 dB stable noise maker calibrator.

Measurement Results

The noise levels measured during the study are presented in Table 4.39. As can be seen from the table, the highest noise level was measured to be 89.6 dBA at Bucak Plateau during the measurement on February 18-19, 2002, and 89.3 dBA at Sultanhani during the measurement on November 29, 2000.

Table 4.39 L_{eq}, L_{max} and L_{min} Values, Measurement Locations and Noise Sources

No	Location	Hour	L_{eq} (dBA)	L_{max} (dBA)	L_{min} (dBA)	Source
Measurement Date: November 29, 2000						
1	Sultanhani (Settlement-municipality)	10:20	74.9	89.3	49.0	Traffic, Announcement, Human
2	Tepekoy (Rural area)	10:40	40.2	60.0	31.6	Wind
3	Bezirci Lake (Rural area)	11:11	39.9	62.5	31.0	Wind
4	Bezirci Plateau (Rural area)	11:28	58.5	85.2	31.4	Wind, Animal
5	Tonu Plateau (Settlement-village)	11:37	59.3	77.6	32.5	Wind, Human, Animal
6	Well 2 (Rural area-old TPAO well)	11:52	56.8	76.1	34.1	Wind
7	Bucak Plateau (Rural area)	12:13	59.6	79.5	34.2	Wind, Animal
8	Omeraga Plateau (Rural area)	12:25	61.3	81.1	32.7	Wind, Animal
9	Rasim Usagı Plateau (Rural area)	12:40	65.5	80.8	35.1	Wind, Animal
10	Malir Hoyuk Vicinity (Rural area)	12:54	60.8	77.6	34.1	Motorcycle, Tractor
11	Yilanli Plateau (Rural area)	13:14	55.6	79.5	34.2	Motorcycle, Tractor
12	Road (Rural area)	13:27	52.6	76.5	34.7	Motorcycle, Tractor
Measurement Date: February 17-18, 2002						
13	Sultanhani (Settlement-municipality)	16:55	49.3	76.0	35.2	Human, Vehicle, Dog
	Sultanhani (Settlement-municipality)	17:55	47.8	73.7	33.0	Human, Vehicle, Dog
	Sultanhani (Settlement-municipality)	18:55	49.9	68.4	29.6	Human, Vehicle, Dog
	Sultanhani (Settlement-municipality)	19:55	52.8	81.1	31.0	Human, Vehicle, Dog
	Sultanhani (Settlement-municipality)	20:55	46.6	75.3	<30	Vehicle, Dog
	Sultanhani (Settlement-municipality)	21:55	46.8	77.1	<30	Vehicle, Dog
	Sultanhani (Settlement-municipality)	23:00	43.1	60.6	31.8	Human, Vehicle, Dog
	Sultanhani (Settlement-municipality)	00:00	41.4	58.5	<30	Vehicle, Dog
	Sultanhani (Settlement-municipality)	01:00	39.0	59.9	32.5	Vehicle, Dog
	Sultanhani (Settlement-municipality)	02:00	39.1	58.9	32.1	Vehicle, Dog
	Sultanhani (Settlement-municipality)	03:00	39.7	57.4	31.9	Vehicle, Dog
	Sultanhani (Settlement-municipality)	04:00	39.4	57.1	31.8	Vehicle, Dog
	Sultanhani (Settlement-municipality)	05:10	45.5	66.3	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	06:10	41.4	59.7	<40	Vehicle, Dog

	Sultanhani (Settlement-municipality)	07:10	45.6	69.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	08:10	48.6	78.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	09:10	54.5	77.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	10:10	51.3	75.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	11:15	50.7	71.8	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	12:15	44.9	64.9	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	13:15	47.6	72.8	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	14:15	50.9	74.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	15:15	48.2	76.7	<40	Vehicle, Dog
	Sultanhani (Settlement-municipality)	16:15	47.4	71.5	<40	Vehicle, Dog
Measurement Date: February 18-19, 2002						
	Bucak Plateau (Rural area)	17:55	58.3	88.8	<40	Dog
	Bucak Plateau (Rural area)	18:55	44.5	79.5	<40	Dog
	Bucak Plateau (Rural area)	19:55	42.2	74.9	<40	Dog
	Bucak Plateau (Rural area)	20:55	50.4	82.3	<40	Dog
	Bucak Plateau (Rural area)	21:55	46.9	89.6	<40	Dog
	Bucak Plateau (Rural area)	22:55	53.0	81.5	<40	Dog
	Bucak Plateau (Rural area)	00:00	39.4	60.9	<30	Dog
	Bucak Plateau (Rural area)	01:00	50.1	71.2	<30	Dog
14	Bucak Plateau (Rural area)	02:00	48.6	85.2	<30	Dog
	Bucak Plateau (Rural area)	03:00	44.3	64.1	<30	Dog
	Bucak Plateau (Rural area)	04:00	49.5	71.3	<30	Dog
	Bucak Plateau (Rural area)	05:00	41.3	70.4	35.6	Dog
	Bucak Plateau (Rural area)	06:05	50.6	74.9	34.5	Dog
	Bucak Plateau (Rural area)	07:05	51.4	77.8	35.1	Dog
	Bucak Plateau (Rural area)	08:05	46.7	79.5	35.3	Dog
	Bucak Plateau (Rural area)	09:05	59.9	89.1	35.2	Dog
	Bucak Plateau (Rural area)	10:05	51.8	78.6	35.3	Dog
Measurement Date: February 19, 2002						
15	Omeraga Plateau (Rural area)	11:28	52.5	82.4	<40	Human, Wind, Cock, Turkey
16	Rasimusagi Plateau (Rural area)	12:50	39.2	70.5	<40	Wind
17	Hacihuseyin Plateau (Rural area)	14:09	46.5	69.6	<40	Wind

These noise levels are known occur due to traffic, announcements and animals. The average values recorded at the nearest locations to the proposed project site were 39.2 dBA at Rasimusagi plateau and 52.5 dBA at Omeraga plateau. These values are considered as typical values for rural areas, at which the noises originate from natural

sources and lower human activities, rather than mechanical (e.g., industrial and infrastructure) sources.

4.2.17 Present Traffic Load

The comparative distribution of the traffic according to the vehicles in Aksaray Province with respect to Central Anatolia and Turkey is presented in Table 4.40. Accordingly, the traffic load is not so high. Additionally, Sultanhani Sub-distric, where the project site is in its vicinity, is located on Aksaray-Konya highway. The traffic load of the highway is lower in the region after the turn of the project site.

Table 4.40 Motorized Vehicles (1998)

Vehicle	Turkey	Central Anatolia	Aksaray
Automobile	3,838,288	852,633	12,958
Minibus	211,495	33,081	886
Bus	108,361	20,813	375
Pickup	626,004	112,090	1,358
Truck	371,163	84,002	3,495
Motorcycle	940,935	127,696	5,034
Vehicles for Private Use	49,925	11,778	356
Heavy Machinery	117,913	25,492	680
TOTAL	**6,264,084**	**1,267,585**	**25,142**

Source: www.die.gov.tr

4.2.18 Other Characteristics

There are no other characteristics to be evaluated within this section.

4.3 Characteristics of the Socio-Economic Environment

General information on the socio-economic characteristics of the proposed TUGSP area and its vicinity is presented in this section. Within the context of the report, the Central district of Aksaray Province and Sultanhani sub-district of this district, were evaluated together with Gunesli Village of the Central sub-district of Eskil District. The socio-economic analysis not only covers these settlements, but also the Aksaray Province in whole. The evaluation was carried out in detail to fully understand and evaluate the possible impacts of the project on the socio-economical characteristics of the region.

During the "Public Participation Meeting" held in the Municipal Assembly Hall of Sultanhani of the Province of Aksaray on 27.03.2003, the questions asked by the local people and answers to these questions are given in Appendix-S.

4.3.1 Economical Characteristics

The regional economy depends upon agriculture; however, service and industrial sectors are also rather important. The service sector is dominant within urban areas, whereas the dominance is at agriculture sector within rural areas (Tourism Inventory of Aksaray Province, 1992).

4.3.1.1 Main Economic Sectors that Constitute the Economic Structure

The main sectors of the regional economy are evaluated in detail in the following paragraphs. The insufficient infrastructure investments have impeded economical development.

Agriculture

According to the results of the survey on the agricultural lines (households) conducted in the Agricultural Census 1991, the quantity of irrigated and dry agricultural lands in the Province of Aksaray is given in Table 4.27. According to this table, approximately 7% of the cultivated lands is irrigated. This rate is quite lower than the average rate for Turkey, which is 14% (please refer to Section 4.2.9).

Sultanhani has got a smooth and wide land, and three fifth of the present land is used as agricultural land. Only one fourth of the land allocated for agriculture is wetland. The sugar beet and cereals are cultivated on the wetlands while barley, rye and wheat are cultivated on the dry lands (Sultanhani Municipality, 1996).

Animal Husbandry

The animal husbandry has the second important place in the Province of Aksaray following the agriculture. The animal breeding including the sheep breeding is performed in all sections of the province. The animals bred in the province are marketed within the surrounding provinces and districts.

Bee breeding is also noted as another field of animal husbandry as traditionally performed in the province, and it is performed on the plateaus, especially around Mountain Hasan.

According to the data in 1998, the animal availability and production of the province in comparison are given in Table 4.33 and Table 4.34 respectively. As seen in Table 4.33, the sheep and hen breeding is the most common field of animal husbandry and sheep and hen productions constitute 1.5% and 0.2% of the overall quantity of production in the country. Although the cattle breeding is common in the province, it constitutes 0.6% of the total rate in the country. The milk and egg constitute the major part of animal products in the province. The spring wool productions constitutes 1.24% of the average rate in the country (please refer to Table 4.34).

The Sub-district of Sultanhani is one of the most developed animal husbandry centers of the region owing its position. The animal products such as meat, milk and spring wool can be supplied in the sub-district (Sultanhani Municipality, 1996).

Fishery

The fresh water bass and carp are bred in the dam lakes of Mamasun, Hirfanli and Kultepe. The bass, carp, trout and sheatfish are bred in the lakes. There are many breams in Uluirmak. The fresh water lobster bred in Lake Mamasun is exported (Tourism Inventory of the Province of Aksaray, 1992).

Service Sector

The service sector constitutes the second important sector of the Province of Aksaray. Many people work within the fields of trade, transportation, construction, carpeting, training and health and in the public institutions.

Industry

Industry is the third sector following the agricultural and service sectors within the Province of Aksaray. However, the manufacturing industry is at a quite low rate in the overall province. Although the number of factories is high, the small capacities has an

impact on this rate. There are mainly private sector investments in the province. The factory which has the most personnel is Mercedes Benz Turkish Inc., which was established in 1989 (Tourism Inventory of the Province of Aksaray, 1992).

The center of the Sub-district of Sultanhani is a trade center. There are more than 300 trade units and workplaces, and there are also two carpet & thread factories, one agricultural credit cooperative and one sugar beet cooperative. The said sub-district is also known for its carpets all around the country (Sultanhani Municipality, 1996).

Mining

The mining activities, which has quite little share in the sectoral distribution, indicate that the Province of Aksaray is poor in the mineral resources. There are kaolin, marble and mercury reserves in the province (please refer to Section 4.2.7) (Tourism Inventory of the Province of Aksaray, 1992).

Forestry

The Province of Aksaray is not rich in the natural vegetation. The province is not rich in the forestry areas, either. The forestry areas found are in the forms of corrupted oaks and small forests. Only 0.83% of the Province of Aksaray is the forestry area (Tourism Inventory of the Province of Aksaray, 1992). Therefore, the forestry activities cannot be assumed as the source of revenue.

Tourism

Although the province has a significant potential for tourism, the tourism sector could not advance. The tourism and recreation facilities present in the province are not sufficient. Only a little part of the historical and cultural assets constituting the tourism potential of the province has been used for tourism purposes. Many tumuli and underground cities within the Province of Aksaray has not been able to be exposed to the surface yet.

Ihlara – Guzelyurt Tourism Center and Mountain Hasan Winter Sports Tourism Center are located within the Province of Aksaray. There are Thermal Springs Ziga within Ihlara – Guzelyurt Tourism Center.

Caravansary Sultanhani, which is located within Sultanhani, has been visited by many domestic and foreign tourists for long years (please refer to Figure 4.33). Since the Sub-district of Sultanhani is located within the Cappadocia Region, this region is developing rapidly with respect to tourism.

4.3.1.2 Distribution of Regional Labour Force

Table 4.29 shows the distribution of the active population (12+) of the region among the branches of industry. As can be seen from the table, agriculture is the main activity in the province (72.56%), comprising a higher ratio that those of Central Anatolia and Turkey. The second major activity is service, followed by industry.

Table 4.29 Distribution of the Active Population among Branches of Industry (%)

Region	A	B	C	D	E	F	G	H	I	J
Aksaray Province	72.56	0.05	6.37	0.24	4.65	5.05	2.21	0.81	7.79	0.28
Central Anatolia Region	50.48	0.47	10.21	0.50	5.26	7.45	3.74	3.13	18.37	0.38
Turkey	53.66	0.56	11.90	0.34	5.06	7.93	3.32	2.32	14.30	0.61

A: Agriculture, forestry, hunting and fishing
B: Mining industry
C: Manufacturing industry
D: Electricity, gas and water
E: Construction activities
F: Wholesale and retail trade, restaurants and hotels
G: Transportation, communication and storage
H: Financial corporations, insurance and real estate
I : Community, social and personal services
J : Activities not clearly defined

Source: SIS, 1990.

4.3.2 Population

4.3.2.1 Administrative Division

According to the 1997 population census, the population of Aksaray, which was separated from Nigde Province in 1989, is 347,163. There are seven districts in the province. Among these, the Central district, Sultanhani Municipality of this district and Gunesli Village of Central sub-district of Eskil District are the settlements that will be impacted mostly from the proposed TUGSP.

Central district has five sub-districts, namely Central, Acipinar, Sultanhani, Taspinar and Yesilova and has a population of 200,388 according to the 1997 census. Central sub-district has 58, Acipinar has 16, Sultanhani has two, Taspinar has 12 and Yesilova has five villages. Among these, Sultanhani sub-district has a population of is 9029. Administrative division of Aksaray Province is presented in Table 4.42.

Table 4.42 1990 Census Results of Aksaray Province

Districts	Sub-districts and Villages	Population
CENTRAL	City	90,698
	Central Sub-District	44,162
	Acipinar Sub-District	11,450
	Sultanhani Sub-District	9,029

	Sultanhani (BM) (B)	*8,397*
	Yesiltomek	*632*
	Taspinar Sub-District	19,882
	Yesilova Sub-District	14,035
AGACOREN	City	3,543
	Central Sub-District	14,419
ESKİL	City	16,462
	Central Sub-District	5,648
	Basaran	*535*
	Esmekaya (B)	*3,114*
	Gunesli	*1,359*
	Hoget	640
GULAGAC	City	4,111
	Central Sub-District	15,530
GUZELYURT	City	3,795
	Central Sub-District	13,387
ORTAKÖY	City	19,612
	Central Sub-District	16,068
	Balci Sub-District	12,995
SARIYAHSI	City	5,996
	Central Sub-District	5,577
TOTAL		**326,399**

Source: SIS, 1990

There are migrations from the region to other parts of Turkey and to other countries. When the evaluation is done on provincial basis, it is seen that nearly 1/3 of the population is working outside Turkey (i.e., Germany, Kuwait and Russia). Incomes of some villages are totally supplied from abroad. As Aksaray became a province in 1989, it experienced a rapid population increase between 1985-1990 (Tourism Inventory of Aksaray Province, 1992).

4.3.2.2 Urban and Rural Population

According to the results of 1997 census, rural and urban populations of Aksaray Province and its central district are equal; whereas, similar with the country average, urban population is higher in Eskil District (see Table 4.). As can be seen in Table 4., urbanization ratio of Eskil District (74.96%) is different than its province, Aksaray (48.70%), and is higher than Turkey average (65.00%).

Table 4.43 Urban and Rural Populations (1997)

Region	Total Population	Urban (%)	Rural (%)
Central District	200,338	50.51	49.49

Eskil District	25,689	74.96	25.04
Aksaray Province	347,163	48.70	51.30
Turkey Average	62,865,574	65.00	35.00

Source: SIS, 1997.

4.3.2.3 Demographics and Migrations

According to the 1990 SIS data, 12,313 people have immigrated to the Aksaray Province from other provinces, districts and villages; whereas 14,704 have emigrated from Aksaray Province to other provinces, districts and villages. The number of immigrants from Aksaray is greater than the number immigrated to Aksaray and the net immigration between the years 1985-1990 is -2391.

4.3.2.4 Population Growth Rate

According to 1990 and 1997 population census of Aksaray Province, the annual population growth rate is 6.36%, which is lower than the rate of Turkey (11.32%). The populations of Central and Eskil districts of Aksaray have increased 5.85% and 16.18%, respectively, between 1990 and 1997 (SIS, 1997).

4.3.2.5 Average Household Population

According to 1990 population census results, average household sizes of Central Anatolia Region, Aksaray Province, Central District and Eskil District are five, six, five and six, respectively. Aksaray Province and Eskil District have higher averages than the average of Turkey, which is five.

4.3.2.6 Distribution of Age Groups

The distribution of total population over the age groups within Aksaray Province, Central and Eskil districts are presented in Figure 4.35, Figure 4.36 and Figure 4.37, respectively. According to 1990 census, 05-14 age group has the highest ratio in Aksaray Province. The majority of the population of the central district is in 05-14 age group. However, 0-9 age group has the highest ratio in Eskil District. These data indicate that the population of the area of concern is mostly comprised of young people and children and is similar with the national distribution where 05-14 age group is dominant (see Figure 4.38).

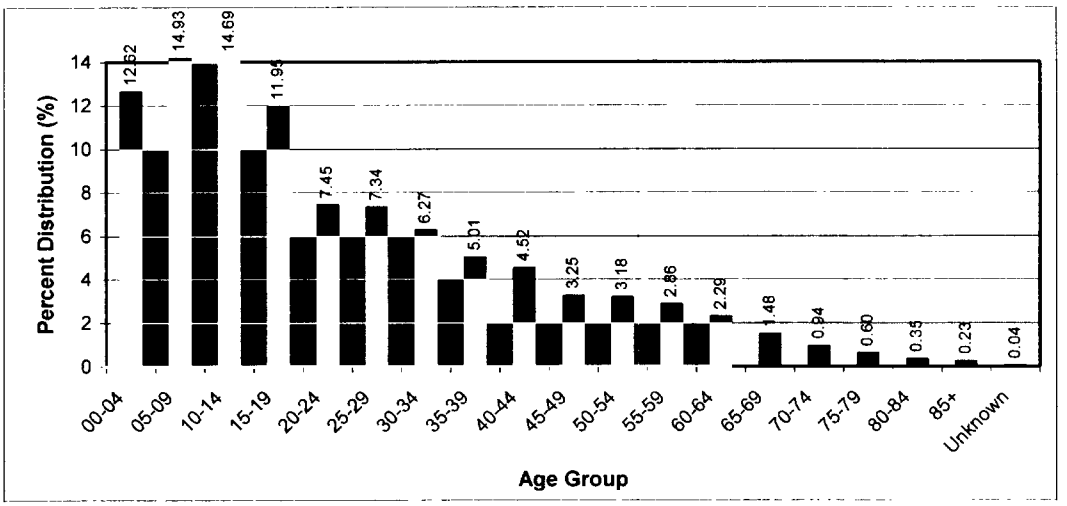


Figure 4.35 Distribution of Population over Age Groups in Aksaray Province

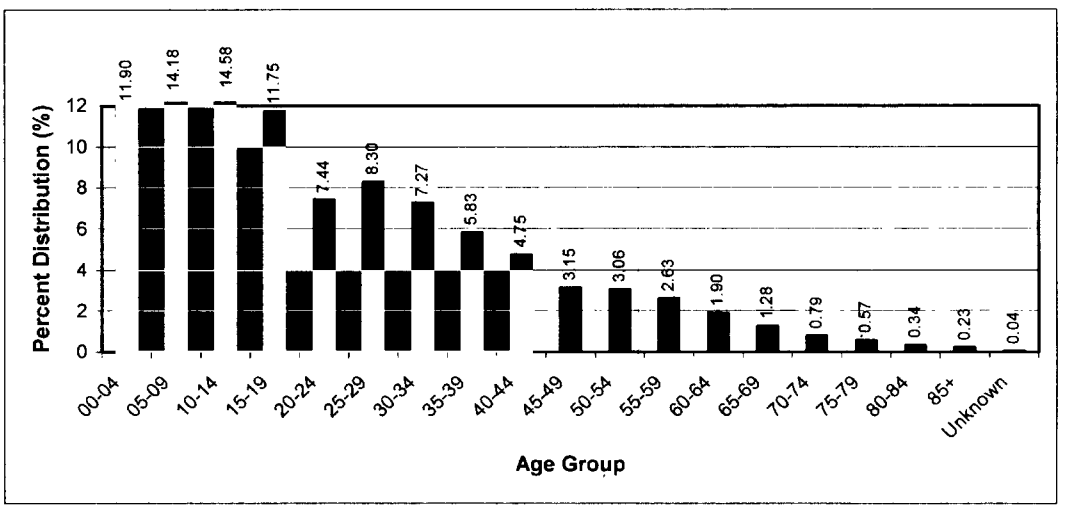


Figure 4.36 Distribution of Population over Age Groups in Central District

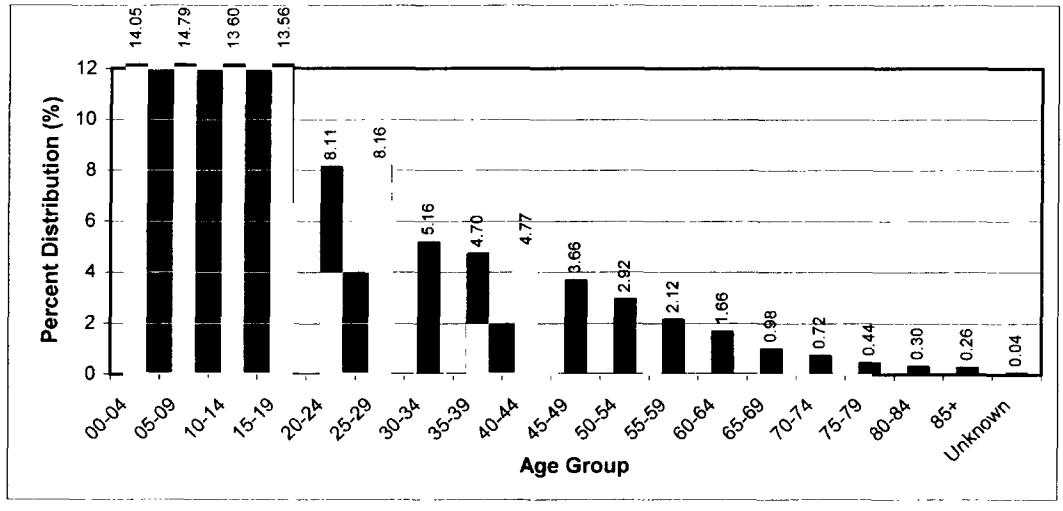


Figure 4.37 Distribution of Population over Age Groups in Eskil District

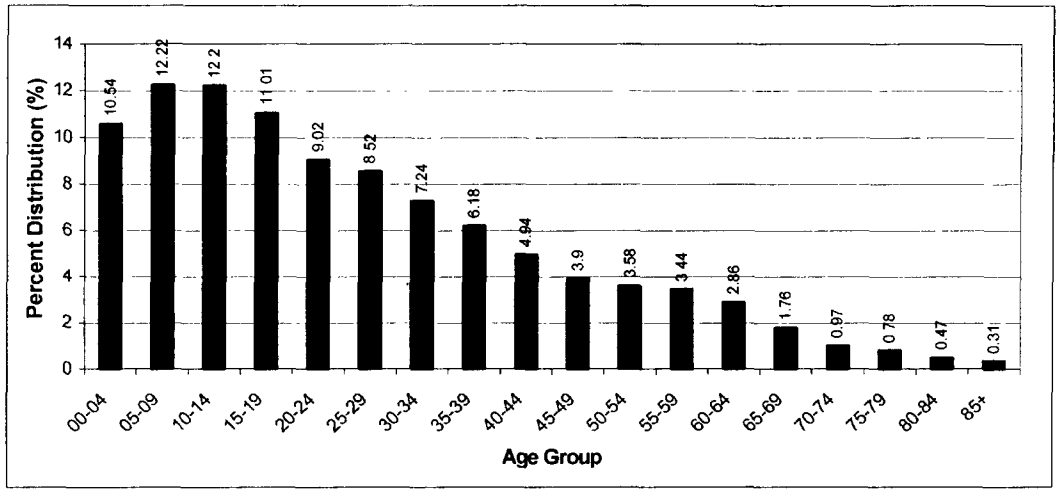


Figure 4.38 Distribution of Population over Age Groups in Turkey

4.3.2.7 Population Density

According to the 1997 cencus, population density of Aksaray Province (44 capita/km²) is much lower than the national density, which is 81 capita/km² (see Table 4.44) (SIS, 1997).

Table 4.44 Population Densities in the Region

Region	Population	Area (km²)	Population Density (capita/km²)
Aksaray Province	347,163	7,802	44
Turkey	62,865,574	774,815	81

Source: SIS, 1997.

4.3.2.8 Population Estimations

The growth in urban and rural populations can be calculated by applying several methods. However, sudden changes in populations due to socio-economical reasons, which cannot be reflected with the population curves, cannot be determined with these methods. In this regard, especially as a result of possible migrations, the estimated populations for the settlements within the project area can be quite different from the real populations.

To determine the population variations of Aksaray province, census results from 1970 to 1990 were utilized. However, data between 1970 and 1985 was obtained as a district of Nigde Province, as Aksaray was separated from Nigde in 1989.

As can be seen from Table 4.45, population estimations for Aksaray were undertaken using three different methods, namely the Bank of Provinces Method (BPM), Arithmetic Method (AM) and Geometric Method (GM). The population estimations carried out by using the Least Squares Methods (Geometric-LSGM and Arithmetic-LSAM) were not included in the table due their inconsistent results. The population estimation graphic of Aksaray Province is presented in Figure 4.39.

Table 4.45 Population Estimations for Aksaray Province

Years	Method Used		
	BPM	***AM***	***GM***
1990	326,399	326,399	326,399
1995	395,874	370,158	395,531
2000	480,136	413,917	479,305
2005	582,335	457,675	580,823
2010	706,286	501,434	703,842
2015	856,621	545,193	852,917
2020	1,038,954	588,952	1,033,566
2025	1,260,098	632,710	1,252,477
2030	1,528,313	676,469	1,517,754

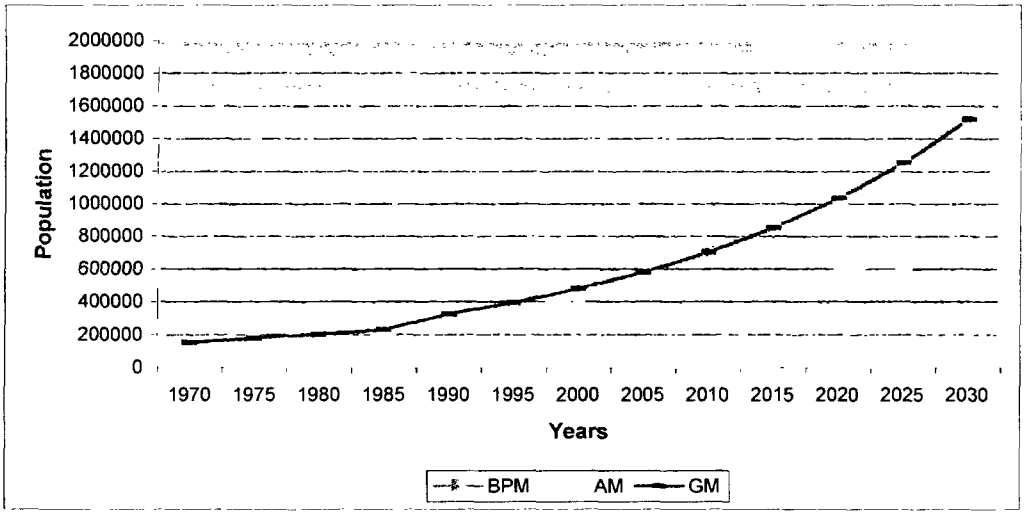


Figure 4.39 Population Estimation Graphic for Aksaray Province

Population estimations for 1997 for Aksaray Province were carried out using the above-mentioned methods with 1970-1990 population census results. This estimation was compared with the real population to determine the method, that gives the closest estimation. Hence, it was understood that the Arithmetic Method (AM) gives the most realistic results.

According to the estimations done by using this method, 1997 population estimation for Aksaray Province is calculated as 387,661. The population of Aksaray Province in 1997, which is 347,163, is very close to the estimated. In that regard, it is decided to use the Arithmetic Method for the population estimations of the province for the year 2000 and the following years. Similarly, as it can be seen in Figure 4.39, the most regular increase was obtained with this method. Population values of 1997 obtained through the other methods were far from the real value, and thus, not evaluated.

4.3.2.9 Birth and Fertility Ratio

Birth and fertility ratios of Aksaray Province, Central and Eskil districts, together with national ratios are presented in Table 4.46 according to the results of 1990 census. Accordingly, the ratio of female to male population in all regions is higher than the national ratio. However, as the ratio of female to male population is close to 1, similarly with Turkey average, it can be seen clearly that there is a balanced distribution in all regions.

Table 4.30 Birth and Fertility Ratios

Region	M/T[1] (%)	F/T[2] (%)	Fertility Ratio	Birth Ratio	F/M[3]
Central District	48.22	51.78	24.53	16.46	1.07
Eskil District	49.14	50.86	29.20	20.40	1.03
Aksaray Province	47.96	52.04	27.56	17.13	1.08
Turkey	50.66	49.34	20.75	15.08	0.97

[1] *M/T: Male/Total* [2] *F/T: Female/Total* [3] *F/M: Female/Male*
Source: SIS, 1990.

The fertility ratio is defined as the ratio of population within 0-4 age group to the population of 15-49 age group, whereas birth ratio is defined as the ratio of population within 0-1 age group to female population of 15-49 age group.

The national fertility ratio is 20.75, whereas the same ratio is higher for Aksaray Province, and Central and Eskil districts. In other words, it can be stated that there are 27, 24 and 29 children of age group 0-4 for every 100 adult of age group 15-49 within Aksaray Province, and Central and Eskil districts, respectively. Similarly, birth ratios of Aksaray Province, and Central and Eskil districts are 17.13, 16.46 and 20.40, respectively. There are 17, 16 and 20 babies for every 100 female in 15-49 age group, respectively. Fertility and birth ratios for all regions are higher than the national ratios.

4.3.3 Income

According to the 1995-1996 "Gross National Product (GNP)" values of State Institute of Statistics on district basis, Aksaray Province has a GNP value of $39,953,288 \times 10^6$ TL, with 0.27% GNP share on national basis. Central and Eskil districts have GNP values of 30,730,990 TL and 1,890,719 TL, respectively, making up to 0.21% and 0.01% GNP shares on national basis. The Central district has the highest share ratio, which is 76.92% on provincial basis, whereas the share ratio of Eskil district is 4,73%.

4.3.4 Unemployment

By definition, economically active population is the ratio of population older than 12, to the population currently employed or who are looking for a job The distribution of economically active female and male population are presented in Table 4.47. Accordingly, the economically active female and male population of Aksaray Province is higher than the national average, whereas it is lower within the Central district. However, the economically active male population of Eskil district is higher than the provincial and national averages.

Table 4.47 Economically Active Population (age 12 and above)

Region	Male (%)	Female (%)
Central District	69.38	9.75
Eskil District	89.69	37.35
Aksaray Province	79.22	53.32
Turkey	78.22	42.76

Source: SIS, 1990

Additionally, the distribution of economically inactive population (12-65+) in Aksaray Province, together with Central and Eskil districts are presented in Table 4.48. Accordingly, The male and female student ratios within the inactive population of Aksaray are higher than the national ratio and for Central district, the male and female student ratios are similar with national ratios. Whereas, female student ratio is much lower in Eskil District. The ratio of housewives within the inactive female population of Central and Eskil districts are higher than the national average of 82.11%.

Table 4.48 Economically Inactive Population and its Distribution (%)

Region	Retired		Housewife	Student		Other	
	Male	Female	Female	Male	Female	Male	Female
Central District	15.57	0.39	84.44	57.28	12.28	27.14	2.88
Eskil District	7.02	0.03	94.59	56.19	4.97	36.78	0.40
Aksaray Province	10.39	0.32	81.27	65.19	15.73	24.41	2.66
Turkey	24.69	1.70	82.11	57.74	14.86	17.57	1.33

Source: SIS, 1990.

Dependency Ratio

Dependency ratio (DR) is the indicator of the employed population. Rate of Dependency is the indicator of the employed (working) population. It is defined as the ratio of every 100 persons at 15-65 age group to the number of persons at 0-14 and 65+ age group. For instance, the rate of dependency of 65+ age group is calculated as the ratio of the population at 65 years old and over to the population at the age group of 15-65. The rates of dependency of the Province of Aksaray, the Central District and the District of Eskil are given in Table 4.50.

Turkey has a young population in general and a major part of this population comprises of the age group of 0-14. The total rate of dependency for the average of Turkey has been calculated as 64.68%, 7.06% of which is the rate of dependency of the age group of 65+ and 57.62% of which is the rate of dependency of the age group of 0-14.

Table 4.50 Dependency Ratios (DR)

Region	65+ Population	0-14 Population	15-64 Population	65+ Age Group DR	0-14 Age Group DR	Total DR
Central District	2,915	36,875	50,874	5.73	72.48	78.21
Eskil District	718	6,987	8,750	8.20	79.85	88.05
Aksaray Province	11,781	137,874	176,606	6.67	78.07	84.74
Turkey	2,417,363	19,745,352	34,265,838	7.06	57.62	64.68

Source: SIS, 1990.

As it can be seen from Table 4.50, Aksaray Province, Central and Eskil districts have higher dependency ratios than Turkey. The total dependency ratios for Aksaray Province, Central and Eskil districts are 84,74%, 78,21% and 88,74%, respectively. In all regions, most part of the total dependency ratio is the dependency ratio of 0-14 age group. Briefly, the dependency ratios in the region is higher than Turkey average and the labour force in the region is lower than the national average.

4.3.5 Health

There are no records on endemic diseases within Aksaray Province and its vicinity.

4.3.6 Social Infrastructure Services in the Region

4.3.6.1 Education

Educational level within the schools in Aksaray Province is lower than national level by means of various indicators. Nevertheless, technical-professional schools are at a high level. According to 1995-1996 data, there are a total of 429 schools of which 305 are primary, 83 are secondary, four are professional and technical secondary, 25 are high and 12 are professional and technical high schools (SIS, 1997). Among the 15 schools in Sultanhani sub-district, 14 are primary schools and one is high school (Sultanhani Municipality, 1996).

In Aksaray Province, there are motor, electricity, mushroom, milk and dairy products, tourism and hotel management departments in Aksaray Technical Academy of Nigde University, at which the education activities have started in 1987. At the same time, Aksaray Engineering Faculty and Economic and Administrative Sciences Faculty of Nigde University is in Aksaray Province. Civil, industrial, mechanical, geological, electrical-electronic, environmental and mining engineering courses are given in the Faculty of Engineering, whereas the Faculty of Economic and Administrative Sciences

have economics, business administration and public administration departments (Aksaray Province Industrial Potential and Investment Areas Research, 1997).

The literacy ratios of Aksaray Province and its two districts according to 1990 census are presented in Figure 4.40. According to the figure, the literacy ratios of Aksaray Province and Eskil district are 76,65% and 78,14%, respectively. These ratios are below the national ratio, which is 80,46%. The literacy ratio of Central district is 81,46% and this ratio exceeds the national ratio.

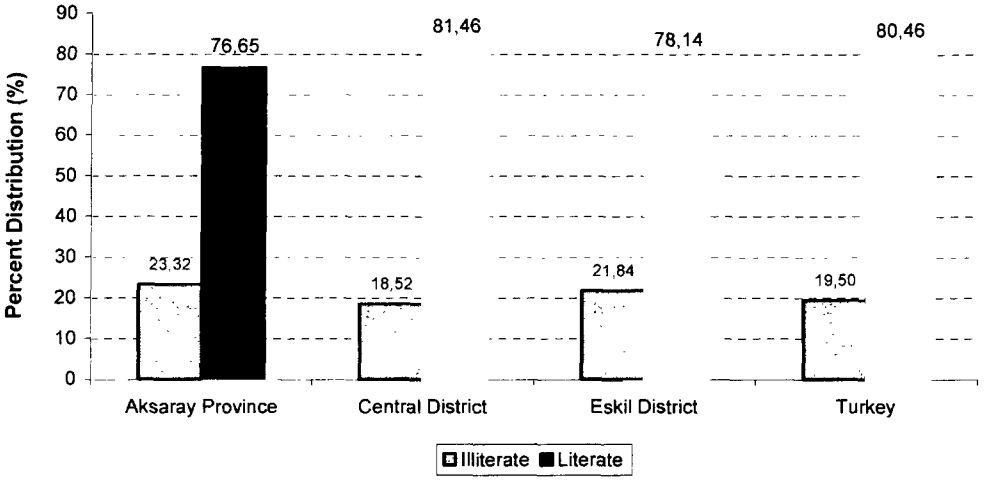


Figure 4.40 Literacy Ratios of Aksaray Province, Central and Eskil Districts

The distribution of literates in Aksaray Province, Central and Eskil districts according to the recent educational level is presented in Table 4.50. Accordingly, approximately 76% of the population of Aksaray is literate, where 47% of 6+ age group is primary school graduate. On the other hand, 1.34% of the population has academy or faculty education. The literacy ratio of the Central district is quite high, and 2.61% of its population is academy/university graduate, that is higher than the provincial ratio.

Table 4.50 Population Distribution According to the Recent Educational Level (%)

Literacy	Central District	Eskil District	Aksaray Province	Turkey
Illiterate	18.52	21.84	23.32	19.50
Literate	81.46	78.14	76.65	80.46
Not graduated from any educational institution	17.81	19.57	18.83	19.76

Primary school graduate	45.97	54.57	47.39	71.50
Secondary school graduate	8.15	2.09	5.40	11.66
Professional secondary school graduate	0.09	0.03	0.04	0.06
High school graduate	4.79	0.60	2.70	8.85
Professional high school graduate	2.00	0.48	0.90	3.19
Academy and/or university graduate	2.61	0.77	1.34	4.72

Source: SIS, 1990.

4.3.6.2 Health Services

There are a total of four health institutions in Aksaray Province by the year 1996, of which one is private and three are governmental (managed by the Ministry of Health). Private sector has 20 beds and the Ministry of Health has 300 beds, adding up to a total of 320 beds in the province (see Table 4.51). According to 1996 data, there are 264 doctors of which 59 of them are experts and 205 of them are general practitioners, 22 dentists, 174 midwives, 169 nurses, 251 health officials and 60 pharmacists, working in the province (SIS, 1997).

Table 4.51 Number of Hospitals and Beds in Aksaray Province

Institution	Number of Hospitals	Number of Beds
Public Hospital	3	300
Private Hospital	1	20
Hospitals of Social Insurance Institution (SSK)	-	-

Source: SIS, 1997.

4.3.6.3 Cultural Services

Since it is located at the intersection of east-west and south-north main roads, Aksaray Province is an important cultural center. There is library and museum at the city center. Besides the cultural activities in the province is carried out at the theatre found in the city center.

4.3.6.4 Other Infrastructure Services

Electricity

Electrical energy of Aksaray Province is supplied from the hydroelectrical power plants of Hirfanli and Seyhan dams (in Adana Province). There is electricity within all settlements

of the province (Aksaray Province Industrial Potential and Investment Areas Research, 1997).

Infrastructure and Drinking Water

Sewer system, collector and treatment system of Aksaray Province are being constructed. Among the 166 villages, which are not within the municipalities, 131 have sufficient drinking water supplies, whereas 35 villages do not have (Aksaray Province Industrial Potential and Investment Areas Research, 1997).

Telecommunication

All settlements within Aksaray Province have access to the national and international automatic telephone calls. Studies to connect telephone lines to some low-populated settlements are still in progress (Aksaray Province Industrial Potential and Investment Areas Research, 1997).

4.3.7 Urban and Rural Land Use in the Project Site and its Vicinity

Aksaray Province is in Central Anatolia Region, located in Central Kizilirmak section where the mountains situated at the north and south of the region digress. The province is flat and the sections higher than 1,000 m are plateaus. The central, northern and southern parts of the province are covered by plains.

Majority of the lands within the province (67.85%) are utilized for agricultural purposes. Within the province, maquis-shrubberies cover 14.59% and non-agricultural areas cover 16.73% of the lands. Only 0.83% of the lands are covered with forests (Tourism Inventory of Aksaray Province, 1992). The distribution of the lands within Aksaray Province according to land use types are presented in Table 4.52 and Figure 4.41 together with their surface areas.

Table 4.52 Land Use Types in Aksaray Province

Lands	Area (ha)	Ratio (%)
Agricultural area	529,400	67.85
Maquis-Shrubbery	113,790	14.59
Forests	6,510	0.83
Non-agricultural Area	130,500	16.73
TOTAL	**780,200**	**100.00**

Source: Tourism Inventory of Aksaray Province, 1992.

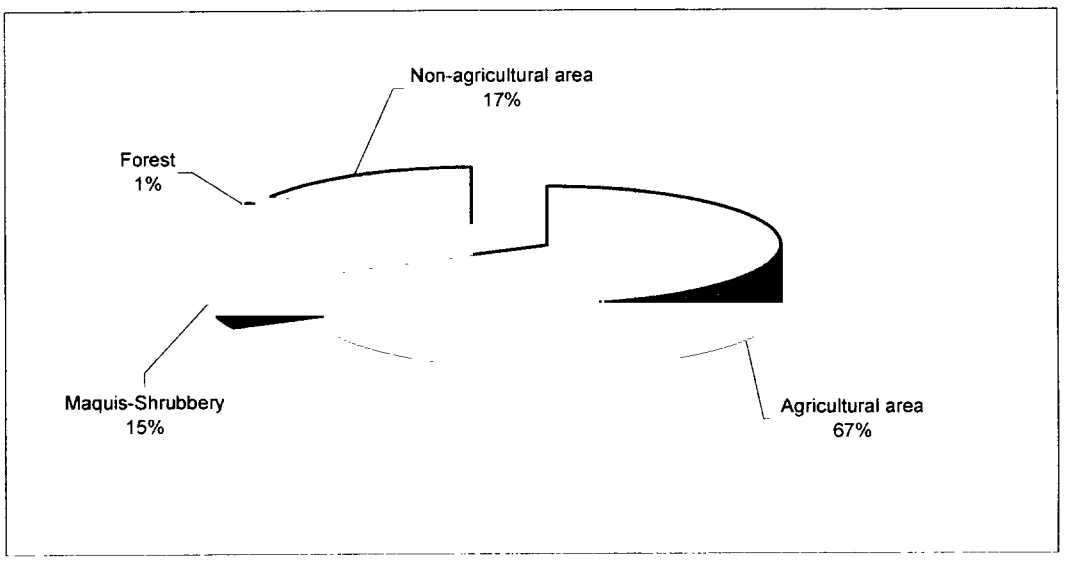


Figure 4.41 Land Use Types in Aksaray Province

4.3.8 Other Characteristics

4.3.8.1 Archaeological and Historical Assets

It is known from the findings obtained by Acemhoyük Tumulus, Asiklihoyuk Tumulus, Guvercinkaya and Musular excavations that Aksaray history goes back to 10,000 BC. Worldwide known Ihlara and Manastir Valleys and many carved settlements and underground cities are within Aksaray province, because of its geological structure. There exists many remains belonging to pre-Christian, Christian and Islam periods. Guzelyurt and Ihlara, which are among the most important religious centers of Christian society, are within this province. Aksaray had hosted many civilizations through out its history of 10,000 years and enriched by their cultural and archaeological remnants. Remains of Hellenistic, Roman, Byzantine, Karamanogullari and Seljuk periods are quite common.

There are many historical, cultural and archaeological assets within Aksaray Province like mosques, Turkish baths, mausoleums, masjids, castles, cemeteries, fountains and bridges, together with protected areas (see Section 4.2.12). In the Central District of Aksaray, Ulucamii, Viransehir, Acemhoyuk Antique Settlements, Egri Minare (Egri Minaret), Zinciriye Madrasah and Museum, Sultan and Agzikara Inns, Yusuf Hakiki Baba and Sheikh Hamid-i Veli tomb and masjids are present. In Eskil District, Kirkdam Underground City is found (Tourism Inventory of Aksaray Province, 1992).

4.3.8.2 Access Network

E-90 highway and Konya-Kayseri road pass through the Aksaray Province. The total length of the roads within the province is 468 km, of which 191 km is state roads and 277 km is provincial. 70 km of provincial roads are stabilized and the rest are asphalt. The village roads within the boundaries of the province are 2,024 km long, where 159 km are asphalt, 1,342 km are stabilized, 245 km are leveled and 278 km are unimproved (dirt track) (Aksaray Province Industrial Potential and Investment Areas Research, 1997). There are no settlements within the province that is not connected to the transportation network.

There is no railroad in Aksaray and the closest stations are located in Ankara, Konya and Kayseri city centers. The closest airport is in Ankara. The distance between Aksaray Province and Nevsehir, Nigde, Konya and Ankara are 73 km, 116 km, 142 km and 220 km, respectively.

5 IMPACTS ON THE AREA DEFINED IN SECTION 4 OF THE PROJECT AND MEASURES TO BE TAKEN

In this section, the environmental impacts, which are probable to occur until the termination of opening of first two caverns and the construction of above ground facilities of the proposed TUGSP, are surveyed by presenting the relevant activity definitions; the measures required to be taken to minimize the adverse impacts are discussed.

5.1 Site Preparation, Activities in Construction Phase of the Project, Impacts on Physical and Biologic Environment and Measures to be taken

Surface Facilities and Opening of Caverns

Three dimensional seismic studies were carried out by TPAO in November 2000 within the site of about 80 km² determined in the area and considering the obtained results, the locations of 10 caverns in which the natural gas will be stored and the surface facilities were determined (see Figure 2.1).

In the content of TUGSP, opening of two caverns will be carried out simultaneously and the required time for this operation is approximately 30-36 months. In this regard, the required time to create all caverns, which are thought to be 10, approximately 150-180 months, (12,5-15 years); natural gas will be commenced to be stored in the caverns created throughout this period. Depending on the formation of the salt layer, the water resource to be used for leaching and the rate of the leaching operation, this period may be extended for a period of 30 months.

After these two caverns are opened, approximately 30–45 months will be necessary for filling these spaces with natural gas and this period may be extended for a further 15 months depending on the natural gas potential and the rate of operation.

Except for the compressor station, which will be constructed at the top of each cavern to be created in the content of TUGSP and which will cover a limited area, there will be an area for the surface facilities. The surface facilities to be constructed will cover an area of around 500 m × 800 m (40 hectare). The structures such as control room, compressor building, filter units, heating and cooling systems, units in which the oil separators are found, pressure reducers, regeneration units, measurement unit, dehydration unit, facility for waste water treatment package, offices, workshop and garages will be found within the area.

Within the scope of the construction works under consideration, foundations, main and auxiliary buildings, delicate works, the mounting of heating, ventilation and plumbing and final site planning studies, the construction of water and gas transmission lines and discharge line will be realized. The criteria to be taken into consideration in the course of site planning are given below.

- Water, electricity and telephones lines will be provided to the central points.
- The discharge of the project site will be provided and internal roads will be rigid surfaced.
- A well-designed illumination infrastructure, a wire fence set up in a way that its control is simple and appropriate control points will be provided.
- A fire system and sufficient connection roads will be built.
- Except for the wire fence, a service building will be constructed adjacent to the main entrance gate and thus the entrance of unauthorized individuals to the site will be controlled.

Before the commencement of the construction activities, an application shall be made to the Agricultural Production and Development General Directorate (TÜGEM) of the Ministry of Agriculture and Rural Affairs, in order to determine whether the project area is included within the scope of the Law on Pastures numbered 4342. In case the area is a pastureland, permission shall be obtained from TÜGEM for changing the purpose of assignment before the construction.

Discharge Line

The brine discharge line is a gravitational line and shall provide discharge to Tuz Golu, the receiving body. The discharge region is the unproductive/arid region of Tuz Golu and has an approximate distance of 6000 m to the winter level limit (boundaries) of the lake and 7000 m to the unproductive/arid region border. The diameter of the discharge line, which will have a length of 39 km is envisaged to be 500 mm. It is envisaged that the construction activities of this line will be completed in 1.5 months.

In relation with the usage of the land along the pipeline route, being under the "Law on Transit Pipe Lines Law" numbered 4586, the pipelines are excluded from the scope of Article 14 of the "Law on Pastures" numbered 4342.

Natural Gas Branch Line

The pipeline to be constructed from the Kayseri–Konya–Seydişehir section of Eastern Anatolia Natural Gas Main Transmission Line will have an approximate length of 14 km

and a diameter of 40" (~ 1m). These construction activities are envisaged to be completed in approximately 2.5 months.

In relation with the usage of the land along the pipeline route, being under the "Law on Transit Pipe Lines Law" numbered 4586, the pipelines are excluded from the scope of Article 14 of the "Law on Pastures" numbered 4342.

5.1.1 Site Preparation, Pipeline Laying, Excavation in the Content of the Works to be Carried Out For Compressor Station and Discharge Process of Leaching Water, Excavation Wastes (Soil, Stone, Sand, etc.), Equipments, Vehicles and Machines to be used in Site Preparation and Facility Construction

Site preparation activities to be performed in the project site will comprise of threefold: (i) topsoil stripping, (ii) pipeline laying, (iii) compressor station and (iv) required excavation works for the discharge of leachate water.

The project site and its vicinity are mostly flat (slope 1-3%), with an average altitude of 1000 m for the region (see Figure 2.2 and Figure 2.3). It is given importance to the appropriate placement of all project units and thus to minimization of excavation in the design phase of TUGSP.

5.1.1.1 Excavation Amount During the Constrcution of Surface Facilities

The dimensions of the area to be constructed by base excavation from the surface facilities are envisaged to be 80 m x 80 m. When it is considered that 1 m base excavation will be made for setting the base on strong ground within this area, the volume of the excavation will be 6.400 m3. Approximately 640 m3 of this amount will be plant soil. The excavation materials will be taken from the area with forks and dozers and will be stored on unused areas in the region being separate from the plant soil. The height of this material will not be more than 1 m.

All excavation material will be protected with precautions preventing dusting as indicated in Article 7 of Regulation on Protection of Air Quality (HKKY) that entered into force being published in the Official Gazette dated 02.11.1986 and numbered 19269 in order to prevent the effects of wind and rain (for example use of nylon covers, compression with binding materials). The excavation will be thereafter used for area arrangement and filling and plant soil will be used for greening purposes. In the storage of excavation soil, the principles indicated in the Solid Waste Control Regulation[1] will be complied with.

[1] *Official Gazette Dated 14.03.1991 & numbered 20814*

5.1.1.2 Amount of Excavation During the Construction of Discharge Line

The brine discharge line is a gravitational line and shall provide discharge to Tuz Golu, the receiving body. The discharge region is the unproductive/arid region of Tuz Golu and has an approximate distance of 6000 m to the winter level limit (boundaries) of the lake and 7000 m to the unproductive/arid region border.

The diameter of the discharge line, which will have a length of 39 km is envisaged to be 500 mm. Within this context, approximately 111.150 m^3 pit excavation will be made for the discharge line and all of this amount will be reused for pit filling during land arrangement (see Figure 5.1).

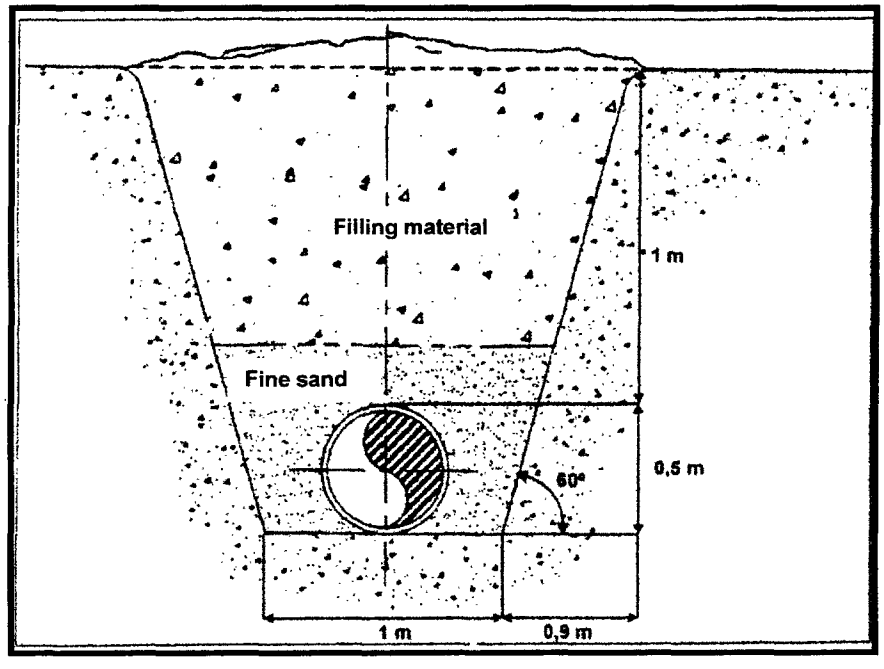


Figure 5.1 Cross Section of the Discharge Line

5.1.1.3 Amount of Excavation During the Construction of the Natural Gas Branch Line

The pipeline to be constructed from the Kayseri–Konya–Seydişehir section of Eastern Anatolia Natural Gas Main Transmission Line will have an approximate length of 14 km and a diameter of 40" (~ 1m). Within this context, approximately 75.600 m^3 pit

excavation will be made for the branch line and all of this amount will be reused for land arrangement and pit filling.

5.1.1.4 Amount of Excavation During the Construction of Compressor Stations

Approximately 150 m^3 excavation will be made for each of the compressor stations that will be constructed at well-head locations. **(See Figure 2).**

5.1.1.5 Excavation Operations

The excavation activities to be realized with conventional working machines will be embraced within the purchased areas. No explosives will be used in excavations. The buildings will be constructed, as prefabricated and ready mixed concrete will be used in the construction. Sand-gravel and construction iron to be used as filling material in the construction activities will be procured from the region and will be transmitted to the facility site. The requirements such as food, communication, accommodation services and labor force will be procured from the neighboring settlement areas.

The excavation materials during the construction of the discharge and branch lines may be used for back-filling and land arrangement purposes. Similarly, during the construction of these lines, requirements such as food, communication, accommodation services and labor force will be procured from the neighboring settlement areas.

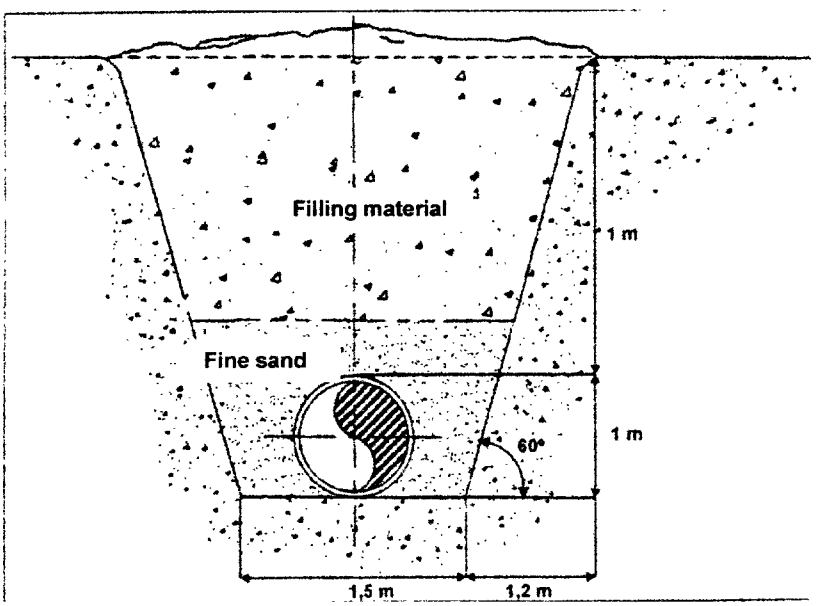


Figure 5.2 Cross Section of the Natural Gas Branch Line

The machines and equipment to be utilized in the site preparation period and the construction phase in the content of TUGSP and their amounts are presented below:

- Truck 4
- Crane 2
- Excavator 2
- Grader 1
- Loader 1
- Vibrating Cylinder 1
- Concrete Pump 1
- Transmixer 2
- Motor pumps 1
- Trailer (Pipe Carrier) 2
- Sideboom 4

The vegetative soil is comprised of soil layers, which are rich in humus, active in terms of microorganism activities, suitable for the plants to grow and 5-40 cm deep from the surface (see Section 5.1.17). These layers will be stripped and will be stored adjacently as piles in areas that are not in use on site. In the course of this storage, the top of soil piles will be covered by nylon covers and the soil loss (erosion) related to precipitation will be prevented. Following the construction phase this vegetative soil, which is rich in minerals, will be used in landscape studies.

Regarding these conditions, it is considered that the excavation planned to be realized in TUGSP construction site will have no important adverse impact on the topography of the region and natural landscape. The probable dust emissions and noise development concerning the site preparation and excavation processes are discussed in Section 5.1.8 and Section 5.1.16 respectively.

5.1.2 Works to be Carried Out For Soil Stabilization

Soil survey studies in the scope of the proposed TUGSP were carried out by ENVY. The report prepared in the consequence of these studies is presented in Appendix-N. The site studies in the content of the soil survey were realized on December 7-11, 2001 at the areas planned for both above ground facilities and conduit line route. The studies were carried out in three groups: (i) drillings, (ii) trenches and (iii) in-situ tests.

In this regard, six (a total of 122.45 m) drillings were performed and 10 trenches were excavated. In the drillings, the standard penetration tests and pressuremeter tests were done. The results obtained in the consequence of these studies are summarized below:

- In the extent of TUGSP, all above ground facilities will be carried by surfacial foundation. The foundation of these structures will be constituted with continual shallow foundations or radial foundations in accordance to the features of the structure. However, the width of the continual foundations will not be less than 120 cm. In this case, net safe bearing capacity of the ground will be taken as 150 kPa (1.50 kg/cm^2). The total settlements under the stresses that will be transferred to the base of the foundation from the upper structure will be within the acceptable limits.
- The marl, which will constitute the base of the foundation, is susceptible to the atmospheric effects and in case of a contact with water, it softens and swells. Therefore, the foundation excavations should be realized in no precipitation season and will not be left open interminably. Moreover, subsequent to the completion of foundation excavation, the base of excavation will be covered with at least 10 cm thick lean concrete as a countermeasure to the bottom heave.
- The excavations of foundation and conduit lines will be realized without a slope. Except from the surficial soil ranging between 0.30 m and 0.70 m in thickness, the material removed from the excavation of conduit lines can be used in backfilling. In the course of excavations, the excavation classes will be considered as 80% soft rock, 10% crowbar and 10% soil.
- In the project phase, the bed coefficient will be taken as 30,000 kN/m^3 for the base of the foundation at the construction site.
- Sultanhani and its vicinity are within the 5th Degree Earthquake Zone.

5.1.3 Operations to be Carried Out to Provide Soil Impermeability at Pipeline, Storage Facility and Other Units

The operations to be carried out to provide soil impermeability at the pipeline, storage facility and other units can be generally listed as follows:

- Following the commencement of gas storage, the impermeability tests will be realized.
- Soil coating systems will be applied at the roofed buildings such as compressor building.
- Level indicators will be used for storage tanks.
- Double walled storage tanks will be used when needed.
- Drainage collectors will be placed under the storage tanks.

- Besides, the theme will be explicated in detail by means of exclusive explanations in operator and maintenance-repair instructions.

5.1.4 Pipeline Design, Information on the Route

5.1.4.1 Technical Specifications of Pipes and Route

With the objective of underground storage of the excess demand of natural gas in the national network by withdrawing it from the network and conveying it again to the national network in case of need, the branching, which will be constructed to the project site from the Kayseri-Konya-Seydisehir part of the Iran-Turkey Natural Gas Pipeline, will be approximately 19 km in length and 40" in diameter (see Appendix-E).The pipeline route and its vicinity is generally flat (slope %1-3) and the average altitude of the area is 1000 m (see Figure 2.2 and Figure 2.3)

Maximum gas withdrawl is taken into consideration, while determining the pipe specifications. Accordingly, pipe characteristics with an approximate capacity of 30 x 10^6 m^3/day are given hereunder:

- Length : 14 km
- Diameter : 40"
- Type : American Petroleum Institute – API 5L standard x 70
- Wall thickness :15.9 mm
- Design Pressure :82.5 barg

5.1.4.2 Isolation and Cathodic Protection

Since the pipes will be coated, there will be no need for a further isolation. Only the welding points of the pipes will be isolated at the construction site.

For the protection of the pipes that will be buried into the opened trenches, opposite current cathodic protection system will be used. Opposite current system consists of: (i) Direct current feeder, (ii) opposite current bed (anode + filling), (iii) cathodic protection test points and (iv) connection cables. A typical cathodic protection system is given in Figure 5.3.

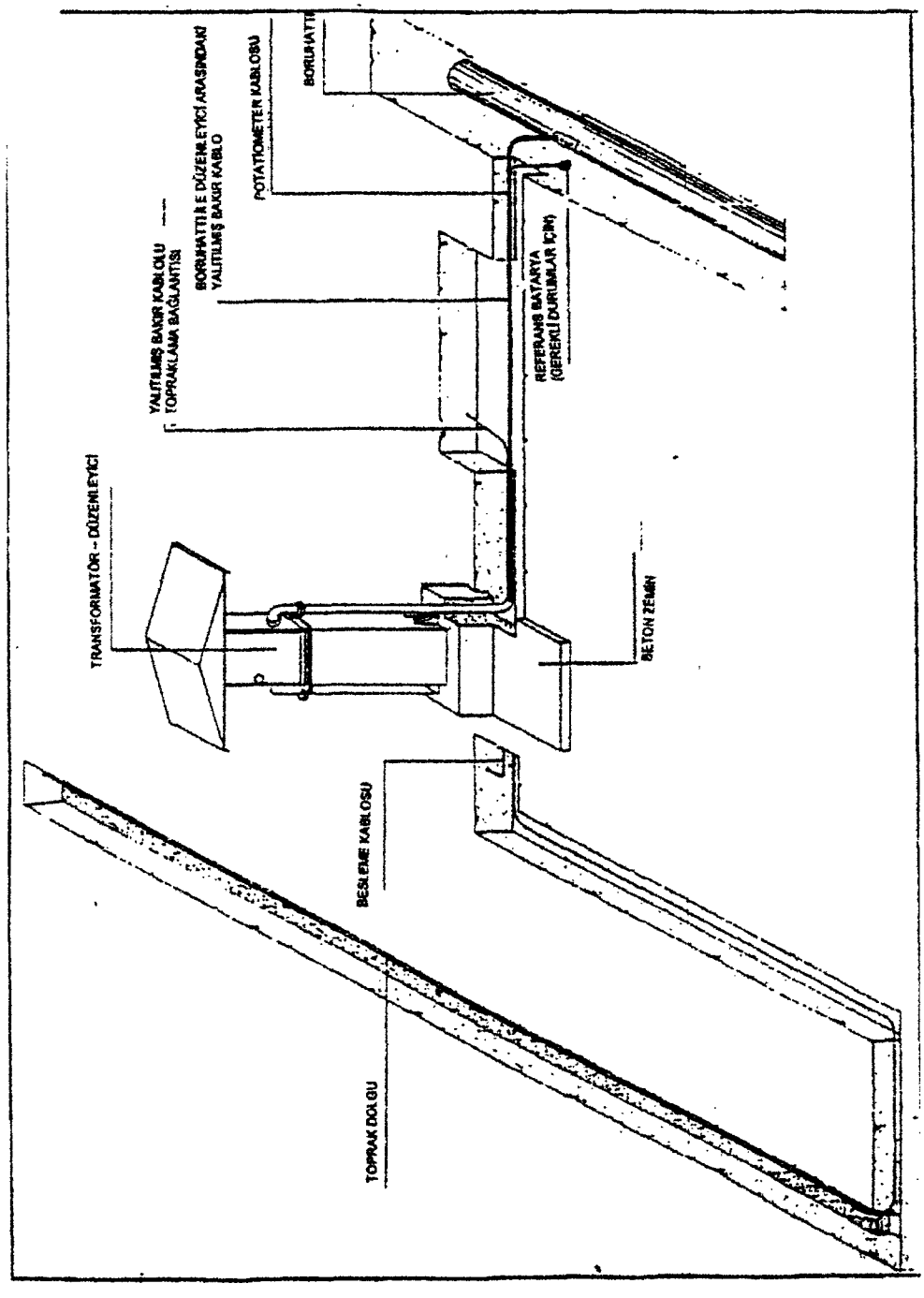


Figure 5.3 Typical cathodic protection system

The protective current intensity values are given hereunder taking into account the characteristics of the structures to be protected, coatings and the line:

- PE coated pipe (0,025 mA/m^2)
- Thermoset epoxy resin coated joints and elbows (0.5 mA/m^2)

The minimum economic life of the cathodic protection system will be 36 years. The number of anodes, the length, depth and dimensions of the bed, the current resistance of the system, its economic life and possible current intensities will be determined. The total ground resistance of the anode circuit (including bed and connection cables) is equal to 80% or less of the output value of the current hold of the direct current feeder.

Horizontal and vertical bed shall consist of Fe – Si anodes within the carbon filled bed. In case the bed is in a salty environment (high chlorine content), Fe – Si – Cr anodes will be used. All anode cables will be connected to a main cable. The embedded connection points between each anode cable end will be fixed with an appropriate connection kit. At the stage of installation, the bed will be determined with an appropriate signing system. In the cathodic protection application, the use of magnesium anodes is also on the agenda and will be assessed as an alternative to the system explained herein above during detailed engineering stage.

5.1.4.3 Technical Information Relating to the Laying of the Pipeline

One of the works to be carried out before the commencement of the construction activities is the determination of the width of the working line (right of way). The width of the working line of the natural gas branch line to be performed within the scope of this project and its typical depiction are given in Figure 5.4. In accordance with this, the width of this working line is envisaged to be 26 m in total, maximum 10 m on one side and maximum 16 m on the other side.

After the determination of the working line width, the operations to be carried out are as given hereunder:

- The map of all infrastructure facilities included along the trench (such as underground cable, water line, sewage line) will be provided and the construction plan will be made in accordance with this structure.
- The rocks in the region and all the materials that may damage the pipe or have an adverse effect on opening the canal will be moved out of the working line.
- During the trench opening activities, care shall be paid for preparing the canal base so as to set the entire pipe surface on the ground and for removing the

rocks, stones and other foreign materials that may damage the pipe from the canal

- Before laying the pipe into the trench, sand material obtained by sieving the excavation materials will be laid on the trench base.
- The excavation soil will be piled at a distance that will prevent falling back in the trench or filling back in the trench with rainwater.
- In cases where the pipeline construction continues on the existing highways, all precautions that will not prevent traffic flow will be taken.
- Along the route, the soil excavated will be loaded directly on the trucks without unloading at asphalt or concrete parts and will be transmitted to a place that will be found appropriate by the relevant local administration.
- On asphalt–coated routes, the asphalt will not be opened by breaking with compressors etc instruments for repairing the surface in an appropriate way, but it will be opened by cutting both sides of the surface with an appropriate tool.
- The pipes brought to the area will be welded and lowered in the canal after making the isolation of the welding points.
- "Sideboom" will be used for lowering the pipes in the canal (see Figure 5.4).
- In cases where hard materials or frozen soil exists in the filling soil that may damage the pipe or wrapping during the filling operation, padding operation will be performed.

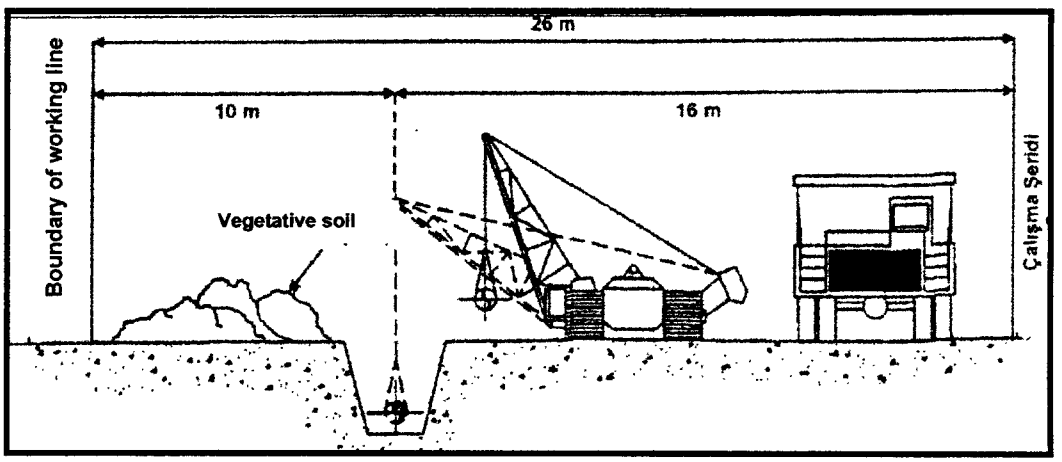


Figure 5.4 Right of Way of Branch Line

5.1.5 Locations and Determination of Caverns

The creation of the caverns in the salt structure and storage of fuel oil, petroleum or natural gas in these cavities is a technology implemented frequently in the world. For

instance, in developed countries such as United States of America (USA), half of the annual gas consumption is preserved as strategic reserve in the underground natural gas stores and in these countries approximately 30% of annual gas demand concerning the residential heating is met from the stores of concern. The number of underground natural gas store is around 450 in North America and around 100 in Europe (Satman, 2000). The information regarding the petroleum, petroleum derivatives and gas storage projects in the world is presented of Table 5.1.

Table 5.1 Model Applications of Underground Storage Projects

Business Holder	Place	Technique Used	Stored Product	Capacity (m^3)	Commissioning Date
GEOSEL-ANOSQUE	Manosque (France)	Leached cavern (salt)	Petroleum, diesel oil, fuel-oil, gasoline, naphtha	6,000,000	1969
GEOGAZ-LAVERA	Lavera (France)	Excavated cavern	Propane Butane	123,000 183,000	1971 1984
GEOMINES-CAEN	May-sur-Orne (France)	Unused mine	Diesel oil, domestic fuel-oil	5,000,000	1972
GEOVEXIN	Gargenville (France)	Excavated cavern	Propane	130,000	1977
ELF-ANTAR FRANCE	Donges (France)	Excavated cavern	Propane	80,000	1977
DISTRIGAZ	Wuustwezel (Belgium)	Aquifer	Natural gas	700,000,000	1986-1995
KNOC	Seul (South Korea)	Excavated cavern	Diesel oil	251,000	1982
CALOR GAS	Killingholme (England)	Excavated cavern	Propane Butane	120,000 120,000	1985 1986
SOMAS	Mohammedia (Morocco)	Leached cavern (salt)	Butane	119,000	1988
LG-CALTEX GAS	Yosu (South Korea)	Excavated cavern	Propane Butane	173,000 123,000	1983
LONE STAR ENERGY STORAGE	North Dayton Dome (America)	Leached cavern (salt)	Natural gas	100,000,000	1987
PEMEX	Tuzandepetl (Mexico)	Leached cavern (salt)	Petroleum	1,500,000	1992
SK-GAS	Ulsan (South Korea)	Excavated cavern	Propane Butane	310,000 240,000	1988
KNOC	Pyongtaek (South Korea)	Excavated cavern	Propane Butane	189,000 120,000	1989
GEOMETHANE	Manosque (France)	Leached cavern (salt)	Natural gas	300,000,000	1993

Business Holder	Place	Technique Used	Stored Product	Capacity (m^3)	Commissioning Date
BUTAGAZ	Sennecey (France)	Excavated cavern	Propane	8,000	1996
KNOC	Pyongtaek (South Korea)	Excavated cavern	Propane	420,000	1996
PRIMAGAZ	Lavera (France)	Excavated cavern	Propane	98,000	1997
ELGAS	Sydney (Australia)	Excavated cavern	Propane	135,000	2000
SK-GAS	Pyongtaek (South Korea)	Excavated cavern	Propane	270,000	1999
LG-CALTEX GAS	Inchon (South Korea)	Excavated cavern	Propane Butane	343,000 136,000	2000
COGEL (CALTEX-SOE)	Shantou (China)	Excavated cavern	Propane Butane	111,000 108,000	1999
REPSOL BUTANO	Carthagene (Spain)	Excavated cavern	Propane Butane	80,000 120,000	Design
TRANSGAS	Carrico (Portugal)	Leached cavern	Natural gas	140,000,000	Construction
SIGAS (Petrogal / BP / Boréalis)	Sines (Portugal)	Excavated cavern	Propane	80,000	Construction
BP-NINGBO HUADONG LPG	Ningbo (China)	Excavated cavern	Propane Butane	250,000 250,000	Construction
SALPG (TOTAL/HPCL)	Visakhapatnam (India)	Excavated cavern	LPG	120,000	Design
TPAO	Kuzey Degirmenkoy (Turkey)	Areas where reserves are consumed	Natural gas	1,900,000,000	Design

Source: http://www.geostock.fr/english/liste.asp

In accordance to the literature studies carried out regarding the topic, it is determined that various layers of underground are used as storage areas (see Appendix-L). For example, it is acknowledged that petroleum, oil products, chemicals, liquefied petroleum gas (LPG), LNG, natural gas and compressed air are stored in the cavities opened in the underground rock layers, porous rocks and salt beds (Source: PLE Advertisement Booklet). Alternatives concerning the natural gas storage are discussed in Section 7.

Accordingly, in the content of TUGSP, it is planned to store the natural gas in the cavities created at the underground salt beds. There are two regions in Turkey where the salt beds are abundant and one of the areas of concern is the south of Tuz Golu and the other is Mersin region. However, since the salt beds in Mersin region are close to the surface and the region is distant to the natural gas transmission lines, this area is not preferred in primacy.

In that context, taking its proximity to the natural gas main pipeline, its convenience in natural cavern creation and drainage processes and its location having the lowest seismicity risk in Turkey into consideration, the south of Tuz Golu is considered to be appropriate for the project.

Due to the fact that the storage process will be realized approximately 1000 m deeper in the ground, first of all three-dimensional seismic studies were performed in the scope of the proposed TUGSP. Thus, three-dimensional seismic studies were carried out by TPAO in November 2000 within the site of about 80 km² determined in the area and considering the obtained results, the locations of 10 caverns in which the natural gas will be stored and the surface facilities were finalized within the boundaries of this seismic study area (see Figure 2.2 and Figure 2.3). The information on the seismic studies of concern is given in Section 4.2.3.

The factors taken into account in the course of the selection of the proposed project site are listed below:

- Its proximity to the main pipeline (Kayseri-Konya-Seydisehir section of Iran-Turkey Natural Gas Pipeline);
- Its convenience in natural cavern formation and drainage processes;
- Being the lowest risked region regarding the Turkey's seismicity;
- Possessing water resources that are used for other purposes;
- Very low agricultural potential in the region.

The criteria taken into consideration during the determination of the locations of the caverns are as follows:

- The properties of the salt layer (depth, thickness, etc.);
- The quality of the salt layer (tectonic movements, etc.);
- The definite distance to the present wells;
- Taking the usage in future into consideration, the required distance (300-600 m) between the caverns and accordingly, wide area.

Accordingly, in the project intending the utilization of 10 caverns, the volume of each cavern will be approximately 500,000 m³. In the following years new caverns could be opened in line with the modifications in the national natural gas policy.

By taking the operational convenience and safety factors into consideration, it is planned that the distance between the caverns will be 300-500 m. Due to the safety criteria, it is required that this area is minimum 500 m remote from the nearest cavern. In this context, the distance of the above ground facilities planned to be constructed in the

content of TUGSP to the nearest cavern is approximately 700 m and the area under consideration will be located outside the boundaries of the salt layer determined in the consequence of the seismic studies (see Figure 2.1). Furthermore, compressor stations, which will cover a small area, will be built at the top of each cavern.

5.1.5 Operations Concerning Flood Prevention and Discharge

There are no surface water resources within the proposed project site and its vicinity. Therefore, no flood problem is believed to occur in the construction site.

All required measures will be taken against the surface water by connecting the drainage system to be set up at the foundation level of the building to the grate conduits and stacks to be set up all through the construction site and the water to be collected at these conduits will be discharged to the open field considering the appropriate distance and topography.

5.1.6 Transportation, Storage and Utilization of Flammable, Explosive, Hazardous and Toxic Materials, Utilized Equipment

No explosives will be used during the site preparation and the construction activities.

The fuels (gasoline, diesel fuel) to be used by the heavy vehicles will be purchased from the relevant commercial organizations as construction site delivery and the required delicacy will be presented to compel the vendor organizations to comply with the relevant legal obligations. Moreover, in the course of storage and usage of the fuels of concern utmost attention will be paid to provide the occupational and worker safety in line with the pertinent legislation. Accordingly, the procurement of secure storage and transportation vehicles will be provided. During the site preparation activities, the related articles of the Regulation on Hazardous Chemicals that entered into force being published in the Official Gazette dated 11.07.1993 and numbered 21634 will be complied with.

Throughout the salt dome creation process, it is required to use blanket fluid. Thus, the leaching process can be carried out under control. In the scope of TUGSP, it is planned that the blanket fluid will be nitrogen gas. The nitrogen to be positioned at the upper level of the leachate in the cavern will preclude the erosion that will occur towards the roof in the cavern and will provide that the cavern will be of the appropriate geometry at the end of the leaching process (see Figure 5.5).

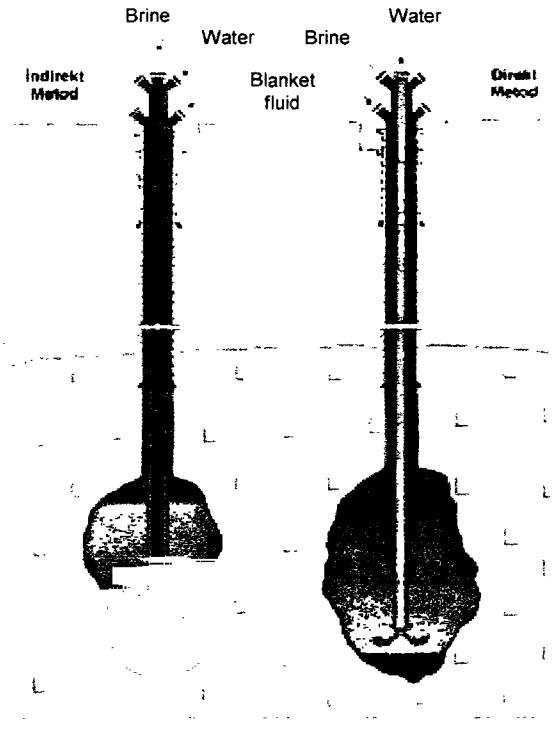


Figure 5.5 Blanket Fluid Usage During the Leaching Process

In addition, the solution level in the cavern will be controlled by nitrogen. The nitrogen, which will be stored in the tanks above ground in low temperature and in liquid phase, will be connected to the cavern area via integrated pipe system and will be pumped to the caverns by pumps. Predominantly nitrogen, which has a proportion of 78% in the atmosphere, is not a flammable, explosive or toxic gas. However, it's most significant characteristic is that it replaces the ambient gases. Therefore, the closed areas where it will be stored should be ventilated properly against any seepage possibility.

In the course of the leaching process, for every 1 m^3 of water to be pumped to the cavern 0.05 m^3 of nitrogen is needed. A total of 500,000 m^3 of nitrogen gas will be used to open one cavern. It is planned to create 10 caverns in the content of the project and this process will persist for around 14 years. In this regard, it is assumed that a total of 5×10^6 m^3 of nitrogen gas will be utilized throughout the project.

The other chemical substance planned to be used in the scope of the project of concern is "oxygen inhibitor". This chemical substance will be used at the area reserved for wells from which the necessary water will be procured for the leaching process in the caverns.

The chemical will be added to the water through the injection unit, which will be located at the outlet of the service store of 1500 m^3 in which the water that will be withdrawn from the wells will be stored. The chemical will remove the oxygen in the groundwater and thus, the corrosion of the equipment and pipelines used in the content of the project will be avoided. The amount of the "oxygen inhibitor" to be utilized in the project is directly proportional to the quantity of the oxygen inside the water taken from the underground reserves. The amount of concern will be clarified subsequent to the analyses of the well water carried out in the further phases of the project.

The inhibitor to be used in the project will be purchased from the relevant commercial organizations as construction site delivery and the required delicacy will be presented to compel the vendor organizations to comply with the relevant legal obligations. Moreover, in the course of storage and usage of the substance of concern utmost attention will be paid to provide the occupational and worker safety in line with the pertinent legislation. Accordingly, the procurement of secure storage and transportation vehicles will be provided.

5.1.7 Dust Emitting Processes, Their Impacts on Biological Environment and Measures to be taken, Dust Emission Calculations

Dust emission will be possible to be encountered during the construction activities due to various sources such as soil stripping, excavations, transportation on unpaved roads and construction materials to be fallen from the vehicles. In the course of the construction the dust emitting processes such as breaking, grinding will not be required.

With the intention to minimize the probable impats regarding the dust emission and to keep the dust emissions at the lowest level, the vicinity of the related areas will be irrigated. Besides, all transportation vehicles to carry excavation materials on site will be covered. The speed of the vehicles will be restricted with 30 km/hour on unpaved roads.

The filling material to be used will be procured from the closest locations to the construction site. Moreover, it will be paid attention to not to allow the crucks to pass on the mud on their wheels to the main roads on rainy days. In the course of application of these minimization methods, the measures proposed in the pertinent provisions of Article 7 of Regulation on Prevention of Air Quality issued in the Official Gazette dated November 2, 1986 and numbered 19269. In consequence, the impact of the dust, to occur during the construction activities, on the environment will be at acceptable levels.

The dust emissions to arise during the construction activities of the project will be discussed in the following sub titles. Regarding the subject, the emission factors stated by United States Environmental Protection Agency (USEPA) are given in Table 5.2.

Table 5.2 Dust Emission Factors

Activity	Emission Factor
Amount of dust emitted from stripping-off plant soil	0.029 kg/ton
Amount of dust emitted during excavation	0.02 kg/ton
Amount of dust formed during loading	0.018 kg/ton
Amount of dust formed during unloading	0.01 kg/ton
Amount of dust formed during unloading of plant soil	0.02 kg/ton
Amount of dust emitted from transportation	0.4 kg/km-vehicle*

**This value is calculated by using the formula $E = 0.3 \times k \times (s/12)^{0,9} \times (W/3)^{0,45}$ of EPA (1995) in order to find the dust emission caused by the roads. In this formula, k is the particle size factor and is 1.5 lb / mile – vehicle for (PM_{10}); s is the silt content of the road material (6.4%) and w is the average vehicle weight (7 tons). Reference: EPA, 1995.*

5.1.8.1 Dust Emissions from the Construction of Surface Facilities

Amount of Dust to Arise During Stripping-off Plant Soil

The amount of top (plant) soil to be stripped-off during the construction of surface facilities is estimated to be 640 m^3 (see Section 5.1.1.1). Accepting that the density of the soil is 2.70 g/cm^3, total dust production is calculated to be 1.728 tons. Estimating that the activitiy will continue for 15 days, the daily dust production is determined to be approximately 115 tons.

Considering 8 hours of work per day, the amount of dust to be generated from the excavation works is calculated as follows:

(115 tons / 8 hours) x (0.029 kg / ton) = 0.4 kg / hour

Amount of Dust During Excavation Works

The amount of excavation to be carried out during the construction of the surface facilities is estimated to be 5.760 m3 excluding the stripping-off topsoil (see Section 5.1.1.1). Considering that soil density is 2.70 g /cm3, total dust production is calculated to be 15.552 tons. Estimating that excavation works will continue for approximately 45 days, the daily dust production amount is determined to be approximately 346 tons.

Considering 8 hours of work per day, the amount of dust to be generated from the excavation works is calculated as follows:

(346 tons / 8 hours) x (0.006 kg /ton) = 0.3 kg / hour

Amount of Dust to Arise During Loading

For the amount of dust to arise from the loading and unloading activities, the site preparation and excavations carried out for compresor buildings are taken into consideration. In this regard, a total of 6,400 m^3 of excavation is planned (see 5.1.1.1). Estimating 2 months (60 days) for the loading activity, the daily loading amount is determined as approximately 288 ton. When it is considered that the daily working period will be 4 hours, the amount of dust to be arisen from the loading activities can be calculated as follows:

(288 tons / 4 hours) x (0.018 kg/ton) = 1.3 kg / hour

Amount of Dust to Arise During Unloading of Excavation Material

The amount of dust to arise from unloading activities is different for the excavation materials and the plant soil. Within this context, the dust emissions that will occur during the unloading of the excavation materials are taken into consideration (see 5.1.1.1). Soil density is assumed to be 2.70 g/cm^3 and total production is calculated to be 15.552 tons. Estimating that the unloading activity will continue for approximately 45 days, the daily unloading amount is determined to be approximately 346 tons.

Taking into account that unloading activity can be performed for 4 hours daily, the dust amount that will occur as the result of this activity can be calculated as follows:

(346 tons / 4 hours) x (0.001 kg / ton) = 0.1 kg / hour

Amount of Dust to Arise During Unloading of Plant Soil

The amount of dust to arise from unloading activities is different for the excavation materials and the plant soil. Within this context, the dust emissions that will occur during the unloading of the excavation materials are taken into consideration (see 5.1.1.1).

Assuming that soil density is 2.70 g/cm^3, total production is calculated to be 1.728 tons. Estimating that unloading operation will continue for 15 days, the daily unloading amount is determined to be approximately 115 tons.

Taking into account that unloading operation will continue for 4 hours daily, the dust amount that will be generated as the result of this activity can be calculated as follows:

(115 ton / 4 hours) x (0.02 kg / ton) = 0.6 kg / hour

Amount *of Dust to Arise from the Roads During Transportation*

While calculating the amount of dust to be aroused from the roads during transportation, it is assumed that the capacity of one truck is 5 tons and it will take a distance of 500 m at once. Taking into account that daily loading and unloading production is 288 tons and the number of trucks that will operate are 4, it is estimated that one truck will make 15 travels a day.

In addition, taking into account that one vehicle will operate for 4 hours a day, the dust emission calculation is given hereunder:

0.5 km/time x 15 times/4 hours x 4vehicles x 0.4kg/km–vehicle = 3.0kg/hour

Control methods such as limiting the speed of the truck during transportation with 30 km/hour and spraying the roads used with water, lower the dust emission as30% and 50% (EPA, 1995). In this context, it is envisaged that the amount of dust that will be generated during transportation will be 1.1 kg/hour.

Total dust amount to be aroused from the construction activities is equal to the sum of all dust emission sources.

Total Dust Amount =stripping off the plant soil+excavation+loading+unloading of excavation material+ unloading of plant soil + transportation

Total Dust Amount = 0.4 kg / hour + 0.3 kg / hour + 1.3 kg / hour + 0.1 kg / hour + 0.6 kg / hour + 1.1 kg / hour = 3.8 kg / hour

This value is over the value 1.50 kg/hour, which is given in Appendix 2 of Air Quality Protection Regulation stating that a modeling study is required. In this context, a modeling study related with the distribution of the dust emissions that will occur during the construction activities in the environment is carried out.

Dust Distribution Modeling

As indicated in the Air Quality Protection Regulation (HKKY) Appendix–2, Section 6.5.1, the contribution factor to the Air Pollution (HKD) for suspended particulate matter in the air is calculated with Formula II, given hereunder;

$$C(x,y,z) = \frac{10^6}{3600.2\pi}\frac{Q}{U_h\sigma_y\sigma_z}\exp\left[-\frac{y^2}{2\sigma_z{}^2}\right]\left[\exp\left[\frac{-(z+h)^2}{2\sigma_z{}^2}\right]+\exp\left[\frac{-(z+h)^2}{2\sigma_z{}^2}\right]\right]\exp\left[-\sqrt{\frac{2}{\pi}}\cdot\frac{V_{di}}{U_h}\int_0^x\frac{1}{\sigma_{z(\delta)}}\exp\left[\frac{-h^2}{2\sigma^2{}_{z(\delta)}}\right]d\delta\right]$$

where;

C(x, y, z) : HKD for each dispersion condition at the top point (mg/m^3)

Q :mass flow rate of the emissions from the emission source (kg/hr)

σy, σz :horizontal and vertical sdispersion parameters (m)

U_h : wind speed (m/s)

h : effective emission height (m)

x, y, z : Cartesian coordinates at the top point (x: in the spreading direction and conditions vertical to this spreading direction, y: horizontal, z: vertical)

Vdi : lowering speed (m/s) (taken as 0.07 m/s in cases where particle size distribution is not certain)

ξ : integration variable in x direction

Followings are accepted in calculation;

Q= 3.8 kg/hr

Average wind speed = 2.5 m/s

Anenometer height = 10 m

V_{di} = 0.05 m/sec

h = 15 m

In the calculation of the precipitating dust, the following formula is used:

$d(x, y) = 86.400 \times \Sigma Vdi \times Ci\ (x,y,0) / 10^3$

For dust distribution simulation, the production and the dispersion of the dust in accordance with distance as the result of utilization of SCREEN3 computer model are given in Table 5.3.

Table 5.3. Particle Materials that May be Caused by the Construction Activities for Surface Facilities and the Distribution of the Precipitating Dust in Accordance With Distance

Distance (m)	Particulate Matter (μg/m^3)	Precipitating Dust (mg/m^2.day)
100	7,622	32,927
200	6,943	29,994
300	4,100	17,712
400	2,591	11,192

500	1,737	7,503
600	1,235	5,335
700	920	3,974
800	712	3,076
900	566	2,445
1000	461	1,992
1100	383	1,655
1200	323	1,395
1300	276	1,192
1400	238	1,028
1500	208	899
1600	183	791
1700	163	704
1800	145	626
1900	130	562
2000	118	510

The long and short term limiting values that must be complied with for particle materials (PM) and precipitating dusts as indicated in HKKY are given in Table 5.4 hereunder;

Table 5.4 Limit Values Indicated in HKKY.

Pollutants	Long TermLimit (UVS)	Short Term Limit (KVS)
PM ($\mu g / m^3$)	150	300
Precipitating Dusts ($mg/m^3.day$)	350	650

Since the dust emission that will be caused by the surface facilities will be a provisional impact, comparison with the values indicated as KVS in HKKY is necessary. In this context, the dust amount and the precipitating dust concentrations at the ground level are estimated to go below the limiting values after1.300 m and 1.800 meters, respectively. In case these excavation activities are carried out between October – March, during which the plateaus are not used, these plateaus will not be affected from this condition. In addition, since these residential locations are not areas that are continuously used and since the buildings are generally for animals, these areas may be shifted to safer areas that are more distant from the caverns.

As a result, it is envisaged that the dust emissions that will be caused by the activities related with the surface facilities are envisaged to be limited with a short period such as 60 days. In this context, the dust emissions can not affect the air quality in the region for a long period.

5.1.8.2 Dust Emissions from the Construction of Brine Discharge Line

50 m section shall be under construction continuously during the construction of the brine discharge line. In other words, the pipes in 50 m sections on the route will be welded, the plant soil will be stripped-off, the pipe will be laid and the trench will be closed. These operations will be completed in approximately one week.

In this context, the main source of the dust emissions related with the pipeline construction will be the excavation activities during the trench opening.

The amount of excavation to be carried out for a 50 m section of the route is estimated to be 143 m^3 (see 5.1.1.2). Assuming that the soil density is 2,70 g/cm^3, total dust production is calculated to be 386 tons. Estimating that the excavation works will last for approximately 4 hours, the amount of dust aroused from the excavation is calculated as follows:

(386 tons / 4 hours) x (0,006 kg/tons) = 0.6 kg/hour

This value is below 1,50 kg/hour that requires dust distribution modeling according to the Annex-2 of HKKY. In this context, there is no need for a modeling of dust distribution that will be generated during the construction of discharge line.

All excavation material will be protected with the precautions preventing dusting as indicated in Article 7 of HKKY in order to prevent the effect of wind and rain (for example use of nylon covers, compressing with binding materials).

5.1.8.3 Dust Emissions Caused by Construction Activities Related with the Branch Line

Similar to the discharge line, there will be a 50 m section under continuous process during the construction of the natural gas branching line. In other words, the pipes in 50 m sections on the route will be welded, the plant soil will be stripped-off, the pipe will be laid and the trench will be closed. These operations will be completed in approximately one week.

In this context, the excavation activities that will be carried out while opening the trench will be the main source of dust emissions related with the pipeline construction.

The excavation amount that will be produced during the excavation operations to be carried out for a 50 m section along the route is estimated to be 270 m^3 (see Section 5.1.1.3). Assuming that soil density is 2,70 g/cm^3, total production is calculated to be 729 tons. Estimating that the excavation works will last for 4 hours, the amount of dust that will be generated by the excavation operations can be calculated as follows:

(729 tons / 4 hours) x (0.006 kg/ton) = 1.1 kg/hour

This value is below 1,50 kg/hour that requires dust distribution modeling according to the Annex-2 of HKKY. In this context, there is no need for a modeling of dust distribution that will be generated during the construction of discharge line.

All excavation material will be protected with the precautions preventing dusting as indicated in Article 7 of HKKY in order to prevent the effect of wind and rain (for example use of nylon covers, compressing with binding materials).

5.1.9 Details Regarding the Operations at the Aquatic Environments in the Project Site

In the scope of the project, the underground salt domes will be leached with water and it is proposed that the brine water (solution) formed owing to this process will be discharged to Tuz Golu.

The process waters taken from the caverns will be collected in the ponds and then the water will be transmitted to the receiving body (Tuz Golu) by means of gravity. The receiving body for the process water taken from the collection pond via the transmission line will be the arid region of Tuz Golu.

The length of the line to be used will be approximately 39,000 m and its discharge point is approximately 6000 m to the winter level border of the lake and approximately 7000 m to the unproductive/arid region border (see Appendix-R). The discharge line will be spiral welded steel pipe (SWSP) St 37, which will be 500 mm in diameter and coated with polyethylene (PE) internally and externally. At the end of the discharge line, there will be five diffusers having a diameter of 150 mm and one diffuser having a diameter of 230 mm, each with a length of 18 m and configured as zigzag holes and the discharge will be carried out towards the receiving body via this diffuser. The diffuser will be mounted on the prefabricated concrete supports (see Figure 5.6).

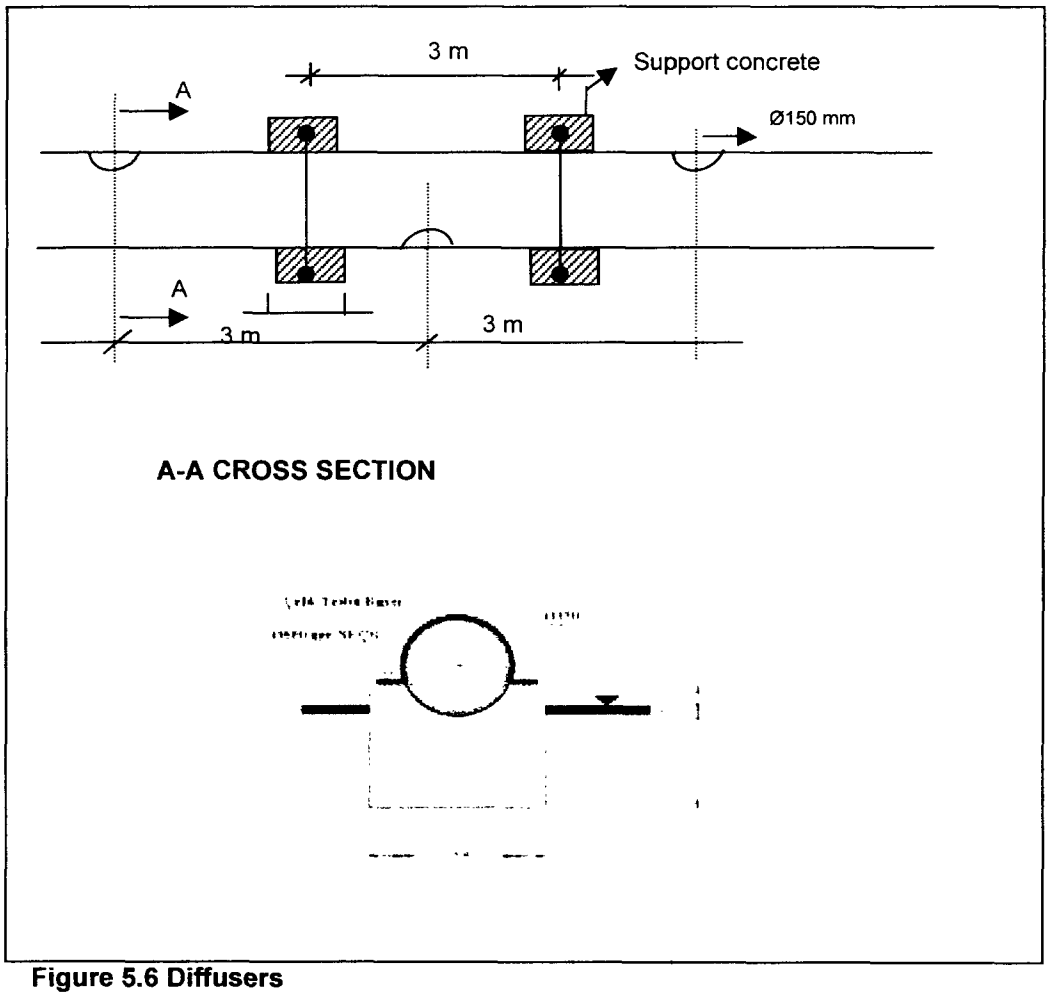


Figure 5.6 Diffusers

In the content of the proposed project, except for the construction activities of the solution discharge line to be carried out at the aquatic regions of Tuz Golu, there will be no construction activity in the aquatic environments. The section of the line having approximately 500 mm diameter, which will be constructed at the aquatic environment, will be 6000 m utmost (see Appendix-R). In this distance the pipeline will not be buried in the ground and will follow the ground.

Diffuser will be mounted to the last 18 m part of the 6000 m section of the line. A diffuser will be mounted to the final 18 m of the part of the line of 6000 m. The diffuser part of the structure will be placed over the concrete support. In this regard, there will be no excavation activity in the course of the construction activities at the aquatic environment. Only drilling will be performed to bury the supports and the water supports will be nailed.

It is presumed that the activities of concern will persist for two months utmost. In this context, the turbidity impact that can occur in the aquatic environment during the activities will be short termed and it will not result in an adverse permanent impact in the environment.

5.1.10 Infrastructure Plan of Transportation, Construction of Infrastructure

There will be no road construction in the content of the project. The existing roads on site will be utilized throughout the construction activities. Besides, water spray will be performed at certain periods to avoid the dusting. The frequency of water spray will be increased in summer times when the weather is hotter and arid.

The distribution of the traffic in Aksaray Province according to the motorized vehicles is presented in Table 4.40 in Section 4.2.16.5 in comparison to entire country. Accordingly, the traffic load is not so much. Sultanhani, which is 17 km north of the project site, is located on Aksaray-Konya highway and the traffic load of the highway is not high. In the section of highway lying behind the turn of the project site, the traffic load is lower. In this regard, the impact of the traffic load on Aksaray-Konya road that will be arisen on account of the activities in construction phase is of inconsequential level. Furthermore, in the scope of the project reclamation studies will be performed at the roads presently utilized for access to the project site from the main road.

When it is considered that the personnel that will work in the content of the project will accommodate in the surrounding settlements, the amount of dust to be arisen due to the transportation of the personnel will be of very low level. The activities concerning the dust formation resulted from the construction activities are presented in Section 5.1.8. In the consequence of the calculations and taken measures, the amount of dust that will be brought out because of the activities in the construction phase of the proposed project will not be in an amount that could impact the environment adversely.

5.1.11 Water Supply System and the Amount of Water Required

The water required in the content of TUGSP will be utilized for the purposes stated below:

- To leach the salt layers during the leaching process and create underground caverns where the natural gas will be stored;
- To meet the water demand (e.g. drinking and usage water) of the personnel;
- The construction activities of the above ground facilities and
- To irrigate the green areas later on.

The water required for all activities to be carried out in the content of the proposed project will be provided from the groundwater reserve located in the vicinity of Bezirci Lake. The permit letter acquired from the General Directorate of DSI for the usage of $5x10^6$ m^3/year of water from the groundwater reserve throughout the proposed TUGSP is given in Appendix -C. Therefore, a total of 6 wells, five main and one backup, will be drilled and used. The wells of concern will be located 6 km northwest to the site proposed for the above ground facilities and the water withdrawn form the wells will be pumped to the project site via a transmission line and will be collected in a storage tank.

The amount of water procured in the scope of the project is given below with regard to the usage purposes:

Water Demand of Caverns

According to the studies, maximum amount of water required for each cavern is 280 m^3/hour. Since the operation will be carried out simultaneously for two caverns, the highest flow rate that will be needed can be calculated as follows:

$$q_{cav} = 280\ m^3/hour \times 2$$
$$q_{cav} = 560\ m^3/hour$$

Water Demand of Surface Facilities

The amount of water to be used at the surface units will be 10 m^3/hour. The amount of concern will be utilized for the water demand of the personnel, fire and irrigation water. The water, which will be withdrawn from the store via a different line, will be transmitted to the surface facilities via a line of 6 km in length. The groundwater reserves are presently used as usage water. However, together with the opening of the wells and putting them into operation, the well waters will be analyzed permanently and in case of water quality deterioration, the necessary treatment units will be employed. The drinking water demand of the personnel will be provided by means of the water that will be carried by tanks to the project site from the Provincial Center.

Dilution Water Demand

It will be used to avert the brine water from being crystallized inside the pipes in winter, on days when the air temperature is very low (at most two weeks in one year) and its amount will be approximately 100 m^3/hour.

Total Water Demand

Total maximum water demand will be the sum of water demand of caverns, surface facilities and dilution water demand. In this case,

$$Q_{total} = q_{cav} + q_{above\ ground\ facilities} + q_{rarefaction}$$
$$Q_{total} = 560\ m^3/hour + 10\ m^3/hour + 100\ m^3/hour$$
$$Q_{total} = 670\ m^3/hour.$$

In this regard, the annual water amount to be needed is calculated as,

$$Q_{annual} = (560\ m^3/hour + 10\ m^3/hour) \times 365\ day/year \times 24\ hour/day$$
$$Q_{annual} = 4.993.200\ m^3/year$$

This value is below the value $5x10^6\ m^3$, which is the annual groundwater usage amount that is permitted by DSI. The value of concern, which will be withdrawn in control from the safe sections of groundwater reserves, is not accepted to bring out an adverse impact on baseline situation.

5.1.12 Electrification Plan in the Content of the Project

The electrical energy required for the construction and operation activities to be carried out on the proposed project site will be provided from the electrical lines that will be installed to the site. The total energy need in the operation phase of the facility is 5 MVA. It is planned to provide the amount of concern from one of the posts, which lies within the provincial boundaries of Aksaray and is located on Sultanhani-Eskil transmission line of 34.5 kW pertaining to the Turkish Electricity Distribution Corporation (TEDAŞ).

Regarding the topic under discussion, in the consequence of the deliberations realized with the TEDAŞ authorities in the region, it is stated verbally that the matter will be resolved by means of an application. In this context, following the clarification of the transmission line route the required official procedures will be commenced.

The operation of the machines, the safety of the construction site, low voltage energy line to be utilized for domestic and surrounding illumination will be attained with the underground (buried) cables. All measures stated in the standards will be taken for safety. In this regard, the transformer settling areas will be encircled with fence, warning signs will be furnished, the power switch panels will be locked and safety lots (clearances) will be provided.

It is recognized that no adverse impact will be of question environmentally concerning the issues such as power switch site, transformer and transmission line to be built in the content of the project. Nevertheless, in order to be on the safe side, the visual adverse impacts will be minimized by means of the landscape studies (afforestation, etc.) performed in overall TUGSP project.

5.1.13 Category and Amount of Solid Wastes and Disposal Methods During the Stage Beginning from Site Preparation to Commissioning of the Facilities

In the construction phase of the proposed TUGSP, solid wastes from various sources will be created. These sources can be classified as domestic wastes, residual oils resulting from the oil change of machines and vehicles, other solid wastes (iron pieces, steel, packing materials, material over sieve, etc.) and the solid waste to be arisen due to the insoluble substances inside the solution. The disposal methods of these wastes or how they will be utilized is presented in the following paragraphs.

5.1.13.1 Domestic Solid Wastes

A total of 100 personnel will be employed in the construction phase of TUGSP. The construction personnel will be elected from the residents in the region and there will be no accommodation in the project site. Therefore, the daily solid waste amount per capita will be 0.7 kg[2]. In this regard, it is anticipated that daily total domestic solid waste amount in the construction phase will be 70 kg. Even if temporary and for a short period, this amount will denote an additional load on the local system. As it is stated in the official letter of the Sultanhani Municipality dated February 18, 2002 and numbered 4/2-41, the domestic solid wastes of concern can be disposed at the dumpsite of the municipality (see Appendix-C).

5.1.13.2 Residual Oils

The disposal of the residual oils arisen from the oil change of the machines and vehicles in the course of the construction of the facility of concern will be carried out in compliance with the Hazardous Waste Control Regulation dated 27.08.1995 and numbered 22387. The stored waster will be given to one of the firms licenced by Ministry of Environment.

5.1.13.3 Construction Wastes

[2] *In the reserach realized by USEPA in, it is stated that the solid waste production per capita is 4.6 lb/day (2 kg/day). This value is lower in Turkey (approximately 1kg/day). Given that the personnel to be employed in the facility of concern will not be accomodated in the project site, the solid waste amount per capita will be approximately 0.7 kg/day.*

In the construction phase, solid wastes such as iron pieces, steel, packing materials and similar solid wastes and material over sieve (excavation material which is excess of backfilling) will be formed as well. These wastes will be collected and will be disposed at the dumpsite of the municipality as is stated in the official letter of the Sultanhani Municipality dated February 18, 2002 and numbered 4/2-41 (see Appendix-C).

5.1.14 Types and Consumption Quantities of Fuels and their Emissions and Disposal During the Stage Beginning from Site Preparation to Commissioning of the Facilities

In the course of the construction activities, the fuel will not be used in any operation except for the requirement of various heavy vehicles such as lorry, crane, excavator, grader, loader, vibrating cylinder, concrete pump, transmixer, motor pump, trailer (pipe carrier). In general, diesel fuel will be used in the construction vehicles of concern, whereas gasoline will be used in smaller vehicles. It is predicted that the gasoline consumption will be less than diesel fuel consumption.

Compared to the gasoline motors, the diesel motors, which are different owing to their operating principles, emit lesser carbon monoxide (CO) and hydrocarbon (HC), but more nitrogen oxide (NO_x) and particulate matter (PM) and these emissions are diffused from the sources like exhaust and crankcase leakage. The use of closed injection systems and the low volatility of the diesel fuels prevent the evaporation losses. According to the USEPA emission factors, in case if each heavy vehicle, which is maintained decently and is running with diesel fuel, would be driven with a speed of 0-30 km/hour, it would emit 8.61 g/min CO; 1.38 g/min HC and 6.27 g/min NO_x[3].

The daily pollutant emissions arisen from the heavy vehicles in the construction site are determined. It is accepted in the calculations that one machine of each type is running simultaneously and every machine is operating constantly for eight hours a day. The CO, HC and NO_x emissions calculated according to the USEPA emission factors are given in Table 5.5.

Table 5.5 Daily Pollutant (CO, HC and NO_x) Emissions Resulted from Heavy Machines

Pollutant	Emission Factors (g/sec)	Period (hour/day)	Daily Emission (kg/day)
CO	8.61	8	42
HC	1.38	8	7
NO_x	6.27	8	30

[3] *Air Pollutants Emission Factors, 3rd Edition, USEPA, Research Triangle Park, NC, 1977.*

The emissions resulted from the machines to be used in the construction phase will be temporary. Moreover, total emission believed to occur will be considerably below the emission that can be arisen from any highway and it will not bring out significant impacts on the air quality. Therefore, concerning the air quality no measurement and monitoring program is proposed for the construction phase.

5.1.15 Category and Amount of Wastewaters, Disposal Methods and Discharge Environments During the Stage Beginning from Site Preparation to Commissioning of the Facilities

5.1.15.1 Domestic Waste Waters

A total of 100 personnel will be employed in the construction phase of TUGSP. The construction personnel will be elected from the residents in the region and there will be no accommodation in the project site. Therefore, the daily water demand is determined as approximately 60 L per capita[4].

It is anticipated that the whole amount will return as wastewater. Thus, total domestic wastewater to be arisen in the construction phase will be 6000 L/day. The wastewaters will be collected in impermeable septic tank and will be taken by the sewage trucks of Sultanhani Municipality and disposed as stated in the official letter of Sultanhani Municipality dated February 19, 2002 and numbered 4/2-43 (see Appendix-C). The septic tanks will be constructed in compliance with the terms of references of Bank of Provinces, "Water Pollution Control Regulation Technical Codes Notice", which is issued in the Official Gazette dated January 07, 1991 and numbered 20748, and "Regulation on Pits to be Provided In Places Where Construction of Sewage Watercourse is Not Feasible", which is issued in the Official Gazette dated March 19, 1971 and numbered 13783.

In the content of TUGSP, it is planned that a total of ten caverns will be opened and the opening of two caverns will be carried out simultaneously. The required time for this operation is approximately 30-36 months. In this regard, considering the construction of the other facilities, the project will be completed in approximately 12,5-15 years. Throughout this period, natural gas will be commenced to be stored in the caverns created, while new caverns will be opened as well. In other words, the construction and operation phases will be carried on simultaneously.

[4] *In the "Regulation on the Drinking and Usage Water Project Preparation of Provinces and Towns" of the General Directorate of Bank of Provinces, the daily water need per capita in the settlement areas which their population is less than 3000 individuals is determined as 60 L.*

Together with the commencement of the operation phase of TUGSP, wastewater treatment package will be used instead of the septic tanks and the domestic wastewaters will be treated in this facility, will be used for irrigation or will be discharged to Tuz Golu by connecting to the brine discharge line.

In order not to create mud, which will be in an amount that would result in environmental problems, at the wastewater treatment package facility, biological treatment technique including extended aeration will be preferred. The discharge pertaining to the domestic wastewater treatment facility will be realized in compliance with the criteria given in Table 21.2 of Water Pollution Control Regulation (see Table 5.6) and the wastewater discharge values stated in Fishery Products Law numbered 1380 and Regulation on Aquatic Products[5].

Table 5.6 Domestic Wastewater Discharge Standards

Parameters	Discharge Limits*	
	2 Houred Composite Sample	*24 Houred Composite Sample*
BOD_5 (mg/L)	50	45
COD (mg/L)	160	110
SPM (mg/L)	60	30
pH	6-9	6-9

BOD: Biochemical Oxygen Demand
COD: Chemical Oxygen Demand
SPM: Suspended Particle Matter
**Class 2: Pollutant load is 60-600 kg/day as raw BOD, Population=1,000-10,000*

5.1.15.1 *Oily Waters*

There will be no activity in the construction phase of the project, which will require the formation of industrial wastewater that can merge into the groundwater or will be given to the planned general discharge system. Therefore, there will be no industrial wastewater discharge outside the site throughout the construction phase. Furthermore, it is not anticipated that the various washdown waters and wastewaters that will be probable to arise will contain any pollutant of considerable amount except for the suspended solid (soil, etc.) and oil and grease. The washdown waters of concern will be collected via a distinct line excluding the domestic waters. The washdown waters, which will be passed through the oil holders, will be sent to the wastewater treatment package facility that are used in domestic wastewater treatment.

The waste oils, which will be resulted from the oil change of the machines and vehicles throughout the construction of the facility of concern, will be collected at separate

[5] *Official Gazette dated 27.07.1973 and numbered 14607*

containers and their disposal will be carried out in accordance with the Hazardous Waste Control Regulation dated 27.08.1995 and numbered 22387.

5.1.15.1 Solution Discharge

The detailed information concerning the topic is presented in Section 5.2.5.

5.1.16 Vibration, Sources and Level of the Noise During the Stage Beginning from Site Preparation to Commissioning of the Facilities

The machines and equipment to be utilized in the site preparation period and the construction phase of TUGSP and their noise pressure levels, Lw (SBD), are presented below. The listed noise levels are determined by means of the comprehensive studies, which were previously carried out on the construction equipment.

- Truck 85 dBA
- Crane 105 dBA
- Excavator 105 dBA
- Grader 120 dBA
- Loader 115 dBA
- Vibrating Cylinder 110 dBA
- Concrete Pump 115 dBA
- Transmixer 115 dBA
- Motor pump 120 dBA
- Trailer (Pipe Carrier) 85 dBA

The equivalent noise level that all noise sources form at a certain level is calculated by means of the formula given below:

$$L_{eq} = 10\text{Log}\frac{1}{n}\sum_{i=1}^{n} 10^{L_w/10}$$

L_{eq} = Equivalent SBD value, dBA
N = Number of noise resource
L_w = SBD values of the machines, dBA

In this regard, considering the most pessimistic approach, assuming that at least one of all machines listed above will operate simultaneously, the total equivalent noise level is:

$$L_{eq} = 10\log\left[\frac{1}{10}\left(2\times10^{85/10} + 2\times10^{105/10} + 10^{110/10} + 3\times10^{115/10} + 2\times10^{120/10}\right)\right]$$

L_{eq}= 114,93 dBA

The value (L_p) of the equivalent noise level that will be arisen by the machines considering a certain distance is calculated with the formula given below.

$$L_p = L_{eq} + 10\ Log\ (Q/(4\ \pi\ r^2))$$

Q :Reduction factor chosen due to the flatness or roughness of the field (Modelling was realized by taking the reduction factor as 1 in rough field and 2 in flat field owing that the topography would change throughout the route.)
r :Distance (m)

Due to operation in the open environment, the reduction in the noise level due to atmospheric absorption is calculated with the following formula:

$$A_{atm} = 7{,}4\times10^{-8}\times f^2\times\frac{r}{\phi}$$

A_{atm}: Reduction in the noise pressure level with atmospheric absorption (dBA) (calculated for 50 m and longer distances)

f: frequency of the transmitted noise (1500 Hz)

r: distance from the source (m)

ϕ: relative humidity (60% in accordance with the average of the data for years taken from Aksaray and Karapınar meteorology stations)

The noise levels at various distances are calculated as hereunder with these formulae and are summarized in Table 5.7 and Figure 5.7.

Calculation of noise level for r=10 m

Lp = Leq + 10 x log (Q / 4 π r^2)
Lp = 114.9 + 10 x log (2 / 4 π $(10)^2$)
Lp = 86.9 dBA

Calculation of noise level for r = 50 m

Lp = Leq + 10 x log (Q / 4 π r^2)
Lp = 114.9 + 10 x log (2 / 4 π $(50)^2$)

Lp = 72.9 dBA

$Aatm = 7.4 \times 10^{-8} \times f^2 \times r/\phi$

$Aatm = 7.4 \times 10^{-8} \times 1500^2 \times 50/60$

Aatm = 0.1 dBA

$L_{50} = Lp - Aatm$

$L_{50} = 72.9 - 0.1$

$L_{50} = 72.8$ dBA

Calculation of Noise level for r = 100 m

$Lp = Leq + 10 \times \log (Q / 4 \pi r^2)$

$Lp = 114.9 + 10 \times \log (2 / 4 \pi (100)^2)$

Lp = 66.9 dBA

$Aatm = 7.4 \times 10^{-8} \times f^2 \times r/\phi$

$Aatm = 7.4 \times 10^{-8} \times 1500^2 \times 100/60$

Aatm = 0.3 dBA

$L_{100} = Lp - Aatm$

$L_{100} = 66.9 - 0.3$

$L_{100} = 76.6$ dBA

Calculation of Noise level for r = 250 m

$Lp = Leq + 10 \times \log (Q / 4 \pi r^2)$

$Lp = 114.9 + 10 \times \log (2 / 4 \pi (250)^2)$

Lp = 59.0 dBA

$Aatm = 7.4 \times 10^{-8} \times f^2 \times r/\phi$

$Aatm = 7.4 \times 10^{-8} \times 1500^2 \times 250/60$

Aatm = 0.7 dBA

$L_{50} = Lp - Aatm$

$L_{50} = 59.0 - 0.7$

$L_{50} = 58.3$ dBA

Calculation of noise level for r = 500 m

$Lp = Leq + 10 \times \log (Q / 4 \pi r^2)$

$Lp = 114.9 + 10 \times \log (2 / 4 \pi (500)^2)$

Lp = 52.9 dBA

$Aatm = 7.4 \times 10^{-8} \times f^2 \times r/\phi$

$Aatm = 7.4 \times 10^{-8} \times 1500^2 \times 500/60$

Aatm = 1.4 dBA

$L_{50} = Lp - Aatm$

$L_{50} = 52.9 - 1.4$

L_{50} = 51.5 dBA

Calculation of noise level for r = 750 m

Lp = Leq + 10 x log (Q / 4 π r^2)
Lp = 114.9 + 10 x log (2 / 4 π $(750)^2$)
Lp = 49.4 dBA
Aatm = 7.4 x 10^{-8} x f^2 x r/ϕ
Aatm = 7.4 x 10^{-8} x 1500^2 x 750/60
Aatm = 2.1 dBA
L_{50} = Lp – Aatm
L_{50} = 49.4- 2.1
L_{50} = 47.3 dBA

Calculation of Noise Level for r = 1000 m

Lp = Leq + 10 x log (Q / 4 π r^2)
Lp = 114.9 + 10 x log (2 / 4 π $(1000)^2$)
Lp = 46.9 dBA
Aatm = 7.4 x 10^{-8} x f^2 x r/ϕ
Aatm = 7.4 x 10^{-8} x 1500^2 x 1000/60
Aatm = 2.8 dBA
L_{50} = Lp – Aatm
L_{50} = 46.9 – 2.8
L_{50} = 44.1 dBA

Calculation of Noise Level for r = 1200 m

Lp = Leq + 10 x log (Q / 4 π r^2)
Lp = 114.9 + 10 x log (2 / 4 π $(1200)^2$)
Lp = 45.3 dBA
Aatm = 7.4 x 10^{-8} x f^2 x r/ϕ
Aatm = 7.4 x 10^{-8} x 1500^2 x 1200/60
Aatm = 3.3 dBA
L_{50} = Lp – Aatm
L_{50} = 45.3 – 3.3
L_{50} = 42.0 dBA

Table 5.7 Distribution of the Noise Resulted from the Machines to the Distance (Flat Field)

Distance from	Lp (dBA)	A_{atm} (dBA)	Total Noise Level

source (m)			(dBA)
0	114,9	-	114,9
10	86,9	-	86,9
50	72,9	0,1	72,8
100	66,9	0,3	66,6
250	59,0	0,7	58,3
500	52,9	1,4	51,5
750	49,4	2,1	47,3
1000	46,9	2,8	44,1
1200	45,3	3,3	42,0

The closest residential location to the project area is Ömerağa Plateau, which is at a distance of 1100 m (see Table 2.1). As the result of the noise measurements carried out during the siteworks, this noise level of the region is determined to be 52.4 dBA (see Section 4.2.16.4).

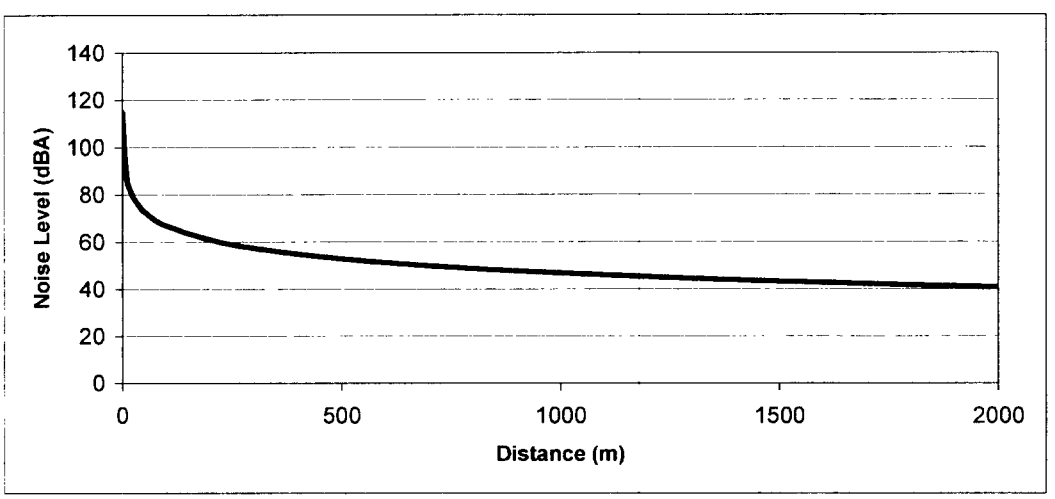


Figure 5.7 Distribution of the Noise Resulted from the Machines to the Distance (Flat Field)

Since the noise levels must be summed in order to obtain all or a weight total level or power levels of a given frequency spectrum or the combined noise levels of noise sources, that is the backplane noise of a source, logarithmic values are summed up after being converted into energy units (Acoustic Society, 1994). This calculation is performed using the following formula:

$$\text{Total noise level} = 10 \times \log \Sigma^{n}_{1}\, 10\, \text{In}/19$$

n: number of noise levels to be summed up

Ln: noise levels to be summed up (dBA)

With the help of the formula given herein above, it is calculated that the noise level that may be created at Ömerağa Plateau due to construction activities is about 53 dBA. As can be seen, the noise level caused by the construction activities will not have a negative impact at this plateau.

The Leq limit values determined for different regions with GKY are given in Table 5.8. In accordance with this, the noise that will be created at Ömerağa Plateau for the closest location during the construction of the surface facilities complies with the limit value determined for Region III.

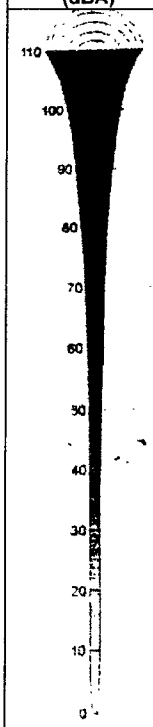
Table 5.8 Noise Limit Values (GKY Table 3)

Region	Explanation	Leq (dBA)
I	Settlement area out of the city (far from traffic)	35 – 45
II	City side settlement City settlement area (100 m distance to traffic flow) Settlement area out of the city, main roads, workplaces (60 m distance to traffic flow)	40 – 50 45 – 55 50 – 60
III	The city center settlement area, main roads, work places (20 m distance to traffic flow)	55 – 65
IV	Industrial Region or roads on which heavy vehicle and buses are operated	60 – 70

The equivalent values of the noise levels and social reaction intensity are given in Figure 5.8. A noise level about 50 dBA is a level that is acceptable at residential locations. The construction activities that will be carried out within the scope of Tuz Golu Basin UGNSP will cause an increase of only 0.6 dBA at Ömerağa Plateau, which is the closest location. In this context, the noise level that will be caused by the construction of the surface facilities is not expected to create any negative impact in the near surrounding.

There will be no explosion during the construction activities and within this period, the precautions indicated in Article 22 of Decree on Worker Health and Work Security will be taken and the employees will be provided with special helmets, earphones or ear taps that are protective against noise. The maximum noise levels that the employees may be subject to as given in GKY Table 2 are indicated in Table 5.9. These values will not be exceeded during the construction activities to be carried out within the scope of the proposed project.

The operations causing noise will be limited within the hours 06:00– 1900, which is stated in Noise Control Regulation and is defining the daylight hours.The works will be restricted with the activities generating low noise levels at nights and on official holidays

NOISE LEVEL (dBA)	SOCIAL REACTION	INTERNAL LOCATION NOISE LEVEL	EXTERNAL LOCATION NOISE LEVEL
		Rock concert	
	Local public action with effective or legal activities		Jet passing at a height of 300 m
		Inside of metro train	
			Gasoline grass cutting machine at a distance of 1 m
	Complaint petitions		
		Hand mixer at a distance of 1 m	
			Diesel truck at a distance of 15 m
	Strongly possible to be complained about		Day time in – city noise
		Shouting at a distance of 1 m Vacuum cleaner at a distance of 3 m	
	Possible to be complained about		Gasoline grass cutting machine at a distance of 30 m
		Normal speech at a distance of 1 m	
	Rare complaints	Large office	Intense traffic at a distance of 100 m
		Dish washing machine in the adjacent room	Day time silent in – city location
	Acceptable	Small theater, conference hall (backplane)	Night time silent in – city location
		Library	Night time silent out of city location
		Bed room at night Concert hall (backplane)	
			Night time silent rural area
		Broadcast and recording studio	
		Hearing limit	

Reference: Hatono. M. 1980

Figure 5.8 Equivalent Values of Levels and Social Reaction intensity

Table 5.9 Maximum Noise Levels

Noise Occurrence Period (hour/day)	Maximum Noise Level (dBA)
7.5	80
4	90
2	95
1	100
0.5	105
0.25	110
0.125	115

5.1.17 Trees to be Cut Down, Flora Species to be Disturbed, Measures to be taken During the Stage Beginning from Site Preparation to Commissioning of the Facilities

In the consequence of the literature studies and site surveys realized in the content of the EIA studies, it is determined that there is no forest or forestry area in the study area and its vicinity. In general, taking the ecological properties of the project site and its vicinity into consideration, it can be uttered that the forest development is not likely. Since no natural forestry vegetation is present on site, no tree cutting will be realized.

Moreover, Bezirci Village Surrounding is not in the scope of the Forest Law numbered 6831 in accordance to the official letter of Aksaray Administration Office of Konya Forestry Administration Directorate of T.R. Ministry of Forestry dated November 20, 2001 and numbered 05.KD.1/537 (see Appendix-C).

Except for the compressor station, which will be constructed at the top of each cavern to be created in the content of TUGSP and which will cover a limited area, there will be 40 hectares of area where the surface facilities will be located. Majority of the construction activities will be carried out on this area and consequently, the vegetation within the 40 hectares of area of concern will be removed. However, since this area is pasture and thicket presently, the vegetation to be removed will not have adverse impact on the vegetation specific to the region.

5.1.18 Size, Land Use Capability and Crops of the Agricultural Areas to be destroyed During the Stage Beginning from Site Preparation to Commissioning of the Facilities

According to the soil investigation studies carried out at the three dimensional seismic study area and its vicinity by the authorities of II. Regional Directorate of Konya Rural Services, the project site and its vicinity (see Figure 1.2) are III. Class rain-fed agricultural areas and surrounding the area of concern settlement areas (plateaux) are present. In the areas where the agriculture is being performed based on precipitation, the productivity is middle and low owing to the soil depth. In line with the information obtained from the site surveys, it is determined that the main agricultural products in the region area wheat, barley and rye.

The areas to be utilized on site will cover an area of 500 m × 800 m (40 hectare) where compressor station, which will be constructed at the top of each cavern and will cover a limited area, and the above ground facilities will be located.

5.1.19 Accommodation and Other Technical/Social Infrastructure Demands of the Personnel During the Phase Beginning from Site Preparation to Commissioning of the Facilities and Personnel Relevant Population

The number of workers will be approximately 100 in the construction phase. 20 of the personnel to be employed will be engineers and formen, while the rest, 80 of them, will be unqualified construction workers. All workers will be provided from the settlement areas in the vicinity and there will be no accommodation at the project site.

The worksite to be constructed within the project site will comprise of the site offices of the supervising personnel, equipment and spare parts warehouses, dining hall, dressing room and an infirmary where a doctor will be employed constantly. The minor injuries will be treated in this infirmary; while more serious incidents will be transferred to Sultanhani Health Clinic or Aksaray State Hospital. The wastes to be arisen from the infirmary will be stored in separate containers and will be disposed in compliance with the relevant articles of the Regulation on the Control of Medical Wastes dated May 20, 1993 and numbered 21586.

The water demand for all activities to be carried out in the content of the project will be supplied from the groundwater reserve in the vicinity of Bezirci Lake and will be withdrawn from the total of six wells, five main and one backup. The wells under discussion are located approximately 6 km northwest of the above ground facilities; the water withdrawn from the wells will be transmitted to the project site by a transmission line and will be collected in a storage tank. The potable water demand of personnel will be carried with tankers. Since Sultanhani Municipality is at approximately 17 km north of the project site, it is anticipated that the food demand will not cause any problems.

5.1.20 Risky and Dangerous Activities Regarding the Human Health During the Stage Beginning from Site Preparation to Commissioning of the Facilities

The probable risks against the human health and safety in the course of the construction phase of TUGSP project are related to the accidents possible to occur in such construction works. In this regard, the contracting company that will realize the construction activities will utilize the information and experience and moreover, the safety principles[6] which are accepted worldwide in order to furnish a site secure for all workers and provide the security of excavation, scaffold and heavy vehicles (cranes, etc.).

[6] *These principles are determined by acts and regulations such as Worker Health and Occupational Safety Act (Official Gazette dated September 12, 1974 and numbered 15004).*

Against the probable occupational accidents, warning signs will be placed on site, the required safety equipment of the workers will be procured and the entries and exits to the construction site will be taken under control by taking the relevant articles of the "Worker Health and Occupational Safety Act" into consideration. Besides, with the intention to minimize the potential environmental contamination risks, the required protection measures will be taken.

5.1.21 Landscape Aspects and Site Reclamations

The purpose of realizing site reclamation at the project site by utilizing landscape aspects is to provide the visual screening of the project facilities and to create a picturesque environment for the project. In that context, the vegetative soil to be removed from the surface during the excavation studies is planned to be piled at a convenient section of the construction site and to be used by spreading it to the required places at a time close to the termination of the construction activities.

The vegetative soil with 10 cm depth from the surface, which is rich in humus, active in terms of microorganism activities, suitable for the plants to grow. The vegetative soil to be excavated from the surface will be piled orderly. The top of the vegetative soil depots will be covered with inorganic (polyethylene and similar material) or organic (grass, grassy flora planting, etc.) materials for protection against erosion, drying, spreading over with wild grass and for the soil to maintain its vigor. No debris and filth such as stone, gravel, sand, lime, liquid fuel leakage, other oils or oily substances, tar having a size exceeding 5 cm should be found inside the vegetative soil. In the course of the construction activities, the above-mentioned aspects will be complied with.

Following the completion of the rough construction works, adequate afforestation studies will be performed within the boundaries of the project site. Flora species convenient to the climate of the region will be used and plans concerning the protection of the present ecologic habitat and nature will be realized at the green areas. The ground cover of the areas where site reclamation studies will be carried out will be of the grass type that is adaptable to the present ecology. The flora species to be used in site reclamation are presented below.

Pinus nigra	: Black Pine
Pinus sylvestris	: Scot's Pine
Cedrus libani	: Lebanon Cedar
Juniperus sabina	: Tam Juniper
Juniperus excelsa	: Grecian Juniper
Juniperus foetidissima	: Juniper

Quercus pubescens	: Downy Oak
Robinia pseudoacacia	: Black Locust
Rosa canina	: Wild Dog Rose
Rosa hemisphaerica	: Sulphur Rose
Elaeagnus angustifolia	: Oleaster
Acer negundo	: Ashleaf Maple
Salix babylonica	: Weeping Willow
Salix caprea	: Goat Willow
Salix alba	: White Willow
Crataegus monogyna	: Common Hawthorn
Fraxinus ornus	: Manna Ash
Berberis spp.	: Barberry species

5.1.22 Health Protection Zone Proposed for the Project

The proposed project site is presently distant from the settlement areas. Moreover, the accident risk will be minimized by means of the emergency response plans discussed in Section 8.2. Given that there is no pollutant emission or discharge that will arise owing to the project or can impact the regions in the vicinity, the health protection zone is proposed as 50 m around the above ground facilities. This value is proposed by taking the similar facilities abroad into consideration and provided that the above ground facilities and structures near the wells will be encircled with fences, it is considered as adequate.

5.1.23 Other Activities

There is no other activity that is required to be discussed in this section.

5.1.23.1 Drilling Activities

Excavation Works During the Site Preparation and the Dust Amount

The excavation activities that will be carried out with conventional work machines during the preparation of the drilling area will be completely carried out within the drilling area. No explosive materials will be used in the excavation operations. The buildings will be prefabricated and precast concrete will be used in the construction.

The drilling area size will be approximately 100 m x 200 m and there will be three pits in this area (wastewater pool, waste mud pool and cut off pool). The dimensions of these pools will be 18 m x 26 m x 3 m (width x length x depth) for wastewater pool, 25 m x 26 m x 3 m (width x length x depth) for waste mud pool and 25 m x 26 m x 3 m (width x length x depth) for the cut off pool.

In this context, the total materials that will occur as the result of the excavation works are given for each area hereunder:

Drilling area: 100 m x 200 m x 0.10 m (top soil depth) = 2000 m^3

Wastewater pool: 18 m x 26 m x 3 m = 1404 m^3

Waste Mud Pool: 25 m x 26 m x 3m = 1950 m^3

Cut Off Pool: 25 m x 26 m x 3m = 1950 m^3

TOTAL: 7304 m^3

Assuming that the soil density is 2,70 g / cm3, total production is calculated to be approximately 19,270 tons. Approximately 5400 tons of this amount will consist of soil tearing off and approximately 14.320 tons of it will consist of excavation operations. The soil tearing off operations are estimated to be completed in 15 days and the excavation operations are estimated to be completed in the following 15 days. In this context, the maximum dust amount that may be caused by the excavation operations can be calculated as follows:

Soil tearing off: (5400 tons / 15 days / 8 hours) x (0.029 tons / ton) = 1.3 kg / hour

Excavation: (14.320 tons / 15 days / 8 hours) x (0.006 kg / ton) = 0.7 kg / hour

These activities will follow each other and these values are below the 1.50 kg / hour value given in HKKY Annex 2. In this context, there is no need to perform a modeling study related with the distribution of the dust emissions that will occur during the excavation activities.

The excavation materials will be stored within the drilling area and will be used for the stabilization of the wastes that will be caused by the drilling activities. In the storage of the excavation soil, the principles indicated in the Solid Waste Control Regulation will be complied with.

Domestic Wastewater Generated During the Site Preparation

During the preparation of the drilling area, domestic wastewater will be generated by the personnel employed in the activities. It is envisaged that approximately 10 people will be employed during these operations. The daily per capita water demand is determined to be 60L at the residential locations with a population less than 3.000 according to the Regulation on The Preparation of Project for City and Town Potable Water and Consumption Water of General Directorate of Bank of Provinces. It is considered that all of this amount will return as wastewater. Hence, the amount of total domestic wastewater that will be generated during the construction stage will be 600 L / day.

The wastewater will be collected in non–leaking sewage pits and as indicated in the letter of Sultanhanı Municipality Presidency dated 19.02.2002 and numbered 4/2 – 43

(see Annex – C), will then be collected with the vidangers of the municipality and removed.

The sewage pits will be constructed in compliance with the specifications determined by Bank of Provinces, "Water Pollution Control Regulation Technical Procedures Regulation" that entered into force being published in the Official Journal dated 07.01.1991 and numbered 20748 and the "Regulation on the Pits to be Constructed at Locations where the Sewage Canal Construction is not Possible" that entered into force being published in the Official Journal dated 19.03.1971 and numbered 13783.

The dimensions of the sewage pits will be approximately 18 m x 26 m x 3m (width x length x depth).

Domestic Solid Wastes Generated During Site Preparation

The domestic solid wastes generated during the preparation of the drilling area (food and office wastes, etc) will be collected in the field at the waste collection area and thereafter, removed at the Municipal waste area as indicated in the letter of Sultanhanı Municipality dated 18.02.2002 and numbered 4/2 – 41. (see Annex – C). The amount of these wastes is estimated to be approximately 15 days x 0.7 kg / day = 10.5 kg.

In addition, scrap materials will be collected in a separate area and there after the ones that can be recycled will be recycled and the ones that can not be recycled will be given to the firms that buy scrap materials.

Domestic Wastewater Generated During the Drilling Activities

During the drilling activities to be carried out at the project area, the personnel to be employed in the activities and the cleaning activities will produce domestic wastewater. It is envisaged that approximately 50 personnel will be employed at the well during the drilling activities.

The daily per capita water demand is determined to be 60 L at the residential locations with a population less than 3.000 in the Regulation on The Preparation of Project for City and Town Potable Water and Use Water of General Directorate of İller Bank. It is considered that all of this amount will return as wastewater. Hence, the amount of total domestic wastewater that will be created at the stage of construction will be 3000 L / day.

The wastewater that are generated will be collected in non–leaking sewage pits and as indicated in the letter of Sultanhanı Municipality Presidency dated 19.02.2002 and numbered 4/2 – 43 (see Annex – C), then will be collected with the vidangers of the municipality and removed.

The sewage pits will be constructed in compliance with the specifications determined by Bank of Provinces, "Water Pollution Control Regulation Technical Procedures Regulation" that entered into force being published in the Official Journal dated

07.01.1991 and numbered 20748 and the "Regulation on the Pits to be Constructed at Locations where the Sewage Canal Construction is not Possible" that entered into force being published in the Official Journal dated 19.03.1971 and numbered 13783.

The dimensions of the sewage pits will be approximately 25 m x 26 m x 3m (width x length x depth).

Oily Waste Waters

During the drilling activities, water will be used for the cleaning of the location and the equipment and for the drilling mud. The produced waste waters and the accumulated rain waters will be collected in canals opened in the project area and will be transferred to the waste water pool that will be constructed in the area. Under article 9 of the Notification issued by the General Directorate of Petroleum Works, in compliance with the provision that "Impermeability of mud and collection pools must be provided before use", the impermeability of the mud pits will be provided and hence soil pollution and the adverse effects that may be caused on the underground waters will be minimized.

The oily wastewater that is produced as the result of the drilling operations will be passed through oil separator and the water that is cleaned off the oil will be reused. The wastewater produced after the completion of the drilling operations will be cleaned off oils and will be collected in the wastewater pool. At the end of the project, the remaining wastewater will be analyzed under the provisions of the Water Pollution Control Regulation and after the determination of the water characteristics; they will be removed with an appropriate method. The oily wastes accumulated in the oil separators will be stored being separate from all other wastes and these wastes will be removed from the area by firms licensed by R.T. Ministry of Environment.

A wastewater pool that is made impermeable using geo–membrane will be constructed and an oil trap will be placed in the channel entering to the pool in order to separate oil and petroleum from the wastewater.

The dimensions of the wastewater pool will be approximately 25 m x 26 m x 3m (width x length x depth).

Impacts on Groundwater

There may be spaces or underground water resources in the formations passed until reaching an impermeable area during the drilling activities. In this case, casing will be made until the impermeable formation along the drilling section, it will be cemented under article 12 of the notification of Petroleum Works General Directorate dated 28.12.1995, and it will be determined that there is no connection between the inside of the well and these levels using cement tie log and pressure tests. Thereafter, the drilling activities will be carried out in this casing. By this way, when any space is reached, there will not be any leakage. In addition, under article 11 of the notification of Petroleum Works General Directorate dated 28.12. 1995, fresh water based drilling liquid will be used until passing the formations carrying fresh water and no chemical substances other than betonite will be mixed to the drilling liquid unless required by the drilling conditions.

Within the scope of Tuz Golu Basin UGNSP, in order to minimize the impacts on the groundwater, casing is placed until reaching the non – leaking formation that is approximately at 660 m for both wells and the drilling operations are carried out in this casing (see Figure 5.9). By this way, any possible effect on the underground sources by a possible drilling mud leakage is prevented. Thereafter, cementing is performed on the casings.

Formation Wastes and Drilling Muds

10 caverns are planned to be opened within the scope of Tuz Golu Basin UGNSP. The wastes that are cut with the drill and carried to the surface during the drilling activities to be carried out while opening these caverns and that have the characteristics of the formation on which the work is performed during that operation will be analyzed under the Hazardous Waste Control Regulation and in case of a hazardous waste, they will be stored separately from other solid wastes. Thereafter, these hazardous wastes will be removed from the area by the firms licensed by R.T. Ministry of Environment. Similar operation will also be applied for the drilling mud.

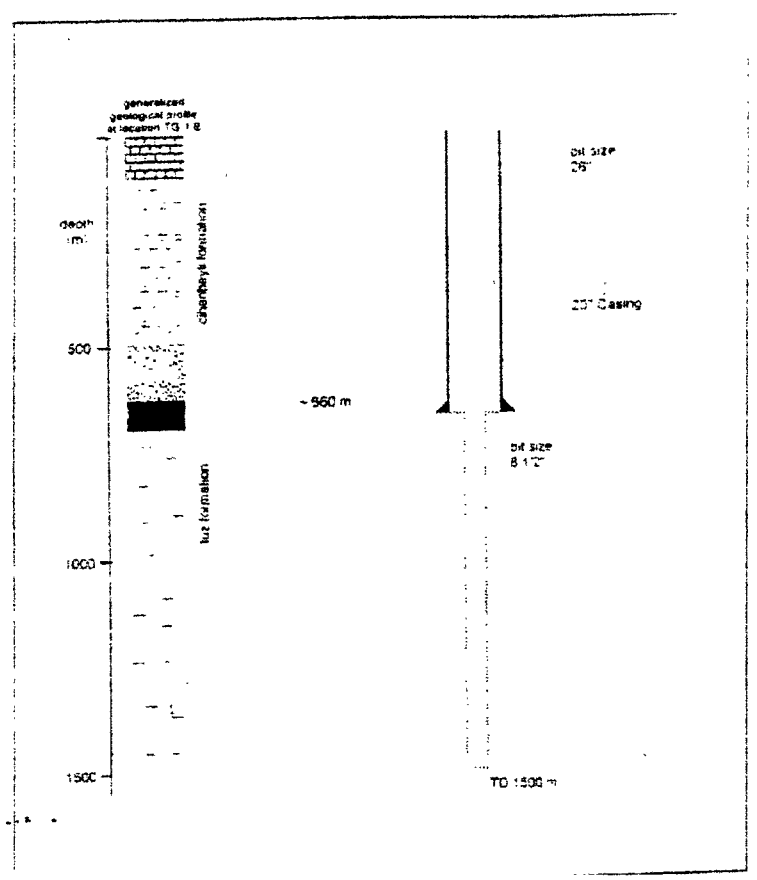


Figure 5.9 Drilling Activities

Formation wastes and drilling mud will be subjected to stabilization and neutralization processes.

Domestic Solid Wastes

The domestic solid wastes produced during the drilling activities (food and office wastes etc) will be removed in the Municipal waste area as indicated in the letter of Sultanhanı Municipality Presidency dated 18.02.2002 and numbered 4/2 – 21 (see Annex – C).

Mud Pit

For the temporary storage of the formation wastes that will be created during the drilling activities and the drilling mud, it is envisaged that pits will be opened in the project area. During the design of these pits, drilling depth, tower type, utilization condition of the area and the soil structure will be taken into consideration. Care will be paid to provide impermeability before the utilization of the mud pits.

The wastes accumulated in the mud pits will be subjected to stabilization and neutralization operations.

While carrying out the drilling activities, due to health and safety reasons, the drilling area and the surrounding of the mud wells will be surrounded with wire mesh and entrance of the people other than the relevant ones to the area will be prevented.

The dimensions of the mud pit will be approximately 15 m x 10 m x 3 m (width x length x depth).

There is no other activity that must be examined in this part.

5.2 Activities in Operation Phase of the Project, Impacts on Physical and Biologic Environment and Measures to be taken

In this section, the environmental impacts, which are probable to occur with the commencement of gas storage in the first two caverns and following the commissioning of the above ground facilities of the proposed TUGSP, are surveyed by presenting the relevant activity definitions; the measures required to be taken to minimize the adverse impacts are discussed.

5.2.1 Characteristics of all Units in the Content of the Project, Detailed Explanation of the Methods, Technologies and Work Flow Chart, Amount and Properties of Machines and Equipments, Services Provided in Other Units

In the scope of the proposed TUGSP, it is planned to store natural gas in 10 caverns, which will be opened inside the salt domes by means of the method referred as solution mining as well in Bezirci Lake Region located approximately 17 km south of Sultanhani of Aksaray Province Merkez District (see Figure 1.1 and Figure 1.2).

The salt domes to be utilized in the project are located approximately 700 m and deeper in the surface and their thickness varies between 700 m and 1500 m. In the scope of the project, it is planned to create a total of 10 caverns, each having around 500,000 m^3 of volume, through leaching of salt domes for 12.5-15 years. 42×10^6 m^3 cushion gas will be stored in each cavern and the storage process will be made with 70×10^6 m^3 gas over the cushion gas. Total cushion gas in 10 caverns will be 420×10^6 m^3 and the total gas amount that will be taken from the network, stored and given back will be 700×10^6 m^3.

In the content of TUGSP, the opening of two caverns will be carried out simultaneously and the required time for this operation is approximately 30-36 months. In this regard, the required time to create all caverns, which are thought to be 10, approximately 12,5-15 years. Throughout this period, natural gas will be commenced to be stored in the caverns created, while new caverns will be opened as well. In other words, the construction and operation phases will be carried on simultaneously. The process flow chart of the facility is given in Figure 5.10.

The units to operate in the facility are presented below:

- Well Area Units
- Water Distribution Units
- Leaching Units
- Brine Discharge Line
- Natural Gas Branch Line

Furthermore, support systems will be found in the facility as well and these systems are listed below:

- Package WastewaterTreatment Facility
- Electric System
- System For Protection Against Fire
- Lighting System
- Communication System
- Administrative Structures
- Service Roads

The comprehensive information pertaining to the support systems mentioned above are presented in Section 3.4.

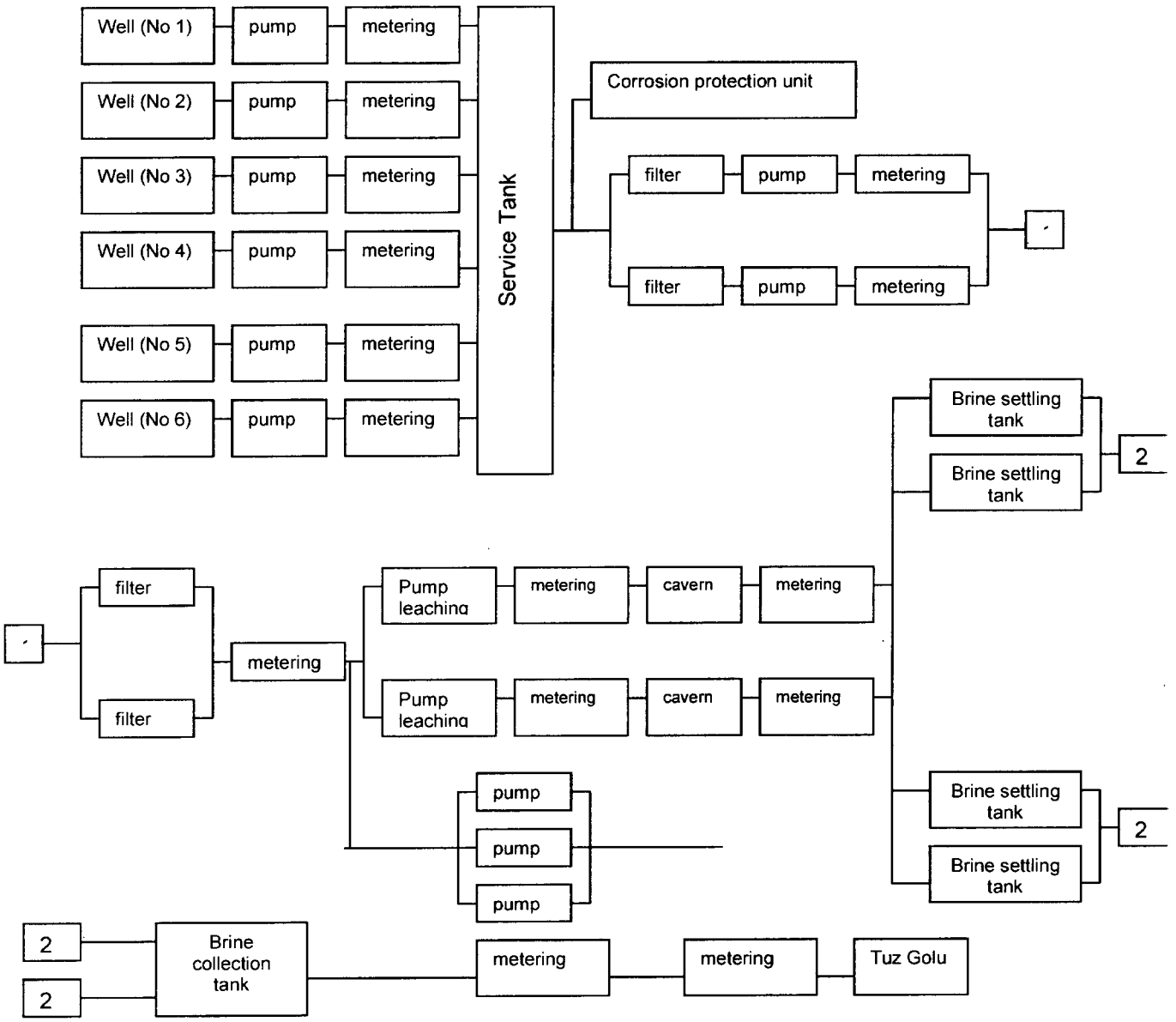


Figure 5.10 TUGSP Process Flow Chart

5.2.1.1 Well Area Units

The water required for all activities to be carried out in the content of the proposed project will be provided from the groundwater reserve located in the vicinity of Bezirci Lake. A total of 6 wells, five main and one backup, will be drilled and approximately 134 m^3/hour of output is accepted from each well. The water to be withdrawn by the pumps will be collected at 1500 m^3 volumed service tank via PE pipes, which are 150 mm in diameter and resistant to 10 Atu pressure and will be transmitted to the surface facilities.

Total amount of water demand of the project is 4,993,200 m^3/year and this value is below the value $5x10^6$ m^3/year, which is permitted by DSI in order to meet the water demand in the scope of the project (see Appendix-C). The pumps will be submersible type.

Table 5.10 Characteristics of the Pumps in Wells

Well No.	N_m (KW)
1 (ACTUAL)	55
2 (ACTUAL)	45
3 (ACTUAL)	45
4 (ACTUAL)	37
5 (ACTUAL)	45
6 (STANDBY)	45

Source: ENVY, 2001

5.2.1.2 Water Distribution Units

The sub-units included in the water distribution units are presented below.

Clean Water Tank

The water to be obtained from the underground reserve will be utilized in domestic use, leaching process and fire fighting. The clean water tank, which will collect the water to be withdrawn from the well area via pumps, will be constructed as reinforced concrete and will have a volume of 1500 m^3 for approximately 10 minute waiting period.

Clean Water Pump and Filters

The water taken out of the clean water tank will be transferred to the surface facilities and will be used as both drinking and usage water and also for leaching and dilution processes.

The water needed for leaching and dilution processes will be pumped to the surface facilities via two pumps. Besides, two clean water filters will be placed at the suction part of each pump at the entry of the line. The characteristics of the pumps are given below.

Q_1 = 330 m³/hour
H_m = 156 m
N_m = 200 kW (two main; a backup was not considered)

Drinking and usage water will be pumped to the above ground facilities via two pumps. Moreover, two clean water filters will be placed at the suction part of each pump at the entry of the line. The characteristics of the pumps are presented below.

Q = 10 m³/hour
H_m = 156 m
N_m = 15 kW (one main, one backup)

Injection Unit

The water collected in clean water tank will be transmitted to the above ground facilities via the pumps after passing through the filters. The water will be chemically dosed against corrosion with a unit to be placed to the exit of the store prior to reaching the above ground facilities; thus the damage on the equipment and line would be prevented.

Clean Water Transmission Line

The water taken out of the clean water tank will be transferred to the above ground facilities and will be used as both drinking and usage water and also for leaching and rarefaction processes. The water required for leaching and rarefaction processes will be transmitted to the above ground facilities via a spiral welded steal pipe (SWSP), which will be 400 mm in diameter, approximately 6000 m in length and coated with polyethylene PE internally and externally, whereas a PE pipe having a diameter of 80mm will be used for drinking and usage water. In the construction phase, the electrical resistance of the ground will be measured and if required, measures will be taken in steal pipes against corrosion.

5.2.1.3 Leaching Units

The sub-units included in the leaching units are presented below.

Filters

Two perforated filters to be placed at the entry of the leaching unit will be used to seize the solid particulates probable to be found in the clean water line and each of these filters will have a capacity of 660 m³/hour.

Main Leaching Pumps

Two pumps to be used parallelly will provide leaching water to two caverns concurrently and the capacity of these pumps will be 280 m³/hour. The pumps, which will be chosen as speed controlled, will be provided in a way that they will be able to meet the variable leaching water demand. The pumps will be connected to the caverns by means of a manifold and will be furnished with valves as to enable the leaching method to be used directly or indirectly during the leaching process.

Blanket Fluid Unit

In the course of the creation of caverns in the salt domes, nitrogen gas will be used as blanket fluid and the leaching process will be carried out under control. The nitrogen to be positioned at the upper level of the leachate in the cavern will preclude the erosion that will occur towards the roof in the cavern and will provide that the cavern will be of the appropriate geometry at the end of the leaching process.

In addition, the solution level in the cavern will be controlled by nitrogen. The nitrogen, which will be stored in the tanks above ground in low temperature and in liquid phase, will be connected to the cavern area via integrated pipe system and will be pumped to the caverns by pumps. In the course of the leaching process, for every 1 m³ of water to be pumped to the cavern 0.05 m³ of nitrogen is needed and a total of 500,000 m³ of nitrogen gas will be used to open one cavern. (see Section 5.1.7)

Brine Balance Tanks

The brine solution to be arisen because of the leaching process in the caverns will initially be taken to the solution balance tanks and solid particulates larger than 200 µm will be seized in this tank. The capacity of each tank, which are planned to be four in total, will be 140 m³/hour. The mud taken from the tanks, which will be cleaned manually on specific times, will be collected by mobilize containers and will be disposed at Municipal dump site.

5.2.1.4 Brine Discharge Line

The brine discharge line will function by means of gravity and will provide the discharge of the brine solution to Tuz Golu, which is the receiving body. The discharge area will be the arid/unproductive region of Tuz Golu and is approximately 6000 m to the winter level border of the lake and approximately 7000 m to the arid/unproductive region border. The discharge line, which will be approximately 39 km in length, will manufactured from SWSP that is 500 mm in diameter and coated with PE externally and internally.

The pipeline route is designed so as to need minimum structures and have the shortest distance. On the line, there will be release valves, which will be 200 mm in diameter and will be used in maintenance and repair periods, and these valves will enable the discharge of the line to the existing dry creek beds. Besides, the sucker required to be placed on the line will be 100 mm in diameter.

The end of the discharge line will be furnished with a diffuser to provide opportunity for the discharge to distribute homogeneously. In this regard, five diffusers having a diameter of 150 mm and one diffuser having a diameter of 230 mm, configured as zigzag holes will be used. The distance between the holes will be 3 m (see Figure 5.6).

5.2.1.5 Natural Gas Branch Line

Natural gas branch line will diverge from the Kayseri-Konya-Seydisehir section of the Eastern Anatolia Natural Gas Main Transmission Line traversing from approximately 19 km north of the project site and will reach up to the cavern area to be created at salt domes. The diameter of line, which is thought to be approximately 19 km, is estimated as 40" (see Appendix-E).

5.2.2 Details on the Natural Gas to be stored

The natural gas to be stored at the project site is the gas, which will arrive to Turkey via Eastern Anatolia Natural Gas Main Transmission Line. The natural gas to be stored will reach to the cavern area, that will be created in the salt domes, through a branching departing from Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line traversing from approximately 19 km of the project site (see Figure 1.2).

5.2.3 Amount and Characteristics of Natural Gas, Interaction of Natural Gas with Wall Rock, Market Circumstances of Natural Gas

In the scope of the project, it is planned to create a total of 10 caverns, each having around 500,000 m^3 of volume, for 10 years through leaching of salt domes, which is a common method worldwide. By this way approximately 42×10^6 m^3 cushion gas will exist

in each cavern and process will be carried out with approximately 70×10^6 m^3 gas, it will be possible to store 70×10^6 m^3 gas in each cavern. Total cushion gas in 10 caverns will be 420×10^6 m^3 and the total gas to be taken from network, stored and given back will be 700×10^6 m^3.

The pressure and gas usage values to be occurred in the caverns due to the gas storage are given in Table 5.11 and the specifications are presented in Table 5.12.

Table 5.11 Pressure and Gas Usage Values in the Caverns

Parameter	Unit	Value
Total Gas Volume	10^6 m^3	1232
Operated Gas Volume	10^6 m^3	800
Cushion Gas Volume	10^6 m^3	432
Maximum Gas Withdraw Rate	10^6 m^3/day	33
Average Gas Withdraw Rate	10^6 m^3/ day	10-15
Maximum Gas Injection Rate	10^6 m^3/ day	25
Average Gas Injection Rate	10^6 m^3/ day	8-12
Estimated Cavern Depth	m	1000-1250
Physical Volume of Cavern	m^3	500,000
Number of Caverns	Number	10
Maximum Pressure on Surface	Bar	200
Maximum Pressure in Cavern	Bar	220
Minimum Pressure on Surface	Bar	73
Minimum Pressure in Cavern	Bar	80

Source: Podzemgazprom Limited (PGP), Russia, Preliminary Feasibility Report

Table 5.12 Characteristics of Natural Gas to be stored

Parameter		Value
Methane	Minimum	82%
Ethane	Maximum	8.5%
Propane	Maximum	2%
Butane	Maximum	1%
Pentane and other heavy hydrocarbons	Maximum	0.5%
Carbon dioxide	Maximum	2%
Oxygen	Maximum	0.5%
Nitrogen	Maximum	4%
Hydrogen sulphur	Maximum	5.10 mg/m^3
Merkaptan sulphur	Maximum	15.30 mg/m^3
Total sulphur	Maximum	102.00 mg/m^3
Thermal value	Minimum	8750 kcal/m^3
	Maximum	10,427 kcal/m^3
Outlet pressure of the gas	Minimum	40 bar
Temperature	Minimum	0°C
	Maximum	25°C

The stored gas will be withdrawn from the caverns to meet the increasing gas demand nationwide especially in winter months and will be given back to Kayseri-Konya-Seydisehir section of Eastern Anatolia Natural Gas Main Transmission Line and will be utilized via the national network. Detailed information concerning the natural gas usage in Turkey is presented in Section 1.3.1.

5.2.4 Accommodation and Other Technical/Social Infrastructure Demands of the Personnel Employed During the Operation of Facility

In the scope of the project, the number of personnel to be employed in the facility following the termination of the construction of the facilities and commencement of natural gas storage will be 20 employees. The distribution of these personnel is envisaged as follows:

- 1 area director
- 1 operation director
- 1 maintenance / repair director
- 7–8 experts (control room)
- 7–8 technicians (maintenance / repair, laboratory)
- 2 office personnel

All workers will be provided from the settlement areas in the vicinity and there will be no accommodation at the project site. The social facilities requisite for the dining and recreation needs of the personnel during lunch will be present. The access of personnel will be provided via services.

Under these circumstances, particularly since there will be no workers from distant settlement areas and the majority of the personnel employed during the operation phase will be provided from the nearby community, it is anticipated that the project will not have any serious adverse impact on the social and technical infrastructure services of the settlement areas in the vicinity in its course of operation phase.

5.2.5 Amount and Procurement Condition of the Water to be used, Resources, Amount and Characteristics of Waste Water, Disposal Methods, Discharge Environments, Impact on Biological Environment and Measures to be taken

The amount of water to be used in the activity units and other units (drinking, usage, boiler cooling, fire and similar purposes) and its procurement methods are discussed comprehensively in Section 5.1.11. In this context, the water, which will be procured from a total of 6 wells, five main and one backup to be drilled in the vicinity of Bezirci Lake, will be 4,993,200 m^3/year in total, namely water need in the cavern (560 m^3/hour), water need at the above ground facilities (10 m^3/hour), rarefaction water need (100 m^3/hour during utmost two weeks annually). This value is below the value $5x10^6$ m^3, which is the annual ground water usage amount that is permitted by DSI.

5.2.5.1 The Category and Amount of Domestic Waste Water, Discharge Environments

Given that the construction and operation phases of TUGSP will be carried out discretely, there will be maximum 120 personnel employed at the facility. Since no accommodation will be of question on site, the amount of daily wastewater per capita is anticipated to be approximately 70 L/day. Therefore, total amount of wastewater will be maximum 9.1 m^3/day. The package wastewater treatment facility having a capacity of 10 m^3/day will be used so as to treat the wastewaters.

In order not to create mud, which will be in an amount that would result in environmental problems, at the wastewater treatment package facility, biological treatment technique including extended aeration will be preferred. The discharge from the domestic wastewater treatment facility will be realized in compliance with the criteria given in Table 21.2 of Water Pollution Control Regulation (see Table 5.13) and the wastewater discharge values stated in Fishery Products Law numbered 1380 and Regulation on Fishery Products.

In this regard, the wastewater discharge will be used for irrigation or will be discharged to Tuz Golu by connecting to the brine water discharge line that will be arisen as a consequence of the leaching process.

Table 5.13 Domestic Wastewater Discharge Standards

Parameters	Discharge Limits*	
	2 Houred Composite Sample	*24 Houred Composite Sample*
BOD_5 (mg/L)	50	45
COD (mg/L)	160	110
SPM (mg/L)	60	30
pH	6-9	6-9

**Class 2: Pollutant load is 60-600 kg/day as raw BOD, Population=1,000-10,000*

5.2.5.2 The Output Calculation Of Domestic Wastewater Treatment Facility

Given that the amount of daily wastewater per capita will be 70 L and the BOD concentration will be 300 mg/L[7], the output of the wastewater treatment facility is calculated as:

(300-45) mg/L /(300 mg/L) = 85%

[7] *This value is an average value, which is accepted generally in domestic wastewaters that are not treated.*

Nevertheless, it is acknowledged that the output of the treatment will be 95-98% at an active mud facility, which is well designed, possessing extended aeration.

5.2.5.3 The Category and Amount of Industrial Wastewater, Discharge Environments

In the content of TUGSP, no industrial wastewater will be produced during the activities of the facility. However, the disposal of waste oils, which will be resulted from the oil change of the machines and vehicles throughout the operation of the facility, will be Hazardous Waste Control Regulation dated 27.08.1995 and numbered 22387.

5.2.5.4 The Characteristics and Amount of Brine Water, Discharge Environments

In the scope of TUGSP, the underground caverns will be formed through the leaching of the salt domes. The brine water, which will arise owing to the leaching process (560 m^3/hour), will initially be taken to the brine balance tanks and will be transmitted to the withholding pond following the removal of the solid particulates larger than 200 µm in this tank. The receiving boy of the brine is Tuz Golu. The discharge of the brine solution to Tuz Golu will be provided via discharge line, which will function by means of gravity. The detailed information regarding the discharge line is presented in Section 5.2.1.4.

At the termination of project, maximum amount of water to be discharged to the receiving body will be 60×10^6 m^3 (10 year), while maximum amount of water to be given in two years will be 12×10^6 m^3 (two years). Regarding that water height of 1 m will be observed in the lake and no evaporation will be realized, the area, which the water to be discharged for 10 years will cover, will be A_{10} = 60 km^2 (circle having a radius of 4.5 km). This value is calculated as A_2 = 12 km^2 (circle having a radius of 2.0 km) for two years. The total surface area of Tuz Golu is 1620 km^2 (see Section 4.2.4.2). In this regard, taking the impact of evaporation into consideration, it is obvious that the water to be discharged will not cause a considerable increase in the water level of Tuz Golu.

With the purpose of determining the characteristics of brine water, samples were taken from the salt domes at the cavern area that is considered to be constructed (see Figure 5.11). The core having a length of 180 m in total was taken from approximately between the depths 700 and 1500 m from two distinct points, UGS1 (Latitude: 4217547, Longitude: 552496) and UGS2 (Latitude: 4217180, Longitude: 552490), within the area of concern. A part of this core was dissolved in water and the saturated water was analyzed. The results obtained from the analyses carried out by Duzen-Norwest Environmental and Health Services Education and Consulting Company are presented in Table 5.14 (see Appendix-M).

Niggle diagram is prepared in order to reveal more evidently if the brine water, which will be obtained in consequence of the leaching process, will possess similar characteristics with the characteristics of Tuz Golu. The diagram of concern has been used for years in basin and irrigational water projects of DSI and drinking water projects of Bank of Provinces in order to determine if distinct waters are of same origin. In this diagram, the anion and cation concentrations in water resources are drawn in one sided logarithmic scale and the anion-cation variations of the waters can be observed. The anion-cation variations of the waters of same origin resembles.

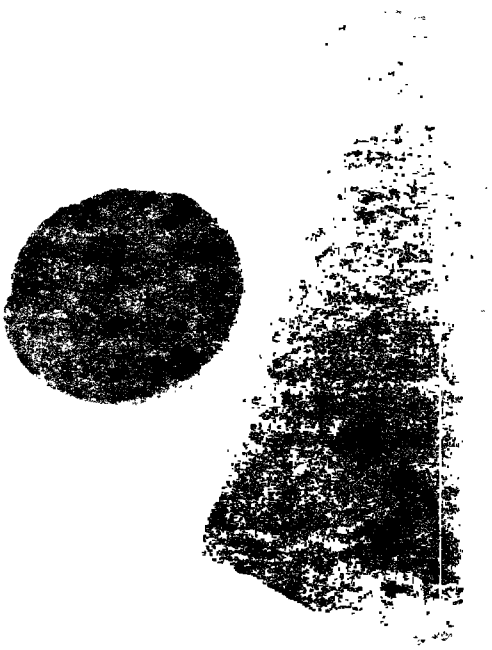


Figure 5.11 Core Sample

Table 5.14 Results of Core Analysis

Parameter	UGS1 Core	UGS2 Core
Fe (mg/L)	0.3	0.6
Cu (mg/L)	0.04	0.03
Zn (mg/L)	0.03	0.03
Cr (mg/L)	< 0.002	< 0.002
Hg (mg/L)	< 0.002	< 0.002
Pb (mg/L)	0.0074	0.0046
Ni (mg/L)	< 0.002	0.005
Cd (mg/L)	0.1	0.1
As (mg/L)	0.0095	0.0046
Na (mg/L)	7000	6500
Se (mg/L)	0.0085	0.0098
Mn (mg/L)	0.0024	0.012

B (mg/L)	0.9	5.3
Al (mg/L)	0.06	0.3
Li (mg/L)	0	0
Br (mg/L)	< 0.02	< 0.042
F^- (mg/L)	0.02	0.02
Co (mg/L)	0.0013	0.0022
Total CN^- (mg/L)	< 0.05	< 0.05
SO_4^{-2} (mg/L)	719	989
Oil and Grease (mg/L)	45	117
Cl^- (mg/L)	10,137	8950
Ammonium Nitrogen (mg/L)	0.14	0.14
NO_3^--N (mg/L)	0	0
Total PO_4^{-3}-P (mg/L)	0.49	0.48
Total Dissolved Substance (mg/L)	18,991	17,622
Chemical Oxygen Demand (COD) (mg/L)	1821	19,317
Biochemical Oxygen Demand (BOD) (mg/L)	0	0
Suspended Particle Matter (mg/L)	14.2	114.5
Total Organic Carbon (mg/L)	0	0
Fecal Coliform (EMS/100 mL)	0	0
Total Coliform (EMS/100 mL)	0	0

In order to understand whether the brine generated as the result of the leaching operation and the Tuz Golu show similar characteristics in a more clear way, Niggle Diagram is prepared. This diagram has been used for years in the potable water projects of Bank of Provinces and the basin and irrigation projects of SHW in order to determine whether different waters are originating from the same source. In this diagram, the anion and cation concentrations are drawn on single sided logarithmic scales and the anion–cation variations of the waters are observed. The anion–cation variations in the waters having the same source show similarity.

Within the scope of Tuz Golu Basin UGNSP, the analysis results of the water sample taken from the Tuz Golu and the analysis results of the salt cores are compared using Niggle diagram. In the diagram, in which the concentrations of the anion and cation (see Figure 5.12), it is seen that the cores and the Tuz Golu anion–cation variations show similarity. In this context, it is possible to reach the result that the water that will be generated as the result of the leaching of the cores and the Tuz Golu have the same source.

As a result, discharge of the solution that will start with the leaching of the salt cores to the Tuz Golu will not have an adverse impacton the existing quality of the lake. In addition, as the result of the discharge of the brine that will be produced by these beds which are the continuity of the salt beds under the Tuz Golu and which have the same composition with them, it is estimated that the Lake, which is subject to continuous water loss, will be affected in a positive way.

In addition, it is considered that the discharge of the solution having the same source parameters with the Tuz Golu will not have an adverse impact on the Salt density or Tuz Golu mirror. Furthermore, the parameters in the Annex – 5 and Annex – 6 lists of the Water Products Law and the relevant Regulation numbered 1380 will be complied with.

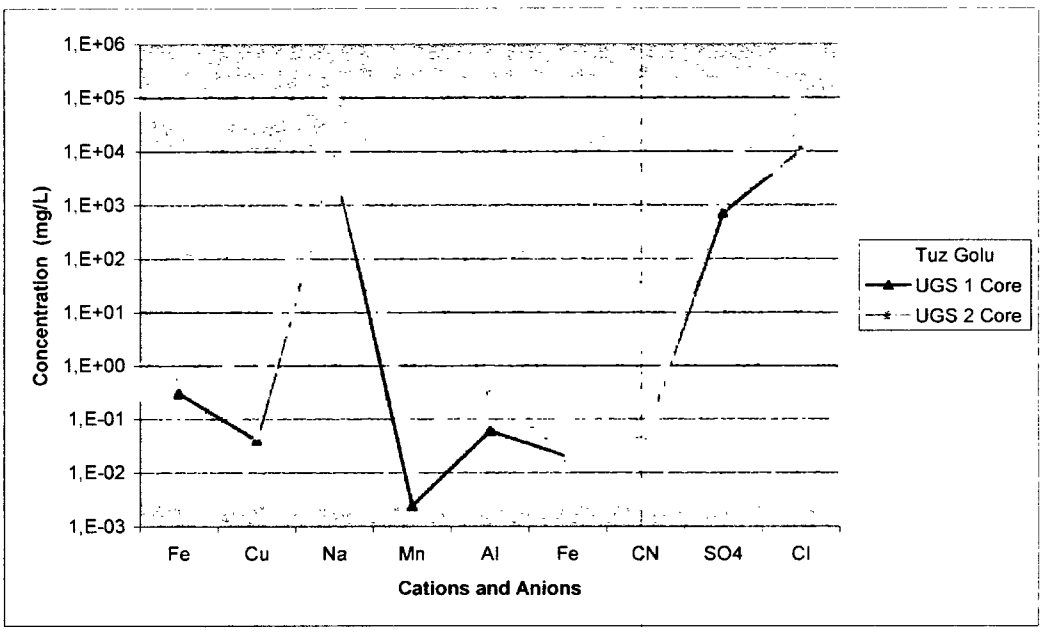


Figure 5.12 Niggle Diagram

In a similar project in Germany, no negative impact has been encountered even after the discharge of the leaching waters to a fresh water source (Fulda River) near the facility for years and this gives an idea about the issues mentioned herein above.

5.2.6 Types, Quantities and Chemical Analyses of Fuels, Flare Systems, Emissions, Stack Gas Treatment Systems, Equipment and Systems to be used for Measurements

The fuel to be used to meet the need of 25-30 personnel to be employed in the operation phase of the proposed project will be natural gas. In this respect, the natural gas, which will be withdrawn via branching to be stored underground and which its characteristics are given in Table 5.12, will be used. Due to the fact that the personnel number is relatively small, the natural gas consumption will be maximum 100 m^3/day in winter months and 10 m^3/day in summer months.

These values are lesser than the amount of natural gas used by an apartment with 10 households. In this regard, the emissions resulted from the fuel to be used for the

personnel will not exceed the limits stated in Regulation on Prevention of Air Quality. Therefore, regarding the emissions no stack gas treatment system will be required.

5.2.7 Amount and Characteristics of Emissions, Disposal Methods and Measures to be taken to prevent the Gas Leakage During the Operation of Facility

In the content of this project, the incidents like gas leakage and fire risk, which can occur due to the facts such as improper design, inappropriate operation, occupational accidents, natural disasters or sabotage, are depicted as "emergency cases" and regarding these cases emergency response plans will be determined. The detailed information regarding the issue is discussed in Section 8.2.

5.2.8 Characteristics and Amount of Solid and/or Hazardous Wastes During the Operation of Facility, Storage and Disposal Methods

In the content of the project, the solid wastes to be occurred during the operational activities will be domestic solid wastes to be brought about by 25-30 individuals. The domestic solid wastes will be collected in garbage bags and dumped to the garbage cans in accordance to the "Solid Waste Control Regulation", which is issued in the Official Gazette dated March 14, 1991 and numbered 20814.

Approximately 20 personnel will be employed during the operation of the facility. Since there will be no accommodation in the facility, the amount of daily solid waste per capita will be 0.7 kg. It is estimated that the amount of total daily domestic solid waste in the construction phase will be 21 kg utmost. As it is stated in the official letter of the Sultanhani Municipality dated February 18, 2002 and numbered 4/2-41, the domestic solid wastes of concern can be disposed at the dumpsite of the municipality (see Appendix-C).

The disposal of the residual oils arisen from the oil change of the machines and vehicles in the course of the operation of the facility of concern will be carried out in compliance with the Hazardous Waste Control Regulation dated 27.08.1995 and numbered 22387 and give to a company licenced by Ministry of Environment.

5.2.9 Vibration, Sources and Level of the Noise During the Operation of Facility and Measures to be taken

The main noise sources in the facility are determined as pumps and compressors in the content of TUGSP. In order to minimize the noise impacts to be occurred together with the commissioning of the project, the methods stated below will be employed.

- Installation of silencers to the entry and exit of the cooling fans,
- Procurement of low noise emanating backup motor, pump and compressors,
- Limitation of truck transportation merely with hours of daylight if required.

It is planned to limit the activities that generate noise in the course of the operation of the facility with the hours 06:00 a.m.-10:00 p.m., which is stated in Noise Control Regulation and is defining the daylight hours. The works will be restricted with the activities generating low noise levels at nights and on official holidays. The noise levels generated from the facility should not exceed the noise disturbance levels in the settlement areas (see Table 5.8) whereas the noise levels at the working areas should not exceed the values given in Table 5.9. In this regard, protective tools and equipment against the noise such as special helmet, earphones or ear plugs will be procured for the workers and therefore, maximum noise levels that the workers can be subject to will not be exceeded.

The maintenance works to be carried out in the content of the project will comprise the site maintenance, equipment control, maintenance and change. The maintenance works will not include activities that emanate noise outside the site and can be experienced by the residential areas.

Furthermore, given that the project site is distant from the settlement areas, the vibration to be formed is not accepted to be sensed by the settlement areas located outside the boundaries of the project site.

Consequently, it is assumed that the noise and vibration to be generated in the course of the operational activities of TUGSP will not exceed the limits stated in Noise Control Regulation and will not have adverse impacts on the natural environment.

5.2.10 Probable Impacts of the Pipeline and Maintenance-Repair Works of the Pipeline on Existing Infrastructure Facilities

The proposed project area and its surroundings are very far from the residential locations (see Figure 2.5). In this context, there is no infrastructure system on the route of the discharge and natural gas branch lines. The sections, where the pipeline intersects the state highway, will be passed with caisson therefore, there will not be any adverse impact on the infrastructure during the maintenance / repair works.

5.2.11 Probable Impacts on Cultural and Natural Heritage and Measures to be taken

The comprehensive information on the cultural and natural heritage is given in Section 4.2.12. No cultural and natural heritage is present on the project site and its vicinity. In this regard, no adverse impact on the assets of concern is of question due to the operational activities.

5.2.12 Impact of the Existing Traffic on the Project

In view of the fact that no raw materials will be demanded during the operational activities of the project, the majority of the additional traffic load will be originated from the transportation of personnel and the procurement of spare parts that would be needed occasionally. The traffic of the personnel transportation vehicles of concern will be restricted with the existing connection roads and inner facility roads. The requisite parking lot for the visitors, service vehicles and vehicles pertaining to the personnel will be provided in the facility. The authorities of the facility will prohibit the access of the vehicles to the surrounding fields. In the consequence of these measures, the operational activities will not have an adverse impact on the regional access network.

5.2.13 Risky and Dangerous Activities Regarding the Human Health and Environment During the Operation of Facility

Considering the activities in the operation phase of the project, there will be no risky activities exhibiting a particular danger in terms of human health and environment. The equipments to be utilized in the operation phase of the facility will be used by educated personnel. Nevertheless, all measures will be taken concerning the health and occupational safety of the workers to be employed in the facility and the relevant legislation, primarily Worker Health and Occupational Safety Act, will be complied. In addition, an education on the topics listed below will be given to the personnel to be employed in the facility by the senior authorities of the facility and pertinent experts:

- Site Security
- Environmental Protection
- First Aid
- Fire Fighting
- Health and Occupational Safety
- Risk Assessment

5.2.14 Landscape Aspects and Site Reclamations

The purpose of realizing site reclamation at the project site by utilizing landscape aspects is to provide the visual screening of the project facilities and to create a

picturesque environment for the project. In this regard, the vegetative soil to be removed from the surface during the excavation studies is planned to be piled at a convenient section of the construction site and to be used by spreading it to the required places at a time close to the termination of the construction activities.

Following the completion of the rough construction works, adequate afforestation studies will be performed within the boundaries of the project site. Flora species convenient to the climate of the region will be used and plans concerning the protection of the present ecologic habitat and nature will be realized at the green areas. The ground cover of the areas where site reclamation studies will be carried out will be of the grass type that is adaptable to the present ecology. The flora species to be used in site reclamation are presented below.

Pinus nigra	: Black Pine
Pinus sylvestris	: Scot's Pine
Cedrus libani	: Lebanon Cedar
Juniperus sabina	: Tam Juniper
Juniperus excelsa	: Grecian Juniper
Juniperus foetidissima	: Juniper
Quercus pubescens	: Downy Oak
Robinia pseudoacacia	: Black Locust
Rosa canina	: Wild Dog Rose
Rosa hemisphaerica	: Sulphur Rose
Elaeagnus angustifolia	: Oleaster
Acer negundo	: Ashleaf Maple
Salix babylonica	: Weeping Willow
Salix caprea	: Goat Willow
Salix alba	: White Willow
Crataegus monogyna	: Common Hawthorn
Fraxinus ornus	: Manna Ash
Berberis spp.	: Barberry species

5.2.15 Other Activities

There is no other activity that is required to be discussed in this section.

5.3 Impacts of the Project on Socio-Economic Environment

In this section of the report, the impacts of the activities accepted to be realized in the content of proposed TUGSP on the socio-economic state of the study area will be assessed.

5.3.1 Income Increases, Employment Opportunities, Demographic Movements, Migrations, Education, Health, Culture, Other Social and Technical Infrastructural Services

It is expected that the proposed TUGSP will constitute an economical progress capability for the local residents and will considerably contribute to the national and regional economy. By means of the natural gas to be stored in the scope of TUGSP, a significant reserve will be developed. The probable impacts of the proposed project on the regional and national economy are discussed in detail in the following sections.

5.3.1.1 National Impacts

A total of 420 x 106 m^3 cushion gas will be stored in 10 caverns that will be opened within the scope of TUGSP project. The amount of the total gas to be taken from the national network and stored and then given back to the network is envisaged to be 700 x $10^6 m^3$.

The project is one of the first projects to be applied in Turkey as of its subject which is the storage of natural gas underground and will be a sample for the applications in the future. Providing a balance between the stored natural gas and the gas demand change between the summer and winter months, the supply – demand balance caused by the natural gas utilization in the country will be provided. With the realization of the project, the natural gas supplied from foreign countries will be stored and a reserve will be created for the country and consistency will be provided in the national electricity and heating sources. Furthermore, resource will be provided for continuous energy transmission to the industrial facilities, the number of which is increasing rapidly in our country.

5.3.1.2.1 Regional Impacts

The most significant impact of the project of concern will be on income increase. It is foreseen that the majority of the requisite equipment and services will be procured from the region in site preparation, construction and operation phases. A part of the total project cost will contribute to the regional economy as the fees to be paid for the labour force, accommodation, rental of the equipment, fuel and services provided from the local businesses.

Furthermore, it is anticipated that approximately 100 workers will be employed in the construction phase. The expenditure to be made for the daily needs of these workers will have an indirect contribution to the local economy.

Together with the commissioning of the facilities in the content of the project, it is planned to employ 20 workers on site permanently. It is expected that the majority of these workers will be comprised of Turkish engineers, technicians and workers and will be provided particularly from the residents in the vicinity.

Taking the studies to be carried out prior to the studies concerning the opening of the caverns to store the natural gas into consideration, it is foreseen that the interval of time required for the termination of the project will be 12,5-15 years. Throughout this period, temporary and permanent employment occasions will be granted in the region. The increase in the number of occupations in the region is recognized to be a positive impact on the local economy. The construction and operation activities of TUGSP will create a supplementary demand to the trade and service sectors in the region and therefore will contribute to the economical progress.

Moreover, new occupational opportunities will be revealed in line with the household expenditures and general expenses of the families of the workers and personnel to be employed in the powerhouse; as a result, economy will progress indirectly.

5.3.1.3 Social Services and Infrastructure

The demands that occur in the consequence of large scaled projects in general can increase the burden of the existing social service and infrastructure in the region. On the contrary, due to the facts that the number of workers to be employed in the construction phase of the project will not be high and the labour force will be provided from the environs, its impacts on the existing social and technical infrastructure will be of insignificant level. Since the main demands of the construction workers will be provided on the construction site (by providing first aid clinic, canteen, communication opportunities and similar units on site), the workers will not have an adverse impact on the services of the residents.

Educational Services

Together with the realization of the project, the residents of the district and villages in the vicinity can come to the region in order to work in TUGSP and new jobs. In view of the fact that the majority of the personnel to be employed will be comprised of the residents

of the region, the regional schools and the present literacy profile are not excepted to be impacted.

Health Services

There will be an infirmary within the boundaries of the facility so as to handle the minor injuries and health problems. In case of serious incidents, the health corporations located in Aksaray Province and its vicinity (particularly Sultanhani, which is the closest settlement area to the facility) will be utilized. However, taking the minor injuries into account, since the health corporations outside the facility will not be applied, no impact is considered on the regional health services. Complying the principles of facility security and occupational health in the construction phase will minimize the probable impacts on regional hospitals.

Technical Infrastructure Services

Fire Fighting

As stated in the preceding sections, the required equipment for fire protection and fire fighting will be present in the proposed TUGSP. Therefore, no adverse impact of the proposed TUGSP is expected on the regional fire brigade services.

Water Supply

The water needed in the course of construction and operation of the facilities in the content of TUGSP, will be provided from the groundwater reserve located approximately 6 km northwest of the above ground facilities in the vicinity of Bezirci Lake. The water, which will be withdrawn from a total of six wells, five main and one backup via pumps, will be transmitted to the project site by a transmission line and will be collected in a storage tank. Consequently, in the course of construction and operation of the facilities in the content of TUGSP, no adverse impact will be of question on the regional water supply system.

Access

The construction acitivities will result in an additional load on the regional transportation network. Given that the impacts of the traffic will be restricted with the connection roads of the above ground facilities, it is accepted that the adverse impacts arisen from the construction activities will be of low level. These impacts will be resulted from the access of the personnel and the transportation of equipments and supplies. The connection road will be built in a way to endure the maximum traffic load expected to occur during construction.

By means of taking the control measures determined by the General Directorate of Highways and local administrations and providing the appropriate traffic order, the disruptions in the traffic flow will be minimized. In the course of operation activities, the most of the additional traffic load will be originated from the transportation of personnel and the procurement of supplies with trucks intermittently. The requisite parking lot for the visitors, service vehicles and vehicles pertaining to the personnel will be provided in the facility. Consequently, the activities will not have an adverse impact, which is significant and long termed, on the regional access network.

The telephone system requisite for the facilities proposed in the content of TUGSP will be provided by General Directorate of Turk Telekom. During the operation of the central, no significant adverse impact is expected to occur on the infrastructure of the present telephone services.

5.3.2 Environmental Benefit-Cost Analysis

In general, the social environmental comprise of the factors, which are defined with socio-economic parameters and related with the humans. The quantification of tehse factors will be realized by empirical social research methods. However, these quantification criteria can change from country to country and from individual to individual, as well. Therefore, it is very hard to evaluate the human health and environmental values in line with the benefit-cost analysis.

Nevertheless, it is possible to express the main benefits and costs of the proposed project qualitatively (see table 5.15). Considering the economic and social impacts that the proposed TUGSP will bring out, it is comprehended that the project will have a positive impact on the region.

Table 5.15 Major Benefits and Costs of the Proposed TUGSP

Major Benefits	Major Costs
To constitute a model as it is the first project to be put into practice regarding its theme	Loss of rainfed agricultural areas which are pasture and thicket presently
To provide the supply-demand balance (summer-winter difference) resulting from the natural gas usage	Decline in the number of the individuals located on site, of the flora species in the region in the construction phase
To constitute a large natural gas reserve for the country	Acceptable increases in the local SO_2, NO_x, PM and CO concentrations
Steadiness to be provided in national electric and heating sources	Limited adverse impacts on social services and infrastructure
To procure steady and constant energy to local industries	Visual impacts

To provide a source for the transmission of healthy and constant energy to industrial facilities	Temporary increase in local truck and bus traffic
Indirect impacts such as the increase in local employment opportunities	

5.3.2.1 Impacts on Land Use

The area, on which the surface facilities will be constructed within the scope of Salt Lake Basin UGNSP, is being used as an area where the animals are accommodated and fed between April – October. The utilization type of the land is pasture and bush area. The region is surrounded with this type of land; therefore the project is not expected to have a negative impact on the land use.

5.3.2.2 Impacts on Biophysical Environment

The probability of occurrence of adverse impacts on plant and animals, as on humans, concerning the soil contamination and noise disturbance that will be probable to bring about in the construction phase of the project will be minimized by means of the measures given in the relevant sections of the EIA report (see Section 5.1 and Section 5.2).

As it is clarified in the sections of concern, since the site of the facility to be constructed is not a forestry area, no environmental cost is expected to arise concerning the forestry areas.

6 PROBABLE AND PERSISTENT IMPACTS FOLLOWING DECOMMISSIONING AND MEASURES TO BE TAKEN

The lifetime of the facilities to be constructed in the scope of the proposed TUGSP will be at least 50 years in compliance with the termination of the gas storage activities. In a similar way, the life of the discharge and branch lines is estimated to be 40 years approximately. At the end of this period, the maintenance of the pipelines will be carried out. In this section of the report, various site restoration and recreation studies to be carried out after the termination of the operational activities of TUGSP and the probable permanent impacts to be occurred by TUGSP at the present stage are discussed.

After the operational activities will be concluded, the probable impacts to occur regarding the water, air and soil qualities and the measures to be taken to minimize these impacts are presented in the following paragraphs.

6.1 Site Restoration

In case the utilization periods of the surface facilities and pipelines are expired, the following activities will be carried out:

- All surface facilities will be disassembled.
- All used areas will be cleaned of obstructions posing danger
- The caverns, from which all of the stored gas is drawn, will be left being filled with water. Against any crashing possibility, the caverns will be closed in filled condition and the entrance of them will be filled with tapping material and concreted (see figure 6.1).
- The left pipelines will be filled and sealed.
- All pits, arcs and other surface hollows that are created as the result of disassembly of the surface facilities will be filled.

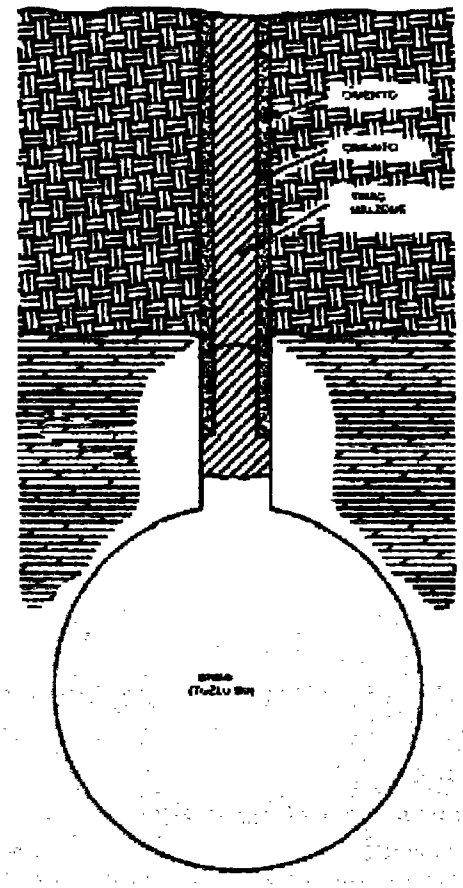


Figure 6.1 Schematic Projection of Abandoned Cavern in the Salt Formation

6.2 Rehabilitation Studies

The proposed TUGSP is not a project, which the activities will be ceased. Therefore, no rehabilitation study is required. In case of the termination of the activities due to any reason, the recreational studies will be commenced at the project site immediately after the filling up and leveling of the site within the content of a determined landscape program. The site will be afforested in compliance with the surrounding vegetation.

6.3 Impacts to the Present Water Resources

The site restoration and recreation studies will be planned in a manner to prevent the accumulation of the water on the ground which is restorated. In that content, regarding the decommisioning and site restoration studies, no adverse impact will be brought about on the quality of groundwater and surface waters.

Furthermore, in case of the ceasement of the project activities, no waste water or similar discharge resulting from the project facilities will be performed. Given these conditions, the termination of the activities of TUGSP project will not adversely impact the present water resources.

6.4 Probable Air Emissions

No air emission to the atmosphere will be realized during or following the decommissioning phase. At the decommissioning phase, the reafforestation of the project site will prevent the wind erosion and hence the dust emissions. Given these conditions, the termination of the activities of of the facilities to be constructed in the conten of TUGSP project will not adversely impact the air quality.

6.5 Other Aspects

Following the decommissioning, the restoration activities will be commenced. The aim is to reinstate the site according to the condition previous to the construction of the facility. The restoration studies to be realized in the content of the project are presented in the preceding sections. In that context, the project will have no adverse impact on the soil quality following the decommissioning phase.

8 MONITORING PROGRAM AND EMERGENCY RESPONSE PLAN

8.1 Monitoring Program Proposed for the Construction, Operation and Post-Operation of the Activity

TUGSP environmental monitoring program is dependent upon the environmental resources and the impact level from the adverseness that can be arisen from the proposed project. With the intention of controlling the compliance of the activities to be carried out in construction, operation and post-operation phases of the project of concern to the national environmental legislation, expert environmental consultants from distinct disciplines will regulate all processes and equipment.

The proposed monitoring approach involves three major topics, namely i) monitoring program in the design and construction phase, ii) monitoring program in the operation phase, ve iii) occupational health and safety. The recommendations about worker health and safety are included in the monitoring program proposed for the mentioned construction and operation stages. The timing table, in which the construction and operation stages of the project are shown, is given in Table 8.1.

8.1.1 Monitoring Program in Construction Phase

In order to minimize the impacts on the environment, it is required to carry out the site works in compliance with the relevant regulations and acts and to supervise these works periodically by an expert environment team established by the governorship throughout the construction period from the beginning of the first stages of the construction activities of the project. In the course of the environmental supervision to be realized in the construction phase, construction sites, workers' camps, supplies depots and equipments shall be controlled.

The water quality monitoring is included in the monitoring program in the construction phase in cases where the construction sites are in close proximity to aquatic environments. In the content of TUGSP, the sites where the construction and infrastructure works will be carried out are not located in the vicinity of aquatic environments. However, the solution to be emanated at the end of the leaching of salt domes will be discharged to Tuz Golu. In that content, by considering the core analysis, heavy metal analysis will be realized montly at the waste water of concern and Tuz Golu.

In the course of the excavation works, the vegetative soil (10 cm) and other normal soil will be removed separately and will be stored in convenient areas. Following the

termination of construction, the stored soil could be utilized for landscape in the scope of site restoration studies.

Table 8.1 Project Timing Table

Work Item
Project development
Work commencement
Tender stage
Detailed Engineering Studies for the wells
Drilling of the wells no 1 and 2
Drilling of the wells no 3 and 4
Drilling of the wells no 5 and 6
Drilling of the wells no 7 and 8
Drilling of the wells no 9 and 10
Leaching station engineering works
Leaching station and other construction activities
Leaching activities of the wells no 1 and 2
Leaching activities of the wells no 3 and 4
Leaching activities of the wells no 5 and 6
Leaching activities of the wells no 7 and 8
Leaching activities of the wells no 9 and 10
Gas station detailed engineering and (Phase 1)
Gas station construction activities (Phase 1)
Gas Injection to the wells no 1 and 2
Gas Injection to the wells no 3 and 4
Gas station detailed engineering and (Phase 2)
Gas station construction activities (Phase 2)
Gas Injection to the wells no 5 and 6 with gas
Gas Injection to the wells no 7 and 8 with gas
Gas Injection to the wells no 9 and 10 with gas
Starting the operation of wells no 1 and 2
Starting the operation of wells no 3 and 4
Starting the operation of wells no 5 and 6
Starting the operation of wells no 7 and 8
Starting the operation of wells no 9 and 10

The vehicles to be used in the construction phase will be chosen in a way to minimize the impacts resulted from noise. Moreover, so as to control the performance of the construction equipment on site, the equipment will be supervised monthly. Again monthly, noise level measurement program will be employed at the project site and the nearest resettlement area. The results of the measurements will be kept at the

construction site and by the project holder and will be displayed when requested from the authorities.

In the course of the construction phase of TUGSP project, the risks to be arisen concerning the human health and safety are pertinent to the accidents that are probable to be encountered at these types of construction works. In that context, the contracting company that would carry out the construction activities will make use of their own information and experience and moreover the safety rules[1] that are accepted globally so as to provide a secure site for all workers and safety of excavation, scaffold and heavy vehicles (such as cranes, etc.).

Warning signs will be placed against the probable occupational accidents, the required security equipment of the workers will be procured and the relevant articles of "Rules and Regulation for Occupational Health and Safety" will be complied, the entrance and exit of the construction site will be under control. Furthermore, the protection precautions necessary for minimizing the potential environmental pollution risks will be taken.

In order to calculate the earthquake danger in the project area both statistical and deterministic methods are used (see Annex – G). Maximum gravity values exceeding 10% and 2% probability value at hard soil level are calculated by using the attenuation relations (absorption of earthquake waves in the ground) proposed by Boore et al (1997), Campbell (1997) and Sadigh et al (1997). The results are given in table 8.2

Table 8.2 Maximum Gravities with Probabilities obtained for the project site

	Probability values in 50 years	
Attenuation curve	10%	2%
Joyner and Boore (1997)	0.14 g	0.24 g
Campbell (1997)	0.16 g	0.31 g
Sadigh et al (1997)	0.20 g	0.38 g
Arithmetical mean of PGA	0.17 g	0.31 g

Two critical earthquakes are determined for the project area using deterministic approach. First of them is the Salt Lake fault, which is the closest known fault; the earthquake that has a magnitude of 7.5 is assumed to develop on this fault at a distance of 50 km to the project area depending on the reverse fault.
Second, taking into account the historical realities showing that in–plate earthquakes having 6.5 magnitudes may develop in any part of Anatolia such as Kırşehir event on 19.4.1938, it is decided to place the epicenter of a 6.5 magnitude earthquake to a distance of 5 km from the project site. Maximum gravity and maximum displacement is

[1] *These rules are determined by acts and regulations like Rules and Regulation for Occupational Health and Safety (Official Gazette dated 12.9.1974 and numbered 15004).*

calculated for these two earthquakes. The results obtained are given in Table 8.3 and Table 8.4 respectively.

Table 8.3 Deterministic maximum gravities obtained for the project site

	Deterministic event	
Attenuation curve	M = 7.5 (at 50 km)	M= 6.5 (at 5 km)
Joyner and Boore (1997)	0.10 g	0.24 g
Campbell (1997)	0.08 g	0.42 g
Sadigh et al (1997)	0.12 g	0.29 g
Arithmetical mean of PGA	0.10 g	0.31 g

Table 8.4 Deterministic Maximum Displacements Obtained for the Project Site (Gregor 1995 attenuation relation)

	Deterministic event	
Attenuation curve	M = 7.5 (at 50 km)	M= 6.5 (at 5 km)
Horizontal	7.8 cm	7.9 cm
Vertical	3.1 cm	4.7 cm

As a result, the project area is at one of the least seismic, most consistent regions of Anatolia. However, the seismic history of Turkey shows evidences that unexpected earthquakes with 6.5 magnitude may be seen in any part of Turkey. For this reason, in terms of the results of such a variable event, taking a "long" period seismic danger in the region would be a better approach. In the long term (average return period in 5000 year order) assessment, PGA will be about 0.3. In the short term assessment (that is 500 year return period) PGA will have 0.17 g value.

In this context, in the design of the facilities within the project area, the magnitude of the earthquake that is estimated to occur in case of the worst-case scenario is taken into consideration. By this way, in case of an earthquake, any kind of precautions related with the surface facilities are taken. In addition, the works carried out in the project area show that the caverns that will be constructed 700 m below the surface will not be affected from any earthquake activity.

However, there will be safety valves along the line that starts from the surface and goes down to the cavern entrance will be provided at different depths. These valves will be automatically closed not only during an earthquake but also in all extraordinary conditions.

8.1.2 Monitoring Program in Operation Phase

The monitoring program to be carried out in the scope of TUGSP project is compulsory to provide the environmental safety and preserve the validity of the obtained permissions.

The water intake and wastewater discharges, which are subjected to monitoring, will be realized in compliance to the standards in Water Pollution Control Regulation. Furthermore, the criteria stated in Regulation and Law on Fishery Products numbered 1380 will be fulfilled. All monitoring studies will be realized in line with the standard techniques proposed by the Ministry of Environment. The monitoring studies will be performed with equipments which their calibration, operation and maintenance will be made in accordance with the instructions of the supplier company. The analyses, which cannot be executed with an apparatus set up on site and portable equipment, will be realized at an authorized laboratory.

The measurements in the operation phase of the project will be the continuity of the monitoring activities carried out in construction phase.

All data obtained during the monitoring studies will be reported to the Ministry of Environment or Provincial Directorate of Environment.

8.1.3 Monitoring Program in Post-Operation Phase

Following the termination of the operation phase of the project, the surface water quality of Tuz Golu will be pursued for one year. Thus, seasonal water samples will be taken and analyzed and Provincial Directorate of Environment.

8.2 Emergency Response Plans

Within the content of this project, the events like gas leakage and fire risk, which can occur due to the facts such as improper design, inappropriate operation, occupational accidents, natural disasters or sabotage, are depicted as "emergency cases" and regarding these cases emergency response plans will be determined. Within this scope, after the start of activity of the proposed project, an Emergency Plan will be prepared and submitted to the Environment Provincial Directorate in line with the matters included in the Notification on Emergency Plan in case of Big Industrial Accidents numbered 2074 – 4906 and dated July 29th 1996. This emergency plan will include the operations to be performed taking into account the possibility of CO_2 gas emission during the drilling activities.

8.2.1 General Structure of Emergency Response Plans

The main purpose of emergency response plans is to define the activities required to be realized for alarm, danger zones, rescue, release and normalization in dangerous incidents and accidents.

Gas sources possess some risks of their own. These risks can be related to technical failures and can also result from human mistakes or other exterior factors. Therefore, the preparation of an efficient emergency plan is significant. The important issues regarding the topic are to realize an immediate response to the emergencies and to provide well-educated personnel to be assigned in the minimization and control of the impacts. Furthermore, the duties and liabilities of the personnel should be determined explicitly in the emergency response plans.

The emergency response plan to be carried out for the project of concern shall be ready constantly for immediate response and control in case of emergency. The plan to be implemented in the operation phase will consist of education, emergency practices, personnel qualification and task definitions.

The emergency response plans are prepared in an adaptable manner in order to utilize the common global methods and by taking the importance of timing into consideration. The reasons of the preparation of emergency response plans can be listed as follows:

- Secure life,
- Secure environment,
- Secure and permanent opportunities.

Although there are no detailed instructions in emergency response plans for every emergency, the liabilities and duties can be determined for each situation. In this regard, the duty of each personnel is stated individually in emergency response plans.

8.2.2 Main Sections of Emergency Response Plans

In coordination with BOTAŞ, the contracting company will inform the relevant governorships, police stations and municipalities with an official letter prior to the commencement of natural gas storage in the caverns, will send its emergency response plans and will make the required attempts for cooperation to be carried out in case of emergencies. The issues to be included in the emergency response plans can be summarized as follows:

- In case of emergencies, all required tools and instruments (4×4 safety vehicles, pickaxe, shovel, special gloves, etc.) and their storage places and conditions will be determined.
- The way that the heavy vehicles like shovel, bulldozer would respond in case of any emergency will be previously planned and the parking lots and maintenance programs of these vehicles will be selected by taking this issue into account.
- The individuals to be involved in emergency response teams and the manner that these teams will carry out their duties will be stated clearly.
- The education and application programs of the emergency response teams and the key personnel will be determined; the in-house education programs will be carried on without delay.
- The periodic examination and maintenance programs of all equipment in the emeregency response list will be prepared and these programs will be put into practice precisely.
- Required evacuation plan and roads for situations that are probably to bring about danger (e.g. flood, landslide, etc.) will be pre-determined (for the workers and even for the residents in the vicinity).
- The prepared emergency response plans will be developed by testing and controlling with continous practices.

8.2.3 Measures to be taken Against Fires on the Pipelines

When a fire breaks out on the pipelines and after the alarm is given, the problem will be tried to be avoided immediately by utilizing the fire fighting resources, which are ready to use at certain locations in the content of emergency response plan. The following issues that are proposed in the emergency response plans to be prepared will be implemented:

- The closest security and fire brigade units (e.g. gendarme) will be informed.
- It will be controlled whether the valves, which are not in the scope of the proposed TUGSP, shut down the line automatically.
- The safety of the environment will be provided by the emergency response team and relevant units (e.g. gendarme).
- The extinguisher teams will fight with fire instantaneously.
- The maintenance and repair of the line will be carried out through the week following the extinguishment of fire.

8.2.4 Measures to be taken Against Fires in the Caverns

Due to the fact that the caverns are located approximately 1000 m deep under the surface, no fire possibility is of consideration at these locations. Moreover, nitrogen will

be used as blanket gas against the leakage risk. In this regard, required measures are taken against the probable leakages.

8.2.5 Measures to be taken In Case of Accident and Sabotage

Against any accident and sabotage possibility that can take place within the content of the proposed TUGSP, pipelines and caverns will be taken under control regularly throughout the operation phase. The parameters such as pressure, temperature and flow rate will be monitored continuously at certain locations on the line and the caverns and abnormal conditions will be reported to the authorities. As a consequence required responses will be realized promptly. In case of an extraordinary situation, the line valves susceptible to pressure will be shut down automatically.

In accordance with the results of the drilling activities carried out during engineering works and the results obtained from the geological surveys, there is no possibility of hydrogen sulfur (H2S) gas emission. The reason of this is that the drilling will be made in rock salt and no H2S gas emission is expected from the salt formation. In this case, which is generally encountered in case of gas and petroleum search drilling operations, the following equipment are added to the drilling tower:

- H2S separator
- Automatic burning H_2S flame
- H_2S detector at different places of the drilling instrument
- Equipment preventing explosion (suitable for H_2S)
- Grade E or CE drilling pipe (suitable for H_2S)
- Oxygen masks and first aid equipment at the surface

In case of carbon dioxide (CO_2) gas emission during the drilling activities, it is not necessary to make an addition to the drilling instrument. In this case, CO_2 gas must be taken out of the drilling area in a controlled way.

During the storage of the natural gas, special importance will be paid to the breaks and cracks in the formation, any kind of precautions related with the subject will be taken and the necessary operations will be performed.

8.3 Environmental Risk Analysis

8.3.1 Determination of Risks

Among the environmental risks that may occur within the scope of Salt Lake Basing UNGSP, the priority belongs to the natural gas, which is the storage material. Within this scope, because of the flammable and explosive characteristics of the natural gas, the pipelines used in the transportation of the natural gas have special importance. Another risk is the CO2 gas that may be emitted from underground during the drilling activities. This gas has also a danger of explosion while getting to the surface.

The natural gas that will be stored within the scope of Salt Lake Basin UNGSP includes approximately 98% methane gas. Although methane gas has no known toxic characteristic, it decreases the level of oxygen in the respirated air. The natural gas, which is lighter than air takes an inflammability feature as the result of mixing with air (in 5 – 15% ratio). In this case, natural gas has different danger levels in open and closed environments. In the open areas, in case of leakages caused by the breaks on the pipe lines or manifolds, the ignition of the natural gas and the fire effects that may occur as the result of this condition and the health effects or fire effects that will be created by the natural gas cloud that is accumulated in the building as the result of pipe breaking may be different.

Explosions may take place in case of exit of CO2 gas that is accumulated in the formations under ground during the drilling activities. But such cases can be noticed beforehand in general and is discharged from the formation in a controlled way. In this context, in order to balance the pressure of the gas that will exit, drilling mud is made denser.
As a result, the biggest danger that can occur within the scope of Salt Lake Basin UNGSP is the ignition of the natural gas transmitted with big pipes.

8.3.2 Environmental Risk Analysis, Impacts and Assessment

As indicated in the "Northern Marmara and Değirmenköy Areas Underground Natural Gas Storage Project Environmental Impact Assessment" Report prepared by TPAO, the worst condition that can be caused by natural gas in the open area is the corrosion crack on the pipe lines carrying the natural gas or full pipe break. In such a case, in case the natural gas spread in the atmosphere is ignited, one of the following conditions can be met in the worst-case scenario:

- Sudden ignition of the leaking gas before the formation of the gas cloud or delayed ignition (jet flame)
- Rapid ignition of the accumulated gas cloud without distribution (flame ball)
- Small burning of the gas cloud (inflammation fire).

In the same report, it is indicated that the worst condition in the closed area is natural gas leakage in the compressor room and ignition and explosion of the accumulated gas cloud.

In the assessment of natural gas risk effects and assessment of these effects, the report prepared by TPAO and indicated herein above is used. In accordance with this, the jet flame that may occur in the open area, flame ball or inflammation fire impacts may be overheat impacts (injury and death) and the effect of the burning products of the natural gas on the air quality. In case no ignition occurs, only gas leakage will be seen and this will result in product loss.

In case of explosion of the accumulated gas in closed areas as the result of leakage, over pressure effects can be seen (injury and death). In case no ignition occurs, health effects caused by gas accumulation in the closed area will be seen.

Risk Factors That May be Caused by Natural Gas

Overheat Impacts

In relation with the environmental impacts that can be created as the result of the jet flame, flame ball and inflammation, TPAO report makes the definitions in Table 8.5.

Table 8.5 Overheat effects

Type of accident	Damage criteria
Jet flame	- 4 kW /m^2 – 1250 BTU / h / ft2: Most fatal danger for the population (being subject to for > 1 min) - 12.5 kW/m^2 – 3900 BTU /h/ f2: Ignition of wooden and plastic materials, in case of very long period of subjection (some 10 minutes) ignition of process equipment - 37,5 kW /m^2 – 11700 BTU /h/ft2: Immediate death, 10 min (jet flame) 20 min (pool fire) process equipment crashing
Flame ball	22 kW/m2: average 1% death ratio with 10 – 20 second fire ball period
Inflammation fire	Low inflammation limit concentration 5%; Fatal in case of 100%

Reference: Northern Marmara and Değirmenköy Areas Underground Natural Gas Storage Project Environmental Effect Assessment TPAO, October 2002, Ankara

As indicated in the report, as the result of the calculations made, "distance with minimum fatal risk for population is determined to be 72 – 400 m. as indicated in section 2, the closest plateau to the surface facilities is at a distance of 1100 m. in this context, it is envisaged that the residential locations near the project area will not be affected by the overheat caused by natural gas fires.

Impacts on Air Quality

In case of a full break on the line with 24" diameter on the pipelines carrying natural gas, approximately 480 kg / second natural gas leakage occurs (TPAO, 2002). In case of burning of this gas, the polluters that will be spread to the atmosphere will be nitrogen oxides (NOx), carbon monoxide (CO) and hydrocarbons (HC).

Assuming that Marmara Ereğli and Sultanhanı Region may have similar topographic structure (low slope) and meteorologic conditions (high wind speed), the result that the emissions that will be caused by the natural gas fire will not have an important negative effect on the surface level can be obtained (TPAO, 2002)

Health Impacts

Natural gas does not have any known chronic health effect and does not have any toxic and carcinogenic feature. In addition to this, in case of contact of the gas with eye and skin, it does not have any known health effect (TPAO, 2002). But in case of leakage of natural gas in closed areas, oxygen level decreases. This case makes respiration difficult. In this context, in case natural gas leakage is determined in closed environments, the environment will be immediately ventilated.

Excessive Pressure Impacts

In case of mixture of natural gas having inflammable characteristics with air in 5-15% ratio it has an explosive effect (TPAO, 2002). In this case, in order to prevent the accumulation of the natural gas in closed areas in any case, the environment will be immediately ventilated. In addition, the natural gas leakages that are determined using sensors and detectors will be notified to the personnel immediately through the use of alarms.

9 RESULTS

9.1 Brief Definition of the Project

Tuz Golu Basin Underground Natural Gas Storage Project (TUGSP) is planned to be realized about 17 km south of Sultanhani Municipality of the Central District of Aksaray Province by Petroleum Pipeline Corporation (BOTAŞ) (see Figure 1.1 and Figure 1.2).

Proposed project site is located in the south of Tuz Golu and the closest distance between the site and the lake is approximately 40 km. The objective of TUGSP is to meet the seasonal fluctuations to be occurred in the future depending on the increase in residential natural gas demand. In that content, it is planned to store natural gas between the salt layers, located at a depth of approximately 1000 m. Within the content of the project the construction and operation phases will be carried out simultaneously and the completion of the construction phase is expected to be approximately 12,5-15 years. The economic lifetime of the project is at least 50 years.

In order to survey the seismic characteristics of the region, seismic studies, which began in November of the year 2000, were carried out within an area of about 80 km² (see Figure 2.2 and Figure 2.3). The site determined for TUGSP was chosen within this study area and its location is shown in Figure 1.2.

9.2 Baseline Assessment

Present environmental resources within the project site are assessed by the site investigations performed by the project team. In this context, comprehensive site studies were realized to determine the local air, water and soil quality and the biological resources. With the intention of assessing the socio-economical condition, when the existing data is not detailed enough, the conversations carried out with the residents and authorities of the region are utilized. The results listed below are obtained regarding the present environmental characteristics within the site selected for TUGSP:

- According to the results obtained from the studies carried out to determine the air quality, there is no significant emission resource in the region proposed for TUGSP and its vicinity. Due to the fact that the region is a rural area, the present air quality is composed of emissions emitted from the heating purposed sources (e.g. coal) and the soil. There are pollution sources (e.g. stack) in Sultanhani, which result from the indigenous coal (see Section 4.2.18.1). The project site is not affected by the air pollution since it is far from the settlement area.

- The general characteristics of the soils at the project site, the distribution of major soil groups, land utilization pattern, slope and erosion levels are surveyed (see Section 4.2.10). Accordingly, the lands of the project site are presently of III. Class, which are lands with dry agriculture (fallowing), pasture and shrub.
- In the course of the water quality-monitoring program, samples are taken from various surface and ground water resources and surveyed (see Section 4.2.18.2 and Section 4.2.18.3). Accordingly, surface waters are "very contaminated waters"; while ground water is "low quality ground water" and "useable water".
- So as to establish an inventory of flora in the project site, a detailed study is realized in the region (see Section 4.2.14.2). The flora inventory of the region is given in Appendix-J comprehensively and in detail. In this section, lichen species, which are indicator particularly in terms of air quality, are listed. The most important seedless flora species at the project site and its vicinity are lichens and mosses. In that content, *Grimnia trichophlla* and *Tortula pulvinata* are the most encountered species in the region.
- There are five amphibian species in the impact area and these species are listed in Appendix-K (see Section 4.2.14.3).
- As indicated by the surveys carried out, a total of 85 endemic and/or rare species are determined. Accordingly, the ratio of the endemic species at the site to the endemic species in the region is 18%. This ratio is below 30%, which is the average of Turkey (see Section 4.2.14.4).
- The socio-economic structure of the region is surveyed in detail (see Section 4.3). In terms of socio-economic indicators, although Aksaray Province is convenient for agriculture and stockbreeding, in recent years significant developments have been accomplished in industry.
- Areas, which possess significance owing to various reasons (ecology, history, natural beauties, etc.), are declared as protection areas through laws that are in force in our country. In accordance with the site and literature surveys, the protection areas located in the project site and its vicinity surveyed within the content of proposed TUGSP are presented in Section 4.2.10.
- Aksaray Province is expedient for access by means of its geographical location and its landscape. It is feasible to access to the province via highway. However, there is no railroad link of Aksaray Province to the other provinces. E-90 highway and Konya-Kayseri highway are traversing through Aksaray Province. The total length of the roads is 468 km, where the length of state highways is 191 km while the provincial roads is 277 km (see Section 4.3.8.2).

9.3 Environmental Impacts of the Project

The probable environmental impacts and measures to be taken to minimize these impacts are discussed in Section 5 in detail. The outline of the evaluation of the significant biophysical and socio-economical impacts that are probable to arise owing to the proposed TUGSP is presented in the following paragraphs.

9.3.1 Impacts on Water Quality

By virtue of the measures to be taken in construction and operation phases, it is not a matter of concern that the proposed project would have permanent adverse impacts on water quality (see Section 5.1.15 and Section 5.2.5).

9.3.2 Impacts on Air Quality

There will be dust emissions resulting from the soil stripping, excavation and transportation in construction phase. However, their impacts on local air quality will be of minimal level. In the course of daily construction activities, total dust emission will be 1.38 kg/hour. Under these conditions, no modeling study is required to be carried out in accordance to the provisions of Appendix-2 of Regulation on Prevention of Air Quality and in case if proposed minimization procedures would be applied meticulously, the impact of the dust to be arisen during the construction activities will be at acceptable levels (see Section 5.1.8). No dust emissions will be of concern in operation phase.

9.3.3 Terrestrial Impacts

Taking the biophysical impacts (air, water, etc. quality), which are discussed in the relevant sections of the project, and the control methods into consideration, excluding the area to be impacted from the construction activities, the operational activities of the proposed project will not have adverse impact on vegetation and soil quality within the project site.

9.3.4 Noise Impacts

The noise level that will be brought about by the construction and operation activities of TUGSP will be at acceptable levels both in daytime and nighttime in accordance to the Noise Control Regulation (see Section 5.1.16 and Section 5.2.9).

9.4 General Assessment

In general, the proposed natural gas storage project has three significant characteristics in terms of environmental impacts: (i) the proposed project's peculiar characteristics such as site and technology selection, (ii) impact assessment study realized for proposed storage area and (iii) operation and monitoring studies carried out by all relevant institutions and entities throughout the activity period.

In order to determine the probable impacts of the design proposed in terms of EIA and the related control methods, detailed site investigations and model estimations were utilized, all probable alternatives were scrutinized, thus it was taken pains to implement the scientific and legal requirements of an EIA study that is fitting to the purpose. Consequent to the above discussions, no permanent environmental impacts and damages are expected regarding the TUGSP activities with the stipulation that the proposed control methods are implemented properly.

Consequently, in case if required consideration will be provided to the measures to be taken against the probable adverse environmental impacts in the course of the realization of the project, the adverse impacts of the activity will not reach up to high levels and the limits determined by the relevant regulation and acts will not be exceeded. During construction and operation stages, the activities will be followed by providing an information flow and coordination between State Hydraulic Works General Directorate, Special Environmental Protection Institution Presidency, Provincial Health Directorate, Provincial Environment and Forestry Directorate and BOTAŞ.

APPENDIX – A EIA REPORT FORMAT

TUZ GOLU BASIN UNDERGROUND NATURAL GAS STORAGE FACILITY
EIA REPORT FORMAT

Cover Page :

Name, address, telephone, fax number of project owner:.....

Name, address, telephone, fax number of the company who had prepared the report:

Qualification certificate no and date of the firm preparing the report:.....

Name of the project:.....

Preparation date of the project: .....

Name of the area, location and if within more than one provinces or districts, name of the defining region selected for the project:.....

List of Contents

Section I: Project Description And Objectives (Project description, life, means of service, markets or service area of the project, its importance and necessity within this area with respect to the economic and social aspects of the country, region and/or province)

Section II: Location of the Project Site

II.1. Site Selection (Representation of the location of activity and the pipeline route, which their uprightness is approved by associated Governorship or Municipality, on Approved Environmental Master Plan which includes legand and plan notes or on Master Plan if it is within the borders of such plan and if these plans are not present, on the existing land use plan together with their coordinates and the representation of the pipeline route on 1/25,000 scaled map)

II.2. The Location of the Activity Units In the Content of the Project (Representation of the locations within the project site of all administrative and social units, technical infrastructure units and if present, other units of the project – pipeline route to be constituted, compressor station, caverns, injection and withdraw wells, etc. - on the Application Plan, size of the outdoor and indoor areas allocated for these activities, flat numbers and heights of the buildings)

Section III: Economic And Social Aspects Of The Project

III.1. Investment Program and Finance Sources Concerning The Realization Of The Project

III.2. Work Flow Chart or Time Table Concerning The Realization Of The Project

III.3. The Benefit-Cost Analysis Of The Project

III.4. Other Economic, Social and Infrastructure Activities Not Found In The Content Of The Project But Planned To Be Realized By Investor Firm Or Other Firms Depending On The Realization Of The Project

III.5. Other Economic, Social and Infrastructure Activities Not Found In The Content Of The Project But Needed for The Realization Of The Project and Planned To Be Realized By Investor Firm Or Other Firms

III.6. Other Issues

Section IV: Determination Of The Project Impact Area And Explanation Of The Present Environmental Baseline Of The Area ([1])

IV.1. Determination of the Project Impact Area (pipeline route to be laid and compressor station will be also taken into consideration)

IV.1.1. Determination of the baseline pollution load in terms of air, water (surface and ground waters), soil and noise of the pipeline, compressor station and storage facility location and impact area

IV.2. Characteristics Of Physical and Biological Environment and Utilization Of The Natural Resources

IV.2.1. Meteorological and Climatic Characteristics

IV.2.2. Geological Characteristics (Physical-chemical features, tectonic movements, mineral resources, landslide, unique formations, avalanche, flood, rock fall, etc.)

a) Regional geology (related cross sections and maps)

b) Geology of the project site (related cross sections and maps)

IV.2.3. Hydrogeological Characteristics of Ground and Thermal Water Resources (water levels, amounts, safe drawing values, flow rate of resources, currently existing casing, deep, artesian, etc. wells, physical, chemical, bacteriological features of the water; present and planned utilization of groundwater, any casing, deep, artesian, etc. wells, the catchment area of the formations bearing groundwater, hydrogeological properties of the lithological units, relations between aquifers, flow dynamics of groundwater, Thermal and Geothermal Water Resources, present and planned utilization, etc.)

IV.2.4. Hydrological and Ecological Characteristics (Physical, chemical, bacteriological and ecological characteristics of lake, fishpond, river and other wetlands of the surface water resources, flow rate and seasonal changes of rivers in this extent, floods, depth and volume of lakes, seasonal changes of lakes, water catchment basin of lakes, oligotrophic, mesotrophic, eutrophic, distrophic classification of lakes, sedimentation, drainage, coastal ecosystems of all water resources, the location of project site with respect to lake, dam, pond, river and other wetlands)

IV.2.5. Present and Planned Utilization of Surface Water Resources (Drinking, consumption, irrigational water, electricity production, dam, lake, pond, product type and production quantity in the production of aquatic products, waterway transportation facilities, water and/or shore utilization for tourism, sports or other similar purposes, other utilizations)

IV.2.6. Species in Inland Waters (Lake, Fishpond, River) (Natural characteristics of these species, species under protection by national and international legislations; their breeding, feeding, sheltering and survival habitats; protective decisions determined for these habitats)

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[1] *When explaining of the questions stated in the EIA Report Format, the information obtained from associated state institution and foundations, research institutions, universities or any other similar agencies are stated in notes section with the institution where the information is obtained from or are spotted on the related map, document, etc. If information based on the studies of the project owner is given, a certificate stating the truth of this information is taken from related state agencies and added to the report.*
The questions asked within the format should be answered individually for natural gas storage activity. pipeline, compressor station and transportation and disposal operations of leaching water.

IV.2.7. Minerals and Fossil Fuel Resources (reserve quantities, present and planned operational conditions, annual production and their importance and economical values for national or local utilization)

IV.2.8. Soil Characteristics and Utilization Condition (soil structure, physical, chemical and biological characteristics of soil, land utilization capability classification, slope stability, erosion, present soil utilization, pasture, meadow, etc. used as natural vegetation)

IV.2.9. Agricultural Lands (agricultural development project areas, plantation areas for special yields, size of irrigated and dry agricultural lands, crop patterns and their annual production and the national importance and economic value of these yields)

IV.2.10. Protection Areas (National Parks, Nature Parks, Wetlands, Natural Monuments, Nature Protection Areas, Wildlife Protection Areas, Wild Animal Breeding Areas, Cultural Assets, Protection Areas, Biogenetic Reserve Areas, Biosphere Reserves, Special Environmental Protection Regions, Special Protection Areas, Protection Areas related with drinking and utilized water resources, Tourism Regions and Centers and other areas under protection)

IV.2.11. Forestry Areas (species and number of trees, size and closeness of their coverage area, present and planned protection and/or utilization purposes of these)

IV.2.12. Flora and Fauna

- Species, endemic, especially local endemic flora species, fauna species living naturally in the area and species under protection by national and international legislations, rare and endangered species and their location in the area, determined protection decisions for these, names and populations of game animals, representation of vegetation types present in the project area on a map. Protection measures required to be taken for species influenced by project activities (in construction and operation phases). Realization of flora studies carried out in the field at vegetation period and determination of this period. ([2])

- Natural characteristics of these species, species under protection by national and international legislations; their breeding, feeding, sheltering and survival habitats; protective decisions determined for these habitats

IV.2.13. Animal Husbandry and Aquatic Products (species, feeding areas, annual production, national importance and economic value of these products)

IV.2.14. Recreational Areas and Areas with High Landscape Value, areas where unique geological and geomorphologic formations are present

IV.2.15. Lands Under Control and Responsibility of Authorized Governmental Agencies (Military Restricted Zones, areas allocated to public institution and foundations with designated purposes)

IV.2.16. Determination of the Baseline Pollution Load in Terms of Air, Water (surface and ground water), Soil and Noise of the Pipeline, Compressor Station and Storage Facility site and Impact Area)

IV.2.17. Traffic Condition of the Region

IV.2.18. Other Characteristics

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[2] *"Flora List Table" is filled out in compliance with the sample given in the appendix and added to the report.*

IV.3. Characteristics of the Socio-Economic Environment

IV.3.1. Economical Characteristics (Main sectors that constitute the economic structure of the region, the distribution of the regional labour force to these sectors, the state and importance of manufactured commodity and service of these sectors in the regional and national economy, other informations)

IV.3.2. Population (Rural and urban population in the region, population demographics, migrations, population growth rate, average household population and other informations)

IV.3.3. Income (The distribution of the regional income over branches of industry, average income per capita in respect to branches of industry)

IV.3.4. Unemployment (unemployed population in the region and ratio of unemployed population to active population)

IV.3.5. Health (Endemic and frequently observed diseases in the region)

IV.3.6. Social Infrastructure Services in the Region (Education, health, cultural services and the state of benefiting from these services)

IV.3.7. Urban and Rural Land Use In The Project Site and Its Vicinity (Distribution of settlement areas, present and planned utilization areas, industrial areas in that content, residences, tourism areas etc.)

IV.3.8. Other Characteristics

Section 5: Impacts Of The Project On The Area Defined In Chapter 4 And Measures To Be Taken (In this section, impacts of the project on the physical and biological environments and the legal, administrative and technical measures to be taken to prevent, mitigate and improve these impacts will be explained individually and in detail for the headings V.1 and V.2)

V.1. Site Preparation, Activities During Construction and Operation Phases, Impacts on the Physical and Biological Environments and Measures To Be Taken

V.1.1. Locations and amount of the areas to be excavated in the content of the works carried out for site preparation, pipeline laying, discharge operation of the compressor station and leaching water, disposal of excavated waste material like soil, stone, sand and etc., and their usage purposes, machinery to be used during excavation, amount and properties of the vehicles and machines and equipments to be used in site preparation and facility establishment phases,

V.1.2. Operations to be carried out to ensure ground safety

V.1.3. Operations to be carried out to prevent ground percolation in pipeline, storage facility and other units

V.1.4. Size and capacity of pipeline, technical features of pipe to be used (cathodic protection, isolation, etc.) and other units, technical information concerning the pipeline laying, information about route

V.1.5. Size of cavern locations, studies carried out for its determination, criteria taken into consideration in the determination of cavern locations

V.1.6. Works related with flood prevention and drainage

V.1.7. Transportation, storage and utilization of flammable, explosive, dangerous and toxic materials to be used during site preparation and construction stages, equipment and machinery to be used for this purpose

V.1.8. Dust emitting activities like crushing, grinding, transportation and storage during construction phase, their impact on biological environment and measures to be taken, dust emission calculations

V.1.9. Activities like excavation, dredging, filling, construction on pile, etc. to be performed for any purpose in aquatic environment within the project area, the location, size of the area and the method of activities to be carried out and amount, disposal locations or utilization purposes of stone, sand, pebble and similar materials excavated due to these operations

V.1.10. Transportation infrastructure plan within the project scope (transportation route, present condition and capacity of the roads, for which purposes they will be used, present traffic load, its location with respect to settlement areas, whether they will bear the vehicles to be used for activity, maintenance, repair and improvement works), activities related with the construction of this infrastructure; materials, chemical substances, equipments and machinery to be used; dust spreading mechanical works like crushing, grinding, transportation, storage during construction of infrastructure

V.1.11. Water supply plan within the project scope, amount of water that will be taken from the water supply reservoires, and amount of these waters according to their usage purposes

V.1.12. Electrification plan within the project scope (workes to be carried out for the application of this plan, and the material to be used, locations where power transmission lines will be located and the locations of transformer, their power

V.1.13. Type and amount of solid wastes to be generated due to the works carried out beginning from preparation of the site until operation of the units, disposal methods of these wastes or purposes of their usage

V.1.14. Types of fuel to be used during the works beginning from preparation of the site until operation of the units, consumption amounts and emissions to be formed from the consumption and their disposal

V.1.15. Type and amount of wastewaters to be generated during the works beginning from preparation of the site until operation of the units, disposal method and discharging environments

V.1.16. Origin and level of vibration and noise generated due to the works beginning from preparation of the site until operation of the units

V.1.17. Species and number of trees to be cut or transported due to required land acquisition for the site preparation and construction area, natural flora species to be destroyed, and size of the area where these activities will be carried out, measures to be taken

V.1.18. Size of agricultural lands to be destroyed due to required land acquisition for the site preparation and construction area, their land use categories and types of agricultural products

V.1.19. Accommodation and other technical/social infrastructural requirements for the personnel, and the related population to be worked during the works carried out beginning from preparation of the site until operation of the units

V.1.20. Activities that are posing risk and danger for human health carried out beginning from preparation of the site until operation of the units

V.1.21. Size of area where the land arrangements (afforestation, green area arrangements, etc.) will be carried out for landscape or for other purposes in the project area, flora and tree species to be selected

V.1.22. Health Band Zone proposed for the project

V.1.23. Other activities

V.2. Activities at the Operation Phase of the Project, Impacts on the Physical and Biological Environment and Measures to be Taken

V.2.1. Characteristics of all operations to be realized in the content of the project, detailed description of methods and technologies to be performed and work flow diagram (caverns to be created at the salt domes, leaching operation, natural gas storage, etc.), which activity will be realized at which unit, capacities and size of units, number and properties of machinery and equipments to be used, services to be given by auxiliary units

V.2.2. How and where the natural gas to be stored will be transported

V.2.3. Amount of natural gas (daily, monthly) to be stored in the activity units, interactions in the adjacent rock due to the pressure changes in gas to be stored, leakage risk of stored gas from the adjacent rocks, volume and pressure of gas to be stored in one cavern, its physical and chemical properties, amounts, locations and means of marketing, to where and how the performed services will be presented and the regaining percentage of ntural gas to be stored economically

V.2.4. Accommodation and other technical/social infrastructural requirements for the personnel, and the related population to be worked during the activities of the facility

V.2.5. Amount and supply manner of the water to be used in the activity unit and other units (with purposes like drinking, usage, process, boiler, cooling, fire, etc.); resource, amount, physical, chemical and bacteriologic properties of waste waters to be generated, materials to be disposed at waste water treatment facility, disposal operations and rates, amount, receptor environment and method of discharge of waste water after treatment operations, its impact on biological environment and measures to be taken (the method of discharge of salty water generated during leaching process, properties and amount of this water, determination of its impacts on the discharging area and its vicinity and measures to be taken)

V.2.6. Types, amount and chemical analyses of fuel to be used in activity units and other units, amounts and units used for burning of fuel and burning systems to be used, emissions, flue gas treatment sytems, equipment and systems to be used for measurements

V.2.7. Emissions (gas leakages, dust, etc.) to be formed during the activity of facility, amount, type and treatment manner of emissions and measures to be taken to prevent the gas leakage (for pipeline, storage area)

V.2.8. Amount and properties of solid and/or hazardous wastes to be generated during the activity of facility, storage-pilling and disposal operations, location and manner of transportation of these wastes or purposes and manner of their re-usage

V.2.9. Sources and levels of vibration and noise to be generated during the activity of the facility and measures to be taken

V.2.10. Probable impacts of the pipeline and maintenance-repair studies of the pipeline to existing infrastructure facilities

V.2.11. Probable impacts on cultural and natural assets and measures to be taken

V.2.12. Impact of project on existing traffic

V.2.13. Activities in the operational phase of the project that are posing risk and danger for human health and environment

V.2.14. Land arrangements to be carried out for landscape or for other purposes in the project area

V.2.15. Other activities

V.3. Impacts of the Project on Socio-Economical Environment

V.3.1. Income increases expected with the project; job opportunities to be created, population demographics, migrations, education, health, culture and other social and technical infrastructure services, changes in the utilization patterns of these services, etc.

V.3.2. Environmental cost-benefit analysis (In this section, the cost and benefits taken from the environment prior to the activity, and the changes to be arised during and after the activity and comparison will be realized)

Section VI: Possible and Continuing Impacts during Decommissioning Phase and Measures to be Taken Against These Impacts

VI.1. Land Improvement

VI.2. Rehabilitation works

VI.3. Impacts on the existing water resources

VI.4. Possible air emissions

VI.5. Other issues

Section VII: Project Alternatives

(In this section, the comparison of the technology, the alternatives of measures to be taken will be realized, the criteria that are taken into consideration and preference order will be explained)

Section VIII: Monitoring Program and Emergency Response Plan

VIII.1. Monitoring program proposed for the construction, operation and decommissioning phases of the project

VIII.2. Emergency response plan (Required measures to be taken against the probable accident, fire and sabotage at the pipeline, storage facility and other units (including loading-unloading))

Section IX: Results

(Summary of all explanations, a general evaluation listing the significant environmental impacts of the project and stating the extent of ensuring success in prevention of adverse environmental impacts in case if the project is realized, preferences among the alternatives in the content of the project and the reasons of these preferences)

Appendices:

(Information, document and techniques, used in the preparation of the report and provided from various foundations, that were not presented within the text of the report)

Notes and References:

Introduction of the EIA team:

Name Surname, Occupation, Cirriculum vitae, References and Signature stating her liability on the report

APPENDIX – I: Flora List Table Sample

APPENDIX – II: Table of personnel which were undertaken to be commissioned in the content of Qualifiedness Certificate Notification

APPENDIX – F METEOROLOGICAL DATA RECORDED AT AKSARAYAND KARAPINAR METEOROLOGICAL STATIONS

Latitude (ϕ) : 38°23'N

Longitude (λ) : 34°05'E

Height (H) : 965 m

(AKSARAY) AKSARAY

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Average local pressure (hPa)	20	907.0	905.4	904.0	903.5	904.3	903.8	902.4	903.4	905.8	908.0	907.8	907.3	905.2
Maximum local pressure (hPa)	20	921.6	921.6	919.7	913.2	913.4	911.5	909.7	909.1	914.6	917.4	918.2	920 0	921.0
Minimum local pressure (hPa)	20	887.0	883.1	884.3	889.7	891.8	893.4	895.0	896 4	895.0	898.2	891.7	888 0	883 0
Average temperature at 07:00 (°C)	20	-1.9	-1.8	1.7	7.8	12.7	16.4	18.8	17.9	13.0	8 0	2.9	0.1	8.0
Average temperature at 14:00 (°C)	20	4.2	5 4	10.2	16.4	21.3	25.6	29.1	29.4	26.0	19 7	11.6	6.2	17.1
Average temperature at 21:00 (°C)	20	0.1	0.9	5.3	10.9	15.2	19 4	23 0	22.4	17.5	11.9	5.7	2.0	11.2
Average temperature (°C)	20	0.6	1.4	5 6	11.5	16.1	20.2	23 5	23.0	18.5	12.9	6.5	2.6	11.9
Average # days with average temperature ≥ 5°C	20	7.4	8.5	18.6	28.2	30.9	30.0	30.6	31.0	30.0	30.4	19 4	11.0	276.0
Average # days with average temperature ≥ 10°C	20	0.4	0.6	5.9	19.5	28.8	30.0	30.6	31.0	29.8	24.1	7.8	1.5	210.0
Average maximum temperature (°C)	20	5 4	6 7	11 6	17.9	22.6	26.8	30.3	30.4	26.9	20.7	12.8	7.4	18.3
Average minimum temperature (°C)	20	-3.4	-3.1	0.2	5.4	9.4	12.8	16.0	15 5	10 8	6.4	1.4	-1.5	5.8
Date of maximum temperature	20	3	23	29	11	23	27	18	7	18	1	2	3	7
Year of maximum temperature	20	1995	1996	1991	1998	1995	1996	1980	1987	1994	1999	1990	1996	1987
Maximum temperature (°C)	20	16.2	21.6	24.6	30.5	33.8	35.8	37.8	38.4	36.5	32.8	25.8	20.6	38.4
Avg. # of days with max. temp. ≥ 30°C	20				0.2	2.1	6.9	16.8	18.4	6 5	0 6			51.5
Avg. # of days with max. temp. ≥ 25°C	20				2.8	10.4	20.2	28.9	29.4	21.5	7.5	0.2		120.9
Avg. # of days with max. temp. ≥ 20°C	20		0.1	2.1	10.9	22.4	29.1	30 5	31.0	28.6	18.5	2.0	0.1	175.3
Avg. # of days with max. temp ≤ -0.1°C	20	5.9	4.7	0 9								0.4	3.1	15.0
Maximum daily temperature difference (°C)	20													
Date of minimum temperature	20	30	7	15	10	4	2	3	25	29	19	26	19	7
Year of minimum temperature	20	1980	1991	1987	1997	1990	1997	1982	1984	1992	1984	1995	1995	1991
Minimum temperature (°C)	20	-19.3	-29.3	-19.0	-7.5	-0.2	3.5	7.0	5.9	1.6	-5.20	-14.0	-14.6	-29.0
Avg. # of days with min. temp. ≤ -0.1°C	20	22.1	19.1	13.1	2.4	0.1					1.4	11 2	18.7	88.1
Avg. # of days with min. temp. ≤ -3°C	20	14.7	11.5	6.2	0 4						0.1	5.5	11.3	49.7
Avg. # of days with min. temp ≤ -5°C	20	10.6	8.0	3.5	0.1						0.1	2.5	7.4	32.2
Avg. # of days with min. temp. ≤ -10°C	20	4.3	3.6	0.9								0.4	1 4	10.6
Avg. # of days with min. temp. ≤ -15°C	20	0.9	1.3	0.3										2.5
Avg. # of days with min. temp. ≤ -20°C	20		0.4											0.4
Avg. # of days with min. temp. ≥ 20°C	20						0.2	2.1	1.8	0.1				4.2
Avg. # of days with min. temp. ≥ 15°C	20				0.1	1.4	6.6	20.1	17 6	3.0	0.1			48.9
Avg. # of days with min. temp. ≥ 10°C	20			0.2	3.3	13.8	26.6	30.0	29 9	19.2	5.2	0.9	0.2	129 3
Avg. # of days with min. temp. ≥ 5°C	20	0.9	1.0	4.2	17.1	27.9	30.0	30.6	31.0	29.1	21.1	7.3	3.0	203.2
Average topsoil minimum temperature (°C)	20	-5.5	-5.1	-2.4	2.3	5.9	9.2	12 8	12.1	6.4	2.7	-1.3	-3.5	2.8
Lowest topsoil minimum temperature (°C)	20	-24.5	-31 4	-21.4	-11.4	-3.6	-0.2	2.4	0.5	-3.7	-10.0	-15.7	-17.2	-31.0

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Avg. # of days with min topsoil temp. ≤ -0.1°C	20	26.5	22 5	21 7	7.7	1.2	0.1			0.9	7.4	17 7	23.9	129.6
Avg. # of days with min. topsoil temp. ≤ -3°C	20	20.0	17.5	12.7	2.8	0.1				0.2	2.9	12.0	16 2	84 4
Avg. # of days with min. topsoil temp. ≤ -5°C	20	14.6	12.1	7.2	1.0						0.9	7.5	10.8	54.1
Avg. # of days with min. topsoil temp. ≤ -10°C	20	6.5	4.6	2.0	0.1						0.1	1.6	3.3	18.2
Average vapor pressure (hPa)	20	4.7	4 7	5 6	7.7	10.0	11.9	13.3	12 7	10.1	8.5	6.5	5.3	8.4
Average relative humidity at 07.00 (%)	20	76	75	74	71	68	65	61	60	62	72	77	77	69
Average relative humidity at 14:00 (%)	20	59	54	48	44	41	37	36	34	34	42	51	59	44
Average relative humidity at 21:00 (%)	20	73	70	62	59	56	50	44	43	48	60	69	73	58
Average relative humidity (%)	20	70	66	62	58	55	51	47	46	48	58	66	69	58
Minimum relative humidity (%)	20	39	34	27	23	27	29	20	19	17	20	24	21	17
Average cloudiness at 07:00 (0-10)	20	6.5	6.2	5.6	5.3	4.1	2.3	1.1	1.0	1 6	3.7	5.5	6.7	4.1
Average cloudiness at 14:00 (0-10)	20	6.4	6.2	6.0	6.1	5.3	3.5	2.0	1.8	2.0	4.0	5.6	6.5	4.6
Average cloudiness at 21:00 (0-10)	20	5.1	4.9	4.1	4.1	3.6	2.3	1.2	0.9	1.1	2.9	4.1	5.7	3.3
Average cloudiness (0-10)	20	6.0	5.7	5.2	5.2	4.4	2.7	1.4	1.2	1.6	3.5	5.1	6.3	4.0
Average # of clear days (cloudiness 0.0-1 9)	20	4.2	4.2	5.4	4.6	5.8	13.3	22.1	23.1	20.0	13.3	6.6	4.0	126.6
Average # of cloudy days (cloudiness 2.0-8.0)	20	17.7	15.9	19.4	20.9	22.5	16.1	8.2	7.9	9 7	14.6	16.7	16.3	185.9
Average # of overcast days (cloudiness 8.1-10.0)	20	10.9	9.3	7.5	5.6	3.4	0.9	0.3	0.1	0.4	4.4	7.6	12.3	62.7
Average total precipitation at 07:00 (mm)	20	14.4	14.1	16.3	19.9	14.8	6.7	5.5	2.6	2 6	10.5	15.1	19.5	142.0
Average total precipitation at 14:00 (mm)	20	12.2	7.4	10.4	10.5	10.6	7.7	5.3	1.8	2.2	9.6	8.9	10.0	96.6
Average total precipitation at 21:00 (mm)	20	8.6	10.5	11.8	19.8	21.6	12.1	3.3	5.3	3.5	10.1	11.4	16.6	134.6
Average total precipitation (mm)	20	35.6	31.8	38.7	49.9	46.1	25.5	10.4	6.6	6.4	27.8	35.7	45.8	360.3
Daily maximum precipitation (mm)	20	33.0	20.6	28 5	28.5	32.1	42.5	24.0	31.5	19.9	65.8	29.4	33.6	65 8
# of days with precipitation ≥ 0.1 mm	20	9.4	9.7	10.4	10.9	10.7	6.3	2.8	2.0	2.6	6.5	7.7	10 8	89.8
# of days with precipitation ≥ 10 mm	20	1.1	08.	1.0	1.5	1.4	0.8	0.3	0.1	0.1	0.9	1.2	1.2	10.4
# of days with precipitation ≥ 50 mm	20										0.1			0 1
Average # of days with snow	20	13 3	13.7	11.4	2 3	0.3					0.3	5.3	12.7	59.3
Average # of days with ground covered with snow	20	10.3	8.4	3.8	0 6	0.1					0.1	1.9	8 1	33.3
Maximum snow thickness (cm)	20	20.0	41.0	29.0	16 0	1 0					5.0	17.0	26.0	41.0
Average # of foggy days	18	8.4	4.9	3.4	0.8	0.1				0.3	1.6	5.4	12.8	37.7
Average # of days with hail	20		0.1	0.6	0.4	0.3	0.3					0.1	0.1	1.9
Average # of days with frost	18	8.4	4.9	3.4	0.8	0.1				0.3	1.6	5.4	12.8	37.7
Average # of days with thunder	18	0.1	0.0	0.9	2 4	4.4	3.7	1.0	0.9	1.0	0.7	0.2	0.1	15.4
Average wind speed at 07:00 (m/s)	20	2.1	2.3	2.1	1.9	1.9	1 9	2.7	2.6	1.8	1.7	1.8	2.1	2.1
Average wind speed at 14:00 (m/s)	20	2.8	3.3	3.6	3.7	3.4	3.3	3.2	3.0	3.0	2.8	2.7	2.6	3.1
Average wind speed at 21:00 (m/s)	20	2.0	2.2	2.4	2.1	2.0	2.2	3.2	2.9	2.1	1.9	1.8	2.0	0 0
Average wind speed (m/s)	20	2.3	2.6	2.7	2.6	2.4	2.5	3.1	2.8	2.3	2 1	2.1	2.2	2.5
Direction of the strongest wind	20	S	SSW	SSE	SSW	WSW	SSW	SW	WSW	WSW	NW	WNW	S	SSW
Speed of the strongest wind (m/s)	20	24.3	25.0	26.3	31.4	20.6	22.3	19.8	20.5	20.0	19.3	20.6	25.5	31.4

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Avg. # of days with storm (≥ 17.2 m/s)	20	0.7	0.6	0.8	0.7	0.4	0.3	0.2	0.2	0.2	0.3	0.2	0.7	5.3
Avg. # of days with strong winds (10.8-17 1 m/s)	20	3.4	3.3	4.5	4.9	5.4	5.5	6.9	7.4	6.0	4.4	3.4	3.0	58.1
Total # of N winds	20	31	29	44	35	30	74	88	72	47	28	34	33	545
Average speed of N winds (m/s)	20	1.8	1.3	1.7	1.9	1.6	2.2	2.5	2.3	2.1	1.3	2.0	1.4	2.0
Total # of NNE winds	20	114	117	105	105	104	166	213	219	128	123	112	113	1619
Average speed of NNE winds (m/s)	20	1.9	2.5	2.4	2.0	1.9	2.2	2.8	2.9	2.5	1.9	2.2	2.2	2.3
Total # of NE winds	20	192	186	184	162	167	220	351	333	242	263	194	194	2688
Average speed of NE winds (m/s)	20	2.6	3.2	2.8	2.2	2.6	2.7	3.7	3.5	3.0	2.7	2.1	2.4	2.9
Total # of ENE winds	20	343	322	324	253	304	311	429	364	349	397	295	313	4004
Average speed of ENE winds (m/s)	20	2.6	2.8	2.8	2.4	2.6	3.1	3.9	3.9	2.8	2.4	2.2	2.3	2.9
Total # of E winds	20	69	72	86	64	70	61	58	84	74	82	65	62	847
Average speed of E winds (m/s)	20	1.7	1.7	2.0	1 7	2.1	2.4	3.0	2 5	1.8	1.5	1.3	1.5	1.9
Total # of ESE winds	20	67	58	85	79	73	43	41	44	59	61	73	80	763
Average speed of ESE winds (m/s)	20	1 4	1.2	1.5	1.5	1.2	1.2	1.6	1.8	1.1	1.1	1 1	1.2	1.3
Total # of SE winds	20	54	45	58	53	70	46	35	45	72	60	36	59	633
Average speed of SE winds (m/s)	20	1.3	1.2	1.6	1 4	1.7	1.2	1.3	1.3	1.2	1 0	1.0	1.2	1.3
Total # of SSE winds	20	106	81	120	104	93	86	48	58	63	71	98	124	1052
Average speed of SSE winds (m/s)	20	1.7	2.0	2.2	1.7	1.6	1.4	1.6	1.3	1.1	1.4	1 9	1.8	1.7
Total # of S winds	20	142	123	126	124	80	54	52	56	76	61	102	162	1158
Average speed of S winds (m/s)	20	4.0	3.7	3.6	3.0	2.4	1.7	1.8	1.7	1.4	2.2	3.4	3.6	3.0
Total # of SSW winds	20	172	176	152	152	108	68	31	50	56	88	135	180	1368
Average speed of SSW winds (m/s)	20	3.5	3.6	3.8	3.7	2.9	2.3	2.2	1.4	2.3	3.3	3.3	3.1	3.2
Total # of SW winds	20	93	88	98	111	94	54	28	44	60	58	76	77	881
Average speed of SW winds (m/s)	20	2.2	3.2	3.4	3.6	3.6	2.9	2.1	2.2	2.8	3.1	2.9	2.6	3.0
Total # of WSW winds	20	114	126	155	148	109	112	67	72	107	123	102	113	1348
Average speed of WSW winds (m/s)	20	2.0	2.2	3.0	3.2	3.1	2.9	2.7	2.6	2.4	2.2	1.9	2.0	2.5
Total # of W winds	20	89	66	83	109	119	148	82	79	94	100	77	72	1118
Average speed of W winds (m/s)	20	1.6	2.4	2.9	3.2	2.9	2.9	2.7	2.6	2.5	2.4	2.1	1.8	2.6
Total # of WNW winds	20	122	86	119	128	155	142	136	166	181	155	138	114	1642
Average speed of WNW winds (m/s)	20	2.1	2.3	2.6	2.7	2.7	2.6	2.9	2.7	2.6	2.3	1.8	1.9	2.5
Total # of NW winds	20	59	40	56	82	85	112	82	87	99	76	67	62	907
Average speed of NW winds (m/s)	20	2.1	2.4	2.8	3.3	3.1	2.8	2.8	2.5	2.3	2.2	2.3	2.1	2.6
Total # of NNW winds	20	50	39	30	41	73	79	73	60	44	61	50	54	654
Average speed of NNW winds (m/s)	20	1.4	1.6	1.6	2.1	2.1	1.9	2 3	1.9	1.9	1.4	1.5	1.6	1.8
Average temperature of 5-cm thick soil (°C)	20	1.7	2.7	7.2	13.7	19.8	25.1	29.1	28.8	23.3	15.2	7.4	3.2	14.8
Minimum temperature of 5-cm thick soil (°C)	20	-4.6	-6.8	-3.6	1.3	2.3	14.0	18.9	20.1	13.1	3.9	-1.7	-3.4	-6.0
Average temperature of 10-cm thick soil (°C)	20	1.2	2.1	6.5	13.0	18.7	23.7	27.5	27.3	22.4	14.8	7.1	2.9	13.9

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Minimum temperature of 10-cm thick soil (°C)	20	-5.6	-6.3	-3.7	2.2	4.2	13.7	17.5	18.3	14.4	3.6	-1.5	-3 4	-6.0
Average temperature of 20-cm thick soil (°C)	20	2.6	2.9	6.6	12.6	18.0	23.0	26.7	26.7	22.8	16.1	8.7	4.4	14.3
Minimum temperature of 20-cm thick soil (°C)	20	-2.8	-3.7	-1.3	4.0	8.1	15.9	19.6	21.2	16.3	6 8	0.2	-0.5	-3.0
Average temperature of 50-cm thick soil (°C)	20	5.2	5.5	7.9	12.9	19.0	23.2	28.3	28.3	24.9	19.3	12.7	8.2	16.3
Minimum temperature of 50-cm thick soil (°C)	20	3.5	3.4	5.8	7.8	14.9	18.9	25.5	23.9	19.1	14.3	9 3	5.3	3.0
Average temperature of 100-cm thick soil (°C)	20	8.3	7.5	8.6	11.2	16.1	19.8	24.3	25.8	24.3	20.6	15.7	11.5	16.1
Minimum temperature of 100-cm thick soil (°C)	20	6.9	6.5	7.0	0.2	13.0	17.4	21.8	23.3	21.0	17.0	12.6	8.6	0.0
Average evaporation (mm)					105.7	165.6	217.7	279.0	270 1	189.5	101.4	22.3		
Daily maximum evaporation (mm)		0.0	0.0	0.0	15.5	14.2	15.3	16.0	17.9	15.1	9 3	3.9	0.0	17.0
Average sunny period (hour. minute)	20	03:13	04:19	05:49	07:07	08:49	11:05	12:01	11:49	10:12	07:15	04:30	03:04	07:26
Average sunshine intensity (cal/cm².min)	20	187.37	266.74	350.17	420.72	488.57	542.48	549.50	501.61	426.63	309 52	207.29	163.50	367.84
Monthly maximum sunshine intensity (cal/cm².min)	20	1.70	1.36	1.60	1.57	1.66	1.60	1.56	1.42	1.36	1.45	1.17	1.03	1.70
Average sea water temperature (°C)														
Maximum sea water temperature (°C)														
Minimum sea water temperature (°C)														

The station was under operation between 1980 to 1999.

1 hPa = 1 mb

Latitude (φ) : 37°43'N
Longitude (λ) : 33°33'E
Height (H) : 1004 m

(KONYA) KARAPINAR

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Average local pressure (hPa)	20	904.1	902.5	900.9	900.5	901.2	900 6	899.2	900.1	902.8	905 0	905.0	904.4	902.2
Maximum local pressure (hPa)	20	918.3	918.1	916.4	909.7	909.9	907.9	906.2	905 2	911.1	913.5	916.0	916.9	918.0
Minimum local pressure (hPa)	20	886.0	882.0	881.6	887.2	889.1	891.6	892.8	893.6	892.4	894.8	889.0	885.7	881.0
Average temperature at 07 00 (°C)	20	-3.5	-3.9	-0.5	6.1	11.3	15.4	17.5	15.9	10.4	5.1	0 5	-1.4	6 1
Average temperature at 14:00 (°C)	20	3.7	4.8	9.9	16.7	21.6	26.0	29.3	29.6	26.0	19.5	11.2	5.8	17.0
Average temperature at 21:00 (°C)	20	-1.1	-0.4	4.0	9 8	14.3	18.6	22.1	21.6	16.9	10 9	4.5	1.2	10.2
Average temperature (°C)	20	-0 5	0.0	4 3	10.6	15.4	19.6	22 7	22.1	17.5	11.6	5.2	1.7	10.9
Average # days with average temperature ≥ 5°C	20	4.8	5.3	15.4	27.8	30.8	30.0	31.0	31 0	30 0	29 7	16.8	8.7	261 3
Average # days with average temperature ≥ 10°C	20	0.3	0.2	3.3	16.8	28.9	30.0	31.0	31.0	29.6	20.3	5.2	1.1	197.7
Average maximum temperature (°C)	20	4 9	6.2	11.3	18.1	22.8	27.2	30.4	30.5	27.0	20 5	12 2	7 0	18 2
Average minimum temperature (°C)	20	-5.2	-5.4	-2.1	3.2	7.1	10.7	13.5	12.7	8.1	3.8	-0.8	-3.0	3.6
Date of maximum temperature	20	19	23	27	11	23	28	24	8	17	1	2	4	24
Year of maximum temperature	20	1987	1987	1991	1998	1995	1980	1998	1987	1994	1999	1990	1980	1998
Maximum temperature (°C)	20	19.6	20.3	24.2	31.4	36.0	37.3	40.1	38.5	36.0	33.2	25.3	18.5	40.1
Avg. # of days with max. temp. ≥ 30°C	20				0.2	2.2	7.8	17.6	17.9	7 6	0.8			54.1
Avg. # of days with max. temp. ≥ 25°C	20				2.8	11.1	21 2	29 6	29 3	21 5	7.3	0.1		122 9
Avg. # of days with max. temp. ≥ 20°C	20		0.1	1.9	11.3	23.0	29.0	31.0	31.0	28.5	17.4	1.9		175.1
Avg # of days with max. temp. ≤ -0 1°C	20	7.0	5.3	1.4								0.7	4.2	18.6
Maximum daily temperature difference (°C)														
Date of minimum temperature	20	31	8	1	10	2	2	6	31	29	19	26	28	8
Year of minimum temperature	20	1980	1992	1985	1997	1981	1991	1985	1984	1992	1984	1995	1992	1992
Minimum temperature (°C)	20	-21.6	-26.8	-22.8	-7.8	-3.1	3 1	5.0	4.5	-3.3	-6.20	-17.7	-19.4	-26.8
Avg. # of days with min. temp. ≤ -0.1°C	20	25.0	22.4	20.0	6.3	0.7				0.4	5.6	16.7	21.9	119.0
Avg. # of days with min. temp. ≤ -3°C	20	18.6	17.4	11.5	2.0	0.1				0.1	1.6	10.9	14.8	77.0
Avg. # of days with min. temp. ≤ -5°C	20	14.5	13.5	7.7	0.8						0.3	6.5	10.5	53.8
Avg. # of days with min. temp. ≤ -10°C	20	6.7	5.8	1.9								1.6	3.3	19.3
Avg. # of days with min. temp. ≤ -15°C	20	2.3	2.7	0.7								0.1	0.5	6.3
Avg. # of days with min. temp. ≤ -20°C	20	0.5	1.1	0.3										1.9
Avg. # of days with min. temp. ≥ 20°C	20							0.1	0.1					0.2
Avg. # of days with min. temp. ≥ 15°C	20					0.1	1.5	8.9	7.1	0.7	0.1			18.4
Avg. # of days with min. temp. ≥ 10°C	20			0.2	1.8	6.1	19 3	28.3	26.1	9.8	2.2	0.4	0.1	94.3
Avg. # of days with min. temp. ≥ 5°C	20	0.6	0.5	1.6	10.1	23.1	29.3	31.0	30.9	24.0	12.1	4.7	2.2	170.1
Average topsoil minimum temperature (°C)	20	-6.4	-6.8	-4.0	1.3	4.9	8.4	11.0	10.2	5.8	1.8	-2.1	-4.1	1.7
Lowest topsoil minimum temperature (°C)	20	-23.0	-28.2	-54.3	-9.2	-5.6	-0.6	1.4	0.4	-5.2	-7.8	-17.7	-20.4	-54.0

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Avg. # of days with min topsoil temp. ≤ -0.1°C	20	27.2	24.0	24.3	10.8	2.6	0.1			1.7	11.0	19.3	23.8	144 8
Avg. # of days with min. topsoil temp. ≤ -3°C	20	21.7	19.5	17.1	4.7	0.4				0.3	4.2	13 8	17.5	99.2
Avg. # of days with min. topsoil temp. ≤ -5°C	20	16.9	16.3	11.6	2.0	0.1				0.1	1.7	9.6	12.5	70.8
Avg # of days with min. topsoil temp. ≤ -10°C	20	8.2	7.2	2.7								2.2	4.8	25.1
Average vapor pressure (hPa)	20	4.8	4.7	5.6	7.5	9.8	11.3	12.2	11.6	9.5	8.0	6.5	5.5	8.1
Average relative humidity at 07:00 (%)	20	85	86	87	82	78	74	69	70	76	85	88	86	80
Average relative humidity at 14:00 (%)	20	64	57	46	38	36	31	29	28	29	37	52	63	42
Average relative humidity at 21:00 (%)	20	82	79	72	64	62	51	41	40	46	62	78	82	63
Average relative humidity (%)	20	77	74	68	61	59	52	47	46	50	61	72	77	62
Minimum relative humidity (%)	20	36	27	35	17	23	19	18	26	27	28	26	23	17
Average cloudiness at 07:00 (0-10)	20	7.2	6.5	5.7	4.9	3.6	1.7	0.7	0.6	1.2	3.4	5.8	7.1	4.0
Average cloudiness at 14:00 (0-10)	20	6.3	6.0	5.9	5.7	5.0	3.2	1.7	1.3	1.6	3.6	5.3	6.5	4.3
Average cloudiness at 21:00 (0-10)	20	5.2	4.7	4.2	3.9	3.5	2.1	1.0	0.9	1.2	2.6	3.8	5.5	3.2
Average cloudiness (0-10)	20	6.2	5.8	5.2	4.8	4.1	2.3	1.1	0.9	1.3	3.2	5.0	6.4	3.9
Average # of clear days (cloudiness 0.0-1.9)	20	3.9	4.7	6.5	6.6	8.2	16.1	23.8	24.7	21.7	15.1	7.2	3.8	142.3
Average # of cloudy days (cloudiness 2.0-8.0)	20	16.5	15.5	16.6	18.2	19.9	12.9	7.1	6.3	8.0	12.0	15.9	15.0	163.9
Average # of overcast days (cloudiness 8.1-10.0)	20	11.4	9.4	9.3	6.0	3.4	1.3	0.3	0.1	0.4	4.4	8.1	13.2	67.3
Average total precipitation at 07:00 (mm)	20	14 3	11.0	13.0	13.1	8.1	5.9	0.5	0.8	1.9	8.0	10.3	15.1	102.0
Average total precipitation at 14:00 (mm)	20	7.7	5 4	6.5	7.6	8.3	4.0	2.1	0.7	4.2	6.0	9.5	9.2	71.2
Average total precipitation at 21:00 (mm)	20	8 8	7.6	8.0	16.8	19.7	17.0	11.2	5.6	4.9	10.7	9.2	12.5	132.0
Average total precipitation (mm)	20	30.7	23.3	27.7	36.9	36.2	25.0	10.1	6.5	7.2	22.5	27.1	36.9	290.1
Daily maximum precipitation (mm)	20	30.5	25.0	17 4	26.7	55.9	34.5	19 0	16.1	28 3	31.7	31.7	28.4	55.9
# of days with precipitation ≥ 0.1 mm	20	9.7	8 9	10.3	9.3	10.0	5.6	2.7	1.7	2.1	5.8	8.0	10.9	85.0
# of days with preciptation ≥ 10 mm	20	0.8	0.4	0.3	0.9	0.9	0.7	0.4	0.2	0.1	0.6	0.8	1.1	7.2
# of days with precipitation ≥ 50 mm	20				0.1									0.1
Average # of days with snow	20	13.1	16.2	11.7	2.0	0 5					0.3	6.0	12.9	62 7
Average # of days with ground covered with snow	20	9.0	9.1	4.2	0.6						0.1	1.9	7.3	32.2
Maximum snow thickness (cm)	20	26.0	41 0	30 0	7.0							14.0	26.0	41.0
Average # of foggy days	18	15.4	9.5	4.4	0.9	0.1					1.8	11.3	21.8	65.2
Average # of days with hail	20	0.1	0.6	0.3	1.2	0.4	0.6				0.2		0.1	3.5
Average # of days with frost	18	15.4	9.5	4.4	0.9	0.1					1 8	11.3	21 8	65.2
Average # of days with thunder	19	0.1	0.1	0.4	1.8	5 2	3.9	1.2	0.9	1 1	0.9	0.2	0.2	16.0
Average wind speed at 07:00 (m/s)	20	2.0	2.1	2.0	1.9	1.6	1.8	2.3	1.9	1.4	1.3	1.8	2.0	1.9
Average wind speed at 14:00 (m/s)	20	3.1	3.6	3.8	4.1	3.6	3.6	3.7	3.4	3.0	2 9	3 2	3.1	3.4
Average wind speed at 21:00 (m/s)	20	2.3	2.5	2.6	2.7	2.2	2.4	2.9	2.7	2.2	1.9	2.1	2 3	0.0
Average wind speed (m/s)	20	2.5	2.8	2.8	2.9	2.5	2.6	3.0	2.6	2.2	2.1	2.4	2.5	2.6
Direction of the strongest wind	20	NNW	S	SSW	WSW	NNW	W	NW	NNW	WSW	NNW	NNW	SSW	W
Speed of the strongest wind (m/s)	20	25.2	23.2	25.2	22.5	23.1	30.2	21.6	19 7	21 6	21.3	20.1	23.2	30.2

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Avg. # of days with storm (≥ 17.2 m/s)	20	0.7	1.2	1.2	1 2	0.6	0.6	0.3	0.2	0.3	0.2	0.5	0.8	7.8
Avg. # of days with strong winds (10.8-17.1 m/s)	20	5.3	5.3	8.5	8.7	6.7	6.3	6.4	4.1	3.3	3 4	4.6	5.7	68.3
Total # of N winds	20	167	177	168	132	166	327	438	347	211	198	167	154	2652
Average speed of N winds (m/s)	20	3.4	3.9	3.3	3.5	2.8	3.2	3.5	3.5	3.0	2.9	3.5	3.2	3.3
Total # of NNE winds	20	244	291	282	248	335	408	564	542	452	385	252	224	4227
Average speed of NNE winds (m/s)	20	2.2	2.5	2.6	2.4	2.4	2.6	3.2	2.9	2.4	2 2	2.1	2.0	2.5
Total # of NE winds	20	152	115	131	111	126	144	138	196	215	216	159	111	1814
Average speed of NE winds (m/s)	20	1.5	1.6	1.7	1.8	1.8	1.9	2.1	1.8	1.9	1.6	1.4	1.3	1.7
Total # of ENE winds	20	86	80	93	82	101	70	85	118	159	111	93	75	1153
Average speed of ENE winds (m/s)	20	1.3	1.3	1.4	1.6	1.6	1.6	1.5	1.6	1 5	1.3	1.3	1.1	1.4
Total # of E winds	20	32	24	27	23	24	20	21	33	33	35	33	41	346
Average speed of E winds (m/s)	20	1.1	1.3	1.5	1.3	1.5	1.6	1 7	1.3	1.1	1.4	1.2	1.0	1.3
Total # of ESE winds	20	34	21	34	37	37	18	5	24	17	19	21	35	302
Average speed of ESE winds (m/s)	20	1.4	1.2	1.6	1.7	1.7	2.1	1.4	1.2	1.1	1.1	1.1	1.6	1.5
Total # of SE winds	20	35	35	36	20	32	7	6	14	11	27	29	48	300
Average speed of SE winds (m/s)	20	1.9	2.0	2.1	3.1	2.3	2.3	1.7	1.1	1 9	1.7	2.1	1.8	2.0
Total # of SSE winds	20	195	118	131	96	73	20	9	15	23	63	119	205	1067
Average speed of SSE winds (m/s)	20	3.2	3.6	3.6	3.0	2.9	2.1	2.3	2.0	2 1	2.3	3.3	3.2	3.1
Total # of S winds	20	158	161	129	140	71	33	20	19	34	68	150	168	1151
Average speed of S winds (m/s)	20	5.0	4.7	4.7	4.6	3.8	3.2	3.7	2.5	2.8	3.7	4.6	4.6	4.4
Total # of SSW winds	20	169	174	241	261	157	96	74	76	97	147	153	200	1845
Average speed of SSW winds (m/s)	20	2.9	3.7	3.5	3.8	3.2	2.7	2.9	2.6	2.3	2.7	3.1	3.3	3.2
Total # of SW winds	20	117	82	113	127	117	69	36	37	72	88	127	113	1098
Average speed of SW winds (m/s)	20	2.0	1.8	2.3	2.7	2.3	2.1	2.5	2.2	1.9	2.0	1.9	1.7	2.1
Total # of WSW winds	20	137	123	134	167	192	152	39	58	114	126	121	140	1503
Average speed of WSW winds (m/s)	20	1.5	1.7	2.3	2.6	2.2	2.4	1 8	2.0	2.0	1.6	1.5	1.4	2.0
Total # of W winds	20	50	38	59	78	95	72	40	37	52	64	64	58	707
Average speed of W winds (m/s)	20	1.8	1.9	2.3	3 5	3.2	2.8	3.1	3.1	2 7	1.9	1.8	1.5	2 5
Total # of WNW winds	20	55	33	39	51	72	56	37	30	43	65	57	46	584
Average speed of WNW winds (m/s)	20	1.2	1.6	1.8	2.3	2.7	2.7	2.2	1.9	1.9	1.8	1.3	1.7	1.9
Total # of NW winds	20	45	32	42	46	63	63	45	43	42	50	53	48	572
Average speed of NW winds (m/s)	20	2.2	2.9	3.1	2.8	2.5	2.9	3.4	2.5	2.3	2.0	1.9	2.3	2.5
Total # of NNW winds	20	131	138	158	142	167	221	288	246	160	133	151	139	2074
Average speed of NNW winds (m/s)	20	3.2	3.4	3 6	3.1	2.7	2.8	3.2	3.0	2.6	2.2	2.9	3.4	3.0
Average temperature of 5-cm thick soil (°C)	20	0.8	1.9	6.3	12.8	18.3	23.1	26.7	26.5	22.1	14.5	6.0	2.4	13.5
Minimum temperature of 5-cm thick soil (°C)	20	-4.9	-6.2	-2.1	1.7	5.9	13.2	18.2	18.7	13.6	4.8	-2.8	-3.1	-6 0
Average temperature of 10-cm thick soil (°C)	20	1.3	2.1	6.3	12.6	17.7	22.2	25.4	25.5	21.7	14.7	6.7	3.0	13.3

Meteorological Parameters	Measurement Period (YEAR)	MONTHS												Annual
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Minimum temperature of 10-cm thick soil (°C)	20	-4.4	-4.9	-1 4	2.5	7 6	14.4	19.0	19.9	15.3	6.0	-0 9	-2.2	-4.0
Average temperature of 20-cm thick soil (°C)	20	1.8	2.2	5 8	11.8	16.8	21.2	24.3	24.5	21.3	15 1	7.4	3.6	13.0
Minimum temperature of 20-cm thick soil (°C)	20	-2.9	-3 3	-0.9	3.6	8.2	15.6	19.6	19.8	15.6	7.4	0.9	-1 3	-3.0
Average temperature of 50-cm thick soil (°C)	20	4.2	3.6	5.8	10.3	14.8	18.9	22.1	23.0	21.2	16.7	10.7	6.5	13.2
Minimum temperature of 50-cm thick soil (°C)	20	1.1	0.5	1.4	5.8	10.5	15.1	19.5	20.4	17.4	11.6	6.3	3.2	9.4
Average temperature of 100-cm thick soil (°C)	20	7.3	6.0	6.5	9.3	12.6	16.1	19.1	20.7	20.3	17.8	13.6	9.8	13.3
Minimum temperature of 100-cm thick soil (°C)	20	4.7	0.6	4.0	5.9	9.4	13.2	16.9	0.2	18.2	12.9	10.2	6.7	8.5
Average evaporation (mm)					76.0	155 4	198.4	267.4	249.2	175 0	82.7	15.3		
Daily maximum evaporation (mm)		0.0	0.0	0.0	11.0	10.2	15.3	14.8	12.6	11.7	8.8	2.6	0.0	15.0
Average sunny period (hour. minute)	16	03:09	04:28	06:04	07:37	08:44	10:46	11:36	11:16	10:01	06:57	04:27	02:39	07:19
Average sunshine intensity (cal/cm².min)	16	205.16	291.30	395.14	491.61	559.80	625.75	634.05	579.78	493.48	346.97	233.98	171.17	419.02
Monthly maximum sunshine intensity (cal/cm².min)	16	1 26	1.38	1.60	1.64	1.71	1.71	1.59	1.53	1.55	1.42	1.19	1.13	1.71
Average sea water temperature (°C)														
Maximum sea water temperature (°C)														
Minimum sea water temperature (°C)														

The station was under operation between 1980 to 1999.

1 hPa = 1 mb

SEISMICITY REPORT

Tuz Golu Basin Underground Natural Gas Storage Project
Engineering and Consultancy Services

BOTAS

PETROLEUM PIPELINE CORPORATION

15th OCTOBER, 2001

A. KORUR, ENVY
N. AYTEK, ENVY

Index

List of Figures

1 Introduction

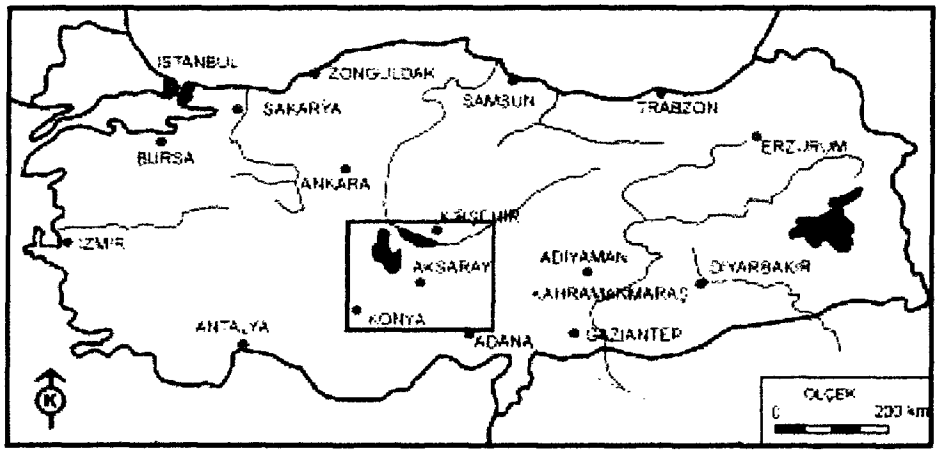
In this report, the seismicity of the natural gas underground storage project planned to be made within the Tuz Golu Basin has been evaluated (see Figure 1.1). The project area is within the boundaries of Aksaray Province and is located to the south of Sultanhanı district. For the determination of the seismicity characteristics of the area, the studies have been executed as to cover a wide field outside the project area.

In the studies, the active faults in the region have been sought, and the earthquakes that have occurred on these faults during the past history and that may occur in the future have been determined. Based on the obtained data, comments have been made on the relation of the active faults with earthquakes and the biggest earthquake to be expected in the region. Additionally, the active faults on which big earthquakes have occurred, although far from the area, have been assessed in terms of the impacts on the area in case any earthquakes occur on these faults.

During the research of active faults at the region, the Active Fault Map of Turkey, aerial photographs and satellite observations have been utilized. Based on the obtained information, the studies were finalized after completing the necessary field observations.

For the information regarding the earthquakes that have occurred in the region, Soysal *et. al.* (1981), Gençoğlu *et. al.* (1990) and Ambraseys (1988) have been utilized. Moreover, during the active fault – earthquake relation evaluation, the publications of Şaroğlu *et. al.* (1987), Barka and Kadinsky (1988) and Eyidoğan and Güçlü (1991) have been utilized.

The information regarding the regional geology has been gathered from the publications (Atabey, 1989) of Mine Investigation and Research (MTA) General Directorate.



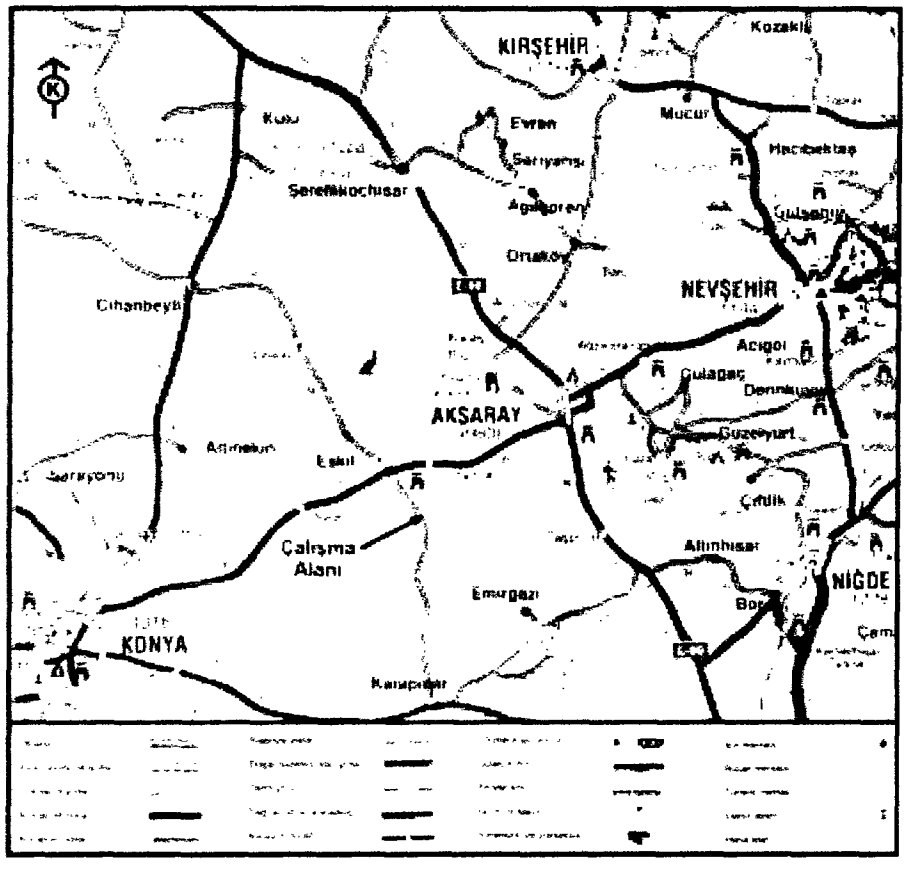


Figure 1.1 Project Location

2 Geology of the Study Area

The geology of the Tuz Golu Basin Underground Natural Gas Storage Project area and its surroundings has been presented in Figure 2.1 as shown at the 1/500.000 scale Turkish Geological Map. Accordingly, the project area is located on rock groups comprised of Neogene aged lacustrine sediments. The rock groups found at the region are arranged in order from old to young at the stratigraphic cross section in Figure 2.2 (Atabey, 1989).

The foundation of the Tuz Golu Basin is formed of metamorphites belonging to Paleozoic aged Kaman Group. The sediment pack covering this pack with nonconformity has settled in the Upper Cretase-Eocene time interval. It is generally in marine character and composed of fragments. The younger sediment group of the region is comprised of sedimentaries of terrestrial and evaporative character most of which belong to the Mezgit Group. These units covering the bottom units with nonconformity have settled in the Oligocene-Miocene time interval. The young aged rock groups of the region belong to the Miocene-Pliocene old Peçenek formation. Peçenek formation has occurred in the neo-tectonic era. The current salt formation in today's lakes is the characteristic feature of the presence and volcanism of the direction pulsed faults and the area geology.

2.1 Kaman Group

The three metamorphic units gathered under the name of Kaman Group and shortly defined blow, are being intersected with the Ortaköy granotoide.

Kalkanlıdağ Formation (PMC): It is composed of amphibolite schist, mica schist, cyllimanite quartz schist granitite gneisses. It is Paleozoic aged.

Tamadağ Formation (PMt): The unit comprising of chloro-schist, chalk-schist and marble is approximately 200 meters thick and Paleozoic aged.

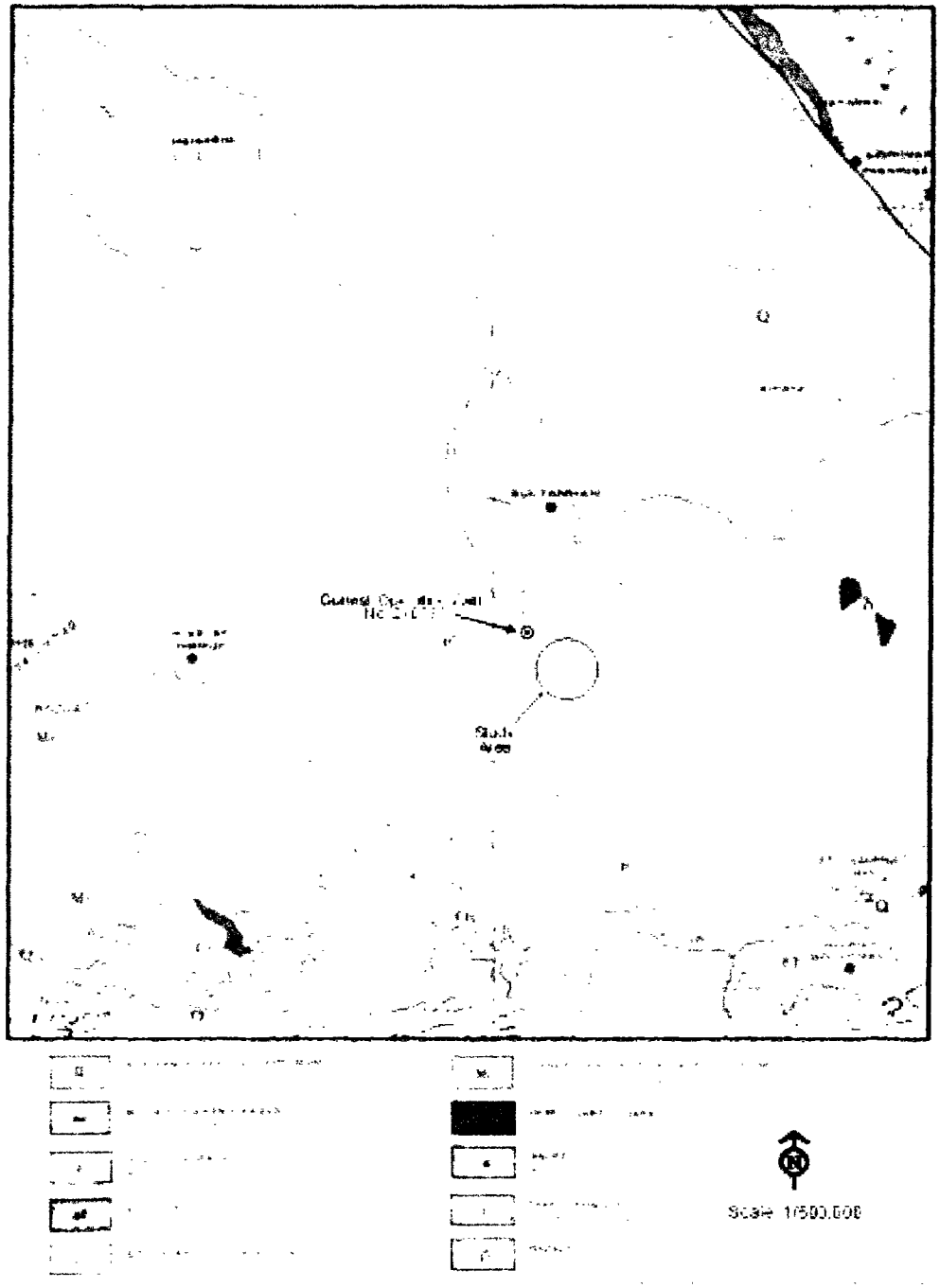


Figure 2.1 1:500,000 Scaled Geological Map of the Proposed TUGSP Site and its Vicinity

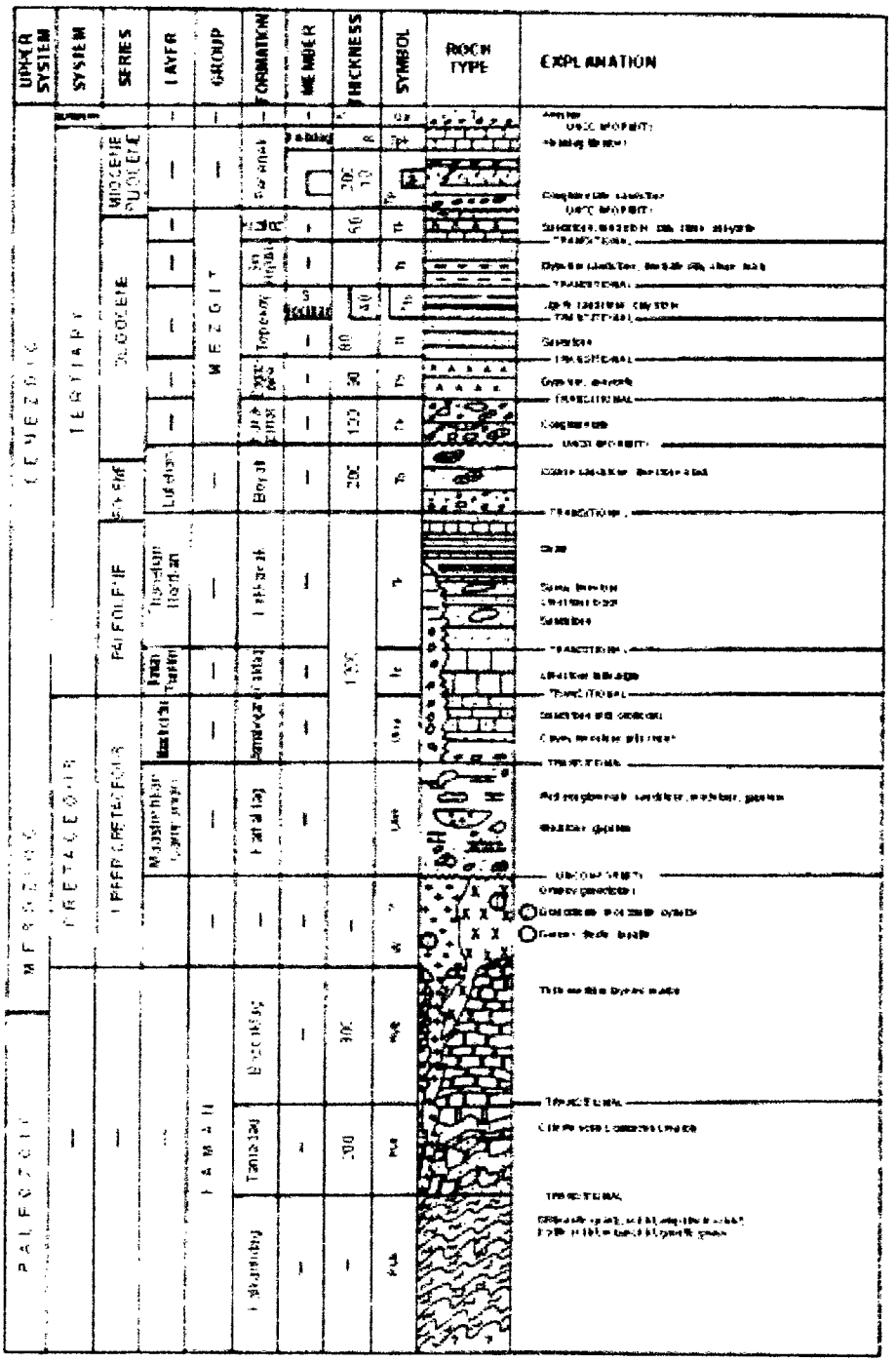


Figure 2.2 Stratigraphical Cross-section of the Area

Bozçaldağ Formation (PMb): The unit composed thick medium layered marble is transitive to the Tamadağ formation from bottom. The Bozçaldağ formation having an approximate thickness of 300 meters is Paleozoic aged.

Ortaköy Granotoid: The unit, of which the bottom layers are composed of gabra, diorite, tanalytes is laterally and vertically transitive to grano-diorite, monozoite and cyanides. It bears an age of Upper Cretase.

Kartaldağ Formation (Ukrk): The unit covers older units with nonconformity. Maastrithien-Campanien aged Kartal formation is comprised of red wine-color; loosely hold, gravel stone, sandstone and mudstone. It includes gypsum and coal layers in patches. The gravel stones located at the unit base is magmatic and metamorphic-based gravels. The unit passes to sand stones of indefinite layers that includes loosely fitted, well-rolled, cross layered in patches, mile stone intermediate strata. The approximate thickness of the unit is 250 meters. It has been formed by the river sediments settled to a wide shore plain being time-to-time subjected to naval impact. The Kartaldağ formation passes to the Asmaboğazı formation to the top.

Asmaboğazı Formation (Ukra): The unit, being Upper Cretase-Maastrithien aged, is composed of medium-fine grain sized, yellowish-gray colored, middle-fine layered orbitoides-including sandstones and medium-fine layered, gray colored, Rudist-including sandy limestones. Its relation with the Çaldağ formation is transitive.

,Çaldağ Formation (Tc): The unit is Tanesien-Danien aged. It is yellowish gray, white in color, thick-medium layered, unlayered in patches. The Çaldağ formation is composed of hard reddish brittle surfaced Algae-including limestones. The average thickness of the unit is 30 meters.

Kırıkkavak Formation (Tk): This unit, being Illeridian-Tanesian aged, is comprised of sandstone, sandy limestone and shales. The unit is transitive to Çaldağ from bottom and Boyalı formation from the top. The unit is of greenish colored sandstone of thin-medium layered, generally derived from offiolitic material and laminated shale-character. As an medium additive to the sandstones and shales, there are medium-thin layered, carved-filled structured, hard and Algae-including sandy limestones. This formation being recifal medium product is transitive to the lower units.

Boyalı Formation (Tb): The unit is Lutesian aged. It is comprised of thick layered, poor grown, thin-medium size sand grained, porous, loose cemented, yellowish-gray colored sandstones. Among the sandstones at the base, there are gravels derived from magmatic, metamorphic stones. These sandstones being shallow naval stemmed in character, becomes more of terrestrial substance added. The foundation of Boyalı foundation is transitive to Kırkkavak formation. Over the unit, the units belonging to Mezgit group are placed in a nonconforming manner. This unit, which has been named by Uygun *et al.* (1982), is approximately 200 meters thick.

2.2 Mezgit Group

The Mezgit Group forming of five formations being inter-transitive horizontally and vertically, is Oligocene aged and the ordering of the group from bottom to top is as below:

- Karapınar Formation (Tk_1): Composed of gravel, has a thickness of 100 meters.
- Boğazdere Formation (Tb_1): Composed of anhydrite and gypsum, has a thickness of 90 meters.
- Tepeköy Formation (Tt): Composed of sandstone, has a thickness of 80 meters.
- Şereflikoçhisar member (Tts): Composed of lignite, sandstone and clay stone, has a thickness of 40 meters.
- Şıhkuyusu Formation (Tk_1): Composed of gypsum, sandstone, laminated clay stone and marls, has a thickness of 100 meters.
- Kızılöz Formation (Tk_1): Composed of sandstone, clay stone, gravel and anhydrites, has a thickness of 50 meters.

The sediment package of Mezgit group is covered by units settled in the Miocene-Pliocene time interval.

Peçenek Formation (Tp): It is composed of gravels, trough-like cross layered, loosely fit, medium-thin layered sandstones, marl and tuff intermediate surfaces, and mile stone. The unit is Miocene-Pliocene aged and approximately 150 meters thick.

Kavak Member (Tpk): This member separated in the Peçenek formation is about 10 meters thick. The unit is composed of enumbrates including white-pink colored pumice particles.

Kışlak Member (Tpk_1): Kışlak member, being another member of Peçenek formation, is composed of gastropod shell fragmented, thick and indefinite layered, white-gray colored, small graveled limestones. The approximate thickness of this member of chalky outlook is 8 meters.

The alluviums being fragmented substance conglomerates showing propagation at wide areas in the Tuz Golu Basin, comprises the youngest Quaternary aged sediment groups.

3 The Active Faults of the Region

In this study executed as to inspect the pre-study realized with satellite images and aerial photographs in the field, the active fault map of Turkey (Şaroğlu *et al.,* 1992) and its related report (1997) has been taken as basis.

As a result of the performed investigations, no active fault has been found passing within the project area and bearing a destructive earthquake character. Moreover, according to the same observations, within the 50 km-diameter circle, with the facility area at center, no active fault has been observed. As can be seen at the Turkish Active Faults Map issued by MTA General Directorate (see Figure 3.1), the closest active faults to the region is the Tuz Golu fault in the east and the Karadağ opening crack taking place inside the Kılbasan-Hotamış Lake fault zone in the southwest.

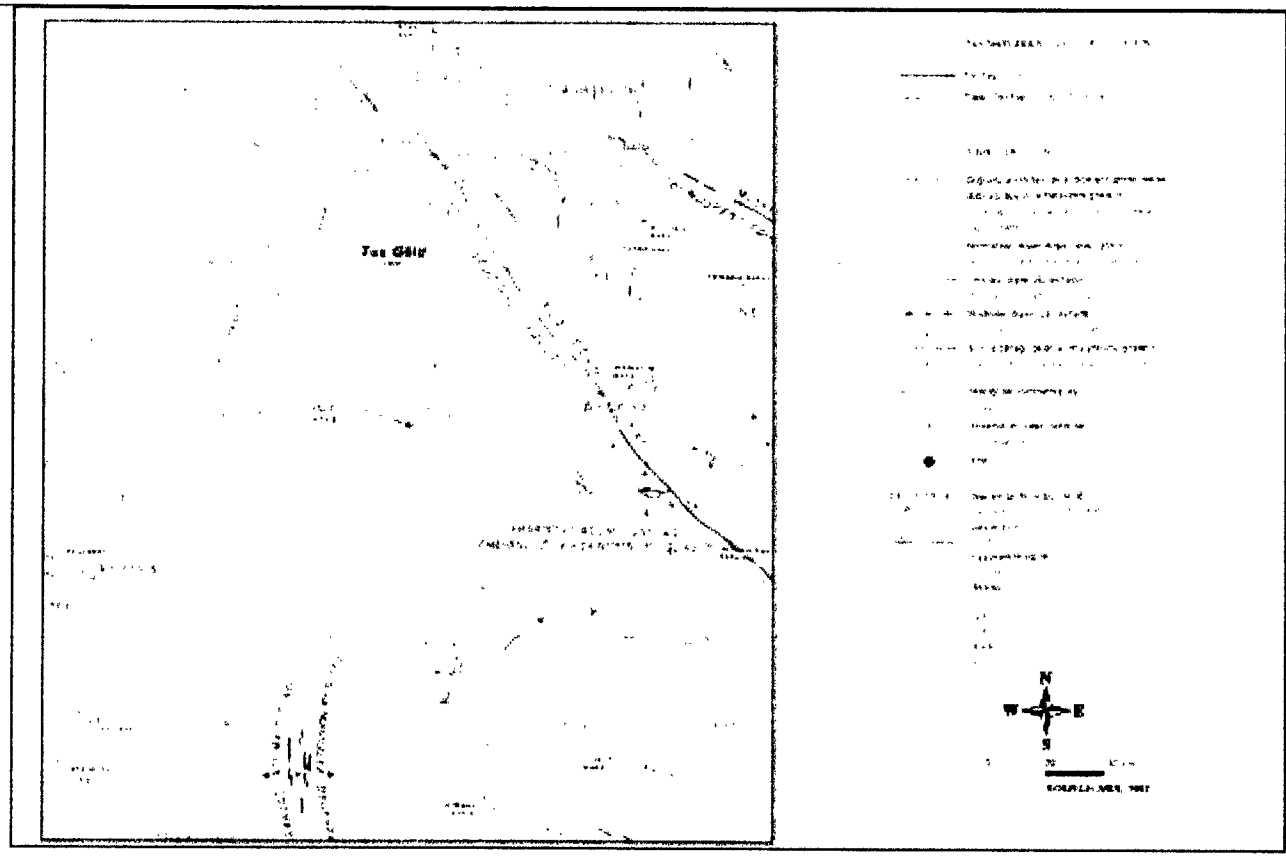


Figure 3.1 Active Fault Map of Region

3.1 Tuz Golu Fault

The fault is located approximately 53 kilometers east of the project site. This fault is northwest – Southeast directed and 180 kilometers long. The fault morphologically limits the Tuz Golu Basin in the north, and passes near the summit point of Quaternary aged Hasandağı in the south.

About 100 kilometer-long northwest section of the Tuz Golu fault up to Aksaray neighborhood bears the same characteristic properties. The fault can be clearly observed at the satellite images with its linear course (look at Figure 3.1.1). At the location where the fault passes from Seki fillings and foot residues in the northwest, due to the fact that these units are loosely fit, it cannot be well observed in the site. Additionally, landslides and flooding in such fields is also fast developing, therefore the indications of the fault is disappearing or being covered. The fault can be observed at the locations where it impacts the Miocene and older stone groups or where in encapsulates Quaternary aged alluviums. According to the obtained data, the 100 km-long northwest section of the Tuz Golu fault has been mapped as possibly active.

The southwest section of Tuz Golu fault between Aksaray-Bar is 80 kilometers long and N42°W directed (look at Figure 3.1.2). In this section of the fault, it can be seen that it intersects the young lavas of Hasandağı (Emre, 1990).

The Tuz Golu fault transforms into a zone comprising of few fractures in far south, and probably fades out near Bor district. The 80-km long southeast section of the fault intersects some hundred thousand year-old lavas of Hasandağı. Consequently, the mentioned fault has been mapped as active.

In light of the gathered data, it can be said that the Tuz Golu fault is a right side directed, pulse-componented, slope pulsed fault. However, there is no data regarding the pulse quantity of the fault. In the same manner, it cannot be clearly stated whether the movement of the fault in its sloped direction is normal or it is of reverse fault character. However, based on the limited data, it can be said that the fault acts as a reverse fault.

Figure 3.1.1 Satellite Image of the Tuz Golu and the Surrounding

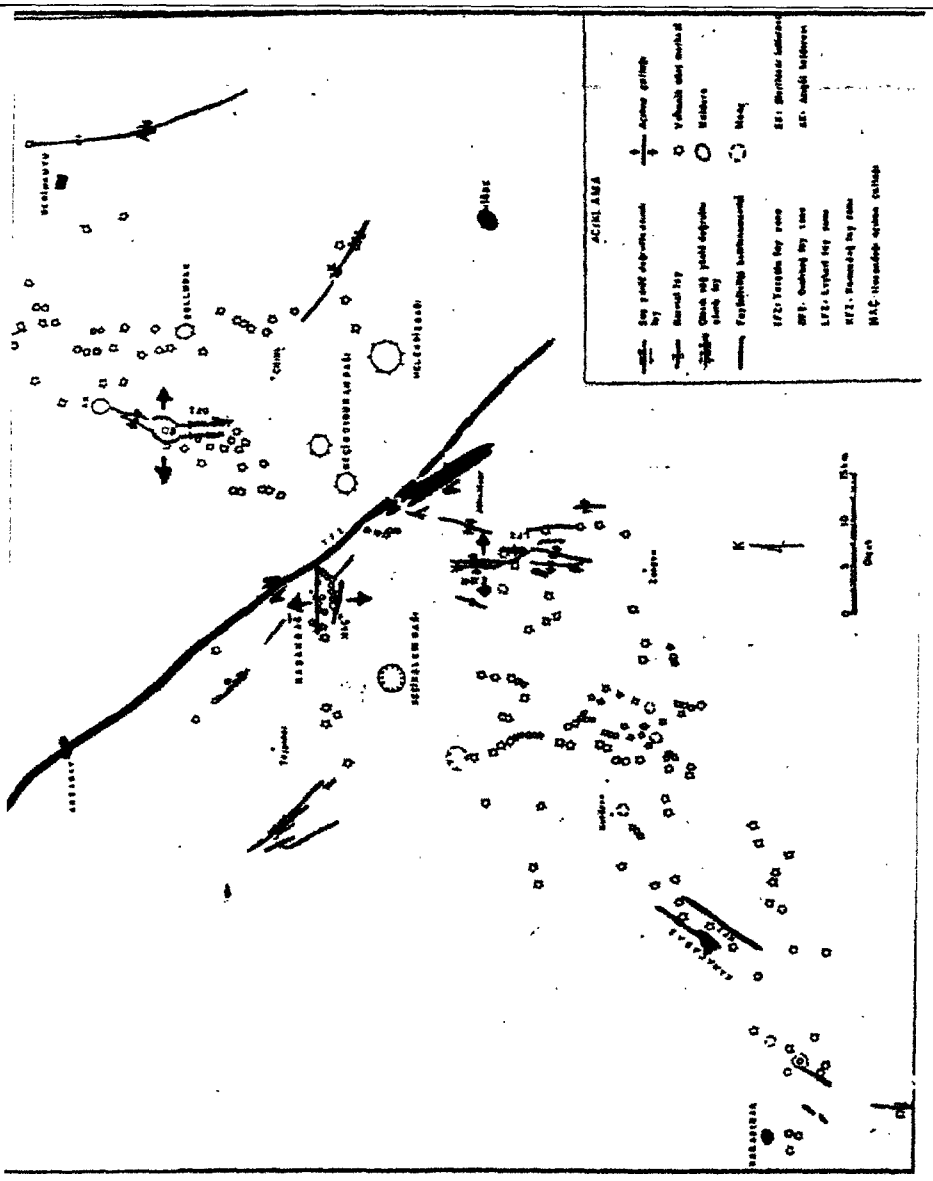


Figure 3.1.2 The Neo-Tectonic Era Structures and Distribution of the Volcanic Outlet Centers Between Aksaray-Karapınar-Niğde-Derinkuyu

3.2 Kılbasan-Hotamış Lake Fault Zone

The Tuz Golu Basin is located between the Kılbasan-Hotamış Lake, being another active fault zone which may be assumed close to the natural gas underground storage site. The fault zone is

approximately 25 km-long and is generally directed at north-south. The two main fractures of the zone shows a continuity which can be deemed as significant (Look at Figure 3.2.1). These fractures being lens shaped and north northwest-south southeast directed, possess a movement mechanism of opening fracture character (Şaroğlu *et al.*, 1987). The fractures have been defined at the Active Fault Map of Turkey (1992) as Karadağ opening fracture (look at Figure 3.2.2 and 3.2.3). The fractures intersect the Miocene aged volcano-sediments, and confine or probably intersect the Quaternary aged alluviums. According to the obtained data, Kılbasan-Hotamış Lake fractured zone is active and the distance of this zone from the natural gas underground storage area is about 110 kilometers.

Besides the Tuz Golu fault and Karadağ opening fracture being in the proximity of the natural gas underground storage area, there are a few other fractures of limited size, discontinuous and of questionable activity in the region. These unnamed fractures are distant from the project site and a destructive earthquake is not foreseen on them.

The closest fault zone to the project area on which a destructive earthquake had occurred is near Kırşehir. Kırşehir region faults are faults not having a specific order, not able to be clearly tracked morphologically, of doubtful activity, and limited size. However, the earthquake that has impacted the surroundings of Kırşehir-Keskin-Yerköy in 1938, has occurred on these fractures (look at Figure 3.2.4 and 3.2.5). The fractures which have expanded at the 1938 earthquake of M_s = 6,6 magnitude and the long axes of the equi-damage curves observed at the macro-seismic map of this earthquake are northwest-southeast (Eyidoğan and Güçlü, 1991; Abraseys, 1988; Arni 1940). The fault mechanism arising in this earthquake are probably of right direction routed pulsed character.

The magnitude of the Kırşehir earthquake in 1938 was M_s = 6,6 and its intensity was IX. The intensity value of the defined earthquake perceived at the project site was VI. The distance of the fractures to the project site is 160 km.

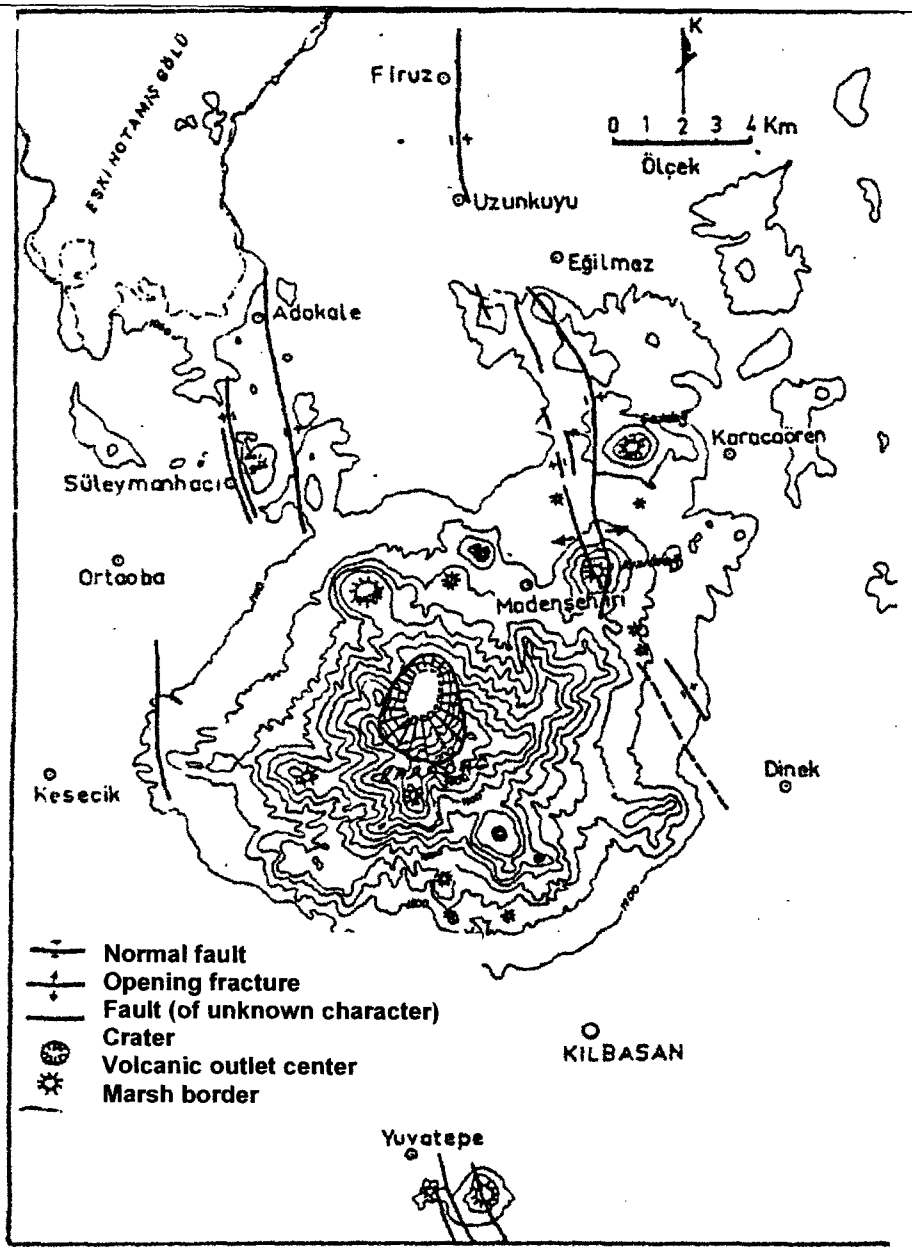


Figure 3.2.1 The Map Showing the Kılbasan-Hotamış Lake Fault Zone and Outlet Centers of Karadağ Vulcanites

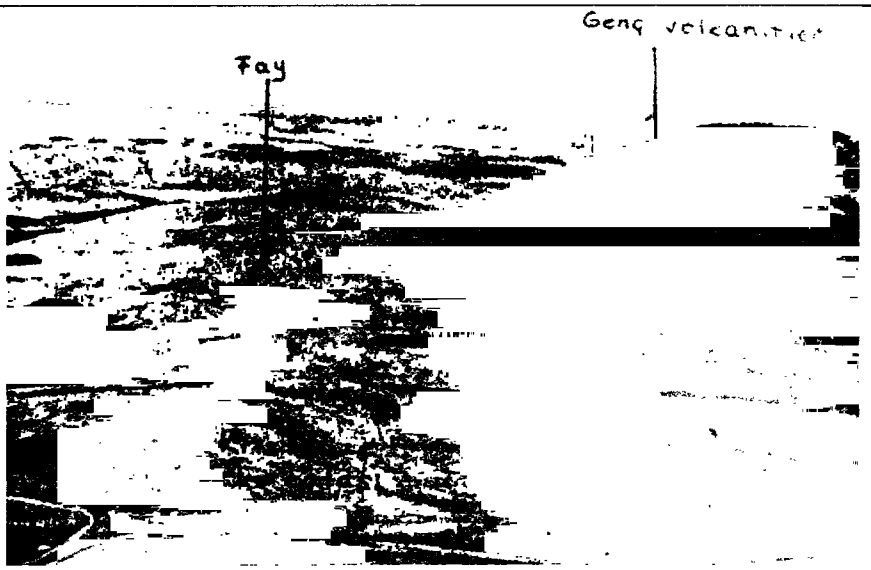


Figure 3.2.2 The Fault Tracked at the Metamorphites in the West of Karadağ (Karaman) Volcano (The View is Towards North; Şaroğlu *et. al.*, 1987)

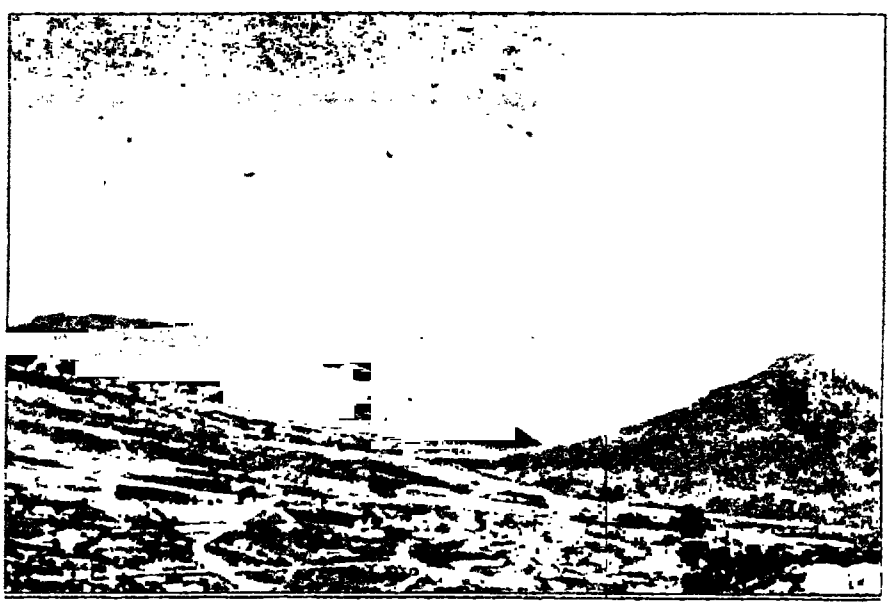


Figure 3.2.3 Vulcanite Cones Located on the Kılbasan-Hotamış (Konya) Fault Zone (The View is Towards Northeast; Şaroğlu *et. al.*, 1987)

Figure 3.2.4 Surface Fractures that have Occurred at the 19th April 1938 Dated Kırşehir Earthquake (Arni, 1940)

East Anatolian Fault among this fault zones, approximately 270 km away from the storage area, and the area is about 300 km away from the North Anatolian Fault. Since there has not been any destructive earthquake on the East Anatolian Fault in the last few centuries, it not very clear to what extent the fault movement shall affect the project site. On the other hand, on the nearby section of North Anatolian Fault to the storage area, there has been a destructive earthquake in 1944. This earthquake, known as Gerede Earthquake, had a magnitude of M_s = 7,2. At the equi-damage zoning map prepared according to the damage types observed at this earthquake, it can be seen that the storage area has been affected at V intensity (look at Figure 3.2.6).

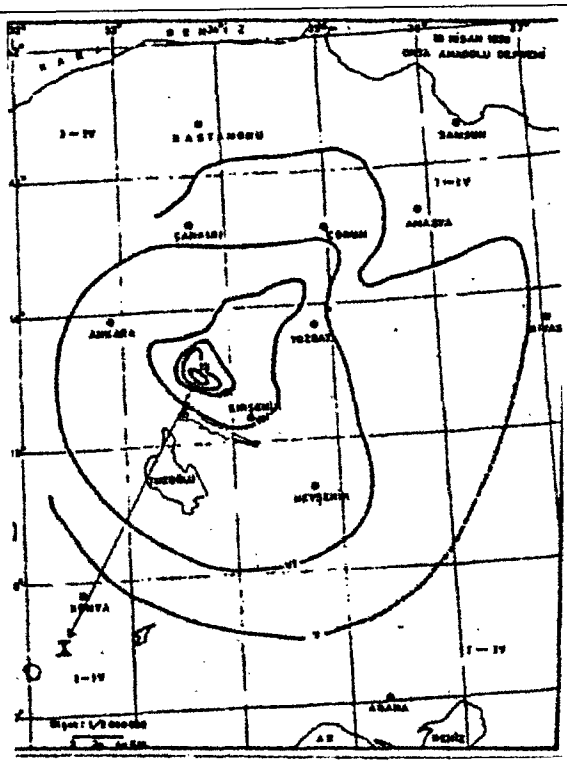


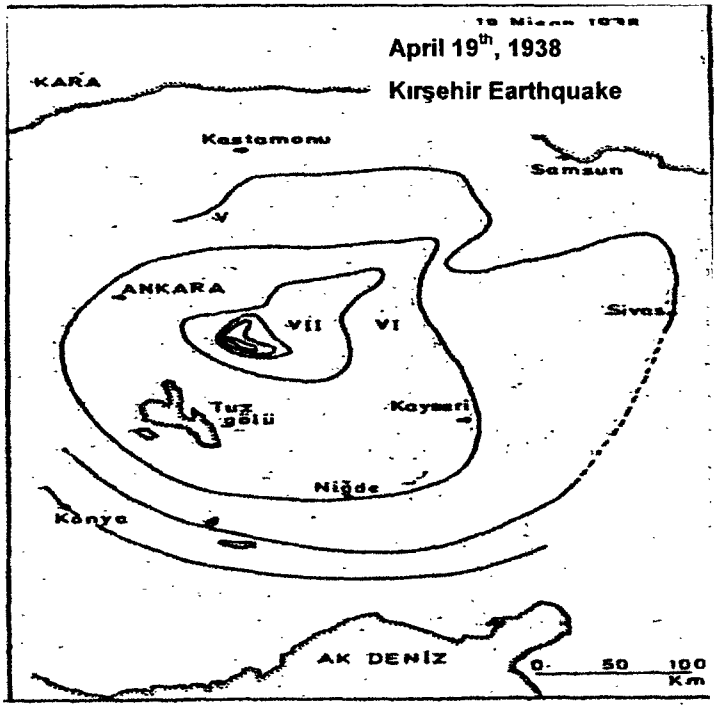
Figure 3.2.5 Macro-seismic Map of the 19th April 1938 Dated Kırşehir Earthquake (Ergin, *et. al.*, 1967)

4 Seismicity of the Study Area

In the assessment of the seismic activity of the natural gas underground storage area planned to be implemented in the Tuz Golu Basin and the surroundings, different data source based historical and instrumental records have been utilized. According to the catalogues covering the time interval between B.C. 2100 and A.D. 1900 years (Soysal *et. al.*, 1981), there is no record for a destructive earthquake occurrence in the region.

Moreover, according the earthquake catalogue recorded instrumentally (Gençoğlu *et. al.*, 1990), there is no record for a destructive earthquake in the region for the past century (look at Figure 4.1). When the epicenter map of the earthquakes that have occurred in the last century (look at

Figure 4.2) is examined, it can be seen that the few epicenters observed in the proximity of the project area are small in magnitude, do not have a linear route and do not show an aggregation.



MEDITERRANEAN SEA

Figure 3.2.6 Equipotent Map of the 19th April 1938 Dated Kırşehir Earthquake (Parejas and Pamir, 1939)

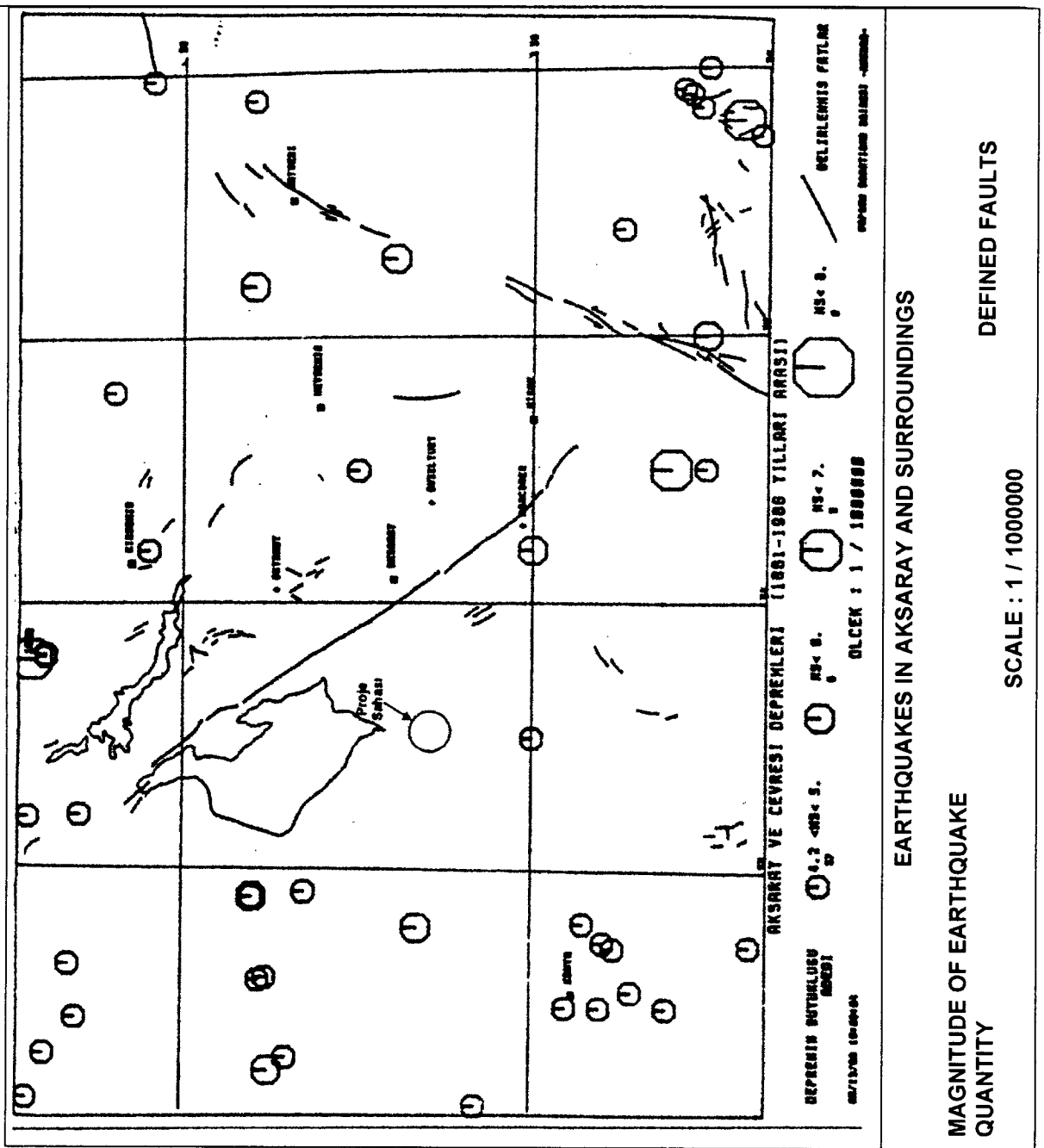


Figure 4.1 Faults at the Region and the Distribution of the 1881-1986 M>4 Earthquakes (Gençoğlu *et. al.*, 1990)

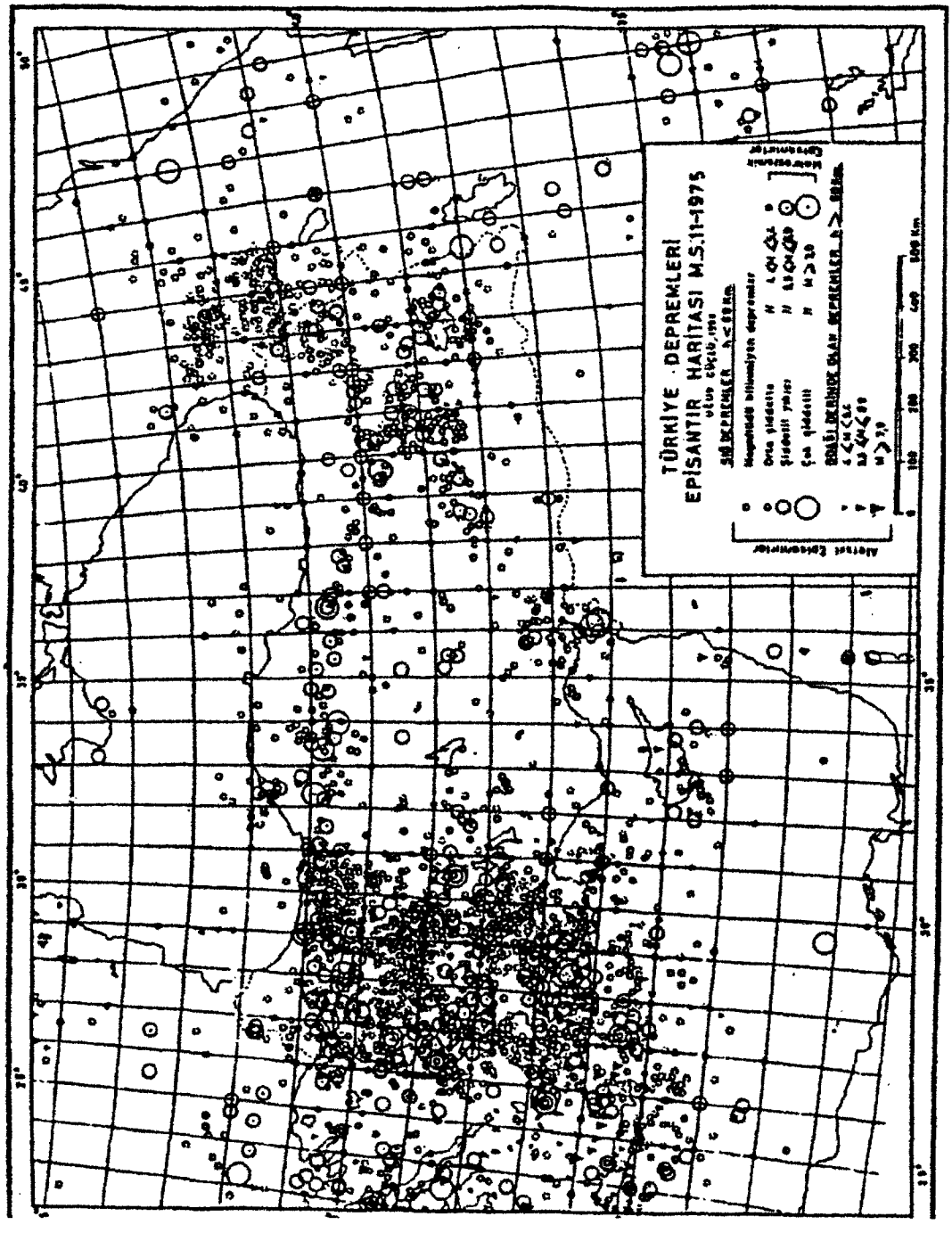


Figure 4.2 Epicenter Map of the Turkey Earthquakes (M.S. 11-1975)

When the sizes are considered, earthquakes with a magnitude interval of M_s = 6-6,5 are expected on the Tuz Golu and Kılbasan-Hotamış faults. In the assumption of this value, the earthquakes that have occurred on similar faults have been taken into consideration (Şaroğlu *et. al.,* 1987; Barka and Kadinsky, 1988; Abraseys, 1988; Eyidoğan and Güçlü, 1991). It is not possible to give certain figures for the repetition periods of the earthquakes on the mentioned faults. However, it can be said that the repetition periods of the earthquakes on Tuz Golu and Karadağ fractures will approximately be 500 years or more.

There is no data at hand pointing to the possibility of a destructive earthquake is to occur at the natural gas underground storage area. The closest faults having a possibility to affect the area with its activity are the Tuz Golu and Karadağ faults.

Due to the distance of both of the faults to the project area, even should a destructive earthquake occur on them, it can be said that the project site will not be impacted at first level. Based on the results of the 1944 dated Gerede and 1938 dated Kırşehir earthquakes, being closest to the survey site and bearing a destructive character, the influence on the region in case of repetition of the earthquakes on these faults, shall be limited.

5 The Location of the Project Area In Terms of the Geodynamics of Turkey

The geodynamic evolution of Turkey is a consequence of the African, Arabian and Eurasian plate movements. Almost for 16 million years, the collisions of the Arabian and Eurasian plates (Şengör, 1980; Şengör *et al.,* 1985) has created the compressive tectonic regime in the region. The compressions arising all around Anatolia has caused the formation of various curved, overlapping, routed pulsed faults and normal faults (Look at Figure 5.1). In the period between the last 16 million and 4 million years, the study site and surroundings has been compressed in north-south direction and consequently, curved and routed pulsed faults and opening fractures have developed. In this stage, the Central Taurus Mountains have rose as an east-west axis anticlinorium. In the same period, various routed pulsed faults have formed with northwest-southeast routed Tuz Golu Fault and north northeast-south southwest routed Ecemiş Fault taking the lead. With the same tectonic activity, volcanoes have surfaced from the opening fractures in t he north-south direction (Şaroğlu *et al.,* 1982; Emre, 1990; Pasquare *et. al.,* 1988).

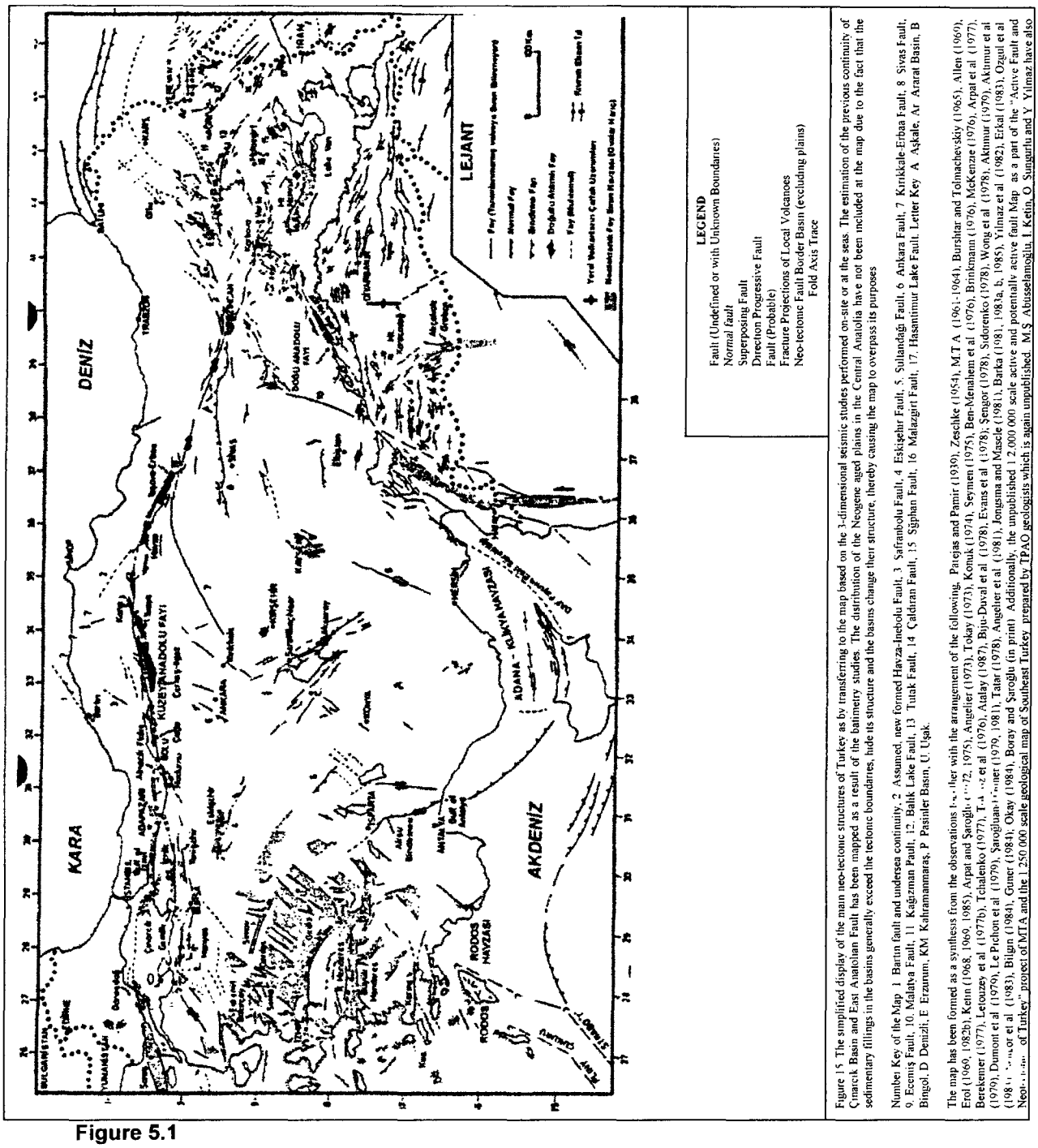


Figure 15 The simplified display of the main neo-tectonic structures of Turkey as by transferring to the map based on the 3-dimensional seismic studies performed on-site or at the seas. The estimation of the previous continuity of Çınarcık Basin and East Anatolian Fault has been mapped as a result of the batimetry studies. The distribution of the Neogene aged plains in the Central Anatolia have not been included at the map due to the fact that the sedimentary fillings in the basins generally exceed the tectonic boundaries, hide its structure and the basins change their structure, thereby causing the map to overpass its purposes

Number Key of the Map 1 Bartın fault and undersea continuity, 2 Assumed, new formed Havza-Inebolu Fault, 3 Safranbolu Fault, 4 Eskişehir Fault, 5. Sultandağı Fault, 6 Ankara Fault, 7 Kırıkkale-Erbaa Fault, 8 Sivas Fault, 9. Ecemiş Fault, 10. Malatya Fault, 11 Kağızman Fault, 12. Balık Lake Fault, 13 Tutak Fault, 14 Çaldıran Fault, 15 Sğphan Fault, 16 Malazgirt Fault, 17. Hasanlımur Lake Fault. Letter Key A Aşkale, Ar Araral Basin, B Bingol, D Denizli, E Erzurum, KM Kahramanmaraş, P Pasinler Basın, U. Uşak.

The map has been formed as a synthesis from the observations [illegible] ther with the arrangement of the following, Pargas and Pamir (1939), Zeschke (1954), M.T.A. (1961-1964), Burshtar and Tolmachevskiy (1965), Allen (1969), Erol (1969, 1982b), Kenn (1968, 1969, 1985), Arpat and Şaroğlu (1972, 1975), Angelier (1973), Konuk (1974), Seymen (1975), Ben-Menahem et al. (1976), Brinkmann (1976), McKenzie (1976), Arpat et al. (1977), Berekenner (1977), Letouzey et al. (1977b), Tchalenko (1977), Ta[illegible]z et al. (1976), Atalay (1987), Biju-Duval et al. (1978), Evans et al. (1978), Şengor (1978), Sidorenko (1978), Wong et al. (1978), Akkinur et al. (1979), Dumont et al. (1979), Le Pichon et al. (1979), Şaroğluan[illegible]ner (1979, 1981), Tatar (1978), Angelier et al. (1981), Jongsma and Mascle (1981), Barka (1981, 1983a, b, 1985), Yılmaz et al. (1982), Erkal (1983), Özgul et al. (1981[illegible]or et al. (1983), Bilgin (1984), Guner (1984), Boray and Şaroglu (in print) Additionally, the unpublished 1:2.000.000 scale active and potentially active fault Map as a part of the "Active Fault and Neo-[illegible] of Turkey" project of MTA and the 1:250.000 scale geological map of Southeast Turkey prepared by TPAO geologists which is again unpublished. M.Ş. Abüsselamoğlu, İ. Ketin, O. Sungurlu and Y. Yılmaz have also

Figure 5.1

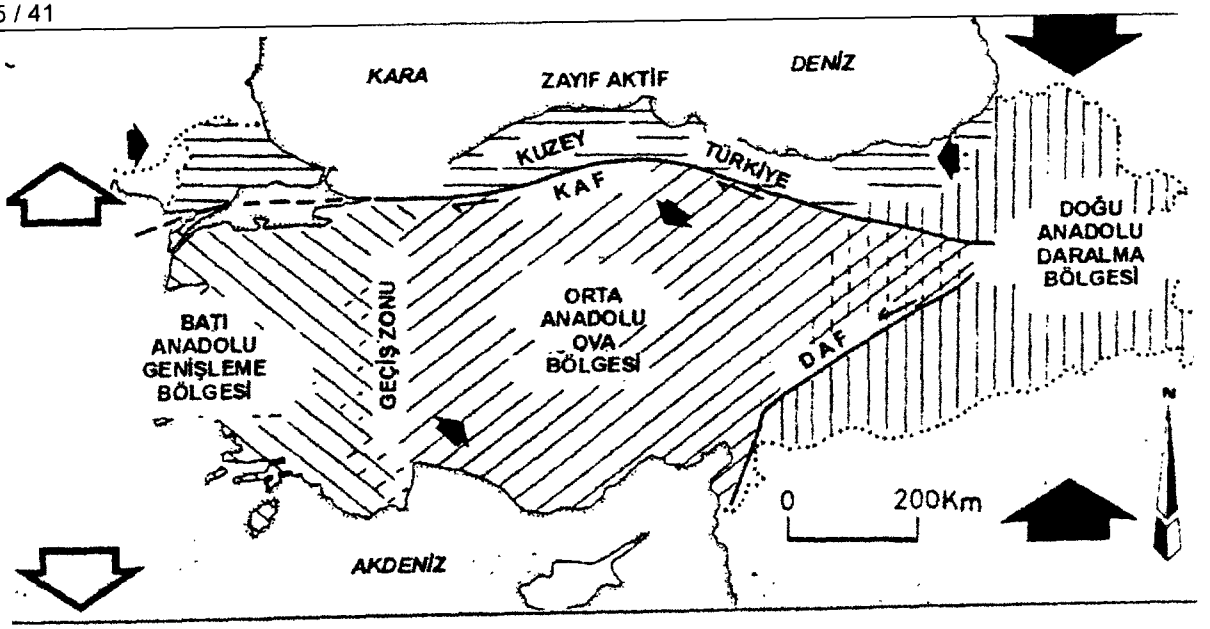


Figure 5.2 **Neo-tectonic Regions of Turkey (Black arrows shows the shortening and white arrows show the lengthening directions. The arrow size is approximately proportional to the total shortening.)**

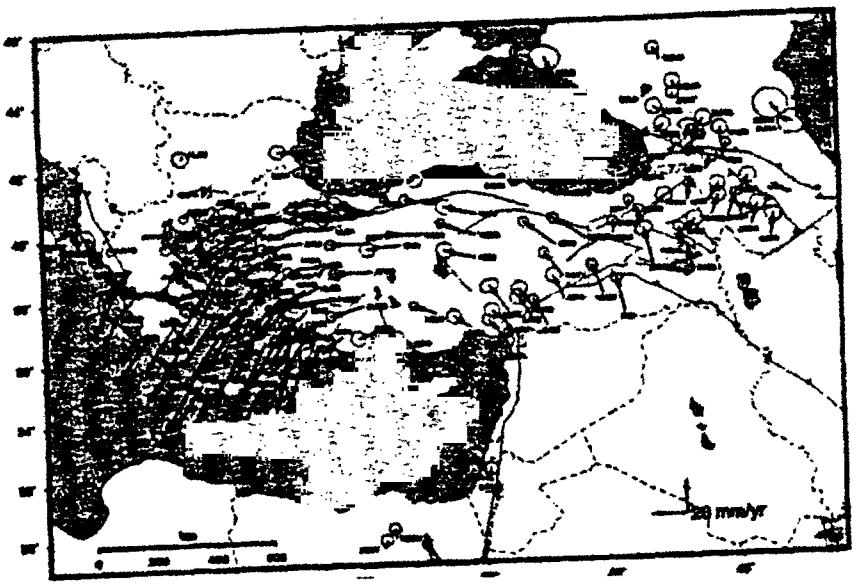


Figure 5.3 **GPS Measurement Results at the East Mediterranean Region (McClusky *et. al.*, 2000)**

6 Results

In light of the information given above, there seems to be no fault that can cause a destructive earthquake at or near the proposed project area region. Additionally, no record has been encountered in the last three-thousand-year earthquake catalogues regarding any destructive earthquake. The most nearby faults awaited to cause a destructive earthquake are Tuz Golu fault and East Anatolian fault, which are significantly far away from the study area (look at Figure 6.1). According to the Turkey Earthquake Zones map prepared based on reduction relation, the region has been shown as a 5th grade earthquake zone (look at Figure 5.3).

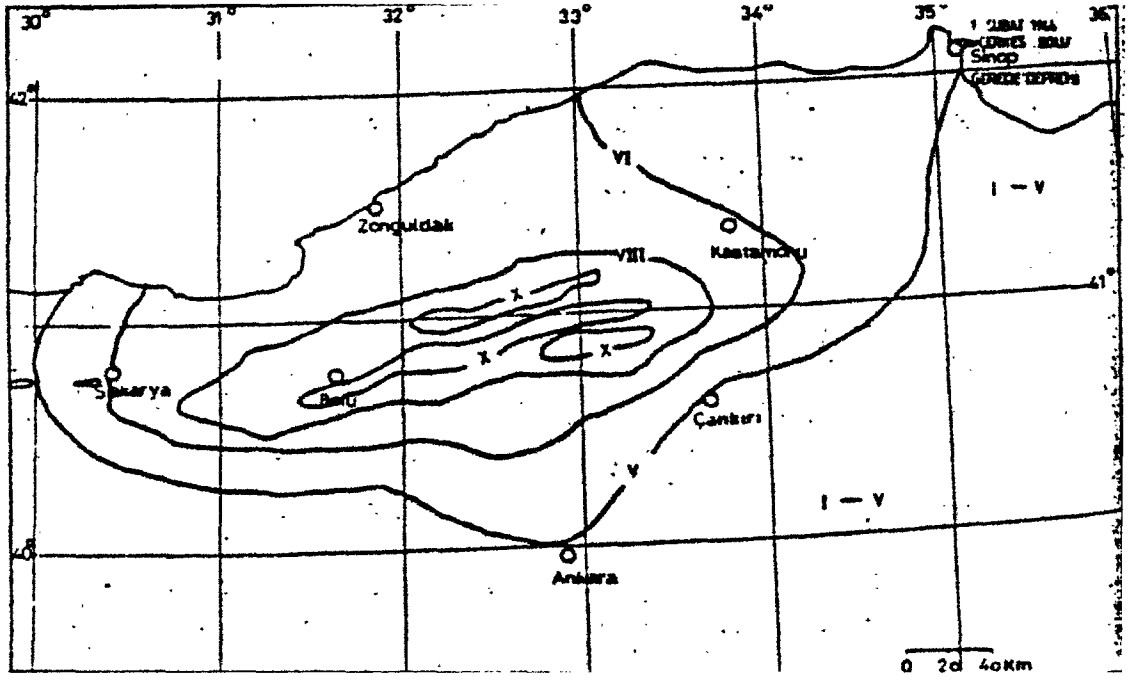


Figure 6.1 Equipotent Map of the 1st February 1944 Dated Bolu-Çerkeş Earthquake (Ergin *et. al., 1967)*

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SEISMIC RISK ASSESSMENT REPORT

Tuz Golu Basin Underground Natural Gas Storage Project
Engineering and Consultancy Services

BOTAS

PETROLEUM PIPELINE CORPORATION

15th OCTOBER, 2001

A. KORUR, ENVY
N. AYTEK, ENVY

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0 Summary

In the tectonics of Central Anatolia; the North Anatolian Fault in the north, the East Anatolian Fault in the east and some in-plate faults interfering with the inner deformation of the Anatolian Block dominate. The North Anatolian Fault is located approximately 300 km north of the project site.

Tuz Golu, Alaca-Ezinepazarı and Ecemiş faults are the most prominent in-plate faults of the Anatolian Block. Alaca-Ezinepazarı fault being a right directed lateral fault, is comprised of two parts. The second block (150 km long) of the Alaca-Ezinepazarı fault departing from the first fault block (90 km long) with 24° inflection is seismically less active.

The Tuz Golu Fault has a northwest-southeast elongation in the east coasts of the basin and is comprised of two sections: (i) northwest section of 100 km long, and (ii) southeast section of 80 km long.

As a result of the at-desk studies, it has been observed that most of the seismic activity has gathered around the parts of the North Anatolian Fault. The remaining events are related with smaller and/or less active in-plate faults.

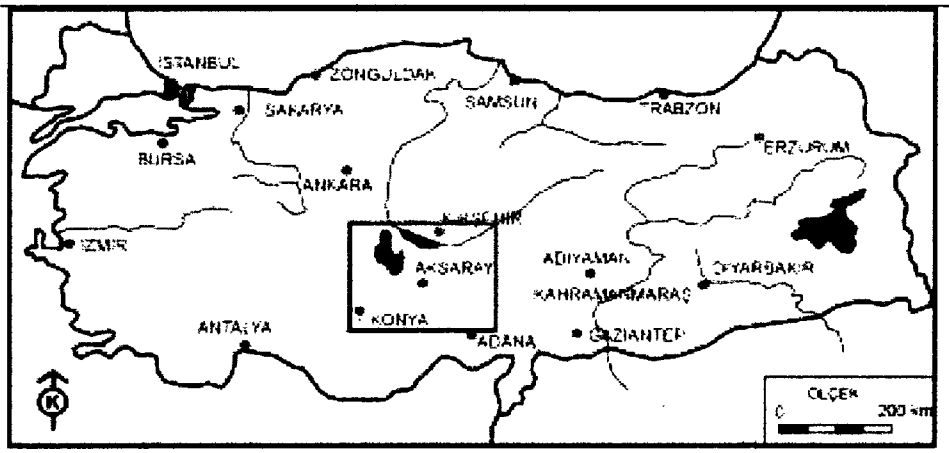
To be able to determine the seismic / earthquake risk of the project site, both probabilistic and deterministic methods have been used. By using a deterministic approach, two critical earthquakes have been determined for the project site. Firstly; the earthquake of 7,5 magnitude due to reverse fault, is assumed to occur on the Tuz Golu Fault which is 50 km away from the project site, being the closest active fault. Secondly; by considering historical facts indicating that in-plate earthquakes, such as the 19.04.1938 dated Kırşehir earthquake, of 6,5 magnitude can develop at any place in Anatolia; it has been decided to place the epicenter of a 6,5 magnitude earthquake at a distance of 5 km from the project site.

As a result, the project site is located at one of the regions of Anatolia having the lowest seismicity characteristic and highest stability. When evaluated in long term (average return period within 5000 year term), PGA will be about 0,3. When evaluated in short term (which is approximately 500 year return period), PGA will bear a value of 0,17g.

1 Seismotectonic Network

The proposed project site for the underground natural gas storage units is located 25 km south of Tuz Golu, at the Tuz Golu Basin within the Provincial boundaries of Aksaray (look at Figure 1.1). In the tectonics of Central Anatolia; the North Anatolian Fault in the north, the East Anatolian Fault in the east and some in-plate faults interfering with the inner deformation of the Anatolian Block dominate (look at Figure 1.2)

Figure 1.3, displays the fragments of the North Anatolian Fault located at the north of the Central Anatolia and that has fractured in the last century with consecutive earthquakes. With the Erzincan Earthquake (Ms= 8) in 26 December 1939, the 385 km section of the North Anatolian Fault has fractured from Erzincan down to the south of Amasya. The fragments fractured during the 20 December 1942 earthquake have a total length of 40 km. The Tosya Earthquake (Ms = 7,3) in 26 November 1943 has a fracturing zone of 300 km between Taşova and the west of Ilgaz. The earthquake series, has moved to more west with the 1944 Gerede earthquake of Ms = 7,3 which has fractured the North Anatolian Fault extending between the east of Çerkeş and the west of Bolu (Barka and Kadinsky-Cade, 1988). The North Anatolian Fault is located approximately 300 km north of the project site.



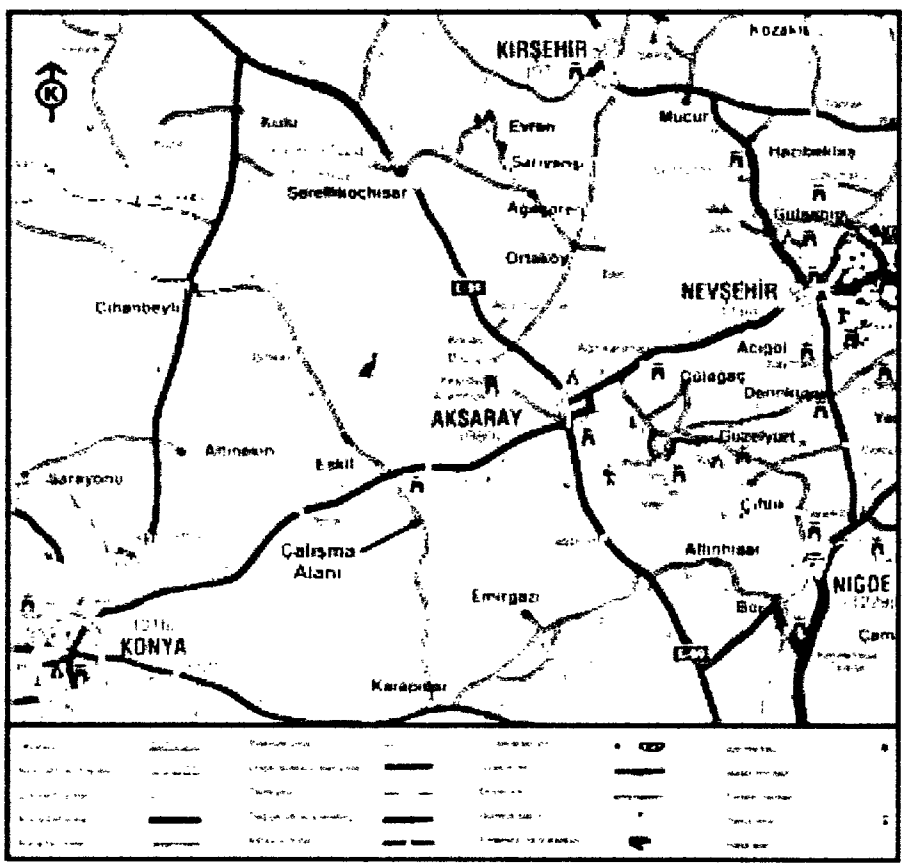


Figure 1.1 Location of the Project Site

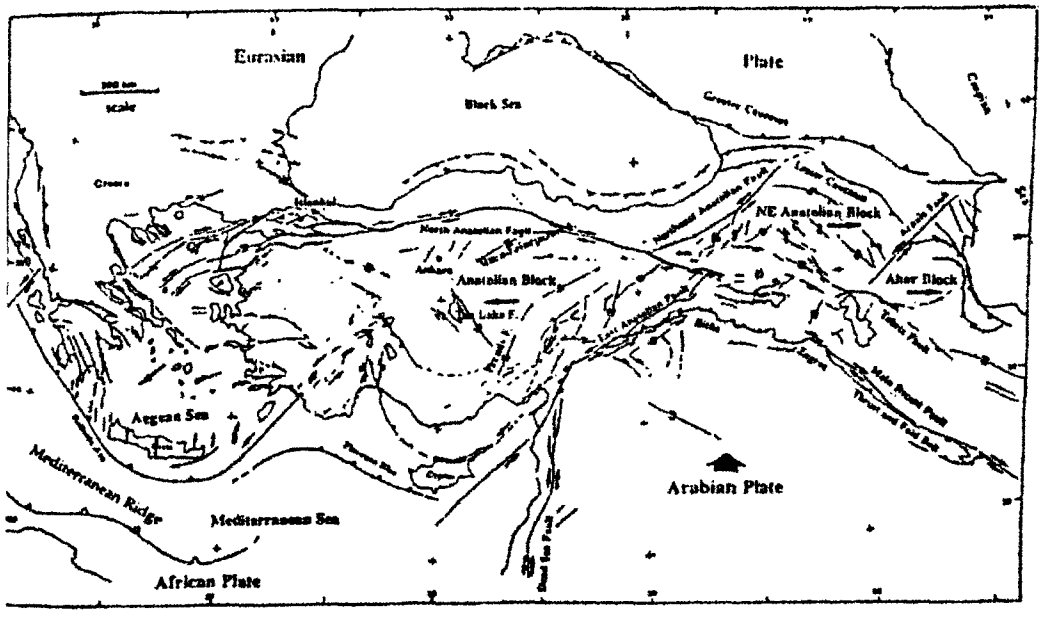


Figure 1.2 The Neotectonic Structure of Turkey and Close Surroundings (Barka and Kadinsky-Cade, 1988)

The relative movement between Anatolian Block and Arabian Plate has been taken over by the left directed lateral East Anatolian fault zone (look at Figure 1.2). The geological slide rate throughout the fault is about 0,5 cm/year. In the last few centuries, very few M > 6,5 earthquakes have occurred over the East Anatolian Fault. These are 1905 (M = 6,8), 1908 (M = 6,7) and 1971 (M = 6,7) earthquakes. It is known to us that the fault zone has historically experienced some earthquakes with intensity > VIII, with 1995 earthquake being the biggest and most recent (Ambraseys, 1970). The East Anatolian Fault is located approximately 300 km east of the project site.

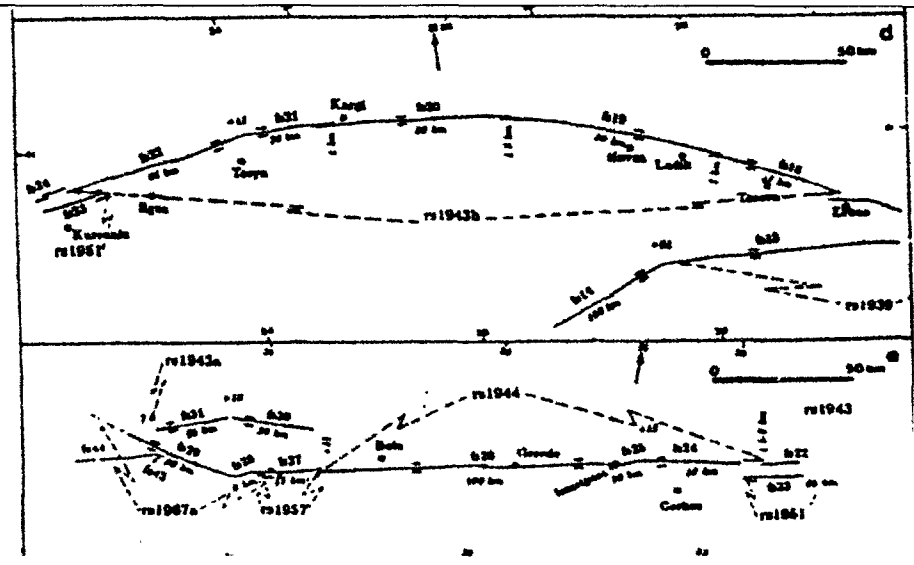


Figure 1.3 The Fragments of the North Anatolian Fault Located at the North of The Central Anatolia and That has Fractured in the Last Century with consecutive earthquakes (Barka and Kadinsky-Cade, 1988)

Tuz Golu, Alaca-Ezinepazarı and Ecemiş faults are the most prominent in-plate faults of the Anatolian Block (look at Figure 1.2). Although the seismicity along these plates are not very significant as compared to the other in-plate ones, the geological studies set out an evidence as per their activity.

Right directed lateral Alaca-Ezinepazarı fault is comprised of two sections. The east fault block of 90 km has been prevented to inflect at 15° to the southwest of Niksar basin and therefore it has separated from the North Anatolian Fault. This section is one of the far west fragments which has fractured during the 26 December 1939 Erzincan earthquake (Ms = 8) (look at Figure 1.3). The second section of the Alaca-Ezinepazarı fault is 150 km long. This part, which has separated from the previous part with 24° inflection, is seismically less active (Barka and Kadinsky-Cade, 1988).

Tuz Golu basin is surrounded with big in-plate faults. The Tuz Golu fault lies in the northwest-southeast direction in the east shores of the basin and is comprised of two sections: (i) northwest section of 100 km long, and (ii) southeast section of 80 km long (look at Figure 1.2).

Northeast-southwest inclined left directed lateral Ecemiş Fault is approximately 100 km long and extends from Erciyes Mountains to the Mediterranean Sea (look at Figure 1.2). Although the creation of the fault has started in the Eocene, the movement still continues as of today (Yetiş and Demirkol, 1984), and this condition has been proven with various macro-seismic interpretations. The seismic activity of this zone has been intensely investigated at the Turkish Electric Authority Report (1983).

Besides the abovementioned faults, the active fault map prepared by the General Directorate of Mine Investigation and Research also points out that there are some small in-plate faults near the proposed project site (look at Figure 1.4). Among these, the fault fractured during the 19 April 1938 Ms = 6,8 Kırşehir Earthquake also takes place.

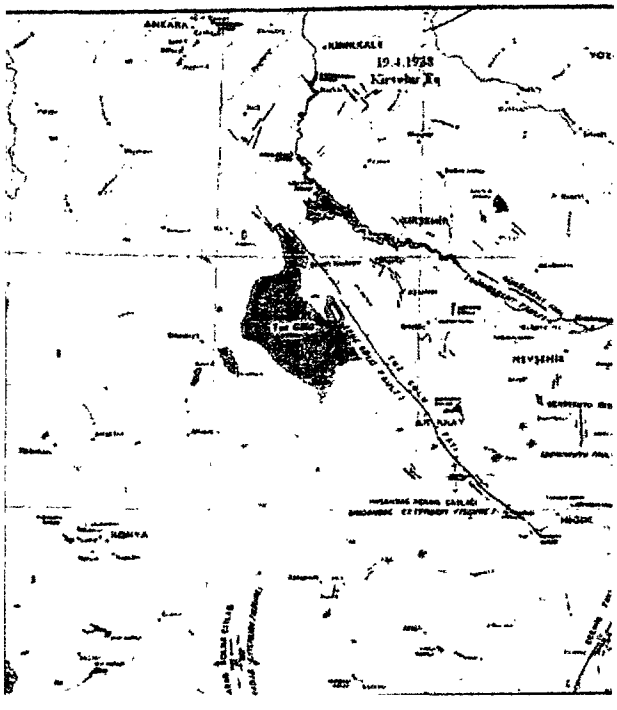


Figure 1.4 The Active Fault Map of the Region (Şaroğlu *et al.*, 1992)

The historical seismicity (as of magnitude, and when present, as of intensity ratio) and the instrumental seismicity of the Central Anatolian region has been given in Figures 1.5, 1.6 and 1.7, respectively. As can be easily seen from these figures, most of the seismic activity is gathered

around the sections of the North Anatolian Fault. The remaining events are mostly related with small and/or less active in-plate faults.

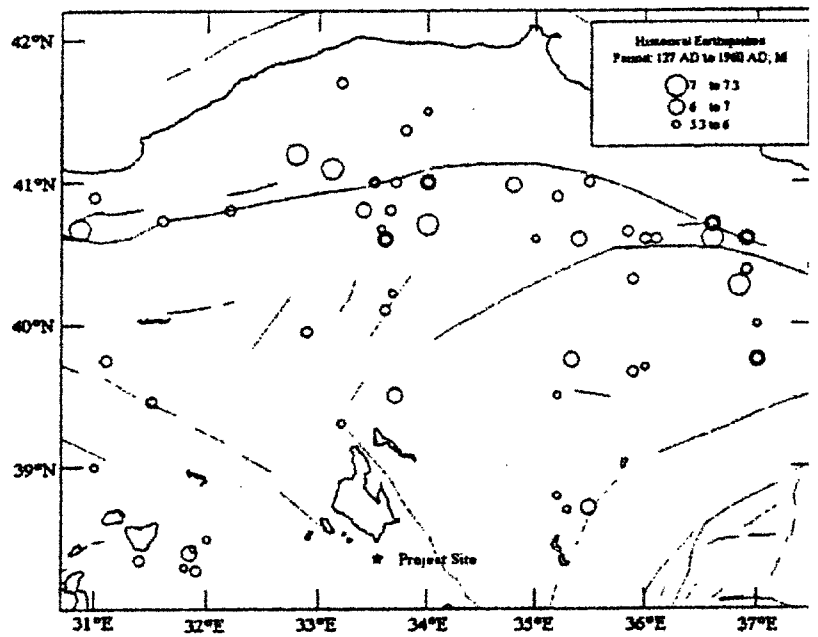


Figure 1.5 Historical Seismicity of the Project Site

2 Assessment of the Earthquake Risk

To calculate the earthquake risk at the project site, both statistical and deterministic methods have been utilized.

1. The Peak Ground acceleration values exceeding the 10% and 2% probability values at the rough soil level have been calculated as by using the attenuation (absorption of the seismic waves within the ground) relations proposed by Boore *et al.* (1997), Campbell (1997) and Sadigh *et al.* (1997). The results are given in Table 2.1.

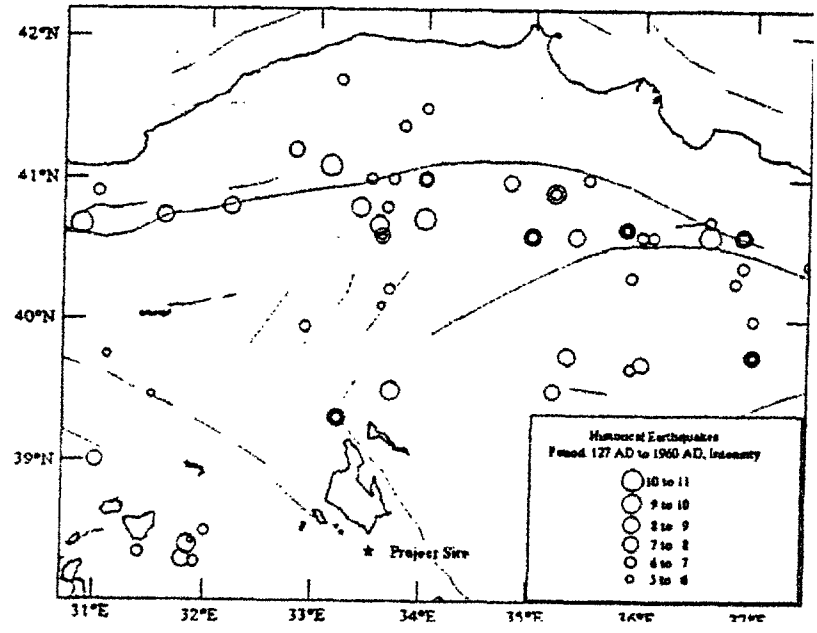


Figure 1.6 Historical Seismicity of the Region

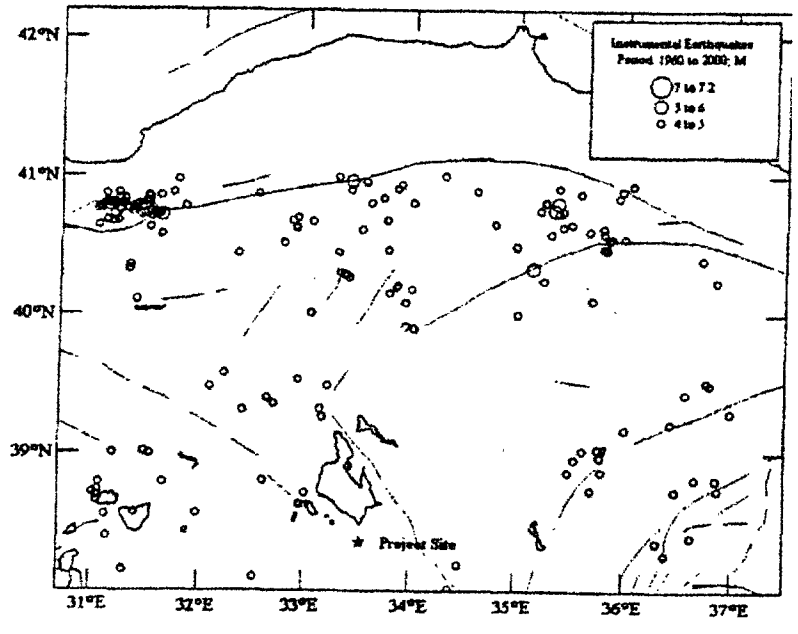


Figure 1.7 Instrumental Seismicity of the Project Site

	Probability values in 50 years	
Attenuation Curve	10%	2%
Joyner and Boore (1997)	0,14 g	0,24 g
Campbell (1997)	0,16 g	0,31 g
Sadigh *et al.* (1997)	0,20 g	0,38 g
Arithmetic average of PGA	0,17 g	0,31 g

Table 2.1 Probabilistic Peak Ground Accelerations Obtained for the Project Site

2. By using a deterministic approach, two critical earthquakes have been determined for the project site. Firstly; the earthquake of 7,5 magnitude due to reverse fault, is assumed to occur on the Tuz Golu Fault which is 50 km away from the project site, being the closest active fault. Secondly; by considering historical facts indicating that in-plate earthquakes, such as the 19.04.1938 dated Kırşehir earthquake, of 6,5 magnitude can develop at any place in Anatolia; it has been decided to place the epicenter of a 6,5 magnitude earthquake at a distance of 5 km from the project site. Peak Ground Acceleration and Peak Ground Displacement have been calculated for these two earthquakes. The obtained results are presented in Tables 2.2 and 2.3, respectively.

	Deterministic Case	
Attenuation Curve	M = 7,5 (at 50 km)	M = 6,5 (at 5 km)
Joyner and Boore (1997)	0,10 g	0,24 g
Campbell (1997)	0,08 g	0,42 g
Sadigh *et al.* (1997)	0,12 g	0,29 g
Arithmetic average of PGA	0,10 g	0,31 g

Table 2.2 Deterministic Peak Ground Accelerations Obtained for the Project Site

	Deterministic Case	
Type of land displacement	M = 7,5 (at 50 km)	M = 6,5 (at 5 km)
Horizontal	7,8 cm	7,9 cm
Vertical	3,1 cm	4,7 cm

Table 2.3 Probabilistic Peak Ground Accelerations Obtained for the Project Site

3 Conclusion

The project site is located at one of the least seismic and most stable regions of Anatolia. However, the past seismic history of Turkey provides evidence that earthquakes of 6,5 magnitude

can arise at almost any unexpected location within the country. Consequently, in terms of the results of such a variable case, it would be a more foresighted approach to account for a long term seismic risk in the site. When evaluated in long term (average return period within 5000 year term), PGA will be about 0,3. When evaluated in short term (which is approximately 500 year return period), PGA will bear a value of 0,17g.

According to the facility to be established on the project site, a more certain seismic risk assessment can be made.

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APPENDIX – H GENERAL INFORMATION ON MAJOR SOIL GROUPS

SOILS

Due to the differences in climate and topography in the region, various soils are developed. The information about soils given in the subtitles below is complied from the sources issued by Ministry of Agriculture and Rural Affairs, General Directorate of Rural Services (GDRS, 1993).

Alluvial Soils

The soils of concern are (A) C profiled young soils, which are transported by the rivers and developed over deposited material. The mineral content depends on the lithological composition of the river basin and the erosion and depositional stages in the course of soil development carried out in the geological periods, and it is heterogeneous. In its profiles, the formation of horizons either does not exist or very slightly evident. On the contrary, layers of various characteristics can be observed. Majority of them are rich in lime, which is washed down from the up-slope fields.

Alluvial soils are classified in accordance to their texture, the region at which they are found or development stages. The topsoil shows transition to the subsoil imperceptibly. As for the alluvial soils having a fine texture and high groundwater, vertical permeability is low. The surface is damp and rich in organic matter. At the subsoil, a minor reduction process is observed. Since the coarse textured ones are well drained, the surface layers break easily.

The vegetation depends on the climate. They are convenient and productive soils, which all kinds of culture plants that can comply with the climate of the region can be cultivated.

Hydromorphic Alluvial Soils

Hydromorphic alluvial soils are intrazonal soils, which their development carries out under the influence of water. Given that their topography is flat or hollow, the groundwater is high. The water can reach up to the surface in some seasons. Even in the case when the groundwater level decreases, the sub layers are constantly moist. The declines and inclines in the groundwater level leads to oxidations and reductions observed consecutively in the layers found over the water level. Consequently bluish gray reduction and reddish oxidation (rust) spots are developed in these layers. The layers resting below the groundwater level are completely glaysols and black spots resulted from the decay of the plant roots are present.
Although the depth is high, the glaysols layers restrict the root section of the plant. Natural vegetation comprises of meadow and pasture, and reeds or other plants that likes water. In

case if simple drainage measures would be taken, the fodder plants and some tree species resistant to water can be cultivated.

Colluvial Soils

In general they are located at the feet of steep slopes and at the mounts of the valleys. They are (A) C profiled young soils, which are developed over the materials that are transported by gravity, soil slide, surface flow and side creeks and deposited.

Moreover, although they mostly resembles the upslope field soils in terms of their characteristics, the grading in the main material either does not exists or insufficient. In the profile, layers of various piece sizes are observed according to the intensity of precipitation or surface run-off and slope degree. These layers are irregular, not parallel to each other as for the alluvial soils.

The soils found on the steep slopes and mounts of valleys are mostly comprised of less soil and contain coarse rocks and debris. The diameter of the pieces lessens with the decreasing rate of the speed of surface run-off. In places where the slope is very low and the particle is similar sized to the alluvial pieces, the colluvial soils merge into the alluvial soils transitionally.

The slope is of one type and increases towards the direction where the material is coming. Although they are subjected to floods occasionally, their drainage is well owing to their slope and texture. They do not have problems such as salinity and being sodic. The natural vegetation varies with the climate and as for the colluvial soils utilized in agriculture their productivity is high in case if the precipitation is sufficient or irrigation is present.

Organic Soils

The organic soils, also referred as moist peat soils, contain high percentage of organic matter in their content. The organic soils develop on a concave topography with a very high groundwater level and no external flow. Therefore, together with the drainage problems, salinity is an additional problem. They are formed in the consequence of slow decomposition of the root, stalk and leaves of the halophytic plants such as reeds, under conditions without air inside high groundwater, and moreover the deposition and accumulation of these substances. These soils are formed as a consequence of slowly decomposition and continuous piling, accumulation of the roots, stems and leaves of very aqua-philic plants like reeds and rushes submerged under high base water in air-free conditions.Therefore, organic soils are in-situ accumulated soils genetically. The organic soils are evaluated in two sections, namely Pit and Mak, in accordance to the decomposition rate of the plant residues in their content.

Considering Pit, the plant residues comprising the organic matter are not completely decomposed. The original state of the plants is evident and it is possible to identify their type. As for Mak, the plant residues comprising the organic matter are completely decomposed. The original state of the plants is not evident and it is not possible to determine their type.

The natural vegetation is marshland forest or reeds and weeds. Their productivity varied from low to medium. In case is the soil possessing a very poor natural drainage would be drained, the productivity increases and special products can be cultivated.

Brown Soils

The brown soils are ABC profiled soils composed of various main materials. Calcification plays a role in their development. In the consequence of this process, an abundant amount of calcium is found in their profiles. Considering the brown soils, which are subjected to erosion, A and C horizons are seen. Their natural drainage is good.

A1 horizon is brown or grayish brown, 10-15 cm in thickness and granular structured. Its organic matter content is medium. Its reaction is neutral or alkalic.

The color of B horizon varies from light brown to dark brown. Its structure is of rough round edged block. This horizon shows a gradual transition to the main material, which is pale brown or grayish and limy.

In brown soils the entire profile is limy. At the bottom of B horizon, whitish and mostly harden lime accumulation layer is found. Under the layer of concern, a gypsum accumulation layer can be observed. These soils remain dry through long periods in summer. During these periods, the chemical and biological activities are slow.

Reddish Brown Soils

Except for their respiration color, almost all other characteristics are same or similar with the brown soils.

A horizon is reddish brown or red typically. Its consistency is soft. B horizon is red or reddish brown, thicker textured and rather compact. $CaCO_3$ accumulation horizon is found under B horizon. This whitish colored horizon can be soft or cemented.

The reddish brown soils are developed over various main materials. The natural vegetation is lengthy weeds and shrubs. Their drainage is good.

Vertisol Soils

Vertisol soils are AC profiled soils. A horizon is thick and dark colored but the amount of organic matter is relatively low and it can contain $CaCO_3$. The upper parts of A horizon is dry, granular structured and mostly cracked, whereas its lower parts are commonly prismatic structured. No evident wash down and accumulation horizons are present.

Vertisols are thick textured, dark colored soils, which generally shrink during arid seasons and dilate in rainy seasons. These soils possess deep and wide cracks, gilgai micro relief and slide surfaces.

Gilgai micro relief is hillocks and mall depressions having 5-15 cm height. The cracks developed due to shrinkage leads to polygons, which their diameter varies between 1-4 m.

The main substance of vertisols is transported material. However, some are formed in-situ in the consequence of the decomposition of basalt or limestone. There is no special climate type for vertisols and their natural vegetation is miscellaneous.

Regosol Soils

The regosol soils are azonal soils, which adopt its all characteristics from the main material different from the other soil development factors. These are azonal soils taking all of its character from the main substance different from other soil formation factors. They are (A) C profiled soils. These soils can be formed by coarse textured sediments derived from calcareous or non-calcareous rocks or soft sediments and also by impartial, not harden deposits.

A horizon is mainly mineral. This horizon is poorly developed, coarse textured and has a low and medium depth. It does not possess an evident transition to C horizon. Regosol soils can develop in all climates. Primarily due to the high permeability and low water withholding capacity of these soils, they are dry at all times no matter what the climate of the region would be.

In general these soils are located at sand dunes, loess and steep inclined glacier accumulation areas. The natural vegetation is composed of frequently poor or very poor developed sparse short weeds. Most commonly, syrian rue, wild oat, spiny restharrow and other thorns, shrubs are encountered.

In regosols, the topography is generally undulated, slightly undulated, partially flat and undulated, whereas the slope is flat, close to flat or slight.

Arid (brine -sodic) Soils

The arid soils mostly possess a concave topography, which is surrounded by alluvial soils and has no external flow, or flat slopes. Accordingly, their salinity is high. The increase in the groundwater level, floods and excessive evaporation lead to salt accumulation on the soil surface. Salt is especially found on the surface as white crystals and also along the profile.

These soils are involved in the halomorphic lower sequence of the intrazonal soils and takes up all characteristics from the salt with high rate. They have evident A, B and C horizons. Because of the high salt content, it is not possible to cultivate culture plants without enhancement. They are still utilized as spoilt pasture. The natural vegetation is halophytic plants and shrubs.

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Moreover, although they mostly resembles the upslope field soils in terms of their characteristics, the grading in the main material either does not exists or insufficient. In the profile, layers of various piece sizes are observed according to the intensity of precipitation or surface run-off and slope degree. These layers are irregular, not parallel to each other as for the alluvial soils.

The soils found on the steep slopes and mounts of valleys are mostly comprised of less soil and contain coarse rocks and debris. The diameter of the pieces lessens with the decreasing rate of the speed of surface run-off. In places where the slope is very low and the particle is similar sized to the alluvial pieces, the colluvial soils merge into the alluvial soils transitionally.

The slope is of one type and increases towards the direction where the material is coming. Although they are subjected to floods occasionally, their drainage is well owing to their slope and texture. They do not have problems such as salinity and being sodic. The natural vegetation varies with the climate and as for the colluvial soils utilized in agriculture their productivity is high in case if the precipitation is sufficient or irrigation is present.

Organic Soils

The organic soils, also referred as moist peat soils, contain high percentage of organic matter in their content. The organic soils develop on a concave topography with a very high groundwater level and no external flow. Therefore, together with the drainage problems, salinity is an additional problem. They are formed in the consequence of slow decomposition of the root, stalk and leaves of the halophytic plants such as reeds, under conditions without air inside high groundwater, and moreover the deposition and accumulation of these substances. These soils are formed as a consequence of slowly decomposition and continuous piling, accumulation of the roots, stems and leaves of very aqua-philic plants like reeds and rushes submerged under high base water in air-free conditions.Therefore, organic soils are in-situ accumulated soils genetically. The organic soils are evaluated in two sections, namely Pit and Mak, in accordance to the decomposition rate of the plant residues in their content.

Considering Pit, the plant residues comprising the organic matter are not completely decomposed. The original state of the plants is evident and it is possible to identify their type. As for Mak, the plant residues comprising the organic matter are completely decomposed. The original state of the plants is not evident and it is not possible to determine their type.

The natural vegetation is marshland forest or reeds and weeds. Their productivity varied from low to medium. In case is the soil possessing a very poor natural drainage would be drained, the productivity increases and special products can be cultivated.

Brown Soils

The brown soils are ABC profiled soils composed of various main materials. Calcification plays a role in their development. In the consequence of this process, an abundant amount of calcium is found in their profiles. Considering the brown soils, which are subjected to erosion, A and C horizons are seen. Their natural drainage is good.

A1 horizon is brown or grayish brown, 10-15 cm in thickness and granular structured. Its organic matter content is medium. Its reaction is neutral or alkalic.

The color of B horizon varies from light brown to dark brown. Its structure is of rough round edged block. This horizon shows a gradual transition to the main material, which is pale brown or grayish and limy.

In brown soils the entire profile is limy. At the bottom of B horizon, whitish and mostly harden lime accumulation layer is found. Under the layer of concern, a gypsum accumulation layer can be observed. These soils remain dry through long periods in summer. During these periods, the chemical and biological activities are slow.

Reddish Brown Soils

Except for their respiration color, almost all other characteristics are same or similar with the brown soils.

A horizon is reddish brown or red typically. Its consistency is soft. B horizon is red or reddish brown, thicker textured and rather compact. $CaCO_3$ accumulation horizon is found under B horizon. This whitish colored horizon can be soft or cemented.

The reddish brown soils are developed over various main materials. The natural vegetation is lengthy weeds and shrubs. Their drainage is good.

Vertisol Soils

Vertisol soils are AC profiled soils. A horizon is thick and dark colored but the amount of organic matter is relatively low and it can contain $CaCO_3$. The upper parts of A horizon is dry, granular structured and mostly cracked, whereas its lower parts are commonly prismatic structured. No evident wash down and accumulation horizons are present.

Vertisols are thick textured, dark colored soils, which generally shrink during arid seasons and dilate in rainy seasons. These soils possess deep and wide cracks, gilgai micro relief and slide surfaces.

Gilgai micro relief is hillocks and mall depressions having 5-15 cm height. The cracks developed due to shrinkage leads to polygons, which their diameter varies between 1-4 m.

The main substance of vertisols is transported material. However, some are formed in-situ in the consequence of the decomposition of basalt or limestone. There is no special climate type for vertisols and their natural vegetation is miscellaneous.

Regosol Soils

The regosol soils are azonal soils, which adopt its all characteristics from the main material different from the other soil development factors. These are azonal soils taking all of its character from the main substance different from other soil formation factors. They are (A) C profiled soils. These soils can be formed by coarse textured sediments derived from calcareous or non-calcareous rocks or soft sediments and also by impartial, not harden deposits.

A horizon is mainly mineral. This horizon is poorly developed, coarse textured and has a low and medium depth. It does not possess an evident transition to C horizon. Regosol soils can develop in all climates. Primarily due to the high permeability and low water withholding capacity of these soils, they are dry at all times no matter what the climate of the region would be.

In general these soils are located at sand dunes, loess and steep inclined glacier accumulation areas. The natural vegetation is composed of frequently poor or very poor developed sparse short weeds. Most commonly, syrian rue, wild oat, spiny restharrow and other thorns, shrubs are encountered.

In regosols, the topography is generally undulated, slightly undulated, partially flat and undulated, whereas the slope is flat, close to flat or slight.

Arid (brine -sodic) Soils

The arid soils mostly possess a concave topography, which is surrounded by alluvial soils and has no external flow, or flat slopes. Accordingly, their salinity is high. The increase in the groundwater level, floods and excessive evaporation lead to salt accumulation on the soil surface. Salt is especially found on the surface as white crystals and also along the profile.

These soils are involved in the halomorphic lower sequence of the intrazonal soils and takes up all characteristics from the salt with high rate. They have evident A, B and C horizons. Because of the high salt content, it is not possible to cultivate culture plants without enhancement. They are still utilized as spoilt pasture. The natural vegetation is halophytic plants and shrubs.

APPENDIX – I SOIL ANALYSIS REPORT

T.R.

PRIME MINISTRY

GENERAL DIRECTORATE OF RURAL SERVICES

Directorate of Soil and Fertilizer Research Institute

SALINITY LABORATORY ANALYSIS REPORT

Sample Owner : ENVY Inc.
Sampling Location : Sultanhani / AKSARAY
Report Date : 03.02.2001

Lab. No	pH	EC (dS/m)	Exchangeable Cations (%)				CEC (me/100g)	Boron (ppm)
			Na	K	Ca	Mg		
2	8.24	57.350	7.55	5.71	71.31	13.01	31.65	1.701
3	8.16	2.638	1.23	4.84	82.47	11.19	18.58	0.034
4	8.21	0.906	1.32	10.57	85.40	2.33	21.85	0.082
5	8.08	5.735	3.92	1.54	77.39	0.65	26.62	0.430
6	8.20	1.066	1.15	6.16	73.60	4.97	32.77	0.073
7	8.15	0.871	8.38	0.90	64.41	22.61	16.58	0.127
8	8.12	1.771	1.75	4.32	53.76	30.36	15.94	0.028
9	7.89	6.882	1.33	7.86	68.00	18.48	12.72	0.060
10	8.15	0.802	1.82	4.39	69.70	20.13	17.53	0.047
11	8.16	1.720	1.58	5.34	78.61	11.68	20.20	0.039
12	8.17	1.261	1.25	11.17	69.06	9.76	24.79	0.045
13	8.19	0.963	1.03	6.22	68.95	14.78	20.23	0.065
14	8.20	1.491	1.93	10.97	80.71	4.54	19.13	0.019
15	8.23	4.014	4.65	3.65	67.64	18.33	15.05	0.061

Note: Since the soil sample number 1 is of inadequate amount, no analyses can be carried out.

Chief of Laboratory
Emel GÜVEN
Chemical Engineer
(Signature)

Head of Department
Sema ÇİZİKÇİ
Agricultural Engineer (M.Sc.)
(Signature)

T.R.
PRIME MINISTRY
GENERAL DIRECTORATE OF RURAL SERVICES
Soil and Fertilizer Research Institute

SOIL PHYSICS LABORATORY
ANALYSIS REPORT

Sender of Sample and Address : Envy Inc. - Aksaray
Report Date : 02.03.2001

Soil No	% Sand	% Silt	% Clay	Texture Class
1	42.81	44.03	13.16	L
4	32.01	36.57	31.42	CL
6	25.55	35.06	39.39	CL
7	88.45	1.69	9.86	LS
11	49.59	25.66	24.75	SCL
12	30.87	38.85	30.28	CL

Note: As 2, 3, 5, 8, 9, 10, 13, 14, 15 numbered soil samples comprise more than 45% of lime, no texture analysis can be carried out.

Faik ERGÜL
(Signature)
Agricultural Engineer
Chief of Laboratory

Sema ÇİZİKÇİ
(Signature)
Agricultural Engineer (M.Sc.)
Head of Water Management Department

T.R.

PRIME MINISTRY

GENERAL DIRECTORATE OF RURAL SERVICES

Directorate of Soil and Fertilizer Research Institute

ANALYSIS REPORT

Report Date : 01/03/2001
Report Number : 0225/2
Sender of Sample : ENVY Inc. (Hakan Yılmaz)

Lab. No	Sample Name	Total Nitrogen (%)	Lab. No	Sample Name	Total Nitrogen (%)
2001/1	1	0.550	2001/9	4 30-60	0.072
2001/2	2	0.190	2001/10	Well 2	0.050
2001/3	3	0.160	2001/11	Bucak Plateau	0.130
2001/4	4	0.170	2001/12	Tönür Plateau	0.250
2001/5	5	0.130	2001/13	Höyük	0.170
2001/6	6	0.150	2001/14	Höyük Altı	0.160
2001/7	7	0.039	2001/15	No information	0.120
2001/8	8	0.067			

(Signature)	*(Signature)*	*(Signature)*
Analysis is carried out by	**Chief of Laboratory**	**Head of Soil Management**
Dilek TERZİ	Kadriye KALINBACAK	Dr. İbrahim GÜÇDEMİR
Agricultural Engineer	Agricultural Engineer (M.Sc.)	Agricultural Engineer (M.Sc.)

P.K. 54, 06172 **Tel:** 0 312 – 315 6560 – 315 5056 **Fax:** 0 312 – 315 2931
Yenimahalle/ANKARA **URL:** http/www.khgm.gov.tr/tgae.htm **e-mail:** tgb_ae@khgm.gov.tr

T.R.
PRIME MINISTRY
GENERAL DIRECTORATE OF RURAL SERVICES
Directorate of Soil and Fertilizer Research Institute

SOIL ANALYSIS REPORT

Address of Sender of Sample:
ENVY Inc. (HAKAN YILMAZ)
AKSARAY SULTANHANI

Report Number
Report Date

To whom the soil belong to, location and date of sample	Order No	Lab. No	Plant to be Sown	Depth cm	Saturation with water %	Total salt %	pH in soil saturated with water	Lime CaCO3 %	Nutrients effective on plants kg/decare		Organic matter %	Pure matter required to be given kg/decare	
									Phosphor P205	Potas. K20		Phosphor P205	Nitro. N
1		1			73 C	0.390	7.86	31.9	90.6	143	6.08		
2		2			65 CL	2.450	8.15	65.2	12.5	21	1.95		
3		3			51 CL	0.107	7.47	48.9	11.4	127	1.79		
4		4			57 CL	0.045	7.58	42.2	13.7	266	1.95		
5		5			62 CL	0.335	7.69	48.9	2.2	51	1.46		
6		6			50 L	0.041	7.68	27.4	7.62	232	1.94		
7		7			44 L	0.035	8.34	28.2	3.23	19	0.33		
8		8			44 L	0.055	7.42	43.3	3.23	105	1.26		
4 30-60		9			67 CL	0.400	7.31	70	2.71	290	0.65		
Well 2		10			36 L	ESERİ	7.74	45.6	10.2	113	1.13		
Between Bucak Plateau/ Well 2		11			41 L	0.073	7.46	34.1	12.5	133	1.39		
Tönür Plateau		12			60 CL	0.054	7.68	41.5	25.8	337	2.72		
Höyük		13			52 CL	0.035	7.78	50.4	15.2	156	1.79		
Höyük Altı		14			45 L	0.048	7.70	46.7	25.5	241	1.79		
Yazısız		15			70 CL	0.181	7.52	58.5	21.4	96	1.78		

APPENDIX – L REGIONAL FAUNA INVENTORY

FAUNA INVENTORY

The fauna inventory was prepared based on land studies with assistance of a broad literature survey and local people's observations. The fauna inventory comprises Amphibians as well. Along with each species, the information such as its scientific name, habitat, distribution in Turkey, population density, risk status, status according to Bern Convention and impact probability are stated. The birds under risk were based on Kiziroglu (1993). As for other fauna species, Demirsoy (1996) and IUCN (1994) are given discretely. The risk classification scales are as follows.

Risk classification used by Demirsoy (1996):

In the studies of Demirsoy, risk classification is given by the category symbols proposed by Wells and others (1983) and utilized in IUCN Red Data Book. These are:

E : *Endangered*: Taxon (species or sub-species) is facing a risk of extinction; factors causing the taxon to be extinct still carries on.
Ex: *Extinct:* Taxon is extinct in the wild or declined under recovery number. However, only regenerates under protection.
I : *In determinate*: The status of taxon is not known.
K : *Insufficient*: The status of taxon is undetermined because of the lack of information.
nt : Taxon is not in danger thus far.
O : *Out of danger*: Taxon is formerly in danger, however recovered by means of protective measures taken.
R : *Rare:* Taxon which is observed in small populations, not in danger presently, however candidate to be involved in "V" category if no required protective measures are taken.
V : *Vulnerable:* Taxon is facing a risk of extinction rapidly and if no measures would be taken, its extinction risk in the near future is high.

Risk classification used by Kiziroglu (1993) for birds:

A1 : Species under extinction or endangered species.
A1.1 : Species under extinction.
A1.2 : Species which are low in number (1-25 couples in Turkey).
A2 : Species which are under a certain level of risk in their range and have a population in between 26-50 couples.
A3 : Species with a population in between 51-200 (500) couples, however which are rather lessen in some regions.
A4 : Species which are lesser in some regions and low in number.
B : Species which temporarily visit Turkey and would be under risk together with the loss of their biotopes.
B1 : Species dwelling for the winter but not breeding in Anatolia.

B2-B3 : Species passing through Anatolia or species dwelling for the winter in Anatolia and having a lower risk level.

Risk classification in accordance to IUCN (1994):

Risk classification is the "Red List Categories" published by IUCN presently. In European countries, the classification of flora and fauna species in accordance to IUCN risk categories has been realized dating from the year 1970. Studies carried out in Turkey are present as well. However, likewise numerous European countries, the risk classification in accordance to IUCN (1994) is not realized in Turkey up till now. The classification of concern in the report is realized within the content of this study.

(EW) : *"Extinct in the Wild"* A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual.

(CR) : *"Critically Endangered"* A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

(EN) : *"Endangered"* A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

(VU) : *"Vulnerable"* Although not included in CR and EN groups, taxon is vulnerable as it is facing a very high risk of extinction in the wild in the medium termed future.

(LR) : *"Lower Risk"* Taxon is not included in any groups listed above and its population is in better condition compared to others. Taxa included in the Lower Risk category can be separated into three subcategories in terms of the risk in the future:

1. **(cd)** : *"Conservation Dependent"* Taxa which are the focus of a continuing taxon- or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
2. **(nt)** : *"Near Threatened"* Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.
3. **(lc)** : *" Least Concern"* Taxa which do not require any protection and are not under risk.

Abbreviations:

W : West
S : South
N : North

E : East
SE : Southeast
End : Endemic

For Birds

Status:

R : Resident birds observed in all seasons
M : Migratory birds breeding in Turkey
WV : Winter visitors (Birds coming to our country in winter just to accommodate)
PV : Passage visitors

Distribution in Turkey:

AR : All Regions
Bs : Black Sea Region
Ma : Marmara Region
Ae : Aegean Region
Med : Mediterranean Region
C : Central Anatolia Region
Ea : East Anatolia Region
SEa : Southeast Anatolia Region

Table K.1. Amphibian (Amphibia)

SCIENTIFIC NAME	COMMON NAME	ERL	BERN	SOURCE	HABITAT	OBSERVED	DISTRIBUTION IN TURKEY	POPULATION DENSITY	IUCN 2000
Anura									
Pelobatidae									
Pelobates syriacus	Eastern Spadefoot	nt	Appendix II	O	Inside loose and soft soils	Project site and its vicinity	Widespread	High	LR-lc
Bufonidae									
Bufo bufo	Common Toad	nt	Appendix III	O	Hides at various hollows such as under the stones, inside the soil during the day and active on nights	Project site and its vicinity	Widespread	Low	LR-nt
Bufo viridis viridis	Green Toad	nt	Appendix II	O	Hides at various hollows such as under the stones, inside the soil during the day and active on nights	Project site and its vicinity	Widespread	High	LR-nt
Hylidae									
Hyla arborea	Tree Frog	nt	Appendix II	O	Over trees and shrub	Project site and its vicinity	Widespread	High	LR-nt
Ranidae									
Rana ridibunda ridibunda	Marsh Frog	nt	Appendix III	O	In water	Project site and its vicinity	Widespread	High	LR-lc

O: Observation

Table K.2. Reptiles (Reptilia)

SCIENTIFIC NAME	COMMON NAME	ERL	BERN	SOURCE	HABITAT	OBSERVED	DISTRIBUTION IN TURKEY	POPULATION DENSITY	IUCN 2000
Testudinidae									
Testudo graeca ibera	Common Tortoise	nt	Appendix II	O	Sandy-gravelly and arid fields	Project site and its vicinity	Widespread	High	LR-lc
Emydidae									
Emys orbicularis	European Pond Turtle	nt	Appendix II	O	Still and running waters	Project site and its vicinity	Widespread	Abundant	LR-lc
Agamidae									
Agama (Laudakia) stellio stellio	Clown Agama	nt	Appendix II	O	Rocky and stony areas	Project site and its vicinity	Widespread except for Northern Anatolia	High	LR-lc
Agama ruderata ruderata	Agama	nt	Appendix III	O	Steppe	Project site and its vicinity	Central, E and SE Anatolia	High	LR-lc
Lacertidae									
Lacerta parva	Squamata Lizard	nt	Appendix II	O	Arid areas and areas with poor vegetation	Project site and its vicinity	Central and NE Anatolia	Medium	LR-lc
Lacerta trilineata galatiensis	Balkan Green Lizard	nt	Appendix II	O	Stony areas rich in flora, orchard and gardens	Project site and its vicinity	Central	Low	LR-lc
Ophisops elegans centranatolia	Snake-Eyed Lizard	nt	Appendix II	O	Arable fields	Project site and its vicinity	Central Anatolia, End	High	VU
Scincidae									
Eumeces schneideri	Afrikan Gold Skink	nt	Appendix III	O	Under stone or inside soil	Project site and its vicinity	Central, S and SE Anatolia	Low	LR-nt

Table K.2. (continued)

SCIENTIFIC NAME	COMMON NAME	ERL	BERN	SOURCE	HABITAT	OBSERVED	DISTRIBUTION IN TURKEY	POPULATION DENSITY	IUCN 2000
Typhlobidae									
Typhlops vermicularis	European Blind Snake	nt	Appendix III	O	Inside damp soil and under stones	Project site and its vicinity	Widespread	High	LR-nt
Boidae									
Eryx jaculus	Sand Boa	nt	Appendix III	O	Sandy and stony areas	Project site and its vicinity	Central, W, S, SE and E Anatolia	High	LR-nt
Colubridae									
Coluber caspius	Caspian Snake	nt	Appendix III	O	Arable field, stony slope, marshland and stony creek banks	Project site and its vicinity	Widespread	High	LR-nt
Coluber najadum	Dahl's Whip Snake	nt	Appendix II	O	Stony or shrubby arid areas	Project site and its vicinity	Central, SW, S, SE, NE and E Anatolia	High	LR-nt
Eirenis modestus	Dwarf Snake	nt	Appendix III	O	Stony areas with poor vegetation	Project site and its vicinity	Widespread	High	LR-nt
Elaphe quatorlineata sauromates	Four-Lined Snake	nt	Appendix II	O	Forests, shrubby and stony areas, arable fields and gardens	Project site and its vicinity	Widespread	Low	LR-nt
Malpolon monspessulanus insignita	Montpellier Snake	nt	Appendix III	O	Stony and arid areas	Project site and its vicinity	W, S, SE and Central Anatolia	Low	LR-nt
Natrix natrix persa	Grass Snake	nt	Appendix III	O	Shrubs close to waters and stony areas	Project site and its vicinity	Widespread	High	LR-nt

Table K.2. (continued)

Natrix tessellata tessellata	Dice Snake	nt	Appendix II	O	In water and water banks	Project site and its vicinity	Widespread	High	LR-nt
Viperidae									
Vipera xanthina xanthina	Ottoman Viper	nt	Appendix II	O	Stony areas	Project site and its vicinity	NW, W and Central Anatolia, End	Low	VU

O: Observation
ERL: European Red List

Table K.3. Birds

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
PODICIPEDIDAE	**Grebes**												
Podiceps cristatus	Great Crested Grebe	2	2	O	A.2	-	Appendix III	P	-	In Water	Ma, Bs, Ae, Med, C, Ea	High	R, WV
Podiceps grisegena	Red-necked Grebe	2	2	O	A.2	-	Appendix II	P	-	In Water	Ma, Bs, Ae, Med, C, Ea	High	WV
Podiceps nigricollis	Black-necked Grebe	2	2	O	A.2	-	Appendix II	P	-	In Water	Ma, Bs, Ae, Med, C, Ea	High	R
Podiceps ruficollis	Little Grebe	2	2	O	A.3	-	Appendix II	P	-	In Water	Ma, Bs, Ae, Med, C, Ea	High	R, M
CICONIIDAE	**Storks**												
Ciconia ciconia	White Stork	1	1	O	A.3	-	Appendix II	P	-	Areas with sparse trees, settlement areas, marshlands and wetlands	AR	Low	M, R
PHOENICOPTERIDAE	**Flamingos**					-			-				
Phoenicopterus ruber	Greater Flamingo	2	2	O	A.2	-	Appendix II	P	-	Wetlands	Ma, Ae, Med, C, Ea, SEa	High	M, WV
ANATIDAE	**Wildfowl**												
Anser anser	Greylag Goose	2	2	O	A.2	-	Appendix III	P	-	Pasture, arable field and marshlands	Ma, Bs, Med, C, Ea	High	R, WV
Anser albifrons	White-fronted Goose	2	2	O	B.2	-	Appendix III	CS	-	Pasture, arable field and marshlands	Ma, Bs, Ae, Med, C, Ea	Medium	WV
Tadorna tadorna	Common Shelduck	2	2	O	A 2	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	High	R, M, WV
Tadorna ferruginea	Ruddy Shelduck	2	1	O	A.2	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	High	WV
Anas platyrhynchos	Mallard	3	1	O	A.4	-	Appendix III	CS	-	Reed bed and still waters	AR	High	R, WV

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Anas crecca	Teal	3	1	O	A.4	-	Appendix III	CS	-	Flat and mountainous areas, water banks rich in flora	Ma, Bs, Ae, Med, C, Ea	High	WV
Anas acuta	Northern Pintail	2	1	O	A.4	-	Appendix III	P	-	Wetlands	AR	High	M, WV
Anas querquedula	Garganey	1	1	O	A.3	-	Appendix III	CS	-	Plain and hilly fields, still waters	AR	High	M
Anas penelope	European Wigeon	2	1	O	A.4	-	Appendix III	CS	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	High	WV, M
Anas clypeata	Common Shoveler	1	1	O	A.4	-	Appendix III	CS	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	High	R, WV
ACCIPITRIDAE	**Hawks, Eagles**												
Aquila chrysaetos	Golden Eagle	1	1	O	A.3	-	Appendix II	P	-	Forest, arable field and meadows	AR	High	R
Aquila heliaca	Imperial Eagle	1	1	O	A.2	VU	Appendix II	P	-	Forests and steppe with sparse trees	AR	High	R, WV
Circus cyaneus	Northern Harrier	1	1	O	A.3	-	Appendix II	P		Marshlands, arable fields; Flat and hilly areas	Ma, Bs, Ae, Med, C, Ea	High	WV
Buteo rufinus	Long-legged Buzzard	2	2	O	A.2	-	Appendix II	P	-	Flat areas without forests and mountains	AR	High	R
Buteo buteo	Common Buzzard	2	2	O	A.3	-	Appendix II	P	-	Forest, arable field and meadows	AR	High	WV
FALCONIDAE	**Falcons**												
Falco tinnunculus	Common Kestrel	3	3	O	A.4	-	Appendix II	P	-	Open fields, forests, provinces	AR	High	R
Falco naumanni	Lesser Kestrel	-	1	O	A.3	VU	Appendix II	P		Plains, High mountains and ruins	AR	High	M
Falco peregrinus	Peregrine Falcon	1	1	O	A.2	-	Appendix II	P	-	Open fields and forests	AR	High	R

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Falco columbarius	Merlin	3	3	O	B.2	-	Appendix II	P	-	Marshlands and hills	Ma, Bs, Ae, Med, C, Ea	Medium	WV
Falco vespertinus	Red-footed Falcon	1	1	O	A.2	-	Appendix II	P	-	Open fields and small forests	AR	High	WV
PHASIANIDAE	**Pheasants, Partridges**												
Alectoris chukar	Chukar	-	2	O	A.2	-	Appendix III	CS	-	Arable fields, meadow and rocky fields	Bs, Ae, Med, C, Ea, SEa	High	R
Coturnix coturnix	Quail	-	2	O	A.4	-	Appendix III	CS	-	Crop fields and meadows	AR	High	M
Grus grus	Common Crane	1	1	O	A.1.2	-	Appendix II	P		Wet meadows	AR	High	M, R, PV
Anthropoides virgo	Demoiselle Crane	1	1	O	A.1.2	-	Appendix II	P	-	Wet meadows	Ma, C, Ea	High	M, PV
RECURVIROSTRIDAE	**Stilts, Avocets**												
Recurvirostra avosetta	Avocet	2	1	O	A.4	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	Medium	M, R. WV
CHARADRIIDAE	**Plovers**												
Charadrius dubius	Little Ringed Plover	2	1	O	A.2	-	Appendix II	P	-	Wetlands	AR	High	M
Vanellus vanellus	Lapwing	2	2	O	A.4	-	Appendix III	CS	-	Wetlands and wet meadows	Ma, Bs, Ae, Med, C, Ea	Medium	R, WV
SCOLOPACIDAE	**Sandpipers**					-							
Tringa stagnatilis	Marsh Sandpiper	2	1	O	B.3	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	Medium	WV, PV
BURHINIDAE	**Thick-knees**												
Burhinus oedicnemus	Stone Curlew	2	1	O	A.3	-	Appendix II	P	-	Wetlands and wet meadows	AR	Medium	M

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
GLAREOLIDAE	**Pratincoles**								-				
Glareola pratincola	Collared Pratincole	2	1	O	A.3	-	Appendix II	P	-	Wetlands	Ma, Ae, Med, C, Ea	Medium	M, PV
LARIDAE	**Gulls**												
Larus melanocephalus	Mediterranean Gull	2	1	O	A.4	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, Med, C	High	R
Larus minutus	Little Gull	1	1	O	B.3	-	Appendix II	P	-	Wetlands	Ma, Bs, Ae, C, Ea	Medium	WV, PV
Larus genei	Slender-billed Gull	2	1	O	B.3	-	Appendix III	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	Medium	WV, PV
Larus argentatus	Herring Gull	2	1	O	-	-	-	P	-	Wetlands	Ma, Bs, Ae, Med, C, Ea	Low	R
COLUMBIDAE	**Pigeons, Doves**												
Columba palumbus	Woodpigeon	3	3	O	A.4	-	-	CS	-	Mountainous regions, trees and provinces	AR	Low	R
Streptopelia decaocto	Collared Pigeon	3	3	O	-	-	Appendix III	P	-	Settlement areas, wooded areas	AR	Low	R
Streptopelia turtur	Turtle Dove	-	2	O	A.2	-	Appendix III	CS	-	Forests close to arable fields and settlement areas	AR	High	M
CUCULIDAE	**Cuckoos**								-				
Cuculus canorus	Cuckoo	-	3	O	-	-	Appendix III	P	-	Forests, shrubs and gardens	AR	Low	M
STRIGIDAE	**Owls**								-				
Athena noctua	Little Owl	1	1	O	A.3	-	Appendix II	P	-	Arable fields, orchards and gardens, rocky fields	AR	High	R

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
APODIDAE	**Swifts**								-				
Apus apus	Swift	2	2	O	A.4	-	Appendix III	P	-	Vicinity of settlement areas, rocky fields and wooded areas	AR	High	M
Apus melba	Alpine Swift	1	1	O	A.4	-	Appendix II	P	-	Rocky slopes	AR	High	M
MEROPIDAE	**Bee-eaters**					-			-				
Merops apiaster	Bee-eater	2	1	O	A.4	-	Appendix II	P	-	Areas with sparse trees and open fields	AR	High	M
CORACIIDAE	**Rollers**												
Coracias garrulus	Roller	1	1	O	A.2	-	Appendix II	P	-	Open and areas with sparse trees	AR	High	M
UPUPIDAE	**Hoopoes**					-			-				
Upupa epops	Hoopoe	-	2	O	A.2	-	Appendix II	P	-	Forests, orchards and gardens	AR	High	M
ALAUDIDAE	**Larks**												
Melanocorypha calandra	Calandra Lark	2	2	O	-	-	Appendix II	P	-	Arable fields	Ma, Ae, Med, C, Ea, SEa	Low	R
Calandrella brachydactyla	Short-toed Lark	2	2	O	A.3	-	Appendix II	P	-	Arid and sandy fields	AR	High	M
Alauda arvensis	Skylark	2	2	O	-	-	Appendix III	P	-	Open fields and crop fields	Ma, Bs, Ae, C, Med, Ea	Low	R
HIRUNDINIDAE	**Swallows, Martins**												
Hirundo rustica	Swallow	2	2	O	-	-	Appendix II	P	-	Settlement areas	AR	Low	M
Delichon urbica	House Martin	2	2	O	A.4	-	Appendix II	P	-	Settlement areas and rocky fields	AR	High	M

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
MOTACILLIDAE	**Pipits, Wagtails**												
Anthus campestris	Tawny Pipit	2	2	O	A.3	-	Appendix II	P	-	Sandy and gravelly fields, sparse and arid shrubs	AR	High	R
Anthus pratensis	Meadow Pipit	-	2	O	-	-	Appendix II	P	-	Wet meadows and marshlands	Ma, Bs, Ae, C, Med, Ea	Low	WV
Motacilla flava	Yellow Wagtail	2	2	O	-	-	Appendix II	P	-	Wetlands, meadows, lake and pond banks	Ma, Bs, Ae, C, Med, Ea	Low	M
Motacilla cinerea	Grey Wagtail	2	2	O	A.4	-	Appendix II	P	-	Wetlands	AR	High	R
Motacilla alba	Pied Wagtail	2	2	O	A.4	-	Appendix II	P	-	Open fields	AR	High	R
TURDIDAE	**Thrushes, Chats**												
Erithacus rubecula	Robin	-	2	O	-	-	Appendix II	P	-	Forests, plains, park and gardens	AR	Low	R
Luscinia megarhynchos	Nightingale	-	2	O	A.3	-	Appendix II	P	-	Forests, plains, park and gardens	AR	High	M
Phoenicurus ochruros	Black Redstart	2	2	O	-	-	Appendix II	P	-	Rocky slopes, house and ruins	AR	Low	R
Phoenicurus phoenicurus	Redstart	-	2	O	-	-	Appendix II	P	-	Park and gardens	AR	Low	R
Saxicola rubetra	Whinchat	2	2	O	-	-	Appendix II	P	-	Areas with sparse trees, wetlands, meadows	AR	Low	R
Saxicola torquata	Stonechat	2	2	O	-	-	Appendix II	P	-	Stony and arid hills, shrubs, sandy fields	AR	Low	R
Oenanthe oenanthe	Northern Wheatear	2	2	O	A.3	-	Appendix II	P	-	Open and arid fields, arable fields and meadows	AR	High	M

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Oenanthe hispanica	Black-eared Wheatear	-	2	O	-	-	Appendix II	P	-	Open scrub and regions with trees	AR	Low	M
Oenanthe isabellina	Isabelline Wheatear	2	2	O	-	-	Appendix II	P	-	Steppe	AR	Low	R
Turdus merula	Blackbird	-	2	O	-	-	Appendix III	CS	-	Forests, plains, park and gardens	AR	Low	R
Turdus pilaris	Fieldfare	-	2	O	-	-	Appendix III	P	-	Forests, arable fields and wet meadows	AR	Low	WV
Turdus philomelos	Song Thrush	-	2	O	-	-	Appendix III	P	-	Forests, park and gardens, settlement areas	Ma, Bs, Ae, Med, C, Ea	Low	R
Turdus viscivorus	Mistle Thrush	-	2	O	-	-	Appendix III	P	-	Forests, park and gardens, settlement areas	AR	Low	R
SYLVIIDAE	**Warblers**												
Cettia cetti	Cetti's Warbler	2	2	O	A.4	-	Appendix II	P	-	Water banks with reeds and canes	AR	High	R
Cisticola juncidis	Fan-tailed Warbler	-	2	O	-	-	Appendix II	P	-	Reed beds, marshlands, meadows and arable fields	Ma, Ae, Med, C, Ea	Low	R
Locustella luscinioides	Savi's Warbler	-	2	O	-	-	Appendix II	P	-	Arable fields	AR	Low	R
Acrocephalus scirpaceus	Reed Warbler	2	2	O	-	-	Appendix II	P	-		AR	Low	M
Acrocephalus arundinaceus	Great Reed Warbler	2	2	O	-	-	Appendix II	P	-	Marshlands and reed beds, park and gardens	Ma, Ae, Med, C, Ea	Low	M
Hippolais icterina	Icterine Warbler	-	2	O	A.3	-	Appendix II	P	-	Park and gardens, forests and road sides	AR	High	M

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Hippolais pallida	Olivaceous Warbler	-	2	O	-	-	Appendix II	P	-	Park and gardens, open fields, forests and shrubs	AR	Low	M
Sylvia melanocephala	Sardinian Warbler	-	2	O	-	-	Appendix II	P	-	Forests and shrubs, park and gardens	Ma, Bs, Ae, Med, C	Low	R
Sylvia hortensis	Orphean Warbler	2	2	O	-	-	Appendix II	P	-	Plains and arable fields	AR	Low	M
Sylvia curruca	Lesser Whitethroat	-	2	O	-	-	Appendix II	P	-	Shrubs, forest sides, gardens	AR	Low	M
Sylvia communis	Whitethroat	-	2	O	-	-	Appendix II	P	-	Forests and shrubs, park and gardens	AR	Low	M
Sylvia borin	Garden Warbler	-	2	O	-	-	Appendix II	P	-	Forests and shrubs, park and gardens	AR	Low	M
Sylvia atricapilla	Blackcap	-	2	O	-	-	Appendix II	P	-	Forests, park and gardens	Ma, Bs, Ae, Med, C, Ea	Low	M
Phylloscopus trochilus	Willow Warbler	-	2	O	-	-	Appendix II	P	-	Forests, park and gardens, water banks	AR	Low	M
MUSCICAPIDAE	**Flycatchers**												
Muscicapa striata	Spotted Flycatcher	-	2	O	-	-	Appendix II	P	-	Forests and shrubs, settlement areas	AR	Low	M
Ficedula hypoleuca	Pied Flycatcher	-	2	O	-	-	Appendix II	P	-	Forests, park and gardens	Ma, Bs, Ae, C, Med, SEa	Low	M
TIMALIIDAE	**Babblers**												
Panurus biarmicus	Bearded Tit	2	2	O	A.2	-	Appendix II	P	-	Reed beds, water banks	Ma, Bs, Ae, Med, C, Ea	High	R
Parus caeruleus	Blue Tit	-	2	O	-	-	Appendix II	P	-	Forests, parks and gardens	AR	Low	R

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
AEGITHALIDAE	**Long-tailed Tits**												
Aegithalos caudatus	Long-tailed Tit	-	2	O	A.2	-	Appendix II	P	-	Thick forests and gardens	AR	High	R
SITTIDAE	**Nuthatches**												
Sitta europaea	Nuthatch	-	2	O	-	-	Appendix II	P	-	Forests, parks and gardens	AR	Low	R
Sitta neumayer	Rock Nuthatch	-	2	O	-	-	Appendix II	P	-	Rocky areas	AR	Low	R
Sitta tephronota	Eastern Rock Nuthatch	2	2	O	-	-	Appendix II	P	-	Steppe	AR	Low	R
REMIZIDAE	**Penduline Tits**												
Remiz pendulinus	Penduline Tit	-	2	O	A.2	-	Appendix III	P	-	Marshlands, forest, lake and river banks	AR	High	R
ORIOLIDAE	**Orioles**												
Oriolus oriolus	Golden Oriole	-	2	O	-	-	Appendix II	P	-	Forests, parks and gardens	AR	Low	M
LANIIDAE	**Shrikes**												
Lanius collurio	Red-backed Shrike	2	2	O	-	-	Appendix II	P	-	Open fields, forest sides, park and gardens	AR	Low	M
Lanius minor	Lesser Grey Shrike	2	2	O	-	-	Appendix II	P	-	Forest sides, parks and gardens	AR	Low	M
CORVIDAE	**Crows**												
Pica pica	Magpie	3	3	O	-	-	-	AS	-	Fields with sparse trees, shrubs, arable fields and orchards, parks	AR	Low	R

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Corvus monedula	Jackdaw	3	3	O	-	-	-	AS	-	Forests, woody areas, rocky places and ruins.	AR	Low	R
Corvus corone	Hooded Crow	3	3	O	-	-	-	AS	-	Forests, open fields and crop fields	AR	Low	R
Corvus corax	Raven	3	3	O	-	-	Appendix III	AS	-	Shrubs, areas where animals breed	AR	Low	R
STURNIDAE	**Starling**												
Sturnus vulgaris	Starling	3	3	O	-	-	-	P	-	Forests and woody areas	AR	Low	R
Sturnus roseus	Rose-coloured Starling	1	1	O	-	-	Appendix II	P	-	Shrubs and rocky areas	AR	Low	M
PASSERIDAE	**Sparrows**												
Passer domesticus	Sparrow	3	3	O	-	-	-	P	-	Villages and provinces, arable fields	AR	Low	R
Passer hispaniolensis	Spanish Sparrow	-	3	O	-	-	Appendix III	P	-	Shrubs, crop fields, orchards and gardens, open fields	AR	Low	R
Petronia petronia	Rock Sparrow	-	3	O	-	-	Appendix III	P	-	Settlement areas	AR	Low	R
FRINGILLIDAE	**Finches**												
Fringilla coelebs	Chaffinch	-	3	O	-	-	Appendix III	P	-	Forests; park, garden and plains	AR	Low	R
Serinus serinus	Serin	-	3	O	-	-	Appendix II	P	-	Park and gardens, river banks	AR	Low	R
Carduelis chloris	Green Finch	-	3	O	A.4	-	Appendix II	P	-	Forests, park and gardens, shrubs, olive grove, forest sides	AR	High	R

Table K.3. (continued)

Scientific Name	Common Name	IA	OA	Source	RDB	IUCN	BERN	GCD	END	Biotope Characteristics	Distribution in Turkey	Impact Probability	Status
Carduelis carduelis	Goldfinch	-	3	O	A.4	-	Appendix II	P	-	Gardens, forest openings, settlement areas	AR	High	R
Carduelis cannabina	Linnet	-	3	O	A.4	-	Appendix II	P	-	Shrubs and trees, forest sides, park and gardens	AR	High	R, WV
EMBERIZIDAE	**Buntings**												
Emberiza hortulana	Ortolan	-	3	O	A.3	-	Appendix III	P	-	Woody areas, forests and crop fields	AR	High	M
Miliaria calandra	Corn Bunting	3	3	O	-	-	Appendix III	P	-	Open fields, arable fields and meadows, dry shrubs	AR	Low	R

WA : Species observed within the activity area
OA : Species observed outside the activity area
O : Observation
RDB : Turkish Red Data Book
GCD : General Directorate of National Parks, Game and Wild Life Central Game Commission Decree
P : Prohibited
CS : Certain Seasons
AS : All Seasons

Table K.4. Mammals (Mammalia)

Scientific Name	Common Name	ERL	Habitat	Distribution In Turkey	Population Density	IUCN 1994 Risk	Bern	Impact Probability
Erinaceidae								
Erinaceous concolor	Eastern Hedgehog	nt	House and ruins	Widespread	Low	LR-lc	-	Low
Soricidae								
Crocidura leucodon	Bicoloured White-toothed Shrew	nt	Dry and sunny regions	Widespread but fragmented	High	LR-lc	Appendix III	Low
Rhinolophidae								
Rhinolophus ferrumequinum	Great Horseshoe Bat	V	Caves, small lairs and rock cavities, ruins	Widespread	Low	VU	Appendix II	High
Rhinolophus hipposideros	Lesser Horseshoe Bat	V	Ruins, basements and roofs	Widespread	High	VU	Appendix II	High
Rhinolophus mehelyi	Mehely's Horseshoe Bat	V	Caves and cavities	Widespread	Medium	VU	Appendix II	High
Vespertilionidae								
Myotis mystacinus	Whiskered Bat	V	Caves, cavities and ruins	Widespread	Low	VU	Appendix II	High
Myotis blythi	Lesser Mouse-eared Bat	V	Caves and cavities	Widespread	High	VU	Appendix II	High
Eptesicus serotinus	Serotine Bat	V	Various cavities	Widespread	Medium	VU	Appendix II	High
Pipistrellus pipistrellus	Common Pipistrelle	V	Various environments	Widespread	High	VU	Appendix III	High
Pipistrellus nathusii	Nathusius' Pipistrelle	V	Open fields and forests	Widespread	High	VU	Appendix II	High
Pipistrellus savii	Savi's Pipistrelle	V	Various environments	Widespread	Medium	VU	Appendix II	High

Table K.4. (continued)

Scientific Name	Common Name	ERL	Habitat	Distribution In Turkey	Population Density	IUCN 1994 Risk	Bern	Impact Probability
Miniopterus scheibersi	Schreiber's Long-fingered Bat	V	Caves and ruins	Widespread	Low	VU	Appendix II	High
Molossidae								
Tadarida teniotis	European Free-tailed Bat	V	Caves and cavities	Widespread but local	Medium	VU	Appendix II	High
Leporidae								
Lepus europaeus	Brown Hare	nt	Forest, shrubs and rocky fields	Widespread	High	LR-nt	Appendix III	Low
Sciuridae								
Spermophilus (Citellus) xanthophrymnus	European Squirrel	nt	Arable fields	Widespread	High	LR-lc	Appendix II	Low

APPENDIX – K REGIONAL FLORA INVENTORY

FLORA INVENTORY

Flora Inventory presented below is prepared based on field surveys and literature researches. "Flora of Turkey and the East Aegean Islands, Volume 1-10" (Davis, P.H., 1965-1988) was used for the identification of the species. This publication is also the reference for the authors of the taxa presented in the list below. The regional flora inventory is prepared is alphabetical order. Habitats, distribution in Turkey, flora region, endemism, condition according to Bern Convention, relative abundance and impact probability of each taxon is given. For the endemic species, the impact probability is given as high regardless of its risk class. The scales and abbreviations used in the table are presented below.

Habitats :

1. Agricultural areas
2. Steppe
3. Dry and open areas
4. Road sides
5. Rocky-Stony areas
6. Wetlands

(+) sign indicates the habitat of the species.

Flora Region :

Eu-Sib	: Europe-Siberia
Ir-Tur	: Iran-Turanien
Med.	: Mediterranean
E.Med.	: East Mediterranean
(mt)	: mountain

Relative Abundance

The numbers given in this column represent the observation frequency and abundance of the taxa and is solely based on field surveys.

- Very rare
- Rare
- Relatively abundant
- Abundant
- Forms unadulterated populations

Endemism (End.)

(+) sign indicates that the species is endemic.

Others:

*	: Planting (culture)
E	: East
W	: West
N	: North
S	: South

Table J.1. Flora Inventory

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
ANGIOSPERMAE	**FLOWERING PLANTS**												
DICOTYLEDONS	-												
Acanthaceae	**Acanthus family**												
Acanthus hirsutus	Hairy bears breeches			+				Wide	Med	+	-	2	High
Amaranthaceae	**Amarant family**												
Amaranthus albus	White pigweed	+						Wide		-	-	2	Low
A. deflexus	Perennial pigweed	+						Wide	-	-	-	2	Low
A. retroflexus	Hathor	+						Wide	-	-	-	2	Low
Alismataceae	**Water plantain family**												
Alisma gramineum	Ribbon-leaved water plantain					+		Wide	-	-	-	4	Low
Apiaceae (Umbelliferae)	**Carrot family**												
Berula erecta **,***	Cutleaf waterparsnip						+	Wide	-	-	-	3	Low
Bifora radians	Wild bishop	+						Wide	-	-	-	4	Low
Bupleurum croceum	-		+	+				Wide	Ir-Tur	-	-	4	Low
B. euboeum *	-			+				Wide	Med.	-	-	2	Low
B. heldreichii *	-		+	+				Wide	Ir-Tur	+	-	2	High
B.rotundifolium	Thorow-wax	+						Wide	-	-	-	4	Low
B. sulphureum	-	+		+				Wide	Ir-Tur	+	-	3	Low
B.turcicum *	-	+						Narrow	Ir-Tur	+		2	High
Caucalis platycarpos	Small bur-parsley	+						Wide	-	-	-	4	Low
Daucus carota	Wild carrot	+			+			Wide	-	-	-	4	Low
Echinophora tournefortii	-		+					Wide	Ir-Tur	-	-	4	Low
Eryngium bithynicum	-		+					Wide	Ir-Tur	+	-	3	High
Falcaria falcanoides **,***	-						+	Wide	-	-		3	Low
F. vulgaris	Sickleweed	+						Wide	-	-	-	4	Low
Ferulago pauciradiata	-		+					Wide	Ir-Tur	+	-	3	High
Scandix pecten-veneris	Shepherd's needle	+						Wide	-	-	-	4	Low
Tordis arvensis ssp. *neglecta*	Spreading hedge-parsley	+						Wide	-	-	-	4	Low
T. leptophylla	Bristlefruit hedge-parsley	+						Wide	-	-	-	4	Low
Turgenia latifolia	Greater bur-parsley	+						Wide	-	-	-	4	Low
Asclepidaceae	**Milkweed family**												
Cynanchum acutum	Stranglewort	+	+			+		Wide	-	-	-	4	Low
Asteraceae (Compositae)	**Thistle family**												
Achillea aleppica ssp. *zederbauer*	-		+					Central Anatolia	Ir-Tur	+	-	3	High
A. biebersteinii	-		+					Wide	Ir-Tur	-	-	4	Low
A. setacea	-		+					Wide	-	-	-	4	Low
A. wilhelmsii	Yarrow		+					Central, W., S., Anatolia	Ir-Tur	-	-	3	Low
Acroptilon repens	Russian knapweed		+					Central, S.Anatolia	Ir-Tur	-	-	4	Low
Anthemis cretica	Mountain dog-daisy		+		+			Central Anatolia	-	-	-	4	Low
A. tinctona var. *tinctona*	Yellow chamomile		+					Wide	-	-	-	4	Low
Artemisia herba-alba	White tujone mugwort		+					Central Anatolia	Ir-Tur	-	-	2	High
A. santonicum +	Sea wormwood						+	Wide	-	-		1	Low
A. scopana	-		+					W., Central Anatolia	-	-	-	3	Low
Bombycilaena erectra	-		+					Central, S. Anatolia	-	-	-	3	Low
Carduus nutans ssp. *nutans*	Musk thistle		+					Wide	-	-	-	4	Low
C. pycnocephalus ssp. *albidus*	Black sedge			+				Wide	-	-	-	4	Low
Carthamus persicus	-		+					Central Anatolia	Ir-Tur	-	-	4	Low
Centaurea bornmuellen	-		+					Central Anatolia	Ir-Tur	+	-	3	High
C. depressa	-	+			+			Wide	-	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
C. tbenca	Iberian star-thistle				+			Wide	-	-	-	4	Low
C. kotschy var. *persica*	-		+					Central Anatolia	-	-	-	2	Low
C. kotschy var. *kotschy*	-		+					Central Anatolia	-	+	-	2	High
C. pichleri	-		+					Central Anatolia	-	-	-	3	Low
C. solstitialis ssp. *solstitialis*	Yellow star-thistle				+			Wide	-	-	-	4	Low
C. urvillei ssp. *urvillei*	Knapweed		+					Wide	Med.	-	-	4	Low
C. virgata	Squarrose knapweed		+	+				Wide	-	-	-	4	Low
Chardinia onentalis	-		+		+			Central, S. Anatolia	Ir- Tur	-	-	2	Low
Chondrilla juncea var. *juncea*	Rush skeletonweed				+			Wide	-	-	-	4	Low
Cichonum intybus	Chicory				+			Wide	-	-	-	4	Low
Cirsium alatum ssp. alatum *,***	-	+						Wide	Ir-Tur	-	-	3	Low
Crepis foetida ssp. *commutata*	Stinking hawk's beard			+				Wide	-	-	-	3	Low
C. aculeata	-												
C. macropus	-		+						-	+	-	2	High
C. sancta	Hawk's beard			+				Wide	-	-	-	3	Low
Crupina crupinastrum	Common crupina		+	+				Wide	-	-	-	4	High
Echinops viscosus ssp. *bithynicus*	Globe-thistle		+	+				Wide	-	-	-	2	Low
Filago pyramidata	Broad-leaved cudweed		+		+			Wide	-	-	-	3	Low
Gundelia tournefortii ssp. *tournefortii*	Tournefort's gundelia	+						Central and S. Anatolia	Ir-Tur	-	-	2	Low
Helichyrsum plicatum ssp. *plicatum*	-		+					Wide	-	-	-	2	Low
Hieracium pannosum	-					+		Exterior Tr. and Central Anatolia	E. Med. (mt.)	-	-	2	Low
Inula aucherana **,***	-					+		Central Anatolia	Ir-Tur	-	-	3	Low
Inula heterolepis	-					+		NW., W. and S. Anatolia	E. Med.	-	-	2	Low
I. oculus-chnsti	-					+		Wide	Eu-Sib	-	-	2	Low
Junnea consanguinea	-		+					Wide	-	-	-	2	Low
J. pontica	-	+	+					Central and N. Anatolia	Ir-Tur	+	-	2	High
Lactuca semola	Prickly lettuce				+			Wide	Eu-Sib	-	-	4	Low
Leontodon aspemmus	-		+	+				Central, W., S. Anatolia	Ir-Tur	-	-	4	Low
L. cnspus ssp. *asper*	-		+					Wide	-	-	-	4	Low
Logfia arvensis	Field filago		+					Wide	-	-	-	4	Low
Matncana chamomilla	Chamomile	+	+			+		Wide	-	-	-	4	Low
Picnomon acarna	Soldier thistle				+			Wide	-	-	-	4	Low
Pilosella x auriculoides	-					+		Wide	-	-	-	4	Low
Rhagadiolus angulosus	-	+			+			Central, S, W. Anatolia	Ir-Tur	-	-	3	Low
Scanola viminea	-				+			Wide	-	-	-	4	Low
Scolymus hispanicus	Spanish salsify				+			Wide	Med	-	-	4	Low
Scorzonera cana var. *cana*	Hairy viperglass					+		Wide	-	-	-	4	Low
S. enophora	-		+					Wide	-	+	-	2	High
S. laciniata ssp. *laciniata*	Cutleaf viperglass	+	+					Wide	-	-	-	4	Low
S. tomentosa	-		+			+		Central, N., W. Anatolia	Ir-Tur	+	-	4	Low
Senecio vernalis	Eastern groundsel	+						Wide	-	-	-	4	Low
Sonchus asper ssp. *glaucescens*	Prickly sowthistle	+						Wide	-	-	-	3	Low
Taraxacum fannosum	-							Central Anatolia	Ir-Tur	+		3	Low
Taraxacum serotinum	Dandelion		+	+				Wide	-	-		4	Low
Tragopogon longirostns var. *abbreviatus*	Goat's beard	+			+			Central Anatolia	-	-		4	Low
Tnpleurospermum callosum	-	+	+					N., S., Central Anatolia	-	+	-	2	High
Xanthium spinosum	Spiny cocklebur			+			+	N., Central Anatolia	-	-	-	3	Low
X. strumanum subsp.strumanum	Common cocklebur			+			+	Wide	-	-	-	4	Low
Xeranthemum annuum	Immortelle		+		+			Wide	-	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats	Distribution in Turkey	Flora Region	Endemizm	Bern	Relative	Impact Probability

		1	2	3	4	5	6				Convention	Abundance	
Boraginaceae	**Borage family**												
Anchusa azurea var. *azurea*	Italian bugloss				+			Wide	-	-	-	4	Low
A. undulata ssp. *hybrida*	Undulate alkanet	+						Wide	-	-	-	4	Low
Buglossoides arvensis	Common borage	+				+		Wide	-	-	-	4	Low
Cennthe minor var. *aunculata*	Lesser honeywort	+			+			Wide	-	-	-	4	Low
Cynoglossum creticum	Blue hound's-tongue				+			Wide	-	-	-	4	Low
Echium italicum	Coastal pale bugloss				+			Wide	Med		-	4	Low
Heliotropium europaeum	European heloitrope	+						Wide	Med.	-	-	4	Low
H. suaveolens	-	+						N.,W., Central Anatolia	-	-	-	4	Low
Lappula barbata	-		+		+			Central, S. Anatolia	Ir-Tur	-	-	4	Low
Moltkia aurea	-		+					W., S., Central Anatolia	Ir-Tur	+	-	4	High
Myosotis sicula	Jersey forget-me-not	+					+	Wide	-	-	-	3	Low
Nonea macrosperma	-	+					+	Central Anatolia	Ir-Tur	+	-	3	High
Onosma armenum	-		+					Wide	-	+	-	4	High
O. aucheranum	-		+					Wide	Med.	-	-	4	Low
O. isauncum	-		+					Wide	Ir-Tur	+	-	4	High
O. tauncum var. *brevifolium*	Golden drops		+			+		Wide	-	+	-	2	High
Paracaryum ancyritanum	-		+					S., Central Anatolia	Ir-Tur	+	-	2	High
P. calycinum	-		+			+		Central, S., N. Anatolia	Ir-Tur	+	-	2	High
P. racemosum var.racemosum	-		+					Central, Anatolia	Ir-Tur	+	-	2	High
Rochelia disperma var. *disperma*	-		+					Central, S. Anatolia	-	-	-	2	Low
Brassicaceae	**Mustard family**												
Aethionema arabicum	-	+						Wide	-	-	-	4	Low
Alyssum desortorum	Dwarf alyssum	+	+					Wide	-	-	-	4	Low
A. murale var. *murale*	Yellowtuft		+					Wide	-	-	-	4	Low
A.pateri	-							Wide	Ir-Tur	+		1	High
A. sibincum	-		+					Wide	-	-	-	4	Low
A. strigosum ssp. *strigosum*	Hairy madwort		+					Wide	-	-	-	4	Low
Arabis nova	-					+		Wide	-	-	-	4	Low
Boreava orientalis	-	+						Wide	Ir-Tur	-	-	4	Low
Cardana draba	Whitetop hoary cress				+			Wide	-	-	-	2	High
Clypeola jonthlaspi	-					+		Wide	Med.	-	-	4	Low
Conringa orientalis	Hare's-ear mustard				+			Wide	-	-	-	4	Low
Crambe tatana var. *tataria*	Crambe				+			Central Anatolia	-	-	-	2	High
Descurainia sophia	Flixweed	+					+	Wide	-	-	-	4	Low
Erysimum crassipes	-		+			+		Wide	-	-	-	4	Low
E. smymaeum	-	+						Wide	-	-	-	4	Low
Isatis glauca ssp. *glauca*	-	+			+			Wide	Ir-Tur	-	-	4	Low
Lepidium latifolium	Perennial pepperweed	+						Wide	-	-	-	4	Low
L. caespitosum *	-	+						Central Anatolia	Ir-Tur	+		2	High
L. cartilagineum *	-	+						Central Anatolia	-	-		2	High
Mathiola coerulea	-	+	+					Central Anatolia	-	-	-	4	Low
Nasturtium officinale	Water-cress						+	Wide	-	-	-	3	Low
Raphanus raphanistrum	Wild-radish	+						Wide	-	-	-	3	Low
Sinapis arvensis	Charlock mustard				+			Wide	-	-	-	4	Low
Sisymbnum altissimum	Tumble mustard	+						Wide	-	-	-	4	Low
S. loeselii	-	+	+		+			Wide	-	-	-	4	Low
Thlaspi perfoliatum	Perfoliate peny-cress						+	Wide	-	-	-	3	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Campanulaceae	**Bellflower family**												

Asyneuma limonifolium ssp. *pestalozzae*	Southern rampion		+					Wide	-	+	-	3	High
A. rigidum ssp. *rigidum*	-		+					Wide	Ir-Tur	-	-	4	Low
Campanula argaea	-					+		Central, S., W. Anatolia	Ir-Tur	+	-	3	High
C. cymbalaria	-					+		Wide	Med.	-	-	4	Low
C. lyrata ssp. *lyrata*	Bellflower					+		Wide	-	+	-	3	High
Legousia speculum-veneris	Large venus's-looking glass			+				Wide	Med.	-	-	4	Low
Caryophyllaceae	**Pink family**												
Agrostemma githago	Corncokle	+						Wide	-	-	-	4	Low
Arenaria serpyllifolia	Thyme-leaf sandwort			+				Wide	-	-	-	4	Low
Bolanthus minuartioides	-		+					Central ,W. Anatolia		+	-	2	High
Dianthus crinitus var. *crinitus*	-		+					Wide	-	-	-	4	Low
D. zonatus var. *zonatus*	-		+					Wide	-	-	-	4	Low
Gypsophila arrostii var *nebulosa*	Arrost's babysbreath			+				Central Anatolia	Ir-Tur	+	-	1	High
G. enocalyx	-		+					Central Anatolia	Ir-Tur	+	-	2	High
Minuartia anatolica var. *arachnoidea*	Anatolian sandwort		+					Central Anatolia	Ir-Tur	+	-	3	High
M. hirsuta ssp. *falcata*	-					+		Central, N., NW Anatolia	-	-	-	3	Low
Moenchia mantica ssp. *mantica*	-			+				Central, NW., E. Anatolia	-	-	-	3	Low
Saponaria orientalis	-					+		Central, N., E. Anatolia	-	-	-	4	Low
S. prostrata ssp. *prostrata*	-	+						Central, E. Anatolia	Ir-Tur	+	-	3	High
Silene cappadocica	-		+					Central, E. Anatolia	Ir-Tur	-	-	3	Low
S. conoidea	Conoid catchfly	+						Central, S, E. Anatolia	-	-	-	3	Low
S. dichotoma ssp. *dichotoma*	Forked catchfly		+					Wide	-	-	-	3	Low
S. italica	Italian catchfly			+				Wide	Med.	-	-	4	Low
S. supina ssp. *pruinosa*	-					+		Wide	-	-	-	4	Low
Spergularia marina	Media sandspurry		+			+		Wide	-	-		4	Low
Spergularia media *	Greater sea-spurrey						+	Wide	-	-	-	3	Low
Vaccaria pyramidata	Cow cockle	+						Wide	-	-	-	4	Low
Velezia rigida	Velezia			+				Wide	Med.	-	-	4	Low
Ceratophyllaceae	**Hornwort family**												
Ceratophyllum demersum	Rigid hornwort	+						Wide	Eu-Sib	-	-	3	Low
Cistaceae	**Rock-rose family**												
Fumana aciphylla	-		+					Central Anatolia	Ir-Tur	-	-	3	Low
F. paphlagonica	-		+					Wide	Ir-Tur	+	-	2	High
Helianthemum salicifolium	Willowleaf frostweed, sun rose		+					Wide	-	-	-	3	Low
Chenopodiaceae	**Goosefoot family**												
Atriplex patula	Common orache	+						NW, Central Anatolia	-	-	-	1	High
A. lasianthia	-		+			+		Wide	-	-	-	3	Low
A. tatarica	Tatarian orache		+			+		Wide	-				
Kalidiopsis wagenitzii	-			+				Nigde	-	+	-	1	High
Camphorosma monspeliaca ssp. *lessingii**	-	+					+	Narrow	-	-	-	3	High
Chenopodium album	Pigweed	+						Wide	-	-	-	3	Low
C. botrys	Jerusalem-oak	+			+			Wide	Med.	-	-	3	Low
Cyathobazis fruticosa	-			+				Central Anatolia	-	+	-	2	High
Halanthium kulpianum	-						+	Narrow	-	-		2	High
Halimione portulacoides	Sea purslane						+	Wide	-	-		4	Low
H. verrucifera	-	+		+				Narrow	-	-		3	High

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Halocnemum strobilaceum	-						+	Wide	-	-		3	Low
Kochia prostrata	Prostrate summercypress			+			+	Wide	-	-	-	4	Low
Microcnemum coralloides	Annual glasswort			+				Narrow	-	-		2	High
Panderia pilosa			+			+		Central, E. Anatolia				3	Low

Petrosimonia brachiata	-						+	Wide	-	-		3	Low
P. nigdeensis	-						+	Wide	-	-		3	Low
Salicornia europaea	Common glasswort						+	Wide	-	-		5	Low
Salsola stenoptera	-			+				Narrow	Ir-Tur	+		2	High
S. anatolica	-			+				Narrow	Ir-Tur	+		2	High
S. crassa	-			+			+	Narrow	-	-		2	High
S. inermis	-			+			+	Narrow	Ir-Tur	-		3	Low
S. nitrana	-			+			+	Narrow	Ir-Tur	-		2	High
S. laricina	-			+			+	Narrow	-			2	High
Suaeda altissima	Sea grass sp.						+	Narrow	-	-		3	High
S. camosissima	Sea grass sp.	+	+					Narrow	Ir-Tur	-		3	High
S. eltonica	Sea grass sp.			+				Narrow	-	-		2	High
S. prostrata ssp. anatolica	Sea grass sp.			+			+	Narrow	-	+		2	High
Clusiaceae (Guttiferae)	**St. John's wort family**												
Hypericum aviculariifolium ssp. *depilatum* var. *depilatum*	-		+					Central, S., Anatolia	Ir-Tur	+	-	3	High
H. onganifolium	-		+					Central, W Anatolia	-	-	-	3	Low
H. perforatum	Common St. John's worth			+				Wide	-	-	-	4	Low
Convolvulaceae	**Morning-glory family**												
Convolvulus arvensis	Field bindweed				+			Wide	-	-	-	4	Low
C. assyricus	-	+						Central, S. Anatolia	Ir-Tur	+	-	3	High
C. compactus	-		+					Central, W. Anatolia	-	-		3	Low
C. galaticus	-	+	+					Central, N. Anatolia	Ir-Tur	+	-	3	High
C. lineatus	Bindweed		+					Central Anatolia	-	-	-	4	Low
Crassulaceae	**Orpine family**												
Sedum hispanicum var. *hispanicum*	Spanish stonecrop					+		Wide	-	-	-	4	Low
Umbilicus erectus	-					+		NW, W, S, E Anatolia	-	-	-	4	Low
Dipsacaceae	**Teasel family**												
Dipsacus laciniatus	Cut-leaved teasel	+						Wide	-	-	-	3	Low
Scabiosa argentea	-	+	+			+		Wide	-	-	-	4	Low
S. rotata	-	+						Central Anatolia	Ir-Tur	-	-	4	Low
Euphorbiaceae	**Spurge family**												
Euphorbia anacampseros var. *anacampseros*	-		+					Central, SW Anatolia	Med.	+	-	3	High
E. hemianifolia	-		+			+		NW, W, Central Anatolia	-	-	-	4	Low
E. stricta	Golden foam	+						Wide	Eu-Sib	-	-	4	Low
Fabaceae	**Pulse family**												
Alhagi pseudalhagi	Camelthorn				+		+	Wide	Ir-Tur	-	-	4	Low
Astragalus baibutensis	-		+					Wide	Ir-Tur	+	-	3	High
A. condensatus	-		+					Central, S, W Anatolia	Ir-Tur	+	-	4	High
A. eriophyllus	-		+					Central, S Anatolia	-	+	-	2	High
A. brachypterus	-		+					Central, N, W, Anatolia	Ir-Tur	+	-	4	High
A. lycius	-		+					Central, S, E Anatolia	-	+	-	3	High
A. lydius	-		+					Wide	Ir-Tur	+	-	3	High
A. melanophrurius	-	+	+					Central Anatolia	Ir-Tur	+	-	2	High

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
A. microcephalus	-		+					Central Anatolia	Ir-Tur	-	-	4	Low
A. odoratus	Lesser milkvetch							Wide		-		3	Low
A. podperae	-	+	+					Central, SW Anatolia	Ir-Tur	+	-	2	High
A. pisidicus	-	+						Central, S, SW Anatolia	Ir-Tur	+	-	2	High
A. tmoleus var. *bounacanthus*	-		+					SW, Central Anatolia	-	+	-	2	High
A. vulnerariae	-		+					Central, SW Anatolia	-	+	-	2	High
A. wedemannianus	-		+					N, S, Central Anatolia	Ir-Tur	+	-	3	High

A. xylobasis var. *angustus*	-		+					Central, N Anatolia	Ir- Tur	+		2	High
Coronilla scorpioides	Annual scorpion-vetch	+						Central, W Anatolia	-	-	-	4	Low
C. varia	Crownvetch				+			Wide	-	-	-	4	Low
Ebenus hirsuta	-		+					Central Anatolia	Ir-Tur	+	-	2	High
Galega officinalis	Goat's rue	+						Wide	-	-	-	4	Low
Genista sessilifolia	Tree-leafed greenweed							Central Anatolia	Ir-Tur			3	Low
Hedysarum cappadocicum	-		+					Central Anatolia	Ir-Tur	+	-	3	High
H. varium	-		+					Wide	Ir-Tur	-	-	4	Low
Lathyrus inconspicuus	Inconspicuous pea	+						Wide	-	-	-	4	Low
Lotus corniculatus var. *corniculatus*	Common bird's-foot trefoil					+		Wide	-	-	-	4	Low
Lotus corniculatus var. *tenuifolius* *	Common bird's-foot trefoil					+		Wide	-	-	-	2	Low
L. gebelia	-		+			+		Central , SE Anatolia	Ir-Tur	-		3	Low
Medicago minima var.*minima*	Bur medick			+				Wide	-	-	-	4	Low
M. sativa ssp. *sativa*	Lucerne, alfalfa	+						Wide	-	-	-	4	Low
Melilotus bicolor	-			+				Central Anatolia	Ir-Tur	+	-	2	High
Onobrychis armena	-					+		Wide	-	+	-	4	High
O. oxyodonta	-		+					Central, W Anatolia	-	-	-	3	Low
O.tournefortii	-					+	+	Central Anatolia	-	+		3	High
Ononis adenotricha var.*adenotricha*	-					+		NW, Central, S Anatolia	Med.	-	-	3	Low
Tetragonolobus maritimus *	Dragon's teeth						+	Wide	-	-		3	Low
Trifolium arvense var. *arvense*	Rabbitfoot clover			+				Wide	-	-	-	4	Low
T. campestre	Hop trefoil	+						Wide	-	-	-	4	Low
T. pannonicum ssp. *elongatum*	Hunganan clover	+	+					N, S, Central Anatolia	-	+	-	3	High
T. resupinatum	Reversed clover	+	+			+		Wide	-	-		4	Low
Vicia cracca ssp. *stenophylla*	Tufted vetch, Bird vetch					+		Wide	-	-	-	4	Low
V. peregrina	Wandering vetch	+						Wide	-	-	-	4	Low
Fagaceae	**Beech family**												
Quercus pubescens	Downy oak		+					W, Central Anatolia	-	-	-	4	Low
Frankeniaceae	**Frankenia family**												
Frankenia hirsuta *	Hairy sea-heath		+				+	Wide	-	-		3	Low
Geraniaceae	**Geranium family**												
Erodium cicutarium ssp. *cicutarium*	Redstem filaree		+					Wide	-	-	-	4	Low
Geranium pyrenaicum	Hedgerow cranesbill					+		Central, W Anatolia	-	-	-	4	Low
G. rotundifolium	Round-leaved cranesbill						+	Wide	-	-	-	4	Low
Globulariaceae	**Globularia family**												
Globularia orientalis	Matted globu.lana		+					Central, S Anatolia	Ir-Tur	-	-	3	Low
G. trichosantha	Globe daisy		+					Wide	-	-	-	4	Low
Halorogidaceae	-												
Myriophyllum spicatum	Eurasian water milfoil						+	Wide	-	-	-	3	Low
Myriophyllum verticillatum **	Whorled water milfoil						+	Wide	-	-	-	3	Low
Hypericaceae	**St. John's wort family**												
*Hypericum salsogineum**	-						+	Dar	Ir-Tur	+		2	High

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Illecebraceae	-												
Herniaria hirsuta	Hairy rupturewort			+				Wide	-	-	-	3	Low
H. incana	Gray rupturewort			+				Central, W Anatolia	-	-	-	4	Low
Paronychia chionaea	-		+					Central Anatolia	-	+	-	2	High
Scleranthus annuus ssp. *annuus*	Annual knawel		+					Central ,W Anatolia	-	-	-	2	Low
Lamiaceae (Labiatae)	**Mint family**												
Acinos rotundifolius	-		+					Wide	-	-	-	4	Low
Ajuga chamaepitys ssp. *chia* var. *chia*	Ground pine			+				Wide	-	-	-	4	Low
A. salicifolia	-							Wide	Ir-Tur	-	-	1	Low

Ballota nigra ssp. *anatolica*	Black horehound			+				Central , W, E Anatolia	Ir-Tur	+	-	3	High
Lallemantia iberica	Dragon's head				+			Wide	Ir-Tur	-	-	4	Low
Lamium amplexicaule	Henbit	+						Wide	Eu-Sib	-	-	4	Low
Lycopus europaeus **,***	-						+	Wide	Eu-Sib	-	-	3	Low
Marrubium parviflorum ssp. *parviflorum*	-	+		+				Central Anatolia	Ir-Tur	-	-	4	Low
Mentha aquatica **	Water mint						+	Wide	-	-	-	3	Low
Micromeria myrtifolia	Micromeria					+		Wide	Med.	-	-	4	Low
Nepeta italica	-					+		Wide	-	-	-	4	Low
N. nuda ssp. *albiflora*	Anne's choice	+						Wide	-	-	-	4	Low
Phlomis armeniaca	-		+					Wide	Ir-Tur	+	-	4	High
P. pungens var. *pungens*	-		+					Wide	-	-	-	3	Low
Prunella laciniata	Carpenter-weed	+						Wide	Eu-Sib	-	-	4	Low
P. vulgaris	Self-heal	+						Wide	Eu-Sib	-	-	4	Low
Salvia aethiopis	Mediterranean sage		+					Wide	-	-	-	4	Low
S. bracteata	-	+						Central, E Anatolia	-	-	-	2	High
S. cadmica	-					+		NW, SW, Central Anatolia	-	+	-	3	High
S. cryptantha	-	+	+			+		Central Anatolia	Ir-Tur	+	-	3	High
S. cyanescens	-	+						Central, E Anatolia	Ir-Tur	+	-	3	High
S. hypargeia	-	+						Central, W and S Anatolia	Ir-Tur	+	-	4	High
S. sclarea	European sage				+			Wide	-	-	-	4	Low
S. synaca	Syrian sage		+					Central Anatolia	Ir-Tur	-	-	4	Low
S. verticillata ssp. *amasiaca*	Whorled sage		+					Wide	Ir-Tur	-	-	4	Low
S. wiedemannii	-	+	+		+			Central Anatolia	Ir-Tur	+	-	2	High
S. virgata	Meadow sage				+			Wide	Ir-Tur	-	-	4	Low
Scutellaria orientalis ssp. *pinnatifida*	Eastern sun		+					Wide	-	-	-	3	Low
Sideritis lanata	Hairy ironwort	+						Central, W Anatolia	Med.	-	-	3	Low
S. montana ssp. *remota*	Mountain ironwort		+					Wide	Med.	-	-	3	Low
Stachys annua ssp. *annua* var. *lycaonica*	Annual woundwort		+					Central Anatolia	Ir-Tur	-	-	3	Low
S. cretica ssp. *anatolica*	Mediterranean woundwort		+					Central, N, S Anatolia	Ir-Tur	+	-	3	High
Teucrium chamaedrys ssp. *chamaedrys*	Germander					+		N, Central and S Anatolia	-	-	-	4	Low
T. orientale var. *orientale*	Oriental germander		+					Wide	Ir-Tur	-	-	3	Low
T. polium	Felty germander		+					Wide	-	-	-	4	Low
T. scordium ssp. scordioides **,***	Water germander						+	Wide	Eu-Sib	-	-	2	Low
Thymus leucostomus var. *argillaceus*	-		+					Central Anatolia	-	-	-	2	High
T. sipyleus ssp. *sipyleus*	-		+					Wide	-	+	-	3	High
Ziziphora capitata	-		+					Wide	Ir-Tur	-	-	4	Low
Z. tenuior	Ziziphora		+					Wide	Ir-Tur	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Linaceae	**Flax family**												
Linum flavum ssp. *scabrinerve*	Golden flax		+					Central Anatolia	Ir-Tur	+	-	3	High
L. hirsutum ssp. *anatolicum* var. *anatolicum*	Hairy flax		+					Central Anatolia	Ir-Tur	+	-	3	High
L. hirsutum ssp. *anatolicum* var. *pseudoanatolicum*	Hairy flax		+					Central Anatolia	Ir-Tur	+	-	3	High
L. nodiflorum	-					+		Wide	Med.	-	-	4	Low
L. tenuifolium	Narrow-leaved flax					+		Wide	-	-	-	4	Low
Lythraceae	**Loosestrife family**												
Lythrum salicana **,***	Purple loosestrife						+	Wide	-	-	-	2	Low
Malvaceae	**Mallow family**												

Alcea pallida	Hollyhock			+	+			Central, W Anatolia	-	-	-	3	Low
Hibiscus trionum	Venica mallow	+						Central ,W Anatolia	-	-	-	2	High
Malva sylvestris	Common mallow	+						Central ,W Anatolia	-	-	-	4	Low
Morinaceae	-												
Monna persica	Prickly whorlflower		+					Wide	Ir-Tur	-	-	4	Low
Onagraceae	**Evening primrose family**												
Epilobium parviflorum ***	Small-flowered hairy willow-herb							Wide	-	-	-	3	Low
Orobanchaceae	**Broom-rape family**												
Orobanche anatolica	-		+					Wide	-	-		4	Low
Papaveraceae	**Poppy family**												
Fumana asepala	-	+						Wide	Ir-Tur	-	-	3	Low
Glaucium grandiflorum var *grandiflorum*	Red horned poppy	+	+					Wide	Ir-Tur	+	-	3	High
G leiocarpum	-					+		Wide	-	-	-	3	Low
Hypecoum imberbe	Sicklefruit hypecoum	+						Wide	-	-	-	3	Low
H. pendulum	Nodding hypecoum	+						Wide	-	-	-	4	Low
Papaver dubium	Long-headed poppy	+	+			+		Wide	-	-			
Papaver rhoeas	Field poppy				+			Wide	-	-	-	4	Low
Roemeria hybrida ssp. *hybrida*	Violet horned poppy	+						Wide	-	-	-	4	Low
Plantaginaceae	**Plantain family**												
Plantago lanceolata	Ribwort plantain	+						Wide	-	-	-	4	Low
P. crassifolia	-		+			+		Central, W Anatolia	Med.	-		4	Low
P. major	Great plantain						+	Central ,W Anaolu	-	-	-	3	Low
P. maritima	Sea plantain		+					Wide	-	-	-	4	Low
Plumbaginaceae	**Leadwort family**												
Acantholimon acerosum var. *acerosum*	Prickly thrift		+					Wide	Ir-Tur	-	-	4	Low
*Limonium iconicum**	-		+					Narrow	Ir-Tur	+	-	3	High
L. globuliferum	-		+				+	Central Anatolia	Ir-Tur	-		3	Low
L. gmelinii	-	+	+			+		Wide	Eu-Sib	-		4	Low
L. anatolicum *	-		+					Narrow	Ir-Tur	+	-	3	High
Plumbago europaea	European plumbago		+					Wide	Eu-Sib	-	-	4	Low
Polygonaceae	**Buckwheat family**												
Noaea mucronata ssp *mucronata*	-		+					Central ,E, W Anatolia	-	-	-	2	High
Polygonum arenastrum	Small-leaved knotgrass				+		+	Central ,E, NW Anatolia	-	-	-	3	Low
P. cognatum	-				+			Wide	-	-	-	3	Low
P. lapathifolium	Pale persicana						+	Wide	-	-	-	4	Low
Rumex acetosella	Sorrel	+						Wide	-	-	-	4	Low
R. crispus	Curly dock	+					+	Wide	-	-	-	3	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Portulacaceae	**Purslane family**												
Portulaca oleracea	Common purslane	+					+	Wide	-	-	-	4	Low
Primulaceae	**Primrose family**												
Androsace maxima	-	+	+					Wide	-	-	-	4	Low
Glaux maritima *	Sea-milkwort						+	Wide	-	-	-	2	Low
Samolus valerandi **	Brookweed						+	Wide	-	-	-	3	Low
Ranunculaceae	**Crowfoot family**												
Adonis flammea	Flame adonis		+					Wide	-	-	-	4	Low
Ceratocephalus falcatus	Bur buttercup	+						Wide	-	-	-	4	Low
C. testiculatus	-	+						Wide	-	-	-	3	Low
Consolida orientalis	Eastern larkspur	+						Wide	-	-	-	4	Low
Delphinium peregnum	Violet larkspur	+						Wide	-	-	-	3	Low
D. venulosum	-	+	+					Central Anatolia	Ir-Tur	+	-	2	High

Nigella arvensis var. *glauca*	Wild fennel		+					Wide	-	-	-	4	High
Ranunculus constantinopolitanus	Pilewort						+	Wide	-	-	-	4	Low
R. reutenanus	-						+	W, S ,Central Anatolia	-	+	-	3	High
Rhamnaceae	**Buckthorn family**												
Rhamnus thymifolius	-					+		Central, W Anatolia	-	+	-	2	High
Resedaceae	**Mignonette family**												
Reseda lutea var. *lutea*	Wild mignonette				+			Wide	-	-	-	4	Low
Rosaceae	**Rose family**												
Amygdalus webbii	-		+					S, W ,Central Anatolia	Med.	-	-	3	Low
Crataegus orientalis var. *orientalis*	Silver hawthorn		+					Wide	-	-	-	4	Low
C. tanacetifolia	Tansy-leaved hawthorn		+					N, Central Anatolia	-	+	-	3	High
Potentilla kotschyana	-		+					Wide	Med.	-	-	3	Low
P. supina	Spreading cinquefoil						+	Wide	-	-	-	3	Low
Pyrus elaeagnifolia ssp. *elaeagnifolia*	Wild pear		+					N, Central, S Anatolia	-	-	-	4	Low
Sanguisorba minor ssp. muncata	Salad burnet	+	+					Wide	-	-	-	4	Low
Rubiaceae	**Madder family**												
Asperula arvensis	Blue woodruff						+	Wide	Med.	-		4	Low
A. bommuellen	-		+					Central Anatolia	Ir-Tur	+	-	2	High
Callipeltis cucullana	-		+					Wide	Ir-Tur	-	-	4	Low
Crucianella distcha	-		+					W, Central Anatolia	Ir-Tur	+	-	2	High
Cruciata taunca	-		+					Wide	Ir-Tur	-	-	4	Low
Galium pepliditolium	-					+		W, Central, S Anatolia	Med.	-	-	3	Low
G. spunum ssp. *spunum*	False cleavers			+				Central , E Anatolia	Eu-Sib	-	-	3	Low
Rutaceae	**Rue family**												
Haplophyllum myrtifolium	-		+					E, Central, S Anatolia	Ir-Tur	+	-	2	High
Salicaceae	**Willow family**												
Salix alba	White willow						+	Wide	Eu-Sib	-	-	4	Low
Scrophulariaceae	**Figwort family**												
Bungea trifida	-			+				Wide	Ir-Tur	-	-	4	Low
Linaria confolia	-		+					Wide	Ir-Tur	+	-	4	High
L. genistifolia ssp. *confertiflora*	Balkan toadflax	+						Central, E Anatolia	Ir-Tur	-	-	3	Low
L. grandiflora	-	+						Wide	Ir-Tur	-	-	3	Low
L. iconia	-	+						Central Anatolia	Ir-Tur	+	-	3	High
Odontites auchen	-	+						Central, E Anatolia	Ir-Tur	-	-	4	Low
Pedicularis comosa var. *sibthorpii*	Crested lousewort		+					Wide	-	-	-	4	Low
Scrophulana canina ssp. *bicolor*	Dog figwort					+		Wide	Med.	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Veronica anagallis-aquatica	Blue water speedwell						+	Wide	-	-	-	4	Low
V. anagallodes ssp. anagallodes **	Faded speedwell						+	Wide	-	-	-	4	Low
V. arvensis	Wall speedwell	+						Wide	Eu-Sib	-	-	4	Low
V. bozakmanii	-	+						Wide	Ir-Tur	-	-	4	Low
V. chamaedrys	Germander speedwell		+					N, W, Central Anatolia	Eu-Sib	-	-	4	Low
V. gnsebachii	-		+					Wide	Med.	-	-	4	Low
V. hederifolia	Ivy-leaved speedwell	+						Wide	-	-	-	4	Low
V. multifida	-	+						N, W, Central, S Anatolia	Ir-Tur	+	-	4	High
V. pectinata ssp. *pectinata*	Speedwell		+					N, W, Central Anatolia	-	-	-	4	Low
V. triphyllos	Fingered speedwell					+		Wide	-	-	-	3	Low
Verbascum ancyritanum	-	+						Central Anatolia	Ir-Tur	+	-	2	High
V. cheiranthifolium var. *asperulum*	-		+					Wide	-	+	-	4	High
V. vulcanicum var. *vulcanicum*	-	+	+					Central Anatolia	Ir-Tur	+	-	2	High
Solanaceae	**Potato family**												
Datura stramonium	Jimsonweed				+			Wide	-	-	-	4	Low

Hyoscyamus niger	Black henbane	+			+			Wide	-	-	-	4	Low
Lycium anatolicum	-	+	+		+			Central Anatolia	Ir-Tur	+	-	3	High
Solanum nigrum	Black nightshade	+						Wide	-	-	-	3	Low
Tamaricaceae	**Tamarix family**												
Reaumeria alternifolia	-		+			+		Wide	Ir-Tur	-	--	4	Low
Tamarix smymensis	Tamarisk						+	Wide	-	-	-	4	Low
Ulmaceae	**Elm family**												
Celtis tournefortii	Oriental hackberry						+	Central , E, S Anadoku	-	-	-	3	Low
Valerianaceae	**Valerian family**												
Valenanella coronata	-	+						Wide	-	-	-	4	Low
V. vesicaria	-	+				+		Wide	-	-	-	4	Low
Zannichelliaceae	**Horned pondweed family**												
Zannichellia palustris ssp. *repens*	Horned pondweed						+	Wide	-	-	-	4	Low
Zygophyllaceae	**Caltrop family**												
Nitraria schoberi *	Nitre-bush			+				Narrow	Ir-Tur	-	-	3	High
Peganum harmala	-				+	+		Wide	-	-	-	4	Low
MONOCOTYLEDONES	-												
Alismataceae	**Water plantain family**												
Baldellia ranunculoides **	Lesser water plantain						+	Narrow	Eu-Sib	-	-	3	Low
Butomaceae	**Flowering rush family**												
Butomus umbellatus	Flowering rush						+	Wide	-	-	-	4	Low
Cyperaceae	**Sedge family**												
Carex hordeistichos	Barley sedge						+	Wide	-	-	-	4	Low
Cladium mariscus **	Great fen-sedge						+	Wide	-	-	-	4	Low
Bolboschoenus maritimus var. *maritimus*	Bladdermallow							Wide	-	-	-	4	Low
Schoenoplectus lacustris	Common club-rush						+	Wide	-	-	-	4	Low
Eleocharis mitracarpa	-						+	Wide	-	-	-	4	Low
Scirpoides holoschoenus **,***	Roundheaded club-rush						+	Wide	-	-	-	4	Low
Schoenus nigricans **	Black bug-rush			+		+	+	Wide	-	-	-	4	Low
Schoenoplectus litoralis	Shore club-rush						+	Wide	-	-	-	+	Low
S. lacustris ssp. *tabernae montani* **,***	Common club-rush						+	Wide	-	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Iridaceae	**Iris family**												
Crocus olivieri ssp. *olivieri*	-		+					Wide	-	-	-	2	High
Gladiolus atroviolaceus	-	+	+					Central Anatolia	Ir-Tur	-	-	4	Low
G. halophilus *	-						+	Narrow	Ir-Tur	+	-	4	High
Juncaceae	**Rush family**												
Juncus articulatus **,***	Jointed rush						+	Wide	Eu-Sib	-	-	4	Low
J. gerardii ssp. *gerardii*	Salt-marsh rush						+	Wide	-	-	-	4	Low
J. maritimus *,**,***	Sea rush						+	Wide	-	-	-	4	Low
J. subnodulosus **	Blunt-flowered rush						+	Wide	-	-	-	4	Low
Juncaginaceae	**Arrow grass family**												
Triglochin palustris **,***	Marsh arrowgrass						+	Wide	-	-	-	4	Low
Lemnaceae	**Duckweed family**												
Lemna gibba	Fat duckweed						+	Wide	-	-	-	3	Low
Liliaceae	**Lily family**												
Allium paniculatum ssp. *paniculatum*	Pale garlic				+			Wide	Med.	-	-	4	Low
A. phrygium	-		+					Central, W Anatolia	Ir-Tur	+	-	2	High
A. scabriflorum	-		+					Central, S, E Anatolia	Ir-Tur	+	-	3	High

A. scordoprassum ssp. *rotundum*	Sand leek				+			Wide	Med.	-	-	4	Low
Asphodeline damascena ssp. *damascena*	-		+					Wide	Ir-Tur	-	-	3	Low
Fritillaria pinardii	-		+					Central, N, S Anatolia	Ir-Tur	-	-	4	Low
Gagea bohemica	Early star-of-bethlehem					+		Wide	-	-	-	3	Low
G. granatellii	-		+					N, Central, S Anatolia	Med.	-	-	3	Low
G. villosa var. *villosa*	-		+					Wide	Med.	-	-	4	Low
Muscari comosum	Tassel hyacinth					+		Wide	-	-	-	4	Low
M. neglectum	Grape hyacinth					+		Wide	-	-	-	4	Low
Ornithogalum narbonense	Pyramidal star-of-bethlehem						+	Wide	Med.	-	-	4	Low
Scilla bifolia	Alpine squill	+						Wide	Med.	-	-	4	Low
Poaceae (Gramineae)	**Grass family**												
Aegilops triuncialis ssp. *triuncialis*	Barbed goatgrass			+				Wide	-	-	-	4	Low
Aeluropus littoralis *	-	+		+		+	+	Wide	-	-	-	2	Low
A. umbellulata ssp. *umbellulata*	-			+				Central, W Anatolia	Ir-Tur	-	-	4	Low
Agropyron orientale	-		+			+		Central Anatolia	Ir-Tur	-		3	Low
Agrostis stolonifera	Creeping bent-grass						+	Wide	Eu-Sib	-	-	4	Low
A. gigantea ***	Meadow redtop						+	Wide	Eu-Sib	-	-	4	Low
Alopecurus arundinaceus	Creeping foxtail	+						Wide	Eu-Sib	-	-	4	Low
A. geniculatus	Marsh foxtail		+			+		Narrow	-	-			
Apera intermedia	-			+				Wide	Ir-Tur	-	-	3	Low
Bothriochloa ischaemum	Yellow bluestem		+					Central ,W Anatolia	-	-	-	4	Low
Briza humilis	Quaking-grass	+	+					Wide	-	-	-	4	Low
Bromus squarrosus	Corn brome	+	+					Wide	-	-	-	4	Low
B. tectorum	Drooping brome	+						Wide	-	-	-	4	Low
B. tomentellus	Russian brome		+					Wide	Ir-Tur	-	-	4	Low
Cynodon dactylon var. *dactylon*	Common stargrass	+						Wide	-	-	-	4	Low
Digitaria sanguinalis	Large crab grass						+	Wide	-	-	-	4	Low
Echinaria capitata	-			+				Wide	-	-	-	4	Low
Elymus hispidus ssp. *barbulatus*	Sea couch-gras		+					Wide	-	-	-	4	Low
Eremopyrum orientale *	Oriental false wheatgrass		+				+	Narrow	-	-	-	4	Low

Table J.1. (cont.)

Species	Common Name	Habitats						Distribution in Turkey	Flora Region	Endemizm	Bern Convention	Relative Abundance	Impact Probability
		1	2	3	4	5	6						
Festuca arundinacea ssp. *arundinacea*	Tall fescue		+			+		Wide	-	-		4	Low
F. callieri ssp. *callieri*	-		+					Wide	-	-	-	4	Low
F. valesiaca	Wallis fescue		+					N, S, Central Anatolia	-	-	-	4	Low
Glyceria plicata	Plicate sweet-grass	+						Wide	-	-	-	4	Low
Hordeum bulbosum	Wild barley				+			Wide	-	-	-	4	Low
H. murinum ssp. *glaucum*	Rabbit barley	+		+				Wide	-	-	-	4	Low
Koeleria cristata	Junegrass		+					Wide	-	-	-	4	Low
Lolium rigidum var. *rigidum*	Rigid rye-grass		+					Wide	-	-	-	4	Low
Melica ciliata ssp. *ciliata*	Hairy melick		+					Wide	-	-	-	4	Low
Phleum bertolonii	Smaller cat's-tail	+	+		+			Wide	-	-	-	4	Low
P. exaratum ssp. *exaratum*	-	+						Wide	-	-	-	4	Low
Phragmites australis	Common reed						+	Wide	Eu-Sib	-	-	4	Low
Poa bulbosa	Bulbous meadow-grass		+					Wide	-	-	-	4	Low
P. nemoralis	Wood meadow-grass					+		Wide	-	-	-	4	Low
P. trivialis	Rough meadow-grass		+					Wide	-	-	-	4	Low
Polypogon monspeliensis	Annual beard-grass						+	Wide	-	-	-	4	Low
Psilurus incurvus	-	+						Wide	-	-	-	4	Low
Puccinellia distans ssp. *distans*	Alkaligrass		+			+		Central ,W Anatolia	-	-		4	Low
Rostraria cristata var. *cristata*	Annual junegrass			+				Wide	-	-	-	4	Low

Sclerochloa dura *	Hard grass						+	Wide	-	-	-	4	Low
Setaria viridis	Green foxtail	+						Wide	-	-	-	4	Low
Sphenopus divaricatus	-		+			+		W, Central Anatolia	-	-		4	Low
Stipa holosericea	-		+					Wide	Ir-Tur	-	-	4	Low
S. hohenackenana	-				+	+		Wide	Ir-Tur	-		4	Low
S. lagascae	Needlegrass												
Taeniatherum caput-medusae ssp. *crinitum*	Medusa-head	+	+					Wide	Ir-Tur	-	-	4	Low
Potamogetonaceae	**Pondweed family**												
Potamogeton pectinatus	Fennel-leaved pondweed						+	Wide	-	-	-	4	Low
Groenlandia densa ***	-						+	Wide	Eu-Sib	-	-	4	Low
Typhaceae	**Cat-tail family**												
Typha domingensis **,***	Cat-tail						+	Wide	-	-	-	4	Low
Zannichelliaceae	**Horned pondweed family**												
Zannichellia palustris **,***	Horned pondweed						+	Wide	-	-	-	4	Low

APPENDIX – M RESULTS OF WATER ANALYSIS

DÜZEN NORWEST

ENVIRONMENTAL AND HEALTH SERVICES
EDUCATION AND CONSULTING COMPANY

REPORT NO: 1840	**Sample No:** 1840	**Report Date:** 26.03.2002
Client Name: ENVY- ENERGY AND ENVIRONMENTAL INVESTMENTS INC.		**Arrival Date of Sample to Laboratory:** 19.02.2002
Client Addressee: Çetin Emeç Bulvarı 8. Cad. No:7 Aşağı Öveçler /ANKARA		**Analysis Date of Sample:** 19.02.2002 - 26.03.2002
Person Concerned: Mrs. Arzu Ertuğrul		**Date of Sampling:** 19.02.2002 (Arrival Date to Lab.)
Client Telephone/Fax No: Tel: 0 312 - 478 47 47 / Fax: 0 312 - 483 21 21		**Analysis Carried Out at:** Düzen Laboratory Group / ANKARA
Definition of Sample: Water sample **(Aksaray - water of Tuz Golu)** of approximately 5 kilograms was sent to the laboratory by the person concerned in 2 one liter glass bottles and 2 one and a half liter plastic bottles (the sample inside the plastic bottles are preserved with acid and sent to the analysis as pH < 2.) for chemical and microbiological analyses.		

PARAMETER	RESULT
Iron (µg/L)	4700
Copper (µg/L)	400
Zinc (µg/L)	200
Total Chromium (µg/L)	< 2.0
Chromium $^{+6}$ (µg/L)	0
Mercury (µg/L)	< 2.0
Lead (µg/L)	235
Nickel (µg/L)	17
Cadmium (µg/L)	1410
Arsenic (µg/L)	37
Sodium (mg/L)	85000
Selenium (µg/L)	9.4
Manganese (µg/L)	30.0
Boron (µg/L)	43000
Aluminum (µg/L)	800
Lithium (mEg/L)	17
Bromide (mg/L)	< 0.1
Fluoride (µg/L)	90

Cobalt (µg/L)	7.5
Cyanide (µg/L)	< 50
Sulphate (mg/L)	5329
Oil and Grease (mg/L)	50
Chloride (mg/L)	124590
Ammonium Nitrogen (mg/L)	1.05
Total Kjeldahl Nitrogen (mg/L)	5.3
Nitrate Nitrogen (mg/L)	0.21
Total Phosphorus (mg/L)	0.45
Total Dissolved Matter (mg/L)	227930
Chemical Oxygen Demand (mg/L)	1821
Biochemical Oxygen Demand (mg/L)	0
Suspended Particulate Matter (mg/L)	28.2
Total Organic Carbon (mg/L)	9.64
Fecal Coliform (EMS/100 ml)	0
Total Coliform (EMS/100 ml)	0

* Detection Limit of ICP for Cobalt is 0.7 (µg/L)

** Detection Limit of IC for Bromide is 0.7 (µg/L)

RESULT: The results of the analyses carried out in the water sample are presented above.

Verified by :

Selim SANIN Ph.D. *(Signature)*

DÜZEN NORWEST

ENVIRONMENTAL AND HEALTH SERVICES
EDUCATION AND CONSULTING COMPANY

REPORT NO: 1833	**Sample No:** 1833	**Report Date:** 26.03.2002
Client Name: ENVY- ENERGY AND ENVIRONMENTAL INVESTMENTS INC.		**Arrival Date of Sample to Laboratory:** 19.02.2002
Client Addressee: Çetin Emeç Bulvarı 8. Cad. No:7 Aşağı Öveçler /ANKARA		**Analysis Date of Sample:** 19.02.2002 - 26.03.2002
Person Concerned: Mrs. Arzu Ertuğrul		**Date of Sampling:** 19.02.2002 (Arrival Date to Lab.)
Client Telephone/Fax No: Tel: 0 312 - 478 47 47 / Fax: 0 312 - 483 21 21		**Analysis Carried Out at:** Düzen Laboratory Group / ANKARA
Definition of Sample: Water sample **(Aksaray yeşilırmak - surface water taken from Tuz Golu)** of approximately 5 kilograms was sent to the laboratory by the person concerned in 2 one liter glass bottles and 2 one and a half liter plastic bottles (the sample inside the plastic bottles are preserved with acid and sent to the analysis as pH < 2.) for chemical and microbiological analyses.		

PARAMETER	RESULT
Iron (µg/L)	380
Copper (µg/L)	< 2.0
Zinc (µg/L)	10
Total Chromium (µg/L)	< 2.0
Chromium $^{+6}$ (µg/L)	0
Mercury (µg/L)	< 2.0
Lead (µg/L)	< 2.0
Nickel (µg/L)	10
Cadmium (µg/L)	< 2.0
Arsenic (µg/L)	136
Sodium (mg/L)	220
Selenium (µg/L)	6.5
Manganese (µg/L)	352.4
Boron (µg/L)	1.21
Aluminum (µg/L)	500
Lithium (mEg/L)	0.36
Bromide (mg/L)	0.287
Fluoride (µg/L)	390

Cobalt (µg/L)	< 0.7
Cyanide (µg/L)	< 50
Sulphate (mg/L)	142
Oil and Grease (mg/L)	155
Chloride (mg/L)	197
Ammonium Nitrogen (mg/L)	3.4
Total Kjeldahl Nitrogen (mg/L)	0
Nitrate Nitrogen (mg/L)	0.75
Total Phosphorus (mg/L)	0.87
Total Dissolved Matter (mg/L)	1183
Chemical Oxygen Demand (mg/L)	13.5
Biochemical Oxygen Demand (mg/L)	0
Suspended Particulate Matter (mg/L)	16.2
Total Organic Carbon (mg/L)	2.85
Fecal Coliform (EMS/100 ml)	0
Total Coliform (EMS/100 ml)	32

* Detection Limit of ICP for Cobalt is 0.7 (µg/L)

** Detection Limit of IC for Bromide is 0.7 (µg/L)

RESULT: The results of the analyses carried out in the water sample are presented above.

Verified by :

Selim SANIN Ph.D. *(Signature)*

DÜZEN NORWEST

ENVIRONMENTAL AND HEALTH SERVICES
EDUCATION AND CONSULTING COMPANY

REPORT NO: 1841	**Sample No:** 1841	**Report Date:** 26.03.2002
Client Name: ENVY- ENERGY AND ENVIRONMENTAL INVESTMENTS INC.		**Arrival Date of Sample to Laboratory:** 19.02.2002
Client Addressee: Çetin Emeç Bulvarı 8. Cad. No:7 Aşağı Öveçler /ANKARA		**Analysis Date of Sample:** 19.02.2002 - 26.03.2002
Person Concerned: Mrs. Arzu Ertuğrul		**Date of Sampling:** 2001
Client Telephone/Fax No: Tel: 0 312 - 478 47 47 / Fax: 0 312 - 483 21 21		**Analysis Carried Out at:** Düzen Laboratory Group / ANKARA
Definition of Sample: Salt sample **(Core number UGS-1 - 1252 m)** of approximately 5 kilograms was sent to the laboratory by the person concerned in nylon bags as blocks for chemical and microbiological analyses.		

PARAMETER	RESULT
Iron (µg/L)	300
Copper (µg/L)	40
Zinc (µg/L)	30
Total Chromium (µg/L)	< 2.0
Chromium $^{+6}$ (µg/L)	0
Mercury (µg/L)	< 2.0
Lead (µg/L)	7.4
Nickel (µg/L)	< 2.0
Cadmium (µg/L)	103.5
Arsenic (µg/L)	9.5
Sodium (mg/L)	7000
Selenium (µg/L)	8.5
Manganese (µg/L)	2.4
Boron (µg/L)	900
Aluminum (µg/L)	60
Lithium (mEg/L)	0
Bromide (mg/L)	< 0.02
Fluoride (µg/L)	20
Cobalt (µg/L)	1.3

Cyanide (µg/L)	< 50
Sulphate (mg/L)	719
Oil and Grease (mg/L)	45
Chloride (mg/L)	10137
Ammonium Nitrogen (mg/L)	0.14
Total Kjeldahl Nitrogen (mg/L)	0
Nitrate Nitrogen (mg/L)	0
Total Phosphorus (mg/L)	0.49
Total Dissolved Matter (mg/L)	18991
Chemical Oxygen Demand (mg/L)	1821
Biochemical Oxygen Demand (mg/L)	0
Suspended Particulate Matter (mg/L)	14.2
Total Organic Carbon (mg/L)	0
Fecal Coliform (EMS/100 ml)	0
Total Coliform (EMS/100 ml)	0

* Detection Limit of ICP for Cobalt is 0.7 (µg/L)

** Detection Limit of IC for Bromide is 0.7 (µg/L)

RESULT: The results of the analyses carried out in the water sample are presented above.

Verified by :

Selim SANIN Ph.D. *(Signature)*

DÜZEN NORWEST

ENVIRONMENTAL AND HEALTH SERVICES
EDUCATION AND CONSULTING COMPANY

REPORT NO: 1842	**Sample No:** 1842	**Report Date:** 26.03.2002
Client Name: ENVY- ENERGY AND ENVIRONMENTAL INVESTMENTS INC.		**Arrival Date of Sample to Laboratory:** 19.02.2002
Client Addressee: Çetin Emeç Bulvarı 8. Cad. No:7 Aşağı Öveçler /ANKARA		**Analysis Date of Sample:** 19.02.2002 - 26.03.2002
Person Concerned: Mrs. Arzu Ertuğrul		**Date of Sampling:** 19.02.2002 (Arrival Date to Lab.)
Client Telephone/Fax No: Tel: 0 312 - 478 47 47 / Fax: 0 312 - 483 21 21		**Analysis Carried Out at:** Düzen Laboratory Group / ANKARA
Definition of Sample: Salt sample **(Core number UGS-2 - 1323 m)** of approximately 5 kilograms was sent to the laboratory by the person concerned in nylon bags as blocks for chemical and microbiological analyses.		

PARAMETER	RESULT
Iron (µg/L)	600
Copper (µg/L)	50
Zinc (µg/L)	30
Total Chromium (µg/L)	< 2.0
Chromium $^{+6}$ (µg/L)	0
Mercury (µg/L)	< 2.0
Lead (µg/L)	4.6
Nickel (µg/L)	5.0
Cadmium (µg/L)	101.0
Arsenic (µg/L)	4.6
Sodium (mg/L)	6500
Selenium (µg/L)	9.8
Manganese (µg/L)	12.0
Boron (µg/L)	5300
Aluminum (µg/L)	300
Lithium (mEg/L)	0
Bromide (mg/L)	< 0.042
Fluoride (µg/L)	20
Cobalt (µg/L)	2.2

Cyanide (µg/L)	< 50
Sulphate (mg/L)	989
Oil and Grease (mg/L)	117
Chloride (mg/L)	8950
Ammonium Nitrogen (mg/L)	0.14
Total Kjeldahl Nitrogen (mg/L)	0
Nitrate Nitrogen (mg/L)	0
Total Phosphorus (mg/L)	0.48
Total Dissolved Matter (mg/L)	17622
Chemical Oxygen Demand (mg/L)	19317
Biochemical Oxygen Demand (mg/L)	0
Suspended Particulate Matter (mg/L)	114.5
Total Organic Carbon (mg/L)	0
Fecal Coliform (EMS/100 ml)	0
Total Coliform (EMS/100 ml)	0

* Detection Limit of ICP for Cobalt is 0.7 (µg/L)

** Detection Limit of IC for Bromide is 0.7 (µg/L)

RESULT: The results of the analyses carried out in the water sample are presented above.

Verified by :

Selim SANIN Ph.D. *(Signature)*

APPENDIX – N IRRIGATION WATER CLASSIFICATION

IRRIGATIONAL WATER CLASSIFICATION

The classification of the water utilized for irrigation is performed in accordance to the criteria stated in the "Water Pollution Control Regulation Technical Codes Notice – Section 7: Use of Treated Wastewaters in Irrigation", which was issued in Official Gazette dated January 7, 1991 and numbered 20748. Accordingly, the information in the Article 46 and 47 of the Notice is given below.

The most significant parameters, required to be studied to determine if the wastewater is appropriate for the discharge to the site or irrigation, are as follows:

- Total concentration of the dissolved materials in the water and electrical conductivity,
- Sodium ion concentration and the ratio of the sodium ion concentration to other cations,
- Concentration of boron, heavy metal and other substances that can be toxic,
- Total concentration of Ca^{++} and Mg^{++} ions in some cases,
- Amount of total solid material, organic material load and floating material such as oil, grease,
- Amount of pathogen organisms.

The dissolved salts, boron, heavy metal and similar toxic materials in the wastewater can accumulate in the environment, can be taken by the plants or remain in the water depending on the climatic conditions of the region and the physical, chemical and biologic properties of the soils. Therefore, if the use and disposal of the treated wastewaters on site is of question, the factors that would be taken into consideration would be the appropriateness of the water to the proposed limit values in terms of physical, chemical and biological parameters and the soil characteristics of the region.

The total concentration of the dissolved salts in the irrigational water can be determined simply by means of electrical conductivity (EC) value. The ratio coefficient (M) between the total salt concentration and electrical conductivity can be used continually once determined in the consequence of experimental studies. When this coefficient is expressed with conductivities (µmho/cm) and salt concentrations (mg/L) at 25°C, its value would be between 0.6-0.7.

Sodium adsorption rate (SAR) is defined as the withholding of the sodium in the treated wastewater used in irrigation by the irrigated soil. SAR is used as the criterion of harmfulness of the water in terms of sodium (or similar alkalis).

The value of SAR is determined with the equation presented below. There, Na^{+}, Ca^{++}, Mg^{++} are inner water concentrations in milliequivalence (meq/t).

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Taking EC and SAR into account, the classification of the irrigational water is realized in accordance to the diagram in **Figure 1**. By means of this diagram, it is possible to reveal the class of the wastewater between the irrigational water classes C_1S_1 – C_4S_4. The quality criteria of the irrigational water required for the various water classes to be used in the agricultural irrigation is presented in **Table 1**.

Table 1. Irrigational Water Quality Parameters taken into Consideration in Classification of Irrigational Waters

Quality Criteria	Irrigational Water Class				
	1st Class Water (Very good)	*2nd Class Water (Good)*	*3rd Class Water (Usable)*	*4th Class Water (Should be used with care)*	*5th Class Water (Detrimental-not convenient)*
$EC_{25} \times 10^6$ µmhos/cm	0-250	250-750	750-2000	2000-3000	> 3000
Exchangeable Sodium Rate (Na%)	< 20	20-40	40-60	60-80	> 80
SAR	< 10	10-18	18-26	> 26	
Sodium Carbonate Residue (RSC) meq/L mg/L	< 1.25 < 66	1.25-2.5 66-133	> 2.5 > 133		
Chloride (Cl^-) meq/L mg/L	0-4 0-142	4-7 142-249	7-12 249-426	12-20 426-710	> 20 > 710
Sulphate ($SO_4^=$) meq/L mg/L	0-4 0-192	4-7 192-336	7-12 336-575	12-20 575-960	> 20 > 960
Total Salt Concentration (mg/L)	0-175	175-525	525-1400	1400-2100	> 2100
Boron Concentration (mg/L)	0-0.5	0.5-1.12	1.12-2.0.	> 2.0	-
Irrigational Water Class *	C_1S_1	C_1S_2, C_2S_2, C_2S_1	C_1S_3, C_2S_3, C_3S_3, C_3S_2, C_3S_1	C_1S_4, C_2S_4, C_3S_4, C_4S_4, C_4S_3, C_4S_2, C_4S_1	-
NO_3^- or NH_4^+ (mg/L)	0-5	5-10	10-30	30-50	> 50
Fecal Coliform** (1/100 mL)	0-2	2-20	20-100	100-1000	> 1000
BOI_5 (mg/L)	0-25	25-50	50-100	100-200	> 200
Suspended Particle Matter (mg/L)	20	30	45	60	> 100
PH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-9.0	< 6 or > 9
Temperature (°C)	30	30	35	40	> 40

** Found out from **Figure 1**.*
*** Can be lesser or more according to the plant species (**see Table 2**).*

The classification of irrigational water according to the endurance level against boron is given in Table 9 of the same Notice (**see Table 2**).

Table 2. Classification of Irrigational Water According to the Endurance of the Plants Against Boron Mineral

Irrigational Water Class	Boron Concentration in Irrigational Water (mg/L)		
	Sensitive Plants[1]	*Medium Enduring Plants Orta Derecede Dayanıklı Bitkiler*[2]	*Enduring Plants*[3]
I	< 0.33	< 0.67	< 1.00
II	0.33-0.67	0.67-1.33	1.00-2.00
III	0.67-1.00	1.33-2.00	2.00-3.00
IV	1.00-1.25	2.00-2.50	3.00-3.75
V	> 1.25	> 2.50	> 3.75

[1] *Sample: Walnut, lemon, fig, apple, grape and beans*

[2] *Sample: Barley, wheat, corn, oats, olive and cotton*

[3] *Sample: Sugar cane, clover, horse bean, lettuce and carrot*

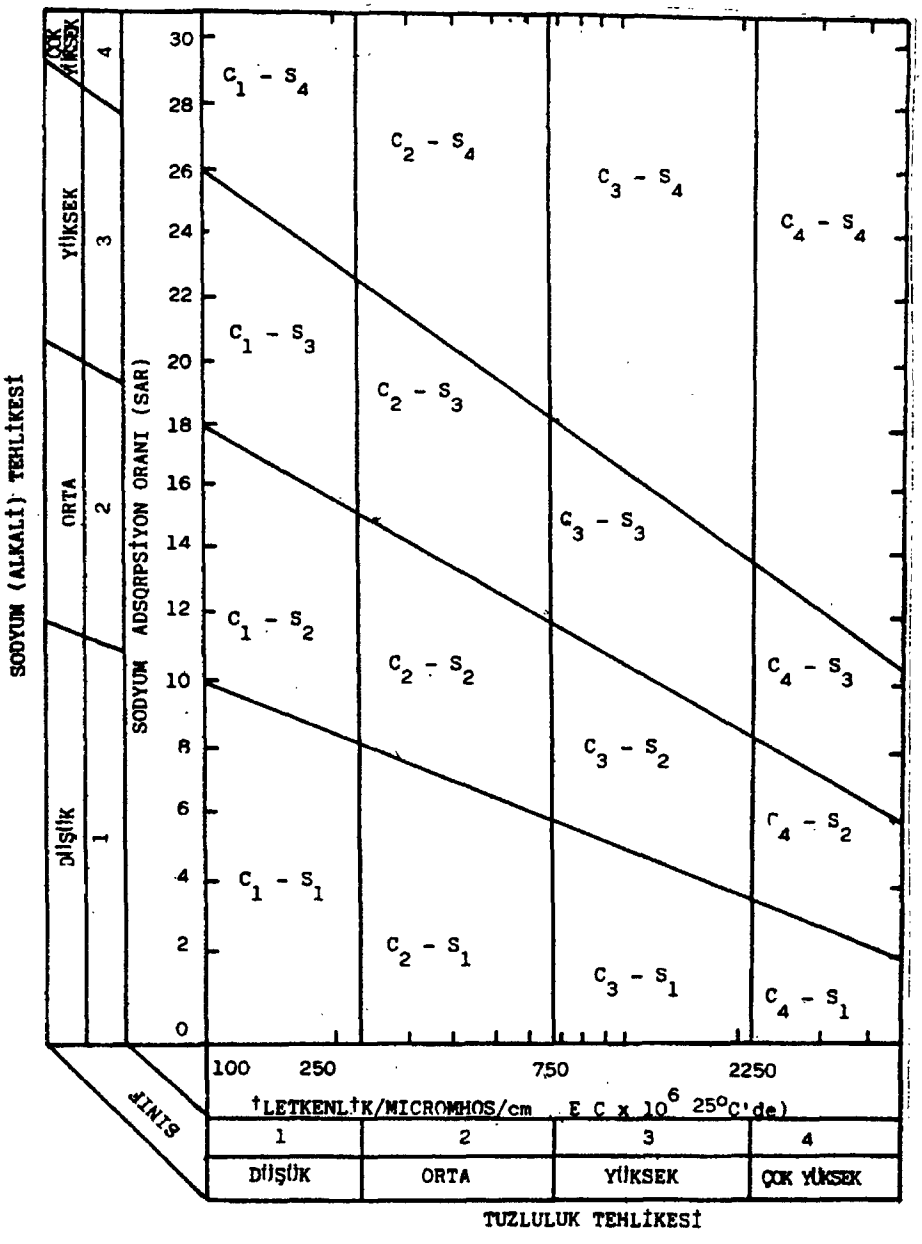

Figure 1. Diagram Used in Classification of Irrigational Water

APPENDIX-O GEOTECHNICAL REPORT FOR SURFACE FACILITIES / PIPELINE ROUTES

Engineering and Consultancy Services for Underground Storage of Natural Gas in Tuz Gölü Basin

BOTAŞ
PETROLEUM PIPELINE CORPORATION

02ND APRIL 2002

T. ÇEBİ, ENVY
N. AYTEK, ENVY

Project:	Engineering and Consultancy Services for UGS in Tuz Gölü Basin	Proj./Job No.:	12.0123
Document Title:	Geotechnical Report for Surface Facilities/Pipeline Routes	Document No.:	CON-0032
Issue:		Date:	
Prepared:	T. Çebi	Date:	2002-04-02
Checked:	F. Şaroğlu	Date:	2002-04-02
Approved:	N. Aytek	Date:	2002-04-02
Revision:	0 Date: 2002-04-02	Release:	

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1 INTRODUCTION

This report includes the results of soil investigations and geotechnical engineering evaluations carried out for surface facilities, brine disposal discharge and fresh water supply pipelines of Tuz Gölü Basin Underground Natural Gas Storage Project.

In the report, firstly the subsoil conditions at the study area are explained; then recommendations about the soil bearing capacity and foundations of the structure are presented in accordance with the site explorations and laboratory test results.

2 GEOLOGY

2.1 General Geology

The Haymana Formation (Mesozoic-Upper Cretaceous in age) and its overlying units, algiceous limestones (Cenozoic-Paleocene in age), are the basements of the Tuz Gölü Basin. The formations in the basin are in the following order;

- Paleocene-Lower Eocene aged Küredağ Formation is composed of lacustrine-marine clay stones, sandstones and conglomerates.
- Küredağ Formation is overlain by Çayraz Formation, which is Lower - Middle Eocene in age. Nummulitious limestones, clay stones and sandstones are the characteristic units of this formation.
- Bala Formation is Oligocene in age and composed of sandy clay stone with conglomerate interlayers, silty clay stones rich in gypsum, and conglomerate-sandstone-clay stone/shale alternations, respectively.
- Bala Formation is overylained by Miocene-Pliocene aged lacustrian deposits (Marl, shale, siltstone and evaporites) and volcanics.
- Traces and alluviums overlain Miocene-Pliocene deposits and they are Pleistocene-Recent in age.

2.2 Local Geology

The Mio-Pliocene aged lacustrian deposits are seen at the south part of the Tuz Gölü Basin. Marl, marly limestone, occasionally silty clay and Quaternary aged alluviums around the lake are observed along the pipeline.

The Mio-Pliocene units are composed of basal conglomerates and sandstones in Tuz Gölü Basin. They are overlained by lacustrian limestones, marl, shale, siltstone and evaporites, respectively. White-cream colored marl and limestone-shale (highly altered)-sandstone interlayers are seen in the construction site. Limestone interlayers are thin medium bedded, moderately altered. Sandstone and shale units are highly altered to clay and sand. Also, occasionally gypsum interlayers are observed.

The alluviums are composed of fine-grained (clay) units in the study area.

3 EARTHQUAKE RISK and SEISMICITY

Turkey is present in one of the most important earthquake belts, "Alps-Himalayan" starting from Azores Islands and reaching over to South East Asia; and also in between African and Arabian Plates moving towards North-Northwest direction and Eurasian Plate in the north. Since the Aegean Plate tries to stop the movement in the west direction of Anatolian Plate, resulted by the forcing of Arab and African Plates, widening in the North-South direction and Aegean Graben system occurred in the region. The earthquakes in Turkey generally occur in the border zones in between Anatolian Plate and the surrounding plates. These zones consist of North Anatolian Fault, South East Anatolian Trusting Belt and Aegean Graben System (Figure 3.1)

The investigation area is in the 5^{th} degree earthquake zone according to Turkey Earthquake Map (Figure 3.2). The superstructure and the foundations should be designed according to "The Regulations for the Structures to be Built in Disaster Areas, 1998". According to the same regulation, the soil in the study area belongs to (B) Soil Group and (Z2) Regional Soil Class.

Besides, due to the same regulation, dynamic ground acceleration coefficient can be taken as A_o = 0.10. Spectrum characteristic periods T_A and T_B are given as 0.15 sec and 0.40 sec for Z2 Regional Soil Class.

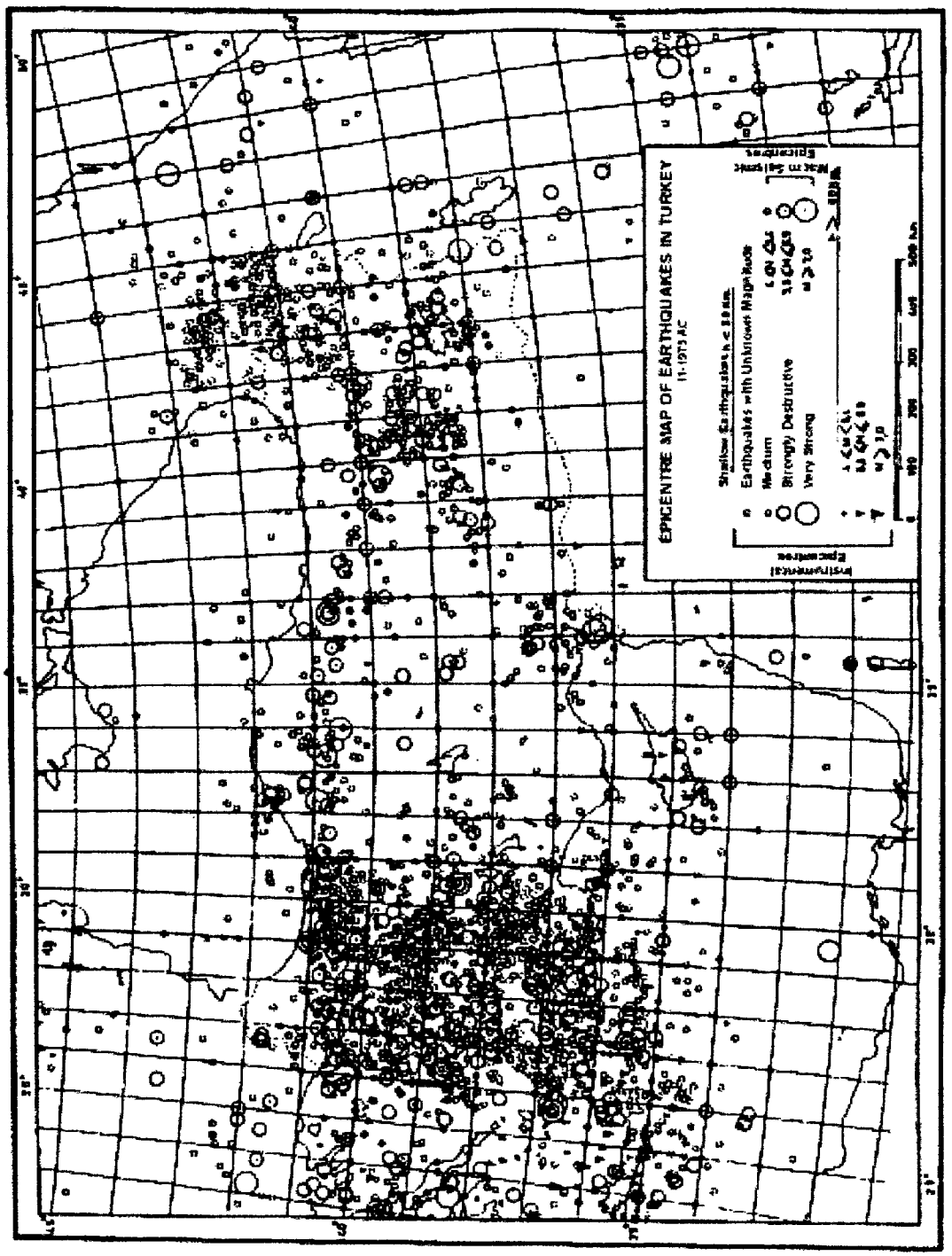


Figure 3.1 Epicenter Map of Turkey Earthquakes Between 11-1975 A.D.

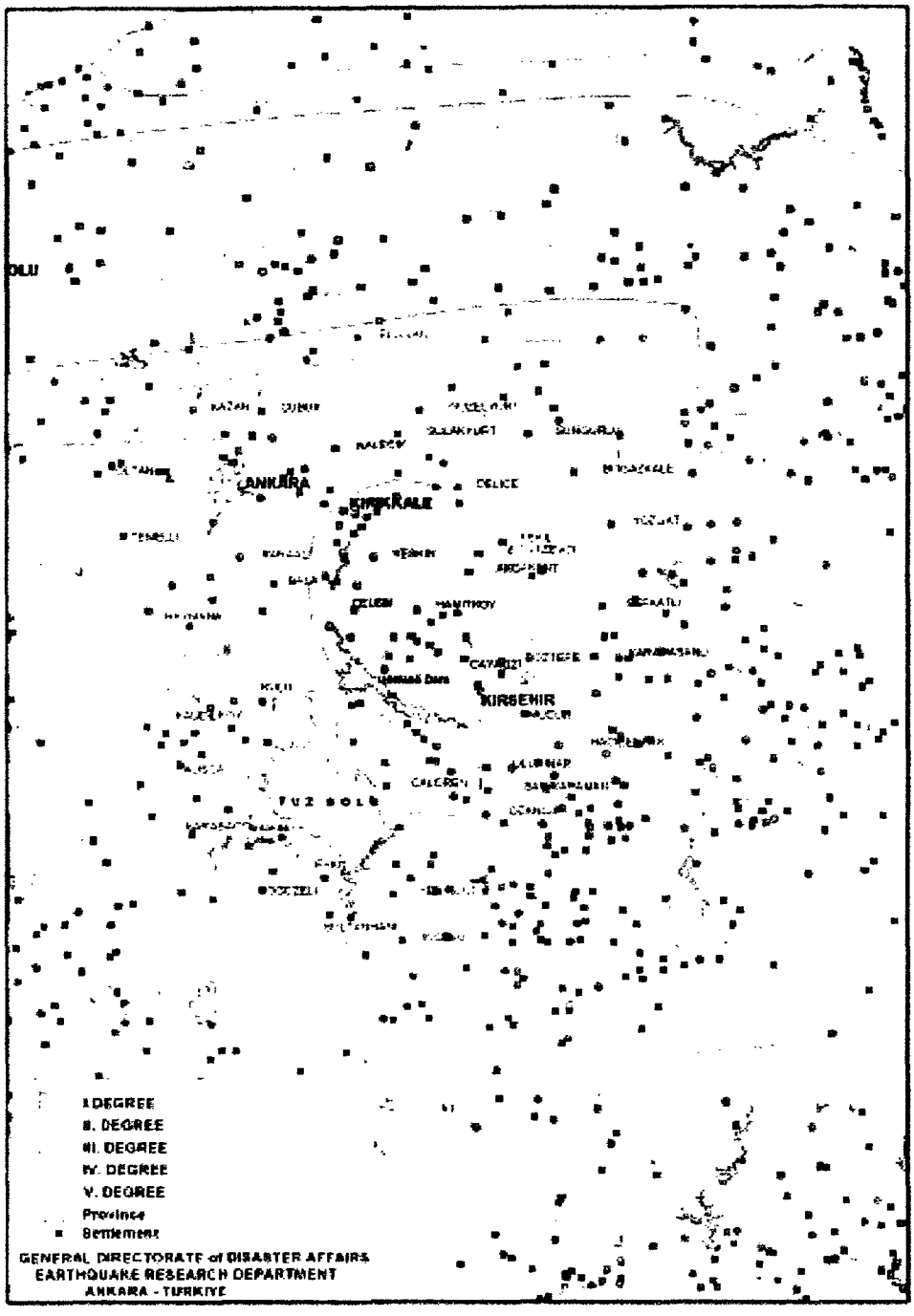


Figure 3.2 Earthquake Regions in Turkey

4 SITE INVESTIGATIONS

Site investigations were carried out between 07.12.2001 - 11.12.2001. Site investigations were performed in three groups as: (i) boreholes, (ii) test pits and (iii) in-situ tests. All studies were done in accordance with the ASTM, BS and TSE standards.

In this scope, six boreholes (total 122.45) were drilled and 10 test pits were excavated. Standard penetration tests and pressuremeter tests were done during drillings.

4.1 Borings and In-situ Tests

At the site, six boreholes with depths 20.20 m and 20.45 m were drilled at the locations shown on the site location plan given in Attachment 1. Borings were performed by truck mounted drilling rig Mobile Drill B-53 and Acker Mark II between the dates 07.12.2001 - 10.12.2001. The depths, aim, elevations and the coordinates of the borings are presented in Table 4.1.

Table 4.1 The elevations and coordinates of boreholes

Borehole No	Depths (m)	Location	Coordinates		Elevation (m)
			E	N	
S-1	20.45	Surface Facilities	51375	17250	1013.390
S-2	20.45	Surface Facilities	51315	17110	1019.225
S-3	20.45	Surface Facilities	51065	17075	1023.260
S-4	20.20	Surface Facilities	51250	16800	1023.390
S-5	20.45	Surface Facilities	51300	16875	1019.305
S-6	20.45	Surface Facilities	51450	16875	1017.310

Disturbed samples were obtained from standard penetration tests (SPT), which were conducted in every 1.50 m interval in order to determine the soil density and soil stiffness of the poorly consolidated rock formation in accordance with the technical specifications (ASTM-1586 and TS-1901). In addition, undisturbed (UD) samples were taken by pushing the thin-walled samplers (Shelby tubes) into the soil by hydraulic pressure whenever the soil conditions were suitable. Disturbed samples were kept in double nylon bags, labeled and sent to laboratory.

In the study area, pressuremeter tests were also performed in the boreholes S-1 and S-5 to determine the deformation properties of the subsoil. Tests were performed with Louis Menard GA type pressuremeter by using 70 mm N type probe. The change in the modulus of deformation (Ep), limit pressure (Pl) and net limit pressure ($P_{l(net)}$) by depth in the boreholes, in which the tests were performed, are given in Attachment 5.

The observed soil profiles, the measured standard penetration numbers, disturbed (SPT) and undisturbed sample depths, pressuremeter test depths and other information were all reported in the detailed boring logs given in Attachment 3 and 4. Idealized geological sections drawn after the evaluation of boring logs are also presented in Attachment 2.

4.2 Test Pits

At the site, 10 test pits, eight of which are on water discharge pipeline and two of which are on fresh water supply pipeline, having variable depths between 1.00 - 1.50 m were excavated by a JCB back-hoe on 11.12.2001. Bagged samples were taken from every test pit for laboratory tests. The elevations and the coordinates of the test pits are presented in Table 4.2.

Table 4.2 Elevation and Coordinates of Test Pits

Test Pit No.	Depth (m)	Locations	Coordinates		Elevations (m)
			E	N	
DAÇ-1	1.50	Discharge Pipeline	50050	21450	974.700
DAÇ-2	1.50	Discharge Pipeline	49500	24250	984.100
DAÇ-3	1.00	Discharge Pipeline	47125	30250	968.400
DAÇ-4	1.20	Discharge Pipeline	46375	32650	951.200
DAÇ-5	1.50	Discharge Pipeline	45950	34875	951.200
DAÇ-6	1.50	Discharge Pipeline	45200	39050	928.500
DAÇ-7	1.00	Discharge Pipeline	45500	42050	915.600
DAÇ-8	1.50	Discharge Pipeline	45650	47150	911.400
SAÇ-1	1.50	Water Pipeline	48300	20250	995.500
SAÇ-2	0.75	Water Pipeline	50010	19150	998.750

5 GROUNDWATER

During site investigations, no groundwater was encountered neither in boreholes nor in test pits.

6 LABORATORY TESTS

The necessary soil mechanics experiments on the disturbed (SPT) and undisturbed (UD) soil samples taken from boreholes and bagged samples taken from test pits were conducted in order to determine their geotechnical properties. All the experiments were performed in accordance with TS-1900 and ASTM standards.

Atterberg Limits tests, sieve analyses and sufficient hydrometer test were conducted as a standard procedure for the classification of soils. The related test results are given in the test results tables in Attachment 6.1. This table also includes the natural water content (w_n), natural unit weight (γ_n), specific weight (G_s) and the classifications with respect to the unified soil classification system (USCS). The grain size curves obtained from the sieve analyses and hydrometer tests are also presented in Attachment 6.1.

Unconsolidated-undrained (UU) triaxial compression tests and unconfined compression (q_u) tests were performed on the undisturbed (UD) samples to obtain shear strength parameters. The results obtained from these tests were given in the tables of soil mechanics test results where as the stress-deformation curves are given separately for each tests in Attachment 6.1.

The consolidation tests were performed on undisturbed (UD) samples to obtain the compressibility of the subsoil layers. The values of modulus of volumetric compressibility m_v and the graphs of e-log p are given in Attachment 6.1. The measured swell pressures were also given test result tables.

The standard proctor tests, besides classification tests, were performed on samples taken from test pits to determine the suitability of the excavated material for filling works. Results of laboratory tests performed on samples taken from test pits are given in Attachment 6.2.

7 GEOTECHNICAL PROPERTIES of the SOILS

At the site, there exist lacustrine deposits made up of white - grayish white and cream-colored marl layers. Marl formations are highly weathered; contain widespread white clay, occasional clay band, limestone interlayer and trace fine limestone gravels. In this chapter, the geotechnical properties of the soils in surface facilities construction site and pipelines are discussed.

7.1 Surface Facilities Construction Site

Because of poorly consolidated marl formations, standard penetration tests could be done and also undisturbed samples could be taken from some levels. During standard penetration tests, SPT blow numbers were observed to be in between N = 23 - 50$^+$, generally N > 50. However at completely weathered and clayey levels, SPT values are varying in between N = 23 - 35.

The properties of the highly weathered marl obtained from laboratory and field test results are summarized as below:

Group Symbol	**CH-CL**
Standard Penetration Number	*N_{30} = 23 - 50$^+$ (N_{ort} = 40)*
Fine Content	*F (%) = 52-99 (representative value F (%) ≈ 92)*
Gravel Content	*G (%) = 0-10 (representative value G (%) ≈ 2)*
Liquid Limit	*LL (%) = 34-107 (representative value LL (%) = 57)*
Plastic Limit	*PL (%) = 16-40 (representative value PL (%) = 23)*
Plasticity Index	*PI (%) = 16-67 (representative value PI (%) = 34)*
Natural Water Content	*w_n (%) = 11-66 (representative value w_n (%) = 34.5)*
Specific Gravity	*G_s = 2.63-2.74 (representative value G_s = 2.70)*
Natural Unit Weight	*γ_n(kN/m^3)=15.5-20.71 (representative value γ_n=18 kN/m^3)*

The unconsolidated-undrained (UU) triaxial compression tests and unconfined compression (q_u) tests were performed on undisturbed samples (UD) taken from the borings. According to test results, the shear strength parameters of clay soil are as follows;

c_u = 50 - 150 kPa (average c_u = 100 kPa)

ϕ_u = 8° - 21° (average ϕ_u = 12°)

q_u = 70.07 – 137.45 (average q_u = 110.50 kPa)

Taking into consideration the clayey layers existing between marl formation, the correlations between SPT resistance-undrained shear strength (c_u) given in the literature were used for the determination of shear strength parameters.

From the relationships given by *Stroud (1974)* between SPT resistance and undrained shear strength (c_u);

for N_{ave}= 40 and PI (%) = 34 $\rightarrow$ $c_u \cong$ 150 kPa

Therefore, also considering the laboratory test results, the short-term shear strength of the marl units could be taken as;

c_u= 100 kPa, ϕ_u = 0° γ_n = 18 kN/m³

It is observed from the pressuremeter tests performed in marl formation that the modulus of pressuremeter, E_p changes in between E_p = 23,800-41,700 kPa (average 31,500 kPa) and the net limit pressure, $(P_1)_{net}$ changes in between $P_{1(net)}$ = 1870-2840 kPa (average 2400 kPa).

In order to determine the deformation parameters of the subsoil, consolidation tests were performed on undisturbed (UD) samples taken from different levels of marl formations. The modulus of volume compressibility (m_v) at different loading levels varies between;

$m_v = 10.0 \times 10^{-5}$ m²/kN

The correlations given in the literature were also used for the determination of deformation parameters. From the relationships given by Stroud (1974);

for N_{ave}= 40 and PI (%) = 34 $\rightarrow$ $m_v \cong 5.5 \times 10^{-5}$m²/kN

According to consolidation test results, it is also seen that clay has swelling potential. Swell pressure values of the marl formation at the site vary between 10-67 kPa.

7.2 Pipelines

At brine disposal discharge and fresh water supply pipeline routes, marl layer takes place under 0.3 - 0.7 m thick top soil.

The properties of the marl at pipeline routes obtained from laboratory test results are summarized as below:

Group Symbol	**SC (CL in some levels)**
Fine Content	*F (%) = 14 – 51 (representative value F (%) ≈ 34.3)*
Gravel Content	*G (%) = 4 – 47 (representative value G (%) ≈ 24.5)*
Liquid Limit	*LL (%) = 34 - 45 (representative value LL (%) = 39)*
Plastic Limit	*PL (%) = 17 - 29 (representative value PL (%) = 24)*
Plasticity Index	*PI (%) = 9 – 20 (representative value PI (%) = 15)*
Optimum Water Content	*W_{opt} = 18.9 - 27.8 (representative value W_{opt}(%) = 24.5)*
Max. Dry Unit Weight	*γ_{max} =14.98- 16.82 (representative valueγ_{max}=15.6 kN/m^3)*

The laboratory tests on a sample taken from DAÇ-1 has given high optimum water content and low maximum dry unit weight values. The consistency limits also have high values. All these results are considered to be due to the salt amount in the sample.

8 RECOMMENDATIONS on FOUNDATION SYSTEM of FACILITIES

In the scope of Underground Natural Gas Storage Project in Tuz Gölü Basin, surface facilities and brine disposal discharge and fresh water supply pipelines are planned to be constructed.

8.1 Surface Facilities

At Surface Facilities site, there will be facilities such as compressors, regulating and metering skid, pressure-reducing skid, coolers and heaters, oil separators, dehydration unit, office building, warehouse, package waste treatment plant.

The foundation soil of all the structures will be weathered marl formation with occasional clay interlayer. The footings of all the structures could be planned as shallow foundations. However, because of the heterogeneous structure of the marl formation, footings are recommended as continuous footings or according to structural properties, raft foundation could be used. Accordingly, also considering the freeze effect, the foundations should be seated minimum 1.0 m below the ground surface and design the footing widths as $B \geq 1.20$ m.

BEARING CAPACITY:

By utilizing related parameters given for marl formation in Chapter 7.1 and by using the following equation to calculate the bearing capacity of a strip footing with;

Foundation depth, $D_f \geq 1.0$ m
Foundation width, $B \geq 1.20$;

$$q_u = c_u . N_c + \gamma . D_f . (N_q - 1) + \tfrac{1}{2} . \gamma . B . N_\gamma$$

$c = 100$ kPa
$\gamma = 18$ kN/m^3
$\phi = 0° \longrightarrow N_c = 5.14,\ N_q = 1,\ N_\gamma = 0$

$q_u = 100*5.14 + 0 + 0 \cong 514$ kPa

$q_{all} = 514/3 = 171$ kPa

Considering that the marl formation is highly weathered and has clay interlayers, net bearing capacity of the foundation soil can be taken as:

q_{all} = 150 kPa (1.50 kg/cm²)

This value can be increased by 1/3 for the earthquake considerations.

SETTLEMENTS:

(a) From Pressuremeter Test Results

Settlements can be calculated by using pressuremeter test results and below equation;

$$s = q^{*} / (9 . E_p) . [2 . B_0 . (\lambda_d . B / B_0)^{\alpha} + \alpha . \lambda_c . B]$$

B : foundation width =1.20 m (minimum foundation width)
q^{*} : net average bearing (here it is taken as $q^{*} = q$ = 150 kPa)
E_p : pressuremeter modulus ≅ 31500 kPa (average)
B_0 : reference width = 0.60m
λ_d and λ_c : factors related to foundation dimensions
α : geologic factor related to soil type and characteristics = 1/2

$$s = 150 / (9\times31,500) \times [2\times0.6\times(1.53\times1.2/0.6)^{0.5} + 0.5\times1.2\times1.2]$$

s ≅ 1.0 cm

(b) From Consolidation Test Results

$$s_{oed} = q_{net}.m_v.H$$

m_v : average = $7x10^{-5}$ m^2/kN
H : 5m (compressible layer thickness)
q_{net} : 150kPa

$$s_{oed} = 150 \times 7 \times 10^{-5} \times 500 = 5.25 \text{ cm} \rightarrow S = 0.60 \times s_{oed} = 3 \text{ cm}$$

Considering that the loads transferred to the soil from the superstructure will be less than net bearing capacity or the decrease of the loads transferred from the structures in case the foundations are seated on deeper layers; the expected settlements will not be more than 1.0 - 2.0 cm.

On the other hand, due to the swelling pressure of marl formation with clay interlayers, that reaches 67 kPa, it is recommended that the foundation should be designed with the minimum base pressure, 50 kPa.

8.2 Pipelines

It is observed that marl is the dominant soil in all test pits performed along the 6000 m long fresh water supply route and 39,000 m long brine disposal discharge route.

The materials excavated along pipeline routes, except the 0.3-0.7 m thick topsoil, could be used for back filling. Excavations for pipeline construction could be performed vertically.

9 RESULTS and RECOMMENDATIONS

Foundations of all surface facilities of Tuz Gölü Basin Underground Natural Gas Storage Project could be planned as shallow foundations. Foundations of these structures could be constructed as continuous footings or raft foundation according to structural properties. However footing widths of continuous footings will not be less than 120 cm. In this case the net bearing capacity of the foundation soil can be taken as;

$$q_{all} = 150 \text{ kPa } (1.50 \text{ kg/cm}^2)$$

Total settlements taking place in foundation soil under the loads transferred from the superstructure will be within allowable limits.

Marl, which is the foundation soil, is sensitive to atmospheric effects and has softening and swelling problems when in contact with water. For this reason, excavations should be done in dry season and not be kept exposed for a long time. Moreover, after the foundation excavation, base should be covered by at least 10 cm lean concrete in order to prevent bottom heave.

Excavations for foundation and pipelines could be done vertically. The materials excavated along pipeline routes, except the 0.3 - 0.7 m thick topsoil, could be used for back filling. The subsoil could be classified as 80 % soft rock, 10 % hard soil and 10 % soft soil for excavation works.

The modulus of subgrade reaction for the foundation soil in construction site could be taken as;

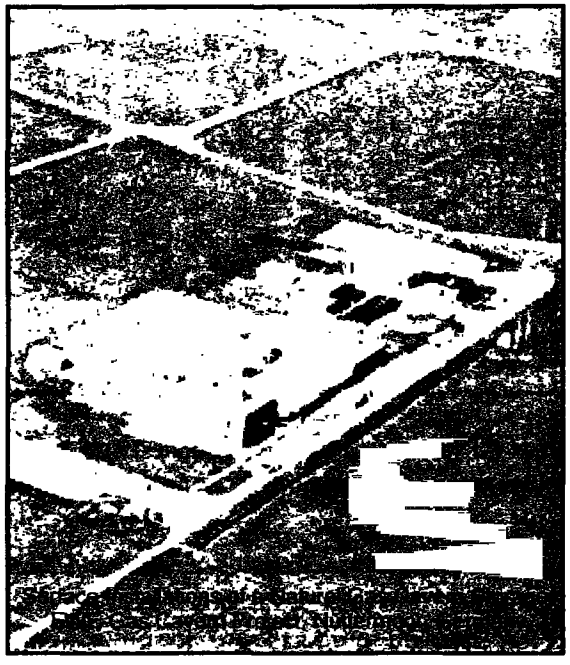
$$k_s = 30.000 \text{ kN/m}^3$$

Sultanhanı and surrounding area are in the 5th degree earthquake zone and related regulations should be considered in earthquake calculations.

UNDERGROUND STORAGE

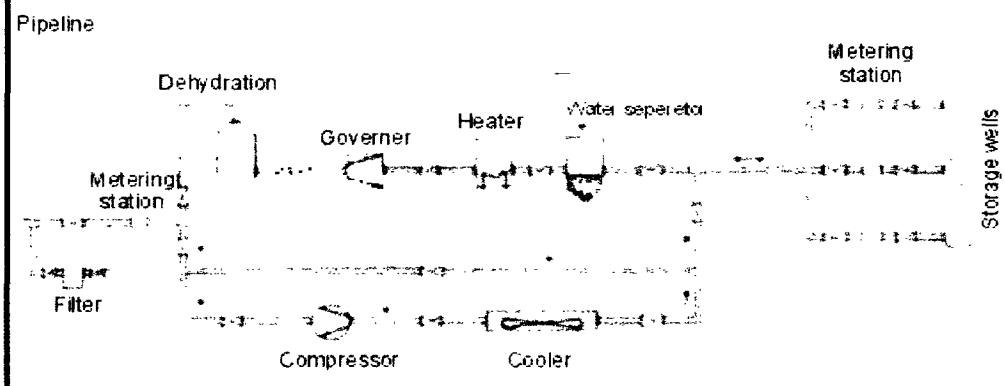
Underground storage of liquefied and gaseous hydrocarbons is called as energy storage. With the increase in energy consumption, there is an increasing dependency on seasonal consumption fluctuations, high percentage of imports and influences due to crises developments. These dependencies can only be counteracted by the storage of adequate quantities of primary energy carriers.

Experience, research and development work have demonstrated underground storage is superior to conventional aboveground storage as:

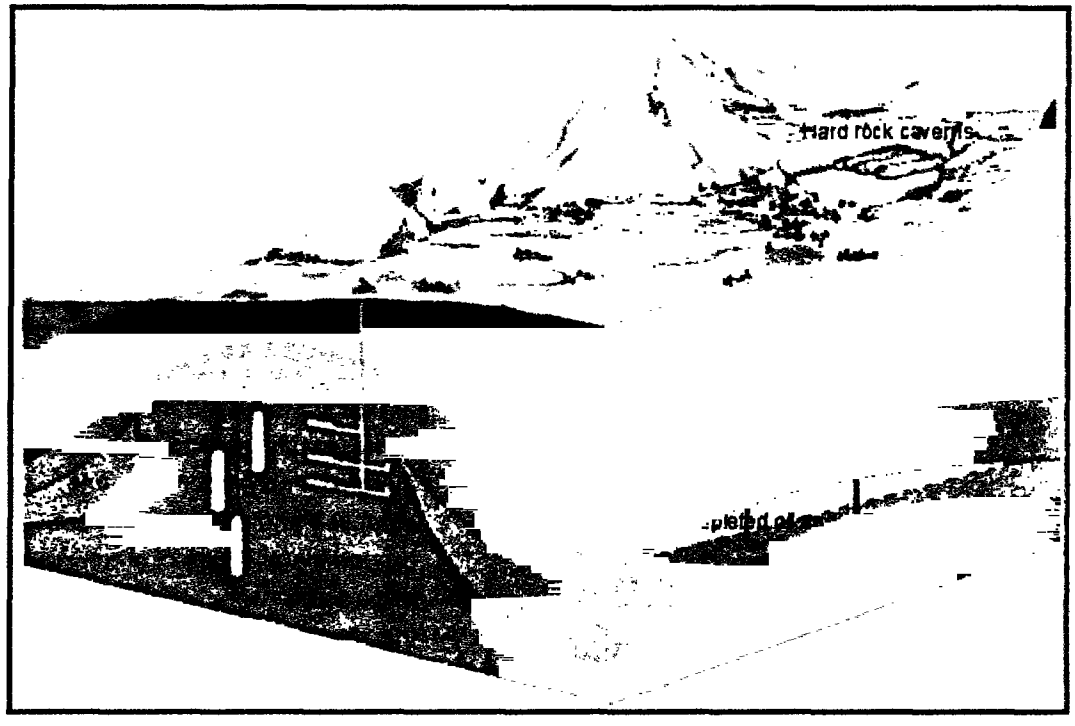


- storages in caverns in salt, hard rock, depleted oil and gas reservoirs, aquifers and abandoned mines incur considerably less costs and are therefore more economical to establish and operate than above-ground installations of a comparably large size;
- the storage stock is safely protected from operational disasters (e.g., fire, explosions) as well as against external and environmental hazards;
- underground storage is environmentally favourable because an impairment of the storage facility environment (landscape, air, water) is practically excluded by storage at great depths.

SCHEMATIC FLOW DIAGRAM OF AN UNDERGROUND STORAGE FACILITY



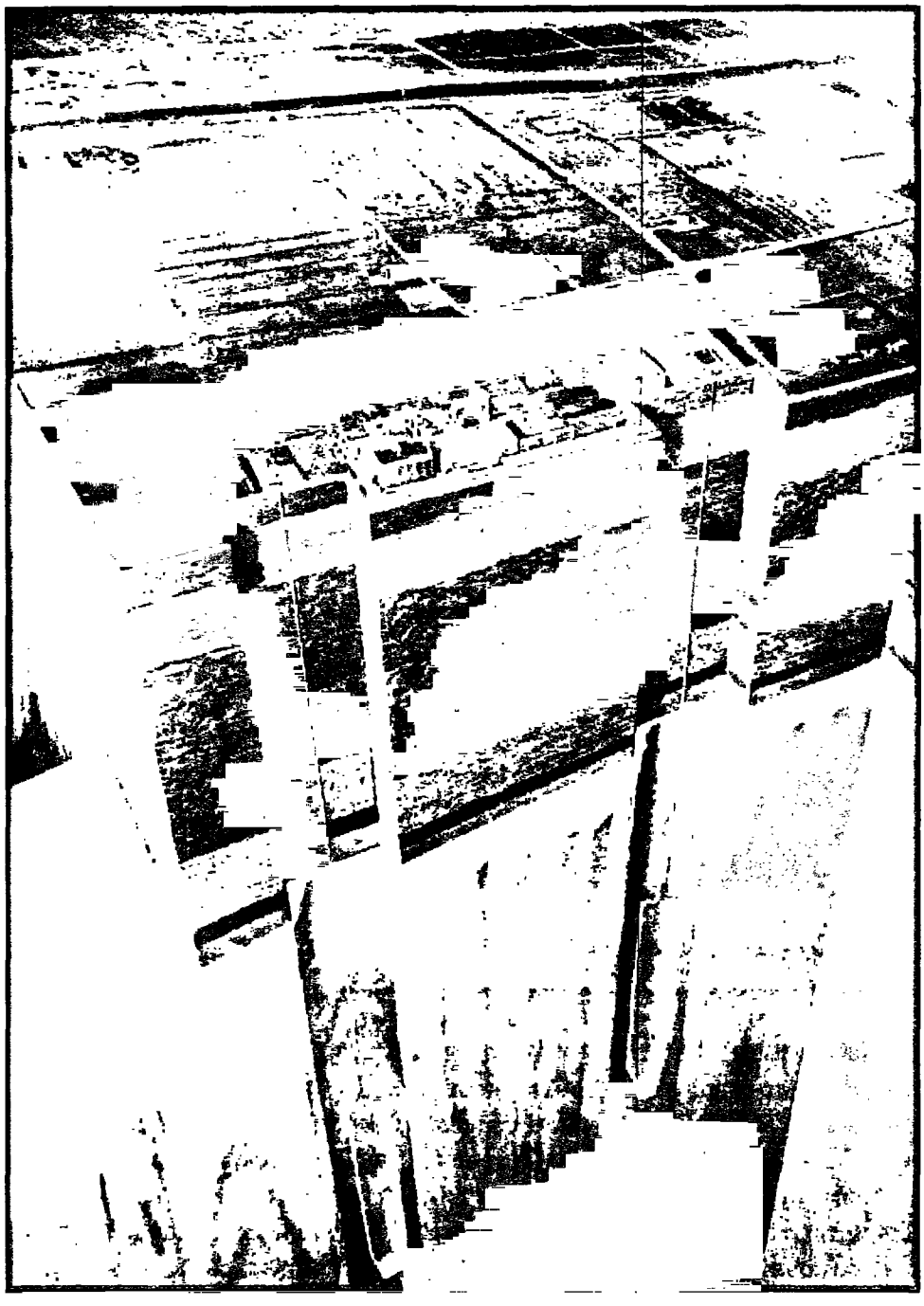
Where to store natural gas underground?



- ✓ **Salt caverns:** Occurring partly in great thickness (salt dome, stratified salt), it offers ideal preconditions for use as underground storage due to its absolute impermeability. Storage caverns in salt are generally established by leaching.
- ✓ **Hard rock caverns:** - magmatic, metamorphic or sedimentary – offers different preconditions for the installation of storages. Hard rock caverns are excavated using conventional methods. If gaseous or liquefied products are to be stored, the tightness of the storage areas is achieved by internal lining and sealing.
- ✓ **Aquifers:** The water-filled pore spaces of sedimentary rocks are suitable for gas storage as long as there are impermeable overburdens above these.
- ✓ **Disused or abandoned mines:** Ore, coal and salt mines are suitable for natural gas storage in many cases.
- ✓ **Depleted oil and gas fields:** They have proven to be tight over geological periods and can therefore also be used for gas storage.

Salt caverns will be used within the scope of Tuz Golu Basin Underground Gas Storage Project. Hence, the following headings give detailed information only on this type of storage.

Salt caverns

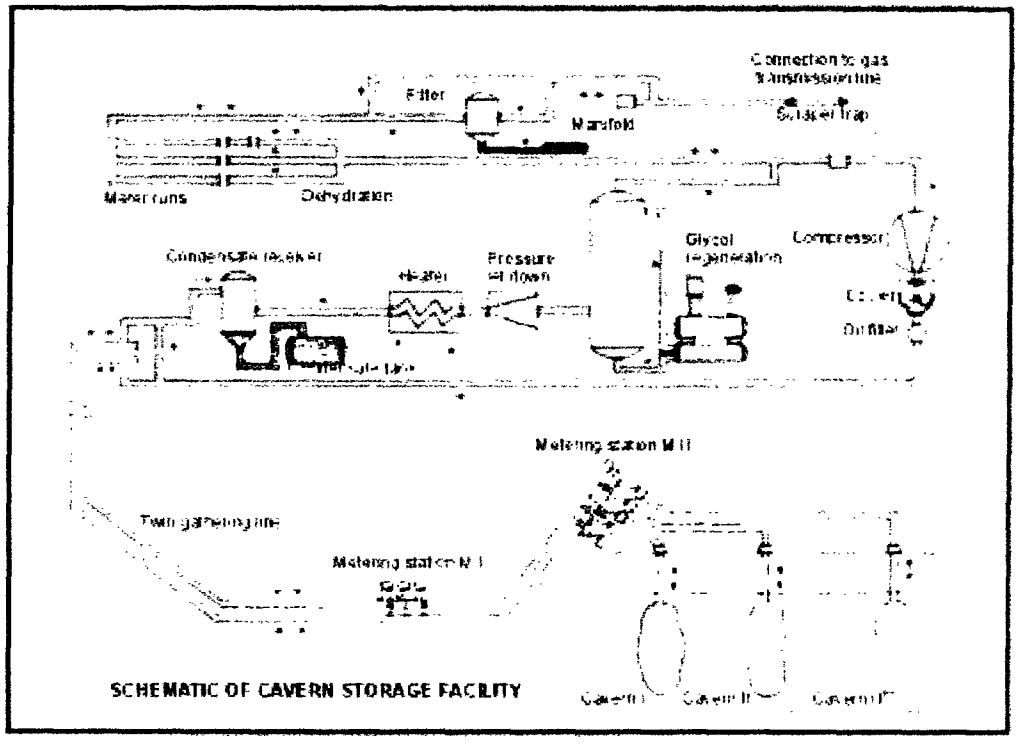


Underground Natural Gas Storage Facility (Schematic)

Leaching Process

The establishment of salt caverns assumes thick salt formations. For the leaching of salt rock formation, approximately 9-10 m^3 of water is required per m^3 of salt, which can be taken from the surface waters, sea or groundwater.

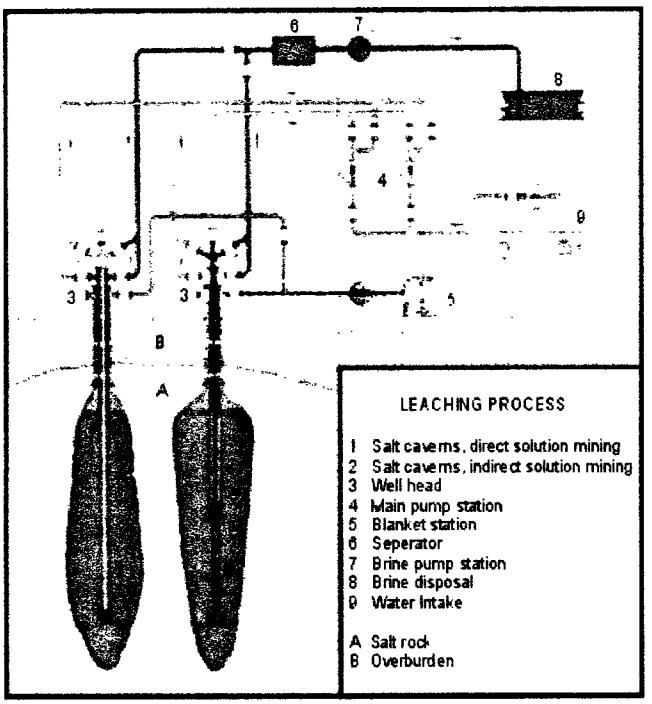
If the operating conditions and the desired storage volume are known, then site investigations and rentability calculations can be made. This is followed by the design of the wells and aboveground installations with pipeline systems, separators, pump stations, energy supply, etc.



The leaching process is carried out via wells, which are drilled from aboveground and extend down to depths of 2000 m depending on the requirements and geological preconditions. The wells have three completely separate communication linkups to the cavern zone due to two freely suspended tubing strings installed adjacently or concentrically to one another. Freshwater or even low salt content water (e.g. sea water) is pumped into the well via one of the linkups. The water dissolves salt at the cavern walls and in doing so, becomes saturated. The brine is displaced via a second linkup to aboveground and channelled off. Wherever it cannot be put to use, the brine is channelled into the sea (into the estuary region of large rivers) or injected under pressure into suitably deep rock formations. Via the third linkup, normally the outermost annulus, a protective medium (blanket) that does not dissolve salt and is lighter than water (e.g. diesel fuel or natural gas), is pumped into the cavern in order to avoid a solution process in the region

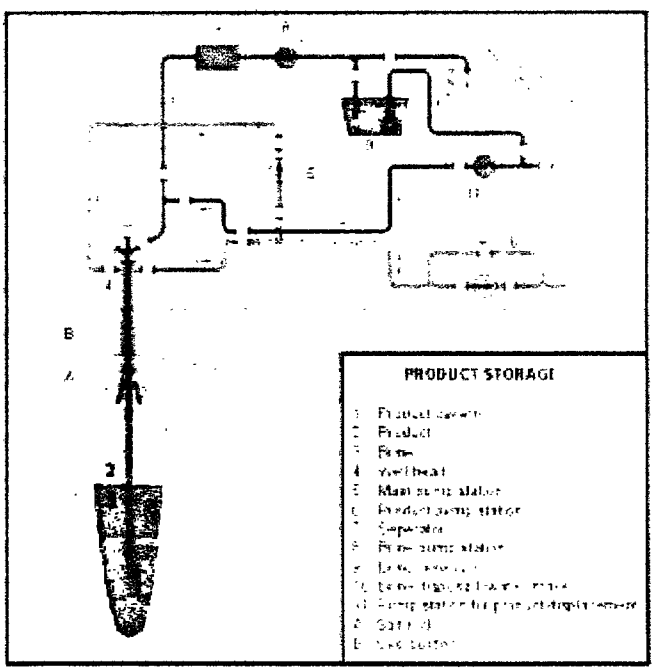
of the cavern roof. Core investigations and borehole surveys make it possible to design the leaching process in such a way that the rock-mechanically admissible dimensions are not exceeded, but put to optimal use.

The leaching method is determined by geological conditions, desired cavern form and economical considerations:



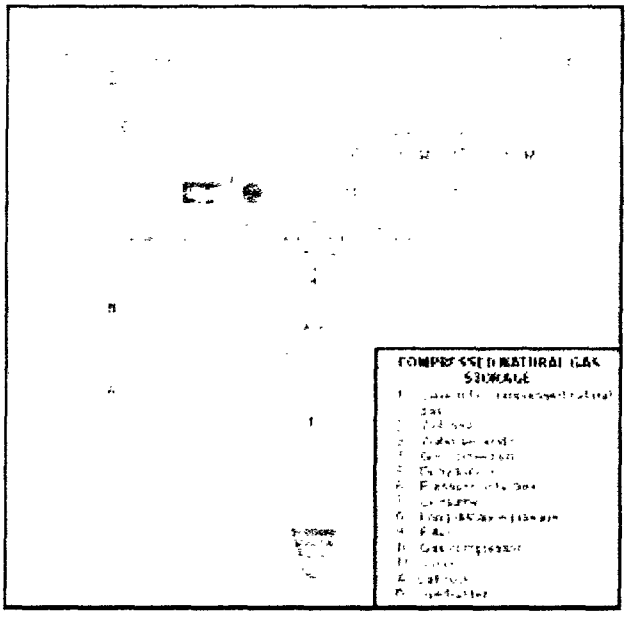
- The *direct leaching method* permits a more speedy development of the cavern in the lower region. Hereby freshwater is fed to the cavern bottom and the brine recovered from the upper region of the cavern back through the inner annulus.
- By the *indirect leaching method* freshwater is passed via the inner annulus into the upper region of the cavern and the brine in the lower region of the cavern is withdrawn via the inner case string. In this way, there is a more speedy development in the upper zone of the cavern.

The desired cavern configuration is achieved by varying the setting depths of leaching strings, leaching rates and by optional application of the direct and indirect method. The leaching process is controlled and monitored by water and brine analyses, echometrical surveys as well as computer-based calculations and simulations.



Depending on the geological conditions and operational requirements, salt caverns can achieve storage volumes of 100,000 to above 500,000 m³. For the later storage operation, both leaching strings are replaced by a production string.

High-Pressure Natural Gas Storage

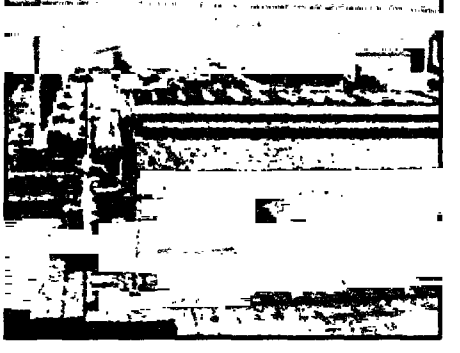


High-pressure natural gas caverns constructed by solution mining are used for short-term or seasonal compensation of fluctuations in supply.

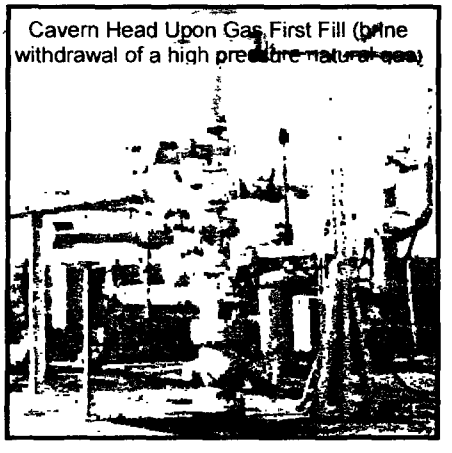
The particular advantages of the storage of natural gas in salt caverns are as follows:

- ✓ The individual volume of a cavern and thus, the working gas volume of the entire cavern can be pregiven and so stipulated in the design.
- ✓ The capacity of a cavern can be gradually adapted by corresponding development stages to meet the rising demand.

Gas Cooler and Preheating Installations



Cavern Head Upon Gas First Fill (brine withdrawal of a high pressure natural gas)

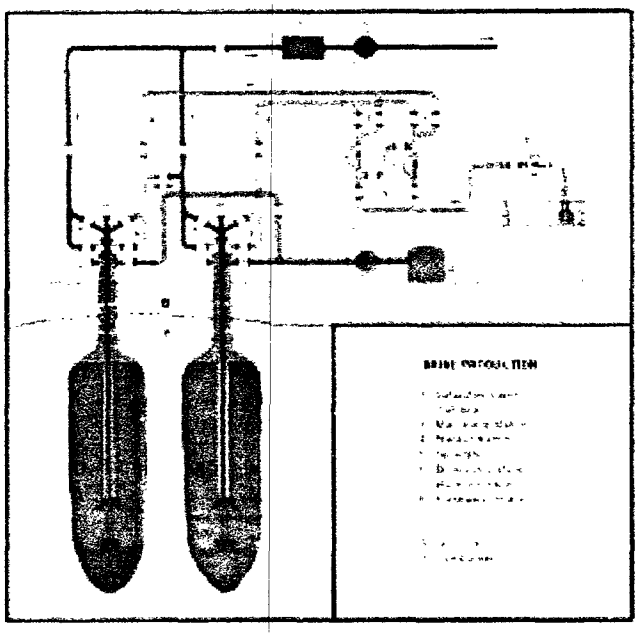


- ✓ The play in working pressure and the working gas are indeed dependent on the depth of the salt reservoir, but can be adapted within wide ranges to meet the requirements. The working gas volume can be 80% and above of the volume stored.
- ✓ The high withdrawal rates permit the use of salt cavern storages not only for purposes of seasonal compensation, but also to cover short-term occurrence of very large output peaks.

Brine Production

Construction of salt caverns is technically equivalent to the production of brine; salt cavern technology is therefore also brine production technology.

Depending on the geological factors, the following leaching methods are usually applied for brine production:



- Brine production by freshwater injection into a well according to the usual cavern construction method.

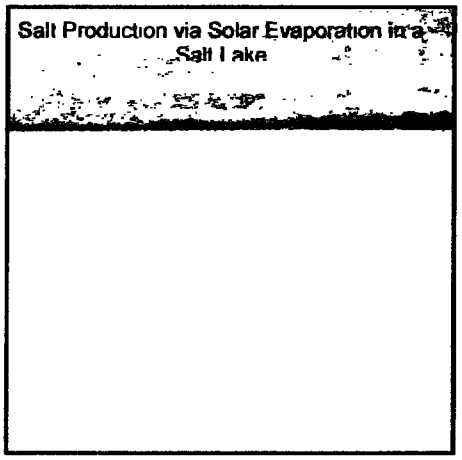
- With salt deposits of small thickness, brine production from two or more wells is recommended. Due to the low leaching stop level these individual cavern develop more quickly in a horizontal direction and coalesce to form one cavern. This is followed by the introduction of the freshwater into one well and the discharge of the brine through the other wells.

- The hydraulic linkup of two or several boreholes can also be produced using the frac method. This occurs due to the heaving of weakness zones at the basis of the salt deposits as a result of hydrofracturing. Finally freshwater is injected into a well, flows through the frac zone and rises to the surface out of the other wells in the form of brine, thereby producing a premature saturation of the brine, an enlargement of the spacing of the wells and a reduction in their number.

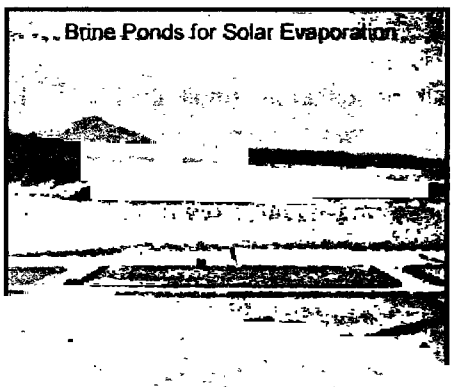
Vacuum Crystallisation Plant

An optimum of efficiency can be achieved, if brine production for industrial brine processing can be combined with the construction of underground storages.

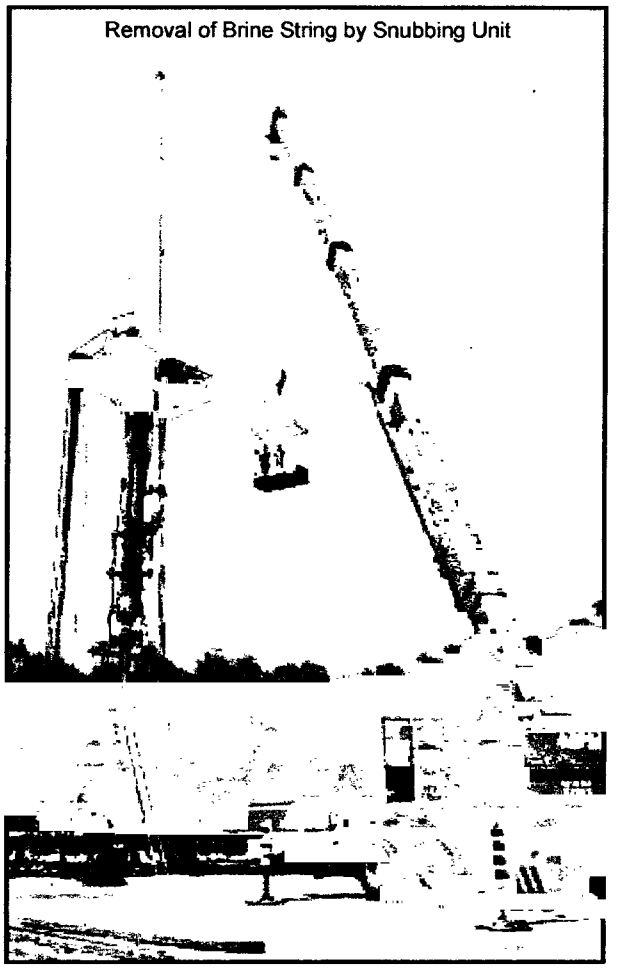
Salt Production via Solar Evaporation in a Salt Lake



Brine Ponds for Solar Evaporation

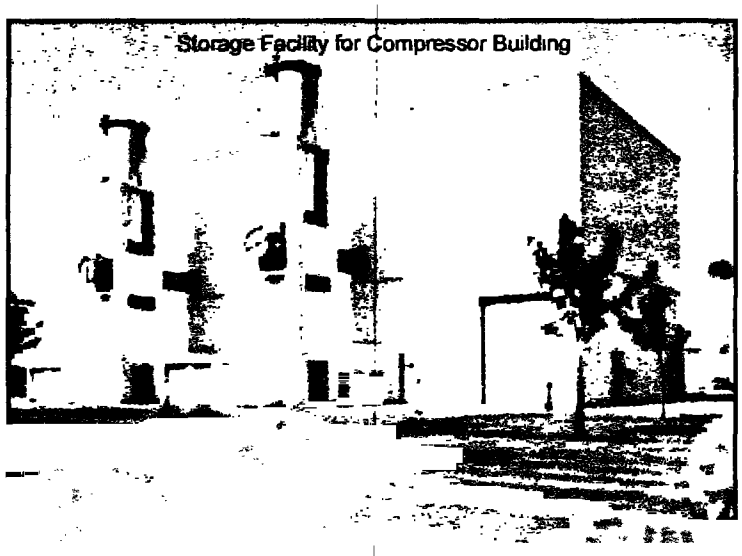


Removal of Brine String by Snubbing Unit



Operation and Maintenance

Facilities for the underground storage of gas require expert operation and maintenance.


Storage Facility for Compressor Building

Tightness is the most essential consideration. Corrosion or poor cementation may be the cause of leaks.

Apart from the safety-oriented operations, reservoir-engineering support is also necessary to prevent damage to the reservoir or the equipment. It is, for instance, essential to optimise operating procedures and to continuously improve models developed for reservoir simulation.

If flow to the well detoriates or other problems occur, it may also become necessary to carry out a well workover. New perforations in the tubing or sand-blasting may substantially improve well performance.

Water encroachment may also be a cause for well workovers, if tubing perforations are too deep. Appropriate well maintenance will always be essential for maximizing benefits from an underground storage reservoir.

Salt storage caverns also require regular engineering support. Cavern shape must, for instance, be surveyed to monitor convergence and to compare convergence rates with rates predicted.

APPENDIX –S PUBLIC CONSULTATION MEETING QUESTIONS AND ANSWERS

QUESTIONS AND ANSWERS

Question: What are the reasons for not using surface water instead of groundwater during the creation of caverns?

Answer: During the alternative evaluation for water supply, the necessary researches were made. Accordingly, no surface water could be determined at a location nearby the project area in the surroundings. The closest surface water source is the Eşmekaya Lake located approximately 30 km northwest of the area. The 4.500 ha area at the mentioned region has been declared as a Site Area in 1992 under the name of Eşmekaya Reed Bed, and declared as Wild Life Protection Area in 1994. In this respect, it will not be possible to obtain the approximately 570 m^3/h (~ 4.993.200 m^3/year) water requirement necessary for the proposed project from a site area. Additionally, bringing water from a source 30 km distant would add extra costs to the project.

The above mentioned explanations are given at Final Report Section 7.3.

Question: How much are will the project cover? Will the regional stockbreeding be affected from the project? Will the project prevent animal transits?

Answer: The project is comprised of (I) surface plants / facilities, (ii) wellheads and (iii) pipelines. The area of the surface facilities is 500 m x 800 m. The wellheads possess a very small area, and it is estimated that this area will be at most 20 m x 20 m. The pipelines will pass underground. In this respect, except for the surface facilities and wellheads, no area will be occupied to negatively affect the animal transit or the agricultural activities.

Question: What measures will be taken for to prevent collapsing and leakage possibilities at the wells opened by TPAO in the proximity and the cavities at 100-300 m depths when natural gas is pumped to the caverns?

Answer: During the drilling activities, it is possible that cavities or groundwater sources be present at the formations transited until an impermeable area is reached. In this case, casing will be placed along the drilling cross section until the impermeable formation and the drilling activities shall be executed within this caisson. In this way, there will not be any leak or leakage when any cavity is reached.

In this respect, the drilling activities performed at both of the wells have been realized in the explained manner. For both of the wells, a caisson has been placed until an impermeable formation is reached at approx. 660 m, and the drilling activities were performed within this caisson. Therefore, it has been prevented for the underground sources to be negatively affected from potential drilling mud leak.

Question: What are the measures to be taken during drilling studies for the collapses that may arise due to the possibility of mud filling to these cavities located underground?

Answer: The answer to this question is the same as the preceding one.

Question: What will be the environmental effect of the nitrogen gas used for impermeability?

Answer: When it is considered that the nitrogen gas ratio in the air we breathe is 78%, it is not foreseen that the nitrogen gas used in the scope of the project to have any negative effect.

Question: How good is the durability to earthquakes?

Answer: The project site is located at one of the least seismic and most stable regions of Anatolia. However, the past seismic history of Turkey provides evidence that earthquakes of 6,5 magnitude can arise at almost any unexpected location within the country. Consequently, in terms of the results of such a variable case, it would be a more foresighted approach to account for a "long-term" seismic risk in the site. When evaluated in long term (average return period within 5000 year term), PGA (peak ground acceleration) will be about 0,3g. When evaluated in short term (which is approximately 500 year return period), PGA will bear a value of 0,17g.

In this respect, during the design of the facilities in the project site, the earthquake magnitude that has been estimated with the worst case scenario has been taken into account. In this manner, every kind of measure has been taken for the surface facilities in case an earthquake occurs. Additionally, the studies performed at the project site, point out that the caverns to be constructed 700 m below the ground will not be affected from any seismic activity.

However, there will be safety valves at the caverns at several depths along the line extending from the surface down to the cavern mouth. These valves will not only be automatically closed during earthquakes, but also in case of all extraordinary phenomenal conditions.

Question: How will the pasture, treasure and agricultural fields be affected? Isn't it necessary for the Parcel and Plate numbers of the wells to be opened and the estates to be utilized at the project to be known?

Answer: The project is currently in the stage of feasibility and the "certain" location of the project has not yet been determined. In this respect, it is not possible to determine the parcel numbers of the project site. However, before the commencement of the construction activities in the region, an application is to be made to the Ministry of Agriculture and Rural Affairs Agricultural Production and Development General Directorate (TUGEM) regarding the fact that whether the project site is included within the 4342 issued Pasture Law. In case the area is a pasture, permission will be taken from TUGEM for allocation purpose modification before the commencement of the investment.

Question: Will the drinking water of the Sultanhani District be affected from the project?

Answer: All the water transmission and discharge lines will be transmitted with closed pipe system. Additionally, it has been researched by DSI whether the water to be necessary for the leaching is present in the region and approval has been given regarding the fact that the approximately annual 5 million m^3 water necessary for this project can be met from the

underground water resources. In this respect, it is not expected for any negative effect to occur on the drinking water resources in the scope of the project.

Question: Can the brine obtained as a result of the leaching of the salt formation be used for irrigation purposes after treatment?

Answer: It is possible for to treat the brine and bring it to the irrigation water criteria. In this respect, the water taken from sea in the Arabian countries is treated. However, this is a very costly process. Since the water amount to arise at the end of the leaching process is very high, and due to the fact that the treatment of the arising brine being very costly, this is not a cost-effective method.

Question: Will the fact that groundwater being used for the project, negatively affect the agriculture in the region?

Answer: The utilization of ground water during the project will not be continuous and shall only be used during the period of opening the caverns (approximately 10 years). In this respect, the opinion of DSI has been taken regarding the ground water reserves in this area and the mentioned institution has allocated a total of approximately 5×10^6 m^3 of water for this project. Therefore, an approximate 10-year utilization of the ground water is not expected to negatively affect the irrigation activities of the region.

Question: What will be the effect of the brine arising as a result of the leaching of the salt formation?

Answer: Detailed explanations are present at section 5.2.5.4 of the EIA Report for this topic. Accordingly, the brine obtained as a result of leaching operation will be discharged to the Tuz Golu. For this aim, a Niggle Diagram has been prepared to clearly determine whether the Tuz Golu shows similar characteristics with the brine (brine). The mentioned diagram is being used for a long time by DSI for basin and irrigation water projects and by Bank of Provinces for drinking water projects, to determine whether different water are of the same source or not. This diagram draws the anion and cation concentrations of the water sources on a single-sided logarithmic scale and the anion-cation changes of the water are observed. In the same-sourced waters, the anion-cation changes at the waters shows similarity.

In the scope of the Tuz Golu UNGSP (Underground Natural Gas Storage Project), the analysis results of the water sample taken from the Tuz Golu is compared with the analysis values of the salt cores via a Niggle Diagram. In the diagram where the anion and cation concentrations are taken into account, it has been seen that the salt cores and the anion-cation changes of the Tuz Golu show a similarity. In this respect, it can be drawn out that the Tuz Golu and the water to be obtained by leaching the salt cores are of the same source.

As a result, the discharge of the brine to be obtained as a result of the leaching of salt cores to Tuz Golu will not negatively affect the present quality of the lake. Additionally, as a consequence of the discharge of the brine to be obtained from the salt beds, which are a continuation of the salt beds located under the Tuz Golu and having the same composition

with the Tuz Golu, to the lake will positively affect the lake, which is subject to continuous water loss.

In a similar in Germany, the fact that the discharge of the leaching waters for long years to a fresh water source (Fulda River) near the project site has not negatively affected the lake, gives a general idea regarding the environmental issues mentioned above.

Note: By the regional community of Bezirci Lake nearby the project site, it has been stated that *Kaisers* occur from time to time in the region.