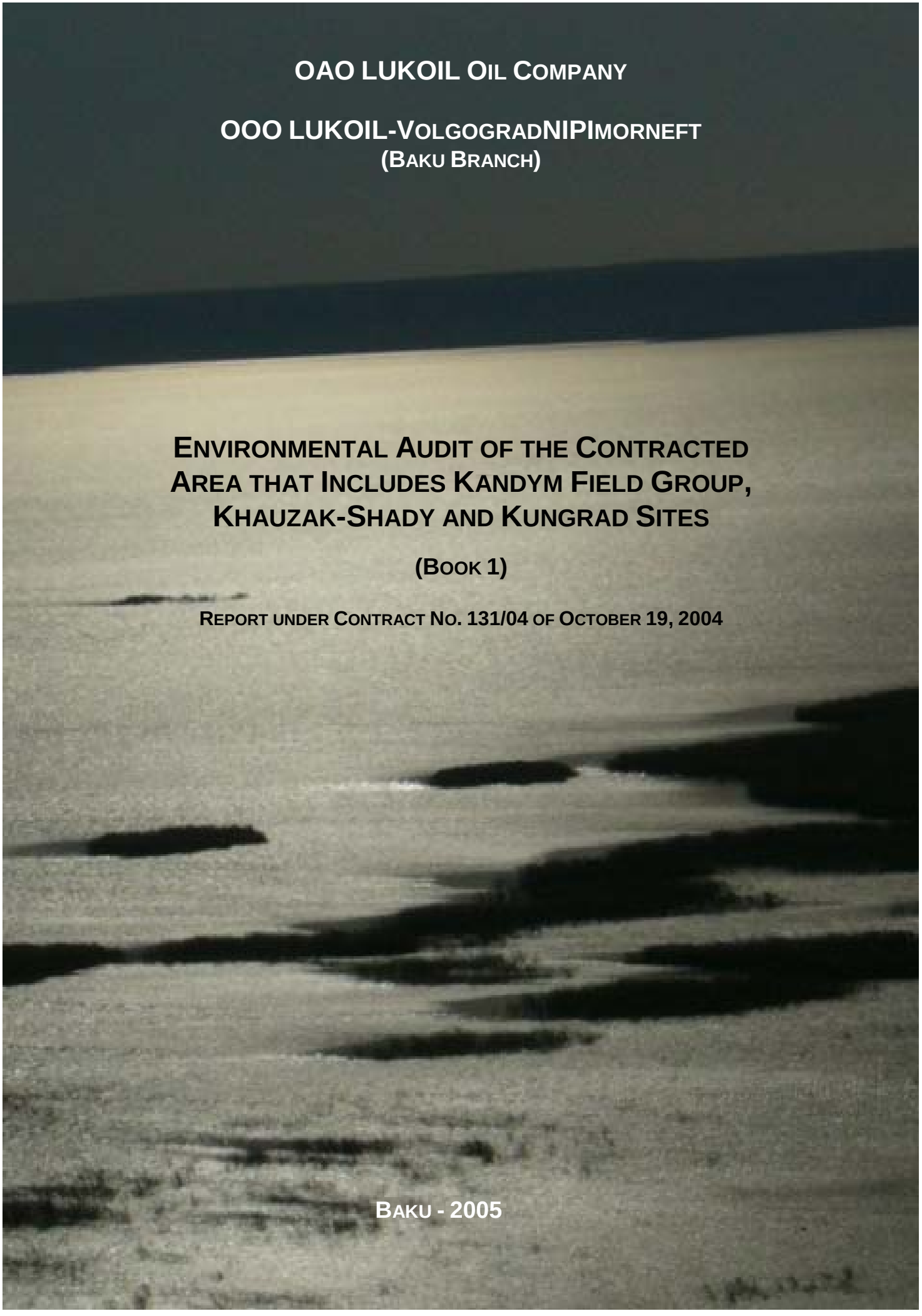

OAO LUKOIL OIL COMPANY

OOO LUKOIL-VOLGOGRADNIPIMORNEFT
(BAKU BRANCH)

ENVIRONMENTAL AUDIT OF THE CONTRACTED AREA THAT INCLUDES KANDYM FIELD GROUP, KHAUZAK-SHADY AND KUNGRAD SITES

(BOOK 1)

REPORT UNDER CONTRACT NO. 131/04 OF OCTOBER 19, 2004

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Author – Baku Branch OOO LUKOIL-VolgogradNIPImorneft

Co-authors – A.G. Khanlarov, Candidate of Technical Sciences, Director of BB of OOO LUKOIL-VolgogradNIPImorneft

V.T. Mamedov, Manager of Scientific and Production Operations of BB of OOO LUKOIL-VolgogradNIPImorneft

Z.R. Akhmedov, Leading Expert of BB of OOO LUKOIL-VolgogradNIPImorneft

M.A. Khanlarov, Manager of BB of OOO LUKOIL-VolgogradNIPImorneft

Participants – OAO UzLITIneftegaz (Chapters 1, 3, 5 and 6)

State Specialized Inspectorate for Analytical Control of the State Environmental Committee of the Republic of Uzbekistan (Chapter 6)

Design Bureau with Pilot Plant under the Nuclear Physics Institute of the Uzbek Academy of Sciences (Chapter 6)

Gosbiocontrol of the State Environmental Committee of the Republic of Uzbekistan (Chapter 4)

OOO “EKOTEXPROEKT” (Chapter 6)

National University of Uzbekistan (Chapter 3)

State Research Institute for Soil Science and Agrochemistry of State Committee for Land Resources of the Republic of Uzbekistan (Chapter 3)

State Geological Enterprise «Uzbekgidrogeologiya» (Chapter 3)

GIDROINGEO Institute (Chapter 3)

“Ecolex” Environmental Law Association (Chapter 2)

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TERMS AND DEFINITIONS

Accumulation	Deposition, sedimentation – common term denoting the processes of terrestrial accumulation of terrigenous, volcanogenic, chemogenic and biogenic material, from which sedimentary rocks are formed. Depending on prevalence of one or another geological factor, the following accumulation types are distinguished: aqueous, wind-driven, glacial, biogenic, anthropogenic and others.
Audit of environmental management system	Regular and documented process of verifying the audit evidence obtained and assessed in an unbiased manner for checking the compliance (or non-compliance) of the organization's environmental management system with the criteria of such system's audit, and informing the client of the findings obtained in the course of such process.
Environmental auditor	Person qualified for conducting environmental audits.
Audit team	One or more auditors appointed to conduct a particular audit. Note. Audit team may also include technical experts and probationary auditors. One of the team's auditors performs the functions of leading auditor.
Audit evidence	Audited information, records or statements relating to particular fact. Note. Audit evidence, which may be qualitative or quantitative, are used by the auditor to check the compliance with audit criteria. Audit evidence is usually based on inquiries, study of documents, observations of activities and conditions, on available measurement and test results, or other tools within the scope of audit.
Biota	Historically established total collection of plant, animal and microbe species inhabiting some large area.
Leading environmental auditor	Person qualified for managing and performing environmental audits.
Environmental impact	Any negative or positive environmental change resulting, fully or partially, from organization's activity, its products or services.
Audit conclusion	Auditor's professional judgment or opinion on the audited entity, which opinion is based on audit findings.
Ground	Generalized term for any rock that mainly occurs in weathering zone of the Earth crust.
Interested party	A person or group of persons interested in entity's ecological efficiency or affected by such efficiency.
Client	Entity ordering an audit. Note. Client may be represented by audited or other entity en-

	titled to order an audit pursuant to regulations or on a contractual basis.
Audit criteria	Policies, methods, procedures or requirements, pursuant to which an auditor verifies the data gathered in respect of an audited entity. Note. Such requirements may include standards, guidelines, organization's specific requirements, as well as legislative or regulatory requirements.
Petroleum	Any forms of petroleum, including crude oil, liquid fuel, oily wastes and refined petroleum products.
(Audited) entity	Particular environmental activity, event, condition, management system and/or information on any of the above.
Environment	External environment, in which an entity functions, including air, water, ground, natural resources, flora, fauna, human and interrelation between them. Note. In this context, the term "external environment" extends from the environment on organization's level to global system.
Organization	Company, association, firm, exercise, regulatory authority or agency or any part or combination thereof, incorporated or unincorporated, public or private, which perform their functions and have their own administrative body. Note. When used in respect of organizations with several functioning organizational units, one such unit may be defined as organization.
Planned environmental index	Detailed requirement applicable to efficiency, which is quantified where practicable, imposed on organization or any part thereof, resulting from target environmental indexes and ought to be complied with in order to achieve target indexes.

Continuous improvement	Process environmental management system enhancement aimed at increase of overall environmental efficiency in accordance with organization's environmental policies. Note. This process does not necessarily take place in all spheres of activities at the same time.
Pollution prevention	Use of processes, effect-oriented techniques, materials or product that allow avoiding pollution, its reduction or control, and may include recycling, refining, process modifications, management mechanisms, efficient use of resources and replacement of materials. Note. Environmental impact mitigation, efficiency upgrading and cost reduction are also referred to potential benefits of pollution prevention.
Audited organization	Organizations subjected to audit.
Response	System of measures aimed at prevention and relief of accidental oil spills and personal security assurance people.

Audit findings	Results of the audit evidence assessment, which results are arranged in compliance with customary audit criteria. Note. Audit findings serve as a basis for audit opinion.
Wind rose	Prevailing wind direction in the given region.
Environmental management system	Part of the general administrative management system that comprises organizational structure, planning, responsibility, techniques, procedures, processes and resources required for development, introduction, implementation, analysis and support of environmental policy.
Technical expert	Person providing to audit team its knowledge or expertise with regard to particular issue, though not participating in the team's activity as an auditor.
Target environmental index	Overall target index reflecting environmental condition, which is quantified where practicable, and arising from the environmental policy pursued by the organization.
Emergency	Situation in particular area, which has formed as a result of an accident, natural hazard, disaster, natural or other calamity, which may entail or have entailed fatalities, damage to health or environment and significant loss of property.

Environmental aspect	Element of organization's activity, its products or services, which may interact with environment. Note - Only those environmental aspects are important that produce or may produce a significant environmental impact.
Environmental audit	Regular and documented process of verifying the audit evidence obtained and assessed in an unbiased manner for checking the compliance or non-compliance of certain types of environmental activities, events, conditions, administrative management systems or any information on the above items, and client notification of the findings obtained in the course of such process with applicable audit criteria.
Environmental policy	Statement by organization of its intentions and principles associated with its overall environmental efficiency, which serves as a basis for operation and establishment of target and planned environmental indexes.
Environmental efficiency of environmental management system	Measurable results of environmental management system associated with organization's control of environmental aspects based on its environmental policy, as well as on target and planned environmental indexes.

1. INTRODUCTION

1.1. Background Note on Gas-Condensate Fields of Contracted Areas

The currently suspended discoveries of Kandym group are on the balance sheet of the Administration for Gas Production and Transportation (AGPT), Gazlitransdobycha, of Uztransgaz joint-stock company, while the fields of Khauzak group are on the balance sheet of Mubarekneftegaz, a subsidiary unitary enterprise of AK Uzgeoneftegazdobycha. Both joint-stock companies are, in their turn, part of Uzbekneftegaz national holding company.

1.1.1. Kandym Field Group

Gas condensate fields (in the order of discovery) Kandym, Akkum (1966), Parsankul (1967), Hodgi (1969), Kuvachi Alat (1973), Western Hodgi (1977), and Kumli (2000) are located in Karaulski district of Bukhara oblast of the Republic of Uzbekistan (RU).

Prospecting operations aimed discovery of hydrocarbon reserves of the fields within the group in question started in 1960-1963. This resulted in the discovery of sulphurous gas accumulations confined to carbon deposits of the Upper Jurassic. The total explored gas reserves within these accumulations approved by the State Reserves Committee as C_1 category reserves make up 201.8 bln cu. m. The majority of them (76%) is represented by the gas reserves of Kandym field – 152.8 bln cu. m (table 1.1) [4].

Table 1.1 **- Commercial reserves of sulphurous accumulations of Kandym field group approved by the State Reserves Committee**

Field	Reserves				
	gas, bln cu. m	condensate		sulphur	
		ths tn	g/cu. m	ths tn	g/cu. m
1	2	3	4	5	6
Kandym	152.843	4,543/3,939	29.0	4,214	19.35
Akkum	10.972	669/535	61.0	79	7.17
Western Hodgi	5.303	101/90	19.0	211	39.70
Parsankul	7.566	288/230	37.1	119	15.69
Hodgi	1.332	38/35	28.0	8	10.00
Kuvvachi-Alat	23.758	356/242	15.0	1,452	60.84
TOTAL	**201.774**	**5,995/5,071**		**6,083**	

High hydrogen sulphide content of formation gases is a ground to approve commercial sulphur reserves across Kandym group fields, and Kandym field where the major resources of hydrocarbons and sulphur are concentrated is viewed as a base field in this field group.

It is located 50 km south of Gazli within a desert plain. The structure was discovered in 1965-66 in the course of seismic survey. In 1966, deep-hole exploratory drilling began across the area, during which gas inflow was registered in the 1st wildcat at the interval of 2055-2111 m from XV-1 horizon. Further prospecting operations confirmed the gas content of XV-2 horizon. Kandym field accumulations are of fully sheeted, arc type, and are characterized by the following parameters: formation pressure – 236.7-237.5 kg/sq. cm, formation temperature - 88-90 ºC.

Kandym field gas is classified as a hydrosulfuric-carbon dioxide-hydrocarbon gas. It has high methane content (92-94 volumetric percent). The ethane content in the gas varies within the range of 2.55-3.02, butane content – within 0.39-0.72%. It also has high content of hydrogen sulphide, whose concentration varies within 1.43 – 2.51%, which corresponds to 19.35-34.00 grams of sulphur per cubic meter (in standard conditions).

The Kandym field condensate is light, methane aromatic, sulphurous, and petrolic. The specific weight of the condensate is 0.784-0.798 grams/cu. cm.. The yield of fractions boiling up to +200ºC is 55-67%. The content of aromatic hydrocarbons in the gasoline cut is 32.7-36.3%, while that of the methane hydrocarbons is 33.5-37.8%.

By now, 32 production wells were drilled at Kandym field, and one field wildcat was left. Those wells are suspended until the start of gas production.

1.1.2. Khauzak Group

In terms of its administrative location, Khauzak-Shady gas-condensate field is in Alat district of Bukhara oblast, Republic of Uzbekistan. The closest settlement is that of Alat, located 60 km to the north-west. Dengizkul community is 8-10 km north of the field, while Mubarek, being a central town of the district (Kagan-Karshi railway line) is 60 km north-west of the field. Urta-Bulak gas field is 20 km south-east of the field.

The exploration drilling at Khauzak-Shady field was commenced in 1967. Drilling well 1 on Khauzak area in 1968 discovered commercial gas content of the Upper Jurassic carbonate deposits. The key prospecting operations across the area were completed in 1974, although supplementary exploration of some of its plots continued until 1993. The total of 20 wildcats and 1 observation well were drilled across the area of Khauzak field.

Most of them (16 wells) were drilled over 1967-74 and abandoned as wells that can no longer be used for the intended purpose. Currently, almost all those wells are flooded with the waters of Dengizkul lake. Over 1988-93, two more wildcats, wells 301 and 302, and observation well 242 were drilled. Those were recorded as part of observation well stock as of 10/01/01.

According to the forecasts, the extractable reserves of the gas accumulation of Khauzak field over the lifetime of the field is 49.7 bln cu. m, which is 84.6% of its in-place reserves (58.8 bln cu.

m.). 510.36 ths tn of stable condensate ($C_{5+higher}$ fractions) will be utilized from this gas volume, and 2,666 ths tn of tank sulphur will be produced.

In 1972, exploration drilling started at Shady area located north of Khauzak field, and in 1974 while testing well 1 of this area commercial gas content of the Upper Jurassic carbonate deposits was discovered, which was then confirmed by testing exploration wells 2 and 3. Drilling wildcat wells 4, 5 and 6 along with drilling and testing exploration wells 1, 2 and 3 resulted in a conclusion that Shady area together with Khauzak represent a common large gas-condensate field. The total of 8 wildcats were drilled across Shady area.

1.1.3. Kungrad Plot

The area of Ustyurt region of the Republic of Uzbekistan is 110 ths sq. km. According to the data available from deep-hole drilling, most part of its area is categorized as the area of low or very low degree of exploration. Over the period of more than 35 years only two large (Shakhpakhty, Ugra) and 5 small/very small gas fields in terms of gas reserves (Kuanysh, Western Barsakelmes, Karachalak, Akchalak, and Kokchalak) were discovered.

A series of activities implemented back in 1988 helped significantly increase the scope of geological prospecting operations, which resulted in 5 new discoveries of gas condensate fields over the last 3 years: Berdakh, Eastern Berdakh, Shagyrlyk, Surgil, Western Aral. Also, gas showings were discovered in Aral and Uchsay structures. On Northern Ugra area the operations resulted in gas inflow from Palaeozoic deposits, and the saturation of Jurassic stratum is now being assessed.

The territory of Kungrad blocks is characterized by low degree of geological and geophysical exploration. Therefore, simultaneous seismic survey operations and drilling of exploration wells is planned at this area.

1.2. Basis to Conduct Environmental Audit of Contracted Area that Includes Kandym Field Group Plot, Khauzak and Shady Plots, Kungrad Plot

According to the Production Sharing Agreement relating to Kandym field group plot, Khauzak and Shady plots and Kungrad plot dated June 16, 2004 between the Republic of Uzbekistan and the investors consortium consisting of OAO LUKOIL, NHK Uzbekneftegaz (the PSA), the interests of the participating Companies that constitute the Investor (clause 3.1 of the PSA) shall be in the relation of 9:1 (fig. 1.1).

Figure 1.1 – **Interests of participating Companies that constitute the Investor**

In addition, OAO LUKOIL shall assign all its rights and obligations in full to LUKOIL Overseas Uzbekistan Ltd. (clause 3.3 of the PSA) acting on behalf of the association of legal entities constituting LUKOIL Overseas Uzbekistan Ltd. and the Uzbek participant.

The Contracted area includes the following (fig. 1.2-1.4):

- ✧ Contracted area for development – Kandym field group plot with the area of 1,840 sq. km, and Khauzak and Shady plots with the area of 320 sq. km.
- ✧ Contracted area for exploration – Kungrad plot with the area of 3,700 sq. km.

Pursuant to clause 23 of the PSA – Health, Safety and Environment – LUKOIL Overseas Uzbekistan Ltd. shall be obliged to conduct oil and gas operations in an efficient and safe manner, subject to the law of the Republic of Uzbekistan and in compliance with the generally accepted standards of international oil and gas industry. Any possible impact on the environment, including effects on the air, ground surface, subsoil, lakes, rivers, flora and fauna, crops and other natural resources must be minimized.

Therefore, for the purpose of assessing the current environmental condition of the Contracted areas, pursuant to clause 23.4 of the PSA, surveys of environmental condition were organized – ***Environmental Audit.***

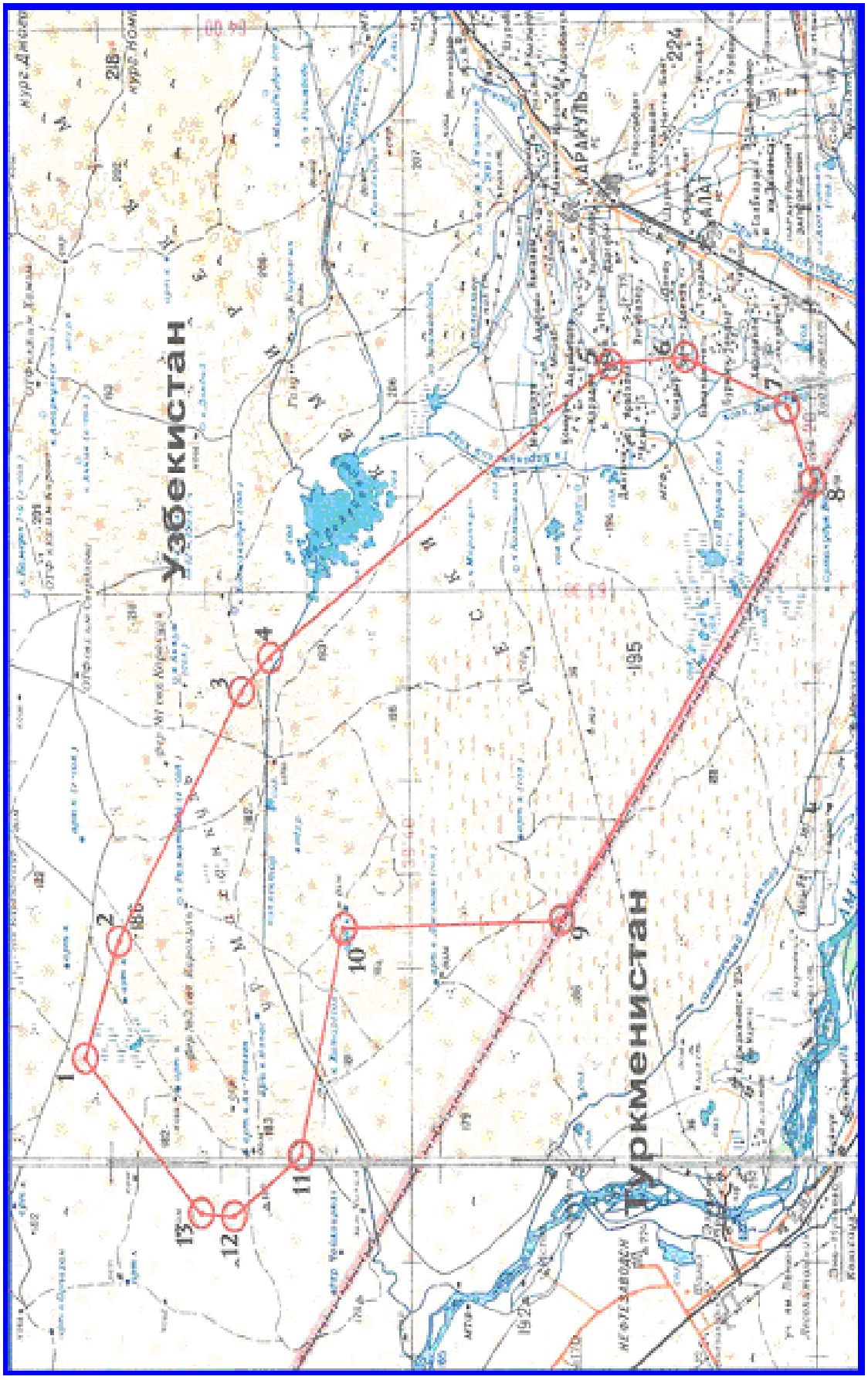


Figure 1.2 – **Diagram of Kandym field group plot**

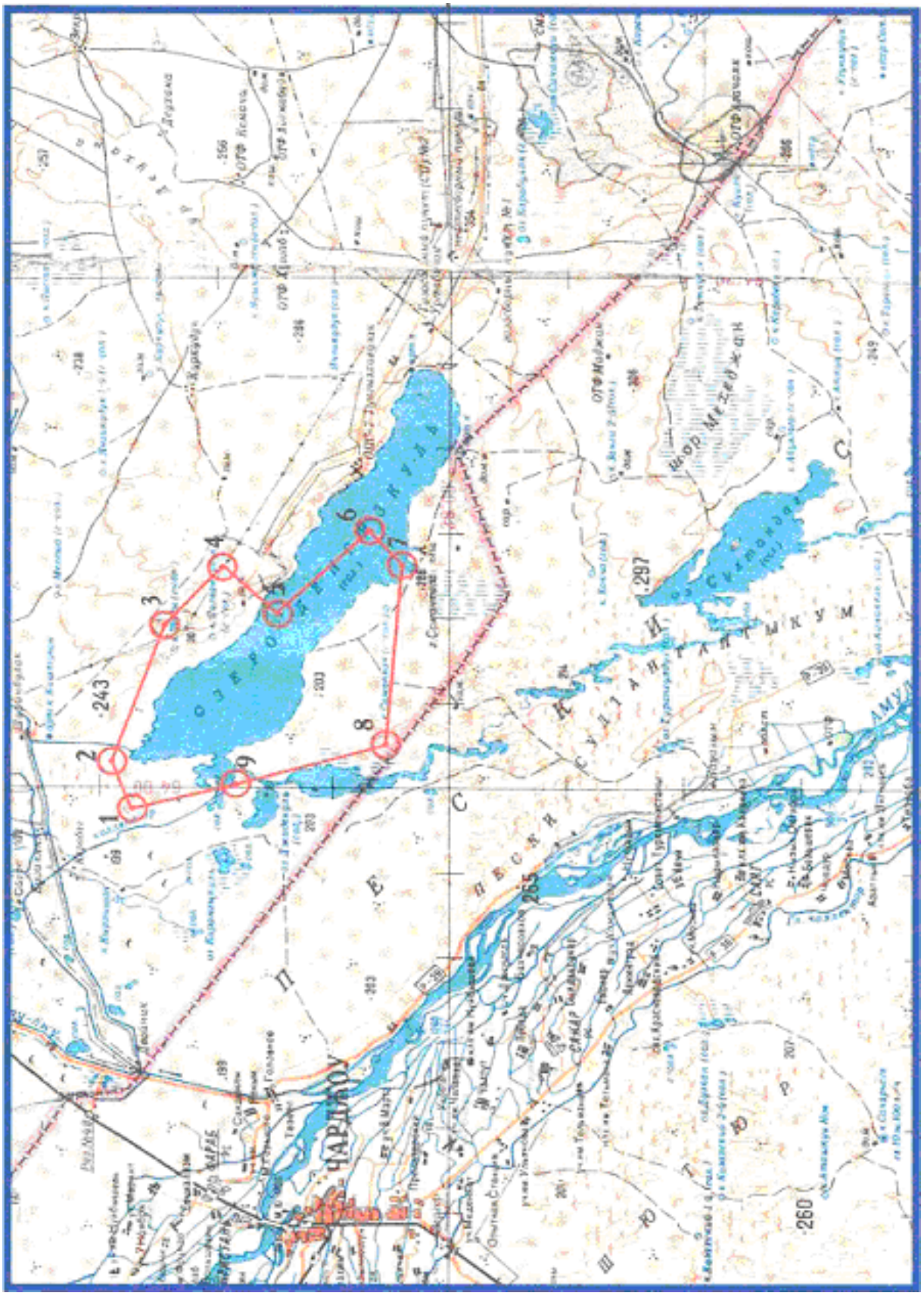


Figure 1.3 – **Diagram of Khauzak and Shady plots**

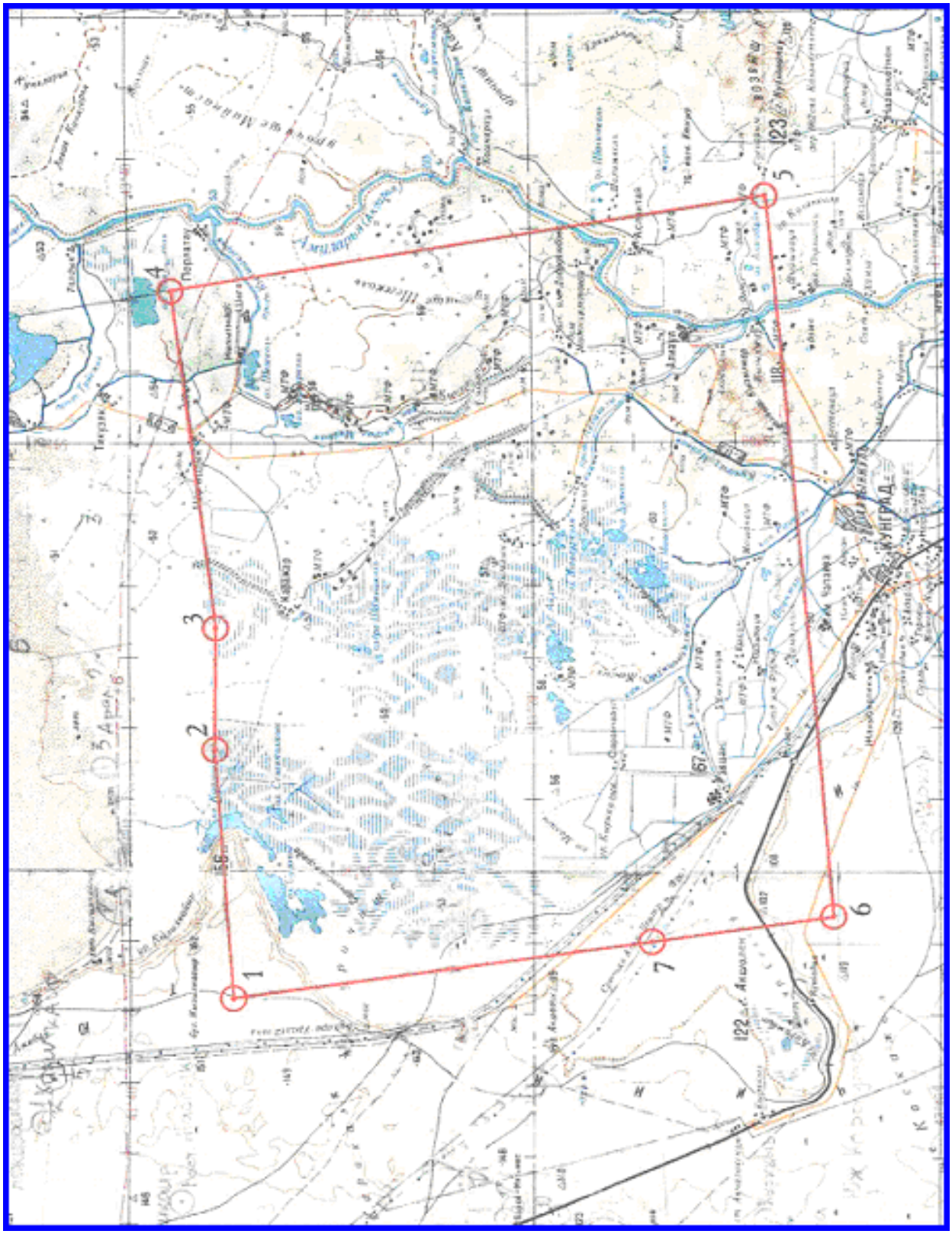


Figure 1.4 – **Diagram of Kungrad plot**

1.3. Techniques for Conducting Environmental Audit of Contracted Areas

The process of assessing the environmental condition is developed to identify the significant potential impact by the design activities on the environment and vice versa. Some of those effects may be determined in a quite accurate manner. However, the exact numerical value can only be determined accurately when the operations start out, and when they are finally over. The appropriate program of environmental audit must be used as a tool to confirm the environmental impact forecasts that were made during the assessment of the initial condition.

As provided by the PSA, environmental Audit of the Contracted area, shall be conducted in compliance with:

- ✧ GOST R ISO 14011-98. Environmental Auditing Guidelines. Audit Procedures, Auditing of Environmental Management Systems.
- ✧ GOST R ISO 14004 – 98. Environmental Management Systems. Requirements and User Guide.
- ✧ GOST R ISO 14004 – 98. Environmental Management Systems. General guidelines on the principles, systems and operation tools.
- ✧ GOST R ISO 14010-98. Environmental Auditing Guidelines. Basic Principles.
- ✧ GOST R ISO 14012-98. Environmental Auditing Guidelines. Qualification criteria for environmental auditors.
- ✧ GOST R ISO 14050 – 99. Environmental Management Systems. Glossary.
- ✧ GOST R ISO19011-2002 INTERNATIONAL. Guidelines on Auditing Management Systems, Quality Systems and/or Environmental Management Systems.
- ✧ Environmental Policies of the European Bank for Reconstruction and Development (EBRD). 2003.
- ✧ Operational Guidelines of World Bank. BP 4.01-1999. Banking Procedures.
- ✧ Operational Guidelines of World Bank. BP 4.01-1999. Banking Procedures. –

the requirements of Uzbek laws and regulations, and in the format of International Financial Corporation (IFC).

Pursuant to GOST R ISO 14011-98, the audit of environmental management systems is conducted to achieve certain goals. Typical goals of such audit would be the following:

- **a.** check compliance of the organization's environmental management system with the criteria of the environmental management system audit;
- **b.** check whether the organization has an environmental management system in place and whether it maintains it in a proper manner;
- **c.** identify potential improvements of the organization's environmental management system;
- **d.** assess if the internal process for management review can ensure that the environmental management system is always adequate and efficient;
- **e.** conduct assessment of the environmental management system of an organization that intends to established contract relations, for example, a potential supplier or partner in a joint venture.

The standard also provides for the techniques for collection of audit evidence and establishes the requirement to collect sufficient audit evidence to be able to determine if the organization's environmental management system complies with the criteria of environmental management system audit.

Note that according to GOST R ISO 14011-98 the audit evidence was collected via inquiry, review of documents, observation of the operations and conditions, and events of incompliance with the criteria of environmental management system audit were registered. The information collected via inquiry was confirmed by additional data obtained from independent sources, for example, observations, records and measurements. The statements that could not be checked, were marked as unchecked information. The process of conducting environmental audit is reflected in the form of a diagram in figure 1.5.

Given the above, this work includes the following actions:

- Examine the basis to conduct Environmental Audit of the Contracted Area that includes Kandym field group plot, Khauzak and Shady plots, Kungrad plot, defining scope of work.
- Description of previous operations (exploration and production drilling of gas wells) on the Contracted areas.
- Determine legal framework of use of the Contracted areas. Analyze regulations of the Republic of Uzbekistan, study international treaties relating to environmental protection, rational use of natural resources, health and safety to which the Republic of Uzbekistan is a party.
- Study requirements of the PSA in the field of compliance with HSE requirements.
- Review geological and geographical features, which includes the following:
  - development of geography, climatic and meteorological conditions on the territory of the Contracted areas;
  - ground (sand) movement;
  - general description of water bodies on the territory of Contracted areas, their origin and degree of pollution;
  - tectonics, description and condition of soils;
  - description of the cross-section and composition of ground water;
  - seismic conditions.
- Description of bio-resources of the Contracted Areas, includes the following:
  - the most common flora and fauna (insects and reptiles, mammals, birds), their species and groups;
  - species listed in the Red Book;
  - zoning of the territory of the Contracted areas according to their bio-sensitivity;
  - description of species who are indicative of man-caused effects;

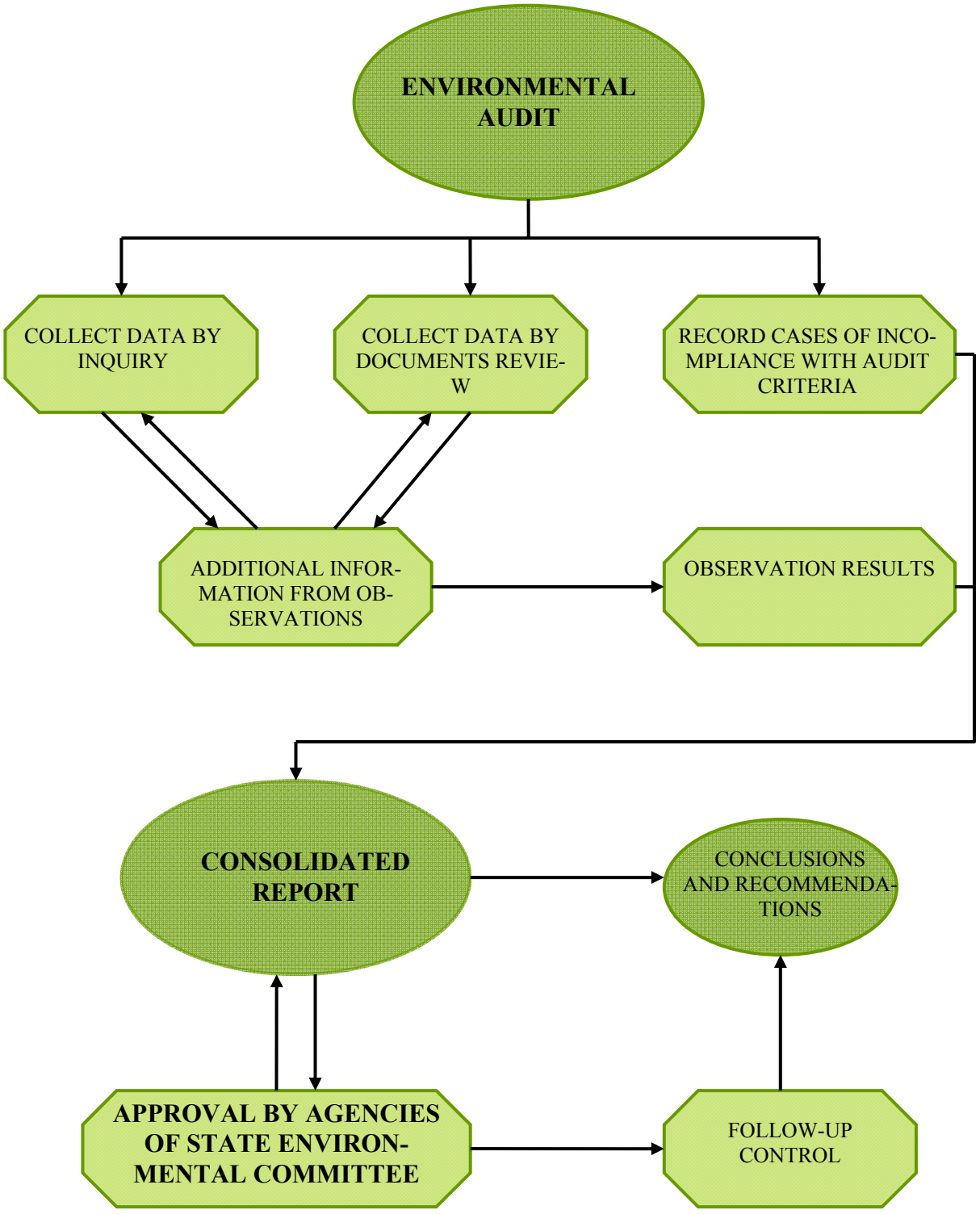


Figure 1.5 – **Environmental audit flowchart**

- ✦ environmental restrictions applicable on the territory of the Contracted areas, including special areas of preferential protection (nature reserves, wildlife preserves, etc.).

✧ Description of social and economic environment and the current situation in the settlements located on the Contracted areas, which includes the following:
- ✦ historical and ethnographic analysis of the culture and way of life, etc.;
- ✦ information on archaeological excavations of historical value;
- ✦ social and economic environment and demography;
- ✦ sanitary and hygienic conditions.

✧ Description of techniques for conducting field surveys at Khauzak and Shady plots, Kandym field group plot, and Kungrad plot, and laboratory research aimed at the following:
- ✦ determine physical and chemical composition of the air (surface water bodies and ground water), and soil;
- ✦ microbiological study;
- ✦ ecotoxicological and pathomorphological analysis of flora and fauna samples collected and caught on the plots under study;
- ✦ determine the radiation environment on the Contracted areas.

✧ Description of the initial environmental condition of the Contracted Areas, which includes the following:
- ✦ initial environmental condition of Khauzak and Shady plots (physical and chemical composition of the air, soil, and water, microbiological and radiation conditions);
- ✦ initial environmental condition of Kandym filed group plot (physical and chemical composition of the air, soil, and water, microbiological and radiation conditions);
- ✦ initial environmental condition of Kungrad plot (physical and chemical composition of the air, soil, and water, microbiological and radiation conditions);

✧ Ecotoxicological and pathomorphological survey of plants and animals collected and caught on the Contracted areas;

✧ Systemic analysis of the end products of environmental expeditions, laboratory tests of the Contracted areas, including: Kandym field group plot, Khauzak and Shady plots, Kungrad plot. Process the results using the methods of mathematical analysis, develop a mathematical model that provides qualitative and quantitative characteristics of the intensity of how the pollutants spread across the area, their interconnection.

✧ Generalize the materials. Review and identify potential environmental impact. Conclusions and recommendations.

✧ Submit a consolidated report to the State Environmental Committee of the Republic of Uzbekistan, and obtain approval of the report by the Committee.

For the purpose of identifying environmental impact and confirming the forecast, the Program for Environmental Audit of Contracted Areas was developed (see attachment 1), which provides for the following actions:

✧ Collect data describing the environment before the commencement of operations.

✧ Monitor changes in physical, chemical and biological features of the environment.

✧ Analyze the changes and interrelation between various environmental aspects.

✧ Determine whether the existing changes in the environment have been caused by human activities or as a result of natural evolution.

2. LEGAL FRAMEWORK OF USING THE CONTRACTED AREA THAT INCLUDES KANDYM FIELD GROUP PLOT, KHAUZAK AND SHADY PLOTS, AND KUNGRAD PLOT

The basic legal provisions governing the relations arising from the production sharing agreement in respect of Kandym filed group plot, Khauzak and Shady plots, and Kungrad plot, are available in the following sources:

- ✧ Legislation of the Republic of Uzbekistan.
- ✧ International treaties to which the Republic of Uzbekistan is a party.
- ✧ Production sharing agreement in respect of Kandym filed group plot, Khauzak and Shady plots, and Kungrad plot between the Republic of Uzbekistan and the investors consortium consisting of OAO LUKOIL and NKH Uzbekneftegaz.

2.1. HSE Laws and Governmental Regulations of the Republic of Uzbekistan

The ***Constitution of the Republic of Uzbekistan*** was adopted on December 8, 1992 at the eleventh session of the Supreme Soviet of the Republic of Uzbekistan of the twelfth convocation. The Constitution was amended by the Law of the Republic of Uzbekistan of 12/28/93 No 989-XII, and the Law of the Republic of Uzbekistan of 4/24/03 No 479-II. The Constitution of the Republic of Uzbekistan establishes absolute supremacy of the laws of the Republic of Uzbekistan and the Constitution of the Republic of Uzbekistan. The state, governmental authorities and executives, non-governmental organizations and individuals shall act according to the Constitution and the laws (art. 15). No provisions of the Constitution may be construed against the rights or interests of the Republic of Uzbekistan. No law or other regulation may contradict the norms and principles established by the Constitution (art. 16).

Pursuant to the Constitution, Laws shall be adopted by the Oliy Madglis (the OM), signed by the President of the country and shall have supreme legal force on the territory of the Republic of Uzbekistan. In pursuance of the Constitution and the laws of the Republic of Uzbekistan, the President of the Republic of Uzbekistan shall issue decrees, regulations and instructions that are binding on the entire territory of the republic (art. 94).

According to the effective laws, the Cabinet of Ministers shall issue regulations and instructions that are binding on the entire territory of the Republic of Uzbekistan upon all the agencies, enterprises, institutions, organizations, executives and individuals (art. 98). The Khokim shall, within the scope of their authority, make decisions that are binding upon all the enterprises, institutions, organizations, associations, executives and individuals on the respective territory (art. 104).

2.1.1. Environmental Law of the Republic of Uzbekistan

Below is a list of legal acts of the Republic of Uzbekistan (Laws of the Republic of Uzbekistan, Regulations of the OM and CM of the Republic of Uzbekistan) governing environmental issues.

1. Law of the Republic of Uzbekistan "On Protection of Nature" No 754-XII of December 9, 1992 (as amended by Laws dated 5/6/95, 4/25/97, 12/25/98, clause V of the Law of the Republic of Uzbekistan of 5/26/00, clause 2 of the Law of 8/31/00, section I of the Law of the Republic of Uzbekistan of 8/30/02, section I of the Law of the Republic of Uzbekistan of 8/30/03, section V of the Law of the Republic of Uzbekistan No 621-II of 4/30/04).

2. Law of the Republic of Uzbekistan "On Protection and Use of Flora" No 543-I of December 26, 1997, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Protection and Use of Flora" No 544 of December 26, 1997.

3. Law of the Republic of Uzbekistan "On Protection and Use of Fauna" No 545-I of December 26, 1997, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Protection and Use of Dauna" No 546-I of December 26, 1997 (as amended by clause XXVI of the Law of the Republic of Uzbekistan dated 5/26/00).

4. Law of the Republic of Uzbekistan "On Protected Natural Areas" No 710-II of December 3, 2004, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Protected Natural Areas" No 711-II of December 3, 2004.

5. Law of the Republic of Uzbekistan "On Air Protection" No 353-I of December 27, 1996, enacted by the Regulation of the OM of the Republic of Uzbekistan No 354-I dated 12/27/96 "On Enactment of the Law of the Republic of Uzbekistan "On Air Protection" (as amended by section XV of the Law of the Republic of Uzbekistan за 8.30.03).

6. Law of the Republic of Uzbekistan "On Radiation Safety" No 120-II of August 31, 2000, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Radiation Safety" No 121-II of 8/31/2000.

7. Law of the Republic of Uzbekistan "On Environmental Review" No 73-II of May 25, 2000, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Environmental Review".

8. Law of the Republic of Uzbekistan "On Forest" No 770-I of April 15, 1999, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Forest" No 771-I dated 15.04.99 (as amended by clause XXXI of the Law of the Republic of Uzbekistan of 5/26/00).

9. Law of the Republic of Uzbekistan "On Water and Water Use" No 837-XII of May 6, 1993, enacted by the Regulation of the Supreme Soviet of the Republic of Uzbekistan "On Procedure for Enactment of the Law of the Republic of Uzbekistan "On Water and Water Use" No 837-XII of May 6, 1993, (as amended by Laws of the Republic of Uzbekistan dated 4/25/97, 8/29/98, section III of the Law dated 8/31/00, clause 4 of section I of the Law of the Republic of Uzbekistan No

175-II dated 12/15/00, section III of the Law of the Republic of Uzbekistan No 568-II dated 12/12/03).

10. Law of the Republic of Uzbekistan "On State Land Cadastre" No 666-I of August 28, 1998, enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On State Land Cadastre" No 666-I of August 28, 1998 (as amended by section XIX of the Law of the Republic of Uzbekistan No 447-II of 12/13/02, section XXII of the Law of the Republic of Uzbekistan dated 8/30/03, section XV of the Law of the Republic of Uzbekistan No 621-II dated 4/30/04).

11. Law of the Republic of Uzbekistan "On Procedure for Enactment of the Land Code of the Republic of Uzbekistan" No 598-I of April 30, 2998.

12. Regulation of the OM of the Republic of Uzbekistan "On Approval of the Guideline on State Committee of the Republic of Uzbekistan for Protection of Nature" No 232-I of April 26, 1996.

13. Regulation of the CM of the Republic of Uzbekistan "On National Strategy and Action Plan of the Republic of Uzbekistan for Preservation of Biodiversity" No 139 of April 1, 1998 (as amended by clause 11 of Attachment 1 to the Regulation of the CM of the Republic of Uzbekistan No 359 dated 9/19/00).

14. Regulation of the CM of the Republic of Uzbekistan "On Action Plan for Environmental Protection in the Republic of Uzbekistan for 1999-2005" No 469 of October 20, 1999 (as amended by clause 8 of Attachment 4 to the regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

15. Regulation of the CM of the Republic of Uzbekistan "On Issues of Implementing Action Plan for Environmental Protection in the Republic of Uzbekistan for 1999-2005" No 389 of October 9, 2000 (as amended by clause 35 of the Attachment to the regulation of the CM of the Republic of Uzbekistan No 112 dated 2/28/03, clause 10 of Attachment 4 to the regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

16. Attachment 1 to the regulation of the CM of the Republic of Uzbekistan "National Strategy for Reducing Greenhouse Emissions (basic provisions)" No 309 of October 9, 2000.

17. Attachment 2 to the regulation of the CM of the Republic of Uzbekistan "Implementing National Strategy for Reducing Greenhouse Emissions" No 389 of October 9, 2000 (attachment 2 was amended by clause 35 of the attachment to the regulation of the CM of the Republic of Uzbekistan No 112 of 2/28/03, clause 10 of attachment 4 to the regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

18. Regulation of the CM of the Republic of Uzbekistan "On Development of Kandym Group Fields, Khauzak and Shady Fields and Geological Prospecting Operations in Ustyurt region of the Republic of Uzbekistan under the Terms and Conditions of Production Sharing Agreement" No 276 of June 11, 2004.

19. Regulation of the CM of the Republic of Uzbekistan "On Implementing the Production Sharing Agreement in respect of Kandym Field Group Plot, Khauzak and Shady plots, and Kungrad Plot" No 428 of September 14, 2004.

20. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Creating and Maintaining a Common System of State Cadastres of the Republic of Uzbekistan" No 225 of July 17, 1996 (as amended by clause 8 of the regulation of the CM of the Republic of Uzbekistan No 278 dated 6/2/97, regulation of the CM of the Republic of Uzbekistan No 534 dated 12/15/98, clause 30 of the regulation of the CM of the Republic of Uzbekistan No 101 dated 3/5/99, clause 1 of the Attachment to the Regulation of the CM of the Republic of Uzbekistan No 499 dated 11/16/99, and clause 4 to attachment 4 to the regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

21. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Implementing State Cadastre of Flora Units of the Republic of Uzbekistan, and of the Regulation on Procedure for Maintaining State Cadastre of Fauna of the Republic of Uzbekistan" No 343 of September 5, 2000 (as amended by clause 2 of the regulation of the CM of the Republic of Uzbekistan No 412 dated 9/25/03).

22. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Classifying Forests by Degree of Protection" No 215 of June 5, 2000.

23. Regulation of the CM of the Republic of Uzbekistan "On Enactment of Law of the Republic of Uzbekistan "On Forest" No 771-1 of April 15, 1999.

24. Regulation of the Supreme Council of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Subsoil" of September 23, 1994.

25. Regulation of the CM of the Republic of Uzbekistan "On Amendments to and Invalidation of Certain Governmental Decisions" No 356 of July 21, 1999 (as amended by clause 14 of the Attachment to Regulation of the CM of the Republic of Uzbekistan No 149 dated 4/14/00).

26. Regulation of the CM of the Republic of Uzbekistan "On Organizing Activities of State Committee for Land Resources of the Republic of Uzbekistan" No 314 of July 27, 1998.

27. Regulation of the CM of the Republic of Uzbekistan "On Limiting Water Use in the Republic of Uzbekistan" No 385 of August 3, 1993.

28. Regulation of the CM of the Republic of Uzbekistan "On Invalidation of and Amendments to Decision of the Government the Republic of Uzbekistan in connection with Adoption of Laws of the Republic of Uzbekistan "On Protection and Use of Fauna", and "On Protection and Use of Flora" No 136 dated March 27, 1998.

29. Regulation of the CM of the Republic of Uzbekistan "On Invalidation of and Amendments to Decision of the Government of the Republic of Uzbekistan in connection with Adoption of Law of the Republic of Uzbekistan "On Protection of Nature" No 278 of June 8, 1993 (as amended by Regulation of the CM of the Republic of Uzbekistan No 136 of 3/27/98, and clause 8 of the Attachment to Regulation of the CM of the Republic of Uzbekistan No 149 dated 4/14/00).

30. Regulation of the Supreme Council of the Republic of Uzbekistan "On Enhanced Protection of Valuable and Endangered Species of Plants and Animals and Regulation of their Use" No 937-XII of September 3, 1993.

31. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Developing and Imp0lementing State Water Cadastre of the Republic of Uzbekistan" No 11 of January 7, 1998 (as amended by clause 3 of attachment 1 to regulation of the CM of the Republic of Uzbekistan No 411 dated 9/24/03, and clause 7 of attachment 4 to regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

32. Regulation of the CM of the Republic of Uzbekistan "On Approval of Rates to Calculate Penalties for Damage to Fauna of the Republic of Uzbekistan" No 293 of July 27, 1995.

33. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Land Code of the Republic of Uzbekistan" No 599-I of April 30, 1998.

34. Regulation of the CM of the Republic of Uzbekistan "On Approval of Some Regulations for Protection of Forests in the Republic" No 506 of November 22, 1999 (as amended by clause 15 of the Attachment to Regulation of the CM of the Republic of Uzbekistan No 149 dated 4/14/00).

35. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline according to Law of the Republic of Uzbekistan "On Subsoil" No 19 of January 13, 1997 (as amended by the attachment to regulation of the CM of the Republic of Uzbekistan No 338 dated 8/30/00, and clause 1 of section II of attachment 4 to regulation of the CM of the Republic of Uzbekistan No 139 dated 3/25/04).

36. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Maintaining State Cadastre of Natural Areas of Preferential Protection of the Republic of Uzbekistan" No 104 of March 10, 1998.

37. Regulation of the CM of the Republic of Uzbekistan "On Approval of the Guideline on Procedure for Creating and Maintaining a Common System of State Cadastres of the Republic of Uzbekistan" No 225 of July 17, 1996 (as amended by clause 8 of the regulation of the CM of the Republic of Uzbekistan No 278 dated 6/2/97, regulation of the CM of the Republic of Uzbekistan No 534 dated 12/15/98, clause 30 of the regulation of the CM of the Republic of Uzbekistan No 101 dated 3/5/99, clause 1 of the Attachment to the Regulation of the CM of the Republic of Uzbekistan No 499 dated 11/16/99, and clause 4 to attachment 4 to the regulation of the CM of the Republic of Uzbekistan No 183 dated 4/14/04).

38. Attachment 1 to regulation of the CM "Guideline on Procedure for Providing Allotment Sites for the Purposes Other than Mining Operations" No 19 of January 13, 1997 (as amended by the attachment to regulation of the CM of the Republic of Uzbekistan No 338 dated 8/30/00, and clause 3 of attachment 7 to regulation of the CM of the Republic of Uzbekistan No 323 dated 7/10/04).

39. Attachment 1 to regulation of the CM of the Republic of Uzbekistan "Action Plan for Environmental Protection in the Republic of Uzbekistan for 1999-2005" No 469 of October 20, 1999.

40. Attachment 1 to regulation of the CM of the Republic of Uzbekistan "Guideline on Procedure for Providing Mining Allotment Sites to Develop Mineral Fields" No 20 of January 13, 1996.

41. Attachment 2 to regulation of the CM of the Republic of Uzbekistan "Guideline on Procedure for Maintaining State Cadastre of Fauna of the Republic of Uzbekistan" No 343 of September 4, 2000 (as amended by clause 2 of regulation of the CM of the Republic of Uzbekistan No 412 dated 9/25/03).

42. Attachment 2 to regulation of the CM of the Republic of Uzbekistan "Guideline on Procedure for Issuing Permits for Development of Sites with Minerals" No 20 of January 13, 1996 (as amended by the attachment to regulation of the CM of the Republic of Uzbekistan No 338 of 8/30/00, Regulation of the CM of the Republic of Uzbekistan No 202 of 4/30/99, and clause 4 of attachment 7 to regulation of the CM of the Republic of Uzbekistan No 323 dated 7/10/04).

43. Attachment 3 to regulation of the CM of the Republic of Uzbekistan "Guideline on Procedure for Removing from Subsoil User's Balance Sheet of Reserves of Minerals Produced or Lost during Mining Operations" No 20 of January 13, 1997 (as amended by the attachment to regulation of the CM of the Republic of Uzbekistan No 338 dated 8/30/00, and clause 4 of attachment 7 to regulation of the CM of the Republic of Uzbekistan No 323 dated 7/10/04).

44. Attachment 2 to regulation of the CM of the Republic of Uzbekistan "Guideline on Governmental Control and Supervision over Subsoil Use and Protection, over Geological Survey of Subsoil and over Rational Use of Minerals" No 19 of January 13, 1997 (as amended by the attachment to regulation of the CM of the Republic of Uzbekistan No 338 dated 8/30/00, clause 1 of section II of attachment 4 to regulation of the CM of the Republic of Uzbekistan No 139 dated 3/25/04, and clause 3 of attachment 7 to regulation of the CM of the Republic of Uzbekistan No 323 dated 7/10/04).

45. Attachment 1 to regulation of the CM of the Republic of Uzbekistan "Guideline on Procedure for Implementing State Cadastre of Flora Units of the Republic of Uzbekistan" No 343 of September 5, 2000.

Below is a summary of several environmental Laws of the Republic of Uzbekistan.

Law of the Republic of Uzbekistan "On Protection of Nature" No 754-XII of December 9, 1992. The Law was amended by:

- ✧ Laws of the Republic of Uzbekistan dated 5/6/95, dated 4/25/97, and dated 12/25/98;
- ✧ clause V of the Law of the Republic of Uzbekistan dated 5/26/00;
- ✧ clause 2 of the Law of the Republic of Uzbekistan dated 8/31/00;
- ✧ section I of the Law of the Republic of Uzbekistan dated 8/30/02;
- ✧ section I of the Law of the Republic of Uzbekistan dated 8/30/03;
- ✧ section V of Law of the Republic of Uzbekistan No 621-II dated 4/30/04.

The Law establishes legal, economic and organizational bases for conservation of natural environment, and rational utilization of natural resources. It aims at balanced and well-coordinated development of relations between humans and the nature, protection of ecosystems, natural complexes and separate units, providing guarantees of protection of the human right to favourable environment.

Pursuant to the Constitution of the Republic of Uzbekistan, land, subsoil, water, flora and fauna, and other natural resources represent the wealth of the entire nation, must be utilized in a rational way, and are protected by the state. The State Environmental Committee of the Republic of Uzbekistan reports to the OM of the Republic of Uzbekistan and exercises governmental control over the compliance by the ministries, governmental committees, agencies, enterprises, institutions and organizations, as well as by individuals with the law in the field of use and protection of land, subsoil, water, air, flora and fauna.

Environmental impact of the economic activities is limited by the environmental quality standards that guarantee environmental safety for the population, reproduction and protection of natural resources. For the purposes of creating territorial production complexes, development of the industry, agriculture, construction and reconstruction of cities, towns and other settlements, maximum permissible values of environmental load are established.

Enterprises, organizations and institutions are required to develop environmental and other criteria that regulate the maximum permissible values of environmental load. Environmental standards are approved by the State Environmental Committee of the Republic of Uzbekistan, by the Ministry of Healthcare of the Republic of Uzbekistan (MH RU), the State Committee of the Republic of Uzbekistan for supervision of safe industrial operations and mining supervision within the scope of their competence.

Utilization of subsoil and minerals is subject to the following:

- integrated and economical utilization of minerals and associated natural resources in the course of mining, and preventing pollution of environment and subsoil;
- rehabilitation of lands disturbed by mining;
- utilization of renewable minerals only to the extent they renew naturally.

Waste management is subject to the procedure established by the law. Owners of wastes are responsible for environmentally safe waste management. Decisions on location of waste management sites on a respective territory are made by local governmental authorities.

Governmental control in the field of environmental protection is exercised by governmental authorities and administrations specially authorized by the governmental agencies for environmental protection. Specially authorized state environmental authorities include:

- State Environmental Committee of the Republic of Uzbekistan.
- Ministry of Healthcare of the Republic of Uzbekistan.
- Agency for supervision over safe industrial operations and mining supervision.
- Ministry of Internal Affairs of the Republic of Uzbekistan.
- Ministry of Agriculture of the Republic of Uzbekistan.
- State Committee for Land Resources of the Republic of Uzbekistan.

Payments for special use of nature and for environmental pollution include taxes, other statutory payments for utilization of natural resources, and compensatory environmental fees (for emissions and discharge of pollutants, waste disposal), fees for protection and reproduction of natural resources.

Tax rates and other statutory payments amounts, including royalties for utilization of natural resources given their abundance, quality and reproductive ability, accessibility, composite nature,

productivity, location, possibilities of processing and waste recycling and other factors, as well as related limits are determined and approved according to the procedure established by the law.

Amounts of compensatory environmental fees are submitted for approval by the State Environmental Committee of the Republic of Uzbekistan to the CM of the Republic of Uzbekistan. Amounts of fees for protection and reproduction of natural resources are established by the CM of the Republic of Uzbekistan.

Payments for utilization of natural resources are included into the prime cost of products (work, services) of the nature users' enterprises. Compensatory environmental fees and excessive (above standard) or other irrational special use of nature are charged to income (profits) of a legal entity.

Fees for utilization of natural resources, their protection and reproduction are paid to the State budget of the Republic of Uzbekistan. Amounts of compensatory environmental fees for emissions and discharge of pollutants and for waste disposal are paid to the nature protection funds. Privileges in payments for special use of nature and in compensatory environmental fees are established by the law.

Payment of fees for the use of natural resources and of compensatory environmental fees does not exempt legal entities or individuals from taking environmental measures, neither does it relieve them from the obligation to compensate damages.

The Republic of Uzbekistan has both voluntary and compulsory insurance of property and revenues of enterprises, institutions and organizations, life, health and property of individuals against damage resulting from environmental pollution and deterioration of natural resources. The procedure and conditions of environmental insurance are established by the law of the Republic of Uzbekistan.

In case of an accident enterprises, institutions or organizations are required to promptly start emergency response operations according to their environmental emergency response plans. While doing that they are required to promptly notify of the accident and of the response activities the local governmental authorities and administrations, state environmental agencies and specialized agencies dealing with response to hazardous environmental accidents.

Enterprises, organizations, institutions, and individuals are required to implement non-waste or low-waste technologies, reduce generation of production and household wastes, sterilize and utilize their waste, comply with the rules for sorting, storage, burial and recycling of waste. It is prohibited to commission facilities that are incompliant with the environmental requirements.

It is prohibited to store and bury wastes in the land of settlements, and those of environmental, health-improving, recreational, historical and cultural value, within the boundaries of water protection zones and sanitary zones of water bodies, and in other locations where they may pose a threat to life and health of humans, and to natural areas and units of preferential protection.

Only in exceptional cases it may be permitted to bury wastes in subsoil. Such permits are subject to positive results of special surveys and to compliance with the requirements relating to safe life and health of humans, safety of environment, preservation of natural resources.

Waste utilization, its burial and storage at the polygons is subject to the permits of state environmental authorities. It is prohibited to utilize raw stock and materials, implement processes and produce finished products (including foodstuffs) without environmental or hygiene certificates or with deviations from their established parameters. Environmental certification is also compulsory in the cases established by the law. The procedure for environmental certification is approved by the CM of the Republic of Uzbekistan.

Law of the Republic of Uzbekistan "On Environmental Review" No 73-II of May 25, 2000. Enacted by the Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Environmental Review". The environmental review refers to checking the compliance of the planned or existing economic and other activities with environmental requirements, and establishing whether the implementation of the unit that is subject to environmental review is acceptable.

The objective of environmental review is to check the following:

- ✧ compliance of the planned economic and other activities with environmental requirements at the stages prior to making a decision on implementing such activities;
- ✧ degree of environmental hazard of the planned or existing economic or other activities that may produce or already produced environmental impact or the impact on human health;
- ✧ whether the planned measures for environmental protection and rational utilization of natural resources are sufficient and well-founded.

Environmental review can be in the form of a state or public environmental review, or environmental audit. Clients of environmental review may publish an announcement in mass media that the review is being conducted. In this event they are required to publish the results of such review within a month from the related completion date.

A list of units that are subject to compulsory announcement of the state environmental review and of the results of such review in mass media is established by the law.

The following are the units subject to state environmental review:

- ✧ draft governmental programs, concepts, layout and development patterns of production facilities, units of economic and social sector;
- ✧ materials relating to selection of land plots for all types of construction sites;
- ✧ front-end loading and design documents;
- ✧ draft regulations and guidelines governing economic and other activities connected with utilization of natural resources;
- ✧ documents relating to creation of new types of equipment, technologies, materials, substances, and products;
- ✧ active enterprises and other facilities producing impact on environment and human health;
- ✧ materials of comprehensive surveys of the territories in order to further classify them as natural areas of preferential protection, environmental emergency zones and environmental disaster zones;
- ✧ all types of construction documents;
- ✧ units subject to special legal regulation.

The State Environmental Committee of the Republic of Uzbekistan acts as a specially authorized agency dealing with state environmental review. The Committee performs the following functions:

- ✧ organize and conduct state environmental review;
- ✧ develop and approve technical regulations and guidelines on state and public environmental review, and environmental audit;
- ✧ engage experts and specialists to conduct state environmental review;
- ✧ forward to banking and other credit institutions representations seeking suspension (termination) of financing, loan facilities or other financial transactions in respect of the units that failed to obtain a positive opinion of state environmental review;
- ✧ control performance of opinions of state environmental review;
- ✧ cooperate with environmental organizations of other countries and international organizations in the field of environmental review;
- ✧ exercise other authority as provided by the law.

State environmental review includes the following activities:

- ✧ check the submitted materials for compliance with the environmental law;
- ✧ analyze whether the data on environmental and social consequences of the planned or existing economic or other activities is reliable and complete;
- ✧ check whether the environmental impact assessment of biological and chemical substances is well-founded;
- ✧ check whether the assessment of the degree of environmental hazard of the planned or existing economic and other activities is correct;
- ✧ determine whether the measures aimed at compliance with environmental safety requirements are sufficient and well-founded;
- ✧ check whether draft environmental standards are well-founded.

For the purposes of conducting state environmental review, a client is required to make the following available:

- ✧ for facilities at the design stage – environmental impact assessment materials containing a draft statement of environmental impact assessment, a statement on environmental consequences, and, in the event provided by the law – an environmental impact statement;
- ✧ for existing facilities – draft environmental standards, environmental impact statement that was developed upon establishing the fact that the facility produces impact on environment and human health. The client is also entitled to submit materials for environmental audit;
- ✧ for facilities specified in the second, third, fifth, and eighth paragraphs of article 11 of this Law – all the documents that were developed.

The period of state environmental review should not exceed thirty days. Depending on the complexity of a unit subject to state environmental review, the period of such review may be extended by the Chairman of the State Environmental Committee of the Republic of Uzbekistan by no more than two months.

Following the results of state environmental review an opinion is issued containing conclusions as to whether the implementation of the unit subject to state environmental review is acceptable. An opinion of state environmental review is binding upon legal entities and individuals with respect to financing for, and implementation of, a unit subject to state environmental review. Fi-

nancing projects by banks and other credit institutions and implementation of such projects is subject to a positive opinion of state environmental review.

Should the opinion of state environmental review state that implementation of a unit subject to state environmental review is unacceptable, the client is required to improve the project according to the proposals contained therein and resubmit the materials for state environmental review or give up the planned or existing economic or other activities.

The opinion of state environmental review stating that the unit subject to state environmental review is compliant with the requirements of such review is valid within thirty years from the date of issuance.

Environmental audit is an independent environmental review of existing enterprises and other units that produce environmental impact. Such review is conducted by environmental auditors (companies) subject to the procedure and conditions established by the law. Environmental audit is conducted at the discretion of the owner of a unit where economic or other activities are performed.

Law of the Republic of Uzbekistan "On Protected Natural Areas" No 710-II of December 3, 2004, enacted by Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Protected Natural Areas" No 711-II of December 3, 2004. This Law governs the relations in the field of organizing, protection and use of natural areas. The key goals of this Law are as follows:

- ✧ conserve typical, unique, and valuable natural units and complexes, the gene pool of plants and animals;
- ✧ prevent man-caused impact on the nature;
- ✧ study natural processes;
- ✧ conduct environmental monitoring;
- ✧ improve environmental education and awareness.

Protected natural areas are represented by land plots and/or water bodies of top priority value for environmental, scientific, cultural, aesthetic, recreational and sanitary purposes that are fully or partially removed from economic circulation on a temporary or permanent basis. The protected natural areas constitute a common ecosystem, whose purpose is to ensure biological and landscape diversity and ecological balance.

Pursuant to the provisions of the Law, the status of natural areas of preferential protection is assigned to national reserves, multipurpose wildlife preserves (protected landscape area), nature parks, national natural landmarks, territories required for conservation, reproduction and rehabilitation of certain natural units and complexes, protected landscapes, territories used to manage certain natural resources. Protected natural areas are a unique feature of a country and are protected by the state.

Any activities other than those in line with the intended purpose of the land plots and water bodies of protected natural areas are prohibited. For the purpose of limiting or prohibiting activities that affect or may affect the condition of protected natural areas, the right to land plots is encumbered.

When a protected natural area is established losses of legal entities and individuals resulting from limitation or termination of their activities are compensated according to the law. Land plots on protected natural areas can be removed for governmental or public needs only in exceptional cases, including in the event of a failure by legal entities or individuals to perform their obligations relating to protection of national natural landmarks, wildlife preserves, and natural breeding nurseries located on the land plots occupied by such entities or individuals.

Governmental agencies reserve land plots to establish protected natural areas. Activities of legal entities and individuals on reserved land plots that pose a threat to conservation of the natural units and complexes to be protected must be limited or banned. ***Such land plots can be granted for use and possession to legal entities and individuals subject to availability of a positive opinion of state environmental review.***

For the purpose of protecting rare and endangered species of plants and animals, and their habitats access of people to certain parts of protected natural areas may be restricted or banned by governmental authorities, legal entities or individuals with jurisdiction over such areas. People can obtain access to protected natural areas according to visiting rules approved by specially authorized governmental agencies.

Governmental authorities, legal entities or individuals with jurisdiction over protected natural areas compose a passport for each territory wherein they specify information describing the area, its rules and administration. The procedure for keeping a passport of a protected natural area is established by the Cabinet of Ministers of the Republic of Uzbekistan.

National wildlife preserves, natural breeding nurseries, national natural landmarks, water protection zones, waterside areas, and zones where surface and ground water is generated are protected by legal entities and individuals on whose land plots they are established or located.

National reserves are protected natural areas of national value with strict protection rules of natural units and complexes, whose purpose is to preserve and study typical ecosystems, and the gene pool of plants and animals. Any activities other than scientific research and environmental monitoring are prohibited on the territory of national reserves. Fire prevention activities are permitted in national reserves.

Multipurpose wildlife preserves (protected landscape areas) are protected natural areas whose purpose is to preserve natural units and complexes of special environmental value in their natural state. Any activities other than scientific research, recreation, environmental monitoring, haying and cattle grazing, gathering spontaneous plants for nutrition purposes, spontaneous medicinal herbs and technical materials for own needs of the employees of multipurpose wildlife preserves (protected landscape areas) and of the individuals who are residents of the conservation zones, are prohibited on the territory of multipurpose wildlife preserves (protected landscape areas).

Nature parks are protected natural areas whose purpose is to preserve and utilize protected natural units and complexes of special environmental, cultural and aesthetic value for environmental, recreational, scientific, and cultural purposes. Nature parks are subdivided into national nature parks and local nature parks, whose legal form is that of a state environmental institution. Areas of nature parks are located on the land plots allocated for use to nature parks, as well as within the boundaries of environmental parks on the land plots of other legal entities and individuals.

The area of nature parks is divided into protected reserve zone, zone for recreation, economic and other use. Size and boundaries of the zones can be changed by governmental authorities with jurisdiction over such zones subject to the opinion of state environmental review.

Areas of nature parks are subject to differentiated rules according to the zoning pattern. The protected reserve zones are subject to the rules established for national reserves. Depending on the condition of natural units and complexes, recreational zones are subdivided into areas with different protection rules. Zones of nature parks used for economic and other purposes represent the area where people are allowed to live, and legal entities or individuals can conduct activities as long as such activities cause no harm to natural units and complexes.

The following is prohibited on the territory of nature parks:

- ✧ felling plantations of trees and bush (except for sanitary and improvement felling);
- ✧ actions that cause modification of hydrological and hydro-geological conditions;
- ✧ actions causing soil erosion, and degradation of flora and fauna;
- ✧ roadway maintenance and service engineering work not connected with the activities of nature parks;
- ✧ waste storage and burial, effluent discharge;
- ✧ moving in new species and subspecies of living organisms for naturalization.

National natural landmarks are protected natural areas with unique irreplaceable natural units of high environmental, cultural and aesthetic value. It is prohibited to conduct any activities on the territory of national natural landmarks if such activities pose a threat to their integrity. Obligations to ensure compliance with the rules of national natural landmarks rest with legal entities and individuals on whose land plots they are located.

Wildlife preserves are protected natural areas whose purpose is to facilitate preservation, reproduction and rehabilitation of certain natural units and complexes. Wildlife preserves are subdivided into biological, paleontological, hydrological and geological (mineralogical) preserves. Any activities that may cause harm to certain natural units and complexes are suspended, terminated or restricted on the territory of wildlife preserves.

Natural breeding nurseries are protected natural areas whose purpose is to facilitate preservation, reproduction and rehabilitation of certain species of plants and animals by creating the conditions they require. Any activities are prohibited on the territory of wildlife preserves if such activities pose a threat to preservation, reproduction and rehabilitation of certain species of plants and animals for whom the preserves are intended.

Fishery zones are protected natural areas that include water bodies or their parts used for preservation, reproduction and rehabilitation of rare or endangered species of fish and other aquatic life. Any activities that pose a threat to preservation, reproduction or rehabilitation of fish and other aquatic life are prohibited in fishery zones.

Protected landscapes include natural resorts, recreation zones, water protection zones, waterside areas, sanitary zones of water bodies, and zones where surface and ground water is generated.

Natural resorts are protected natural areas with medical and health-improving properties that have mineral springs, deposits of therapeutic mud, favourable climatic and other conditions. Natural resorts are subdivided into three types of zones.

The first zone includes areas with medical springs and deposits of therapeutic mud. Any activities other than construction of facilities for utilization of medical springs and therapeutic mud baths are prohibited in this zone. The second zone includes areas assigned to sanatoriums, boarding houses and holiday centres, as well as those populated by people, except for places of temporary stay of medical and service staff. The third zone includes areas adjacent to sanatoriums, boarding houses and holiday centres. Economic activities that cause no harm to medical springs and deposits of therapeutic mud and do not impair conditions of rest and medical treatment are permitted in this zone.

In the natural resorts it is prohibited to do the following:

- ✧ mine minerals except for mineral water and therapeutic mud;
- ✧ chemical industry, pulp-and-paper and metallurgy operations;
- ✧ fell plantations of trees and bush (except for sanitary and improvement felling);
- ✧ utilize pesticides;
- ✧ place burial ground for animal refuse;
- ✧ place storages of pesticides and mineral fertilizers;
- ✧ store and bury waste;
- ✧ change hydrological conditions.

Recreation zones are protected natural areas with geographic conditions and climate suitable for tourism and mass leisure of the population. Depending on the condition of natural units and complexes, recreational zones are subdivided into areas with different protection rules.

In recreation zones it is prohibited to do the following:

- ✧ chemical industry, pup-and-paper and metallurgy operations;
- ✧ fell plantations of trees and bush (except for sanitary and improvement felling);
- ✧ utilize pesticides;
- ✧ place burial ground for animal refuse;
- ✧ store and bury waste;
- ✧ change hydrological conditions.

Water protection zones are protected natural areas adjacent to riverbeds, lakes, water-storage basins, canals, collecting canals and other water bodies. Such zones are established to prevent contamination, pollution, decay and silting of water bodies with soil erosion products, and to maintain favourable water conditions.

Restricted economic activities are permitted in water protection zones. It is prohibited to do the following in such zones:

- ✧ fell plantations of trees and bush (except for sanitary and improvement felling);
- ✧ utilize pesticides;
- ✧ place storages of pesticides and mineral fertilizers;
- ✧ place burial ground for animal refuse;
- ✧ store and bury waste;
- ✧ place sewage and treatment facilities and sewage ponds;

- ✧ place cattle-breeding and poultry farms, spray liquid manure;
- ✧ park, fuel, wash, and repair motor vehicles;
- ✧ place petroleum product storages;
- ✧ wash flax, kenaf and leather.

Waterside areas are protected natural areas within water protection zones that are subject to strict protection rules. In addition to the restrictions and bans applicable to water protection zones, in the waterside areas it is prohibited to do the following:

- ✧ utilize mineral and organic fertilizers;
- ✧ graze cattle;
- ✧ any types of construction except for construction of hydro-economic facilities;
- ✧ place boat moorings outside special locations.

Sanitary zones of water bodies are protected natural areas subject to strict protection rules that are adjacent to water bodies used for drinking, household and medical purposes. Sanitary zones of water bodies are subdivided into protection belts that are subject to different protection rules. Changing river courses, mineral mining and other operations that affect the condition of water bodies are subject to a permit of environmental authorities, agricultural, water management and sanitary supervision agencies.

National biosphere reservations are protected natural areas whose purpose is to preserve biodiversity and ensure rational utilization of natural units and complexes. The area of national biosphere reservations is divided into the following zones:

- ✧ Protected reserve zone, which is subject to the rules applicable to national reserves.
- ✧ Buffer zone, where any activities that may affect the protected reserve zone are prohibited;
- ✧ Transition zone, intended for economic and other activities that cause no harm to natural units and complexes of a national biosphere reservation.

Protected zones are the areas bordering with national reserves, wildlife preserves and national natural landmarks. Economic or other activities are restricted or prohibited in protected zones to prevent impact on the protected natural areas.

Law of the Republic of Uzbekistan "On Air Protection" No 353-I of December 27, 1996. Enacted by Regulation of the OM of the Republic of Uzbekistan "On Enactment of the Law of the Republic of Uzbekistan "On Air Protection" No 354-I dated 12/27/96 *(as amended by section XV of the Law of the Republic of Uzbekistan dated 8/30/03).* Public administration in the field of air protection is exercised by the CM of the Republic of Uzbekistan and the State Environmental Committee of the Republic of Uzbekistan.

Air protection standards define air protection rules, air condition monitoring techniques, and establish other requirements related to air protection. Standards (sanitary norms) relating to protection of air for humans are approved by the Healthcare Ministry of the Republic of Uzbekistan. Standards relating to protection of air for environmental units, preservation of climate and ozone layer are approved by the State Environmental Committee of the Republic of Uzbekistan.

For the purposes of estimating the air condition, common air quality standards are established for the entire territory of the Republic of Uzbekistan.

- ✧ maximum permissible concentrations of pollutants and biological organisms in the air for humans and for environmental units;
- ✧ maximum permissible levels of acoustic, electromagnetic, ionizing and other harmful physical effects on the air for humans and environmental units.

The law may establish higher air quality standards for certain regions. Air quality standards are developed and approved according to the procedure established by the law.

Maximum permissible emissions of pollutants and biological organisms and maximum permissible physical effects on the air are set for each fixed source of emissions or harmful physical effects on air for each pollutant and biological organism or each physical effect factor. Maximum permissible air emissions of pollutants and biological organisms from fixed pollution sources and maximum permissible physical effects on the air are developed by enterprises, institutions, and organizations, and are subject to approval by the State Environmental Committee of the Republic of Uzbekistan or Healthcare Ministry of the Republic of Uzbekistan, respectively.

The procedure for development and approval of maximum permissible emissions of pollutants and biological organisms is established by the State Environmental Committee of the Republic of Uzbekistan, while that for maximum permissible physical effects – by the State Environmental Committee of the Republic of Uzbekistan and the Healthcare Ministry of the Republic of Uzbekistan.

Standards of air consumption for production needs are set at the level, which ensures that no change to its natural composition is possible. Air consumption standards are developed by enterprises, institutions, and organizations, and are approved by the State Environmental Committee of the Republic of Uzbekistan. The procedure for development and approval of air consumption standards is established by the State Environmental Committee of the Republic of Uzbekistan.

Mining, transportation and processing of minerals must be in compliance with the rules for prevention or reduction of air pollution using the techniques approved by the State Environmental Committee of the Republic of Uzbekistan. It is prohibited to place man-made facilities that may represent sources of air pollution or other harmful effects close to settlements.

Production and consumption wastes, being air pollution sources, must be recycled, treated, subjected to odor-control treatment or stored at special polygons, whose location is determined by local authorities subject to a permit by the State Environmental Committee of the Republic of Uzbekistan and the Healthcare Ministry of the Republic of Uzbekistan. Placement, design, construction, reconstruction and commissioning of enterprises, structures, traffic arteries, and other facilities, improvement of the existing and implementation of new processes and equipment must be in compliance with the air protection law.

Placement of construction sites, construction and reconstruction design documents for enterprises, structures, traffic arteries, and other facilities that affect the air are subject to approval by local authorities, the State Environmental Committee of the Republic of Uzbekistan and the Healthcare Ministry of the Republic of Uzbekistan.

Enterprises, institutions, and organizations, whose activities are connected with emissions of pollutants and biological organisms, greenhouse gases and ozone-depleting substances, and with harmful physical effects are obliged to do the following:

- ✧ comply with the rules for operation of facilities, equipment and devices used for treatment of air emissions and for reducing harmful physical effects, and with those of the devices used to control them;
- ✧ create sanitary protection zones around their operational facilities;
- ✧ take measures aimed at reducing emissions and harmful physical effects;
- ✧ control compliance with maximum permissible emissions and harmful effects, make related records and duly submit statistical reports;
- ✧ implement energy-saving technologies, be economical in utilization of fuel and energy resources, utilize green energy sources;
- ✧ take measures to reduce air emissions of pollutants and biological organisms approved by the State Environmental Committee of the Republic of Uzbekistan in view of expected unfavourable meteorological conditions;
- ✧ perform assessment of impact on environment and human health within the area affected by the enterprise operations or transportation infrastructure;
- ✧ ensure the required storage conditions, observe the rules for the use of strong toxic agents and volatile compounds, and those relating to neutralization of containers for them;
- ✧ take measures to prevent major blowouts and emergency escapes to the atmosphere, potentially dangerous situations and measures to reduce trans-boundary air pollution;
- ✧ ensure that the waste is recycled and take measures to prevent air pollution in the course of accumulation and treatment of waste.

Air protection measures should not result in contamination of soil, water and other environmental units. Compensatory environmental fees for harmful effect on the air are charged to the enterprises, institutions, and organizations according to the procedure and rates established by the law.

Payment of compensatory fees for emissions of pollutants and biological organisms, and for physical effects on the air, as well as for air consumption does not release enterprises, institutions and organizations from the obligation to perform air protection measures and to compensate for the harm caused.

Law of the Republic of Uzbekistan "On Water and Water Use" No 837-XII of May 6, 1993. *(as amended by Laws of the Republic of Uzbekistan dated 4/25/97, and of 8/29/98, section III of the Law dated 8/31/00, clause 4 of section I of Law of the Republic of Uzbekistan No 175-II dated 12/15/00, section III of Law of the Republic of Uzbekistan No 568-II dated 12/12/03).* The Law governs water relations, rational utilization of water for the needs of the population and economy sectors, protection of water from pollution, obstruction and exhaustion, prevention and remedying harmful water effects, improvement of the condition of water bodies, and protection of the rights of enterprises, institutions, organizations, farms, and individuals in the field of water relations.

Specially authorized governmental agencies dealing with administration in the field of regulation and utilization of water are represented by the Ministry of Melioration and Water Management (surface water), the State Committee of the Republic of Uzbekistan for Geology and Mineral Resources (ground water), and the State Committee of the Republic of Uzbekistan for supervision over safe industrial operations and mining supervision (thermal and mineral water) within the scope of their authority.

Placement, design, construction, and commissioning of new and reconstructed enterprises, structures, and other facilities, and implementation of new processes that affect water condition must take into account the need to ensure rational utilization of water in compliance with the requirements relating to protection of human health and to the top priority of drinking and household water supply to the population. In addition, the Law provides for measures ensuring record keeping of the amounts of water taken from, and returned to, water bodies, protection of water from pollution, obstruction and exhaustion, prevention of harmful water effects, minimizing the flooding of land as required, protection of land from salinization, waterlogging and siccation, as well as preservation of favourable natural conditions and landscapes.

During placement, design, construction, and commissioning of new and reconstructed enterprises, structures, and other facilities at fishery water bodies, in addition to compliance with this Law, timely measures should be taken to ensure compensation for the harm caused to the fish resources, and other aquatic life, and to the conditions for their conservation, reproduction and rehabilitation. Along the banks of water bodies water protection and waterside areas are established whose purpose is to prevent pollution, obstruction or exhaustion of water bodies, and to maintain favourable water conditions.

Construction and blasting operations, mineral mining, laying cables, pipelines and other service lines, tree felling, drilling and other operations on water bodies, in water protection zones and waterside areas of the water bodies, zones of preferential protection for development of a groundwater field that affect the condition of water are subject to approval by local authorities and administration, environmental authorities, water management and other agencies in accordance with the law.

Special use of water is subject to permits issued by the agencies of the State Environmental Committee of the Republic of Uzbekistan upon proposals of the Ministry of Melioration and Water Management of the Republic of Uzbekistan – when used from surface water sources; and by the State Committee of the Republic of Uzbekistan for supervision over safe industrial operations and mining supervision, and the State Committee of the Republic of Uzbekistan for geology and mineral resources – when used from underground sources.

The procedure for approval and issuance of a permit for special use of water is established by the CM of the Republic of Uzbekistan. Irrigation of agricultural lands with wastewater is subject to a permit issued by environmental authorities with consent of the agencies conducting state sanitary and veterinary supervision. Industrial and other enterprises and organizations as well as public utilities are prohibited to supply water for the purposes of irrigation of agricultural land if such water affects soil fertility and the agricultural products.

It is prohibited to utilize fresh ground water classified as drinking water for production and technical purposes except in the regions with insufficient surface water sources.

Ground water (fresh, mineral, and thermal) not classified as drinking or medical water may be used for technical water supply, extraction of chemical elements it contains, generating thermal energy and other operational purposes subject to the requirements of rational utilization and protection of water, provided that the approved useable water supply is available.

2.1.2. Health and Safety Legislation of the Republic of Uzbekistan

Below is a list of legal acts of the Republic of Uzbekistan (Laws of the Republic of Uzbekistan, Regulations of the OM and CM of the Republic of Uzbekistan) governing health and safety issues.

1. Labor Code of the Republic of Uzbekistan. Enacted by the Regulation "On Procedure for enactment of the Labor Code of the Republic of Uzbekistan" of 4/1/96 *(as amended by the Laws of the Republic of Uzbekistan dated 12/27/96,5/1/98, 8/29/98, 12/25/98, 4/14/99, chapter XII of Law of the Republic of Uzbekistan No 772-I dated 4/15/99, chapter XIV of Law of the Republic of Uzbekistan dated 8/20/99, section VIII of Law of the Republic of Uzbekistan No 220-II dated 5/20/01, section IV of Law of the Republic of Uzbekistan No 271-II dated 8/30/01, section VII of Law of the Republic of Uzbekistan No 320-II dated 12/7/01, and section VI of Law of the Republic of Uzbekistan No 405-II dated 8/30/02).*

2. Law of the Republic of Uzbekistan "On Employment" of January 13, 1992. *(as amended by Laws of the Republic of Uzbekistan dated 5/7/93, 5/6/94, and 5/6/95).*

3. Law of the Republic of Uzbekistan "On Employment" No 616-I of May 1, 1998 (as amended by the Law of the Republic of Uzbekistan dated 12/25/98, part III of Law of the Republic of Uzbekistan No 722-I of 4/15/99, part II of Law of the Republic of Uzbekistan dated 8/20/99, clause IV of Law of the Republic of Uzbekistan dated 5/26/00, section II of Law of the Republic of Uzbekistan No 220-II dated 5/12/01).

4. Law of the Republic of Uzbekistan "On Labor Protection" No 839-XII of 5/6/93, enacted by the Regulation of the Supreme Soviet of the Republic of Uzbekistan "On Procedure for Enactment of the Law of the Republic of Uzbekistan "On Labor Protection" of May 6, 1993 *(as amended by the Law of the Republic of Uzbekistan dated 5/1/98, section IV of Law of the Republic of Uzbekistan No 220-II dated 5/20/01, section IV of Law of the Republic of Uzbekistan No 320-II dated 12/7/01).*

5. Law of the Republic of Uzbekistan "On Health Protection" No 265-I of August 29, 1996, enacted by Regulation of the OM of the Republic of Uzbekistan No 266-I of 8/29/96 "On Enactment of Law of the Republic of Uzbekistan "On Health Protection" (as amended by chapter XIV of Law of the Republic of Uzbekistan No 7720I dated 4/15/99, and section X of Law of the Republic of Uzbekistan No 220-II dated 5/12/01).

6. Law of the Republic of Uzbekistan "On State Sanitary Supervision" No 657-XII of July 3, 1992, enacted by Regulation of the Supreme Soviet of the Republic of Uzbekistan No 658-XII dated 7/3/92 "On Procedure for Enactment of the Law of the Republic of Uzbekistan "On State Sanitary Supervision" (as amended by the Law of May 6, 1995, section V of Law of the Republic of Uzbekistan No 772-I of 4/15/99, and clause 1 of Law of the Republic of Uzbekistan dated 8/31/00).

7. Regulation of the CM of the Republic of Uzbekistan "Rules for Compensation by Employers of Harm to Employees Caused by Severe Injuries, Professional Diseases or Any Other Health

Impairments Connected with Performance of Job Responsibilities" No 48 dated February 1, 1994 (as amended by clause 6 of regulation of the CM of the Republic of Uzbekistan No 74 dated 2/11/9-7, clause 2 of attachment to regulation of the CM of the Republic of Uzbekistan No 103 dated 3/1/01, and clause 3 of attachment No 3 to regulation of the CM of the Republic of Uzbekistan No 162 dated 4/6/01).

8. Regulation of the CM of the Republic of Uzbekistan "On Approval of Regulations Required to Implement the Labor Code of the Republic of Uzbekistan" No 133 of March 11, 1997 (as amended by clause 19 of attachment 3 to regulation of the CM of the Republic of Uzbekistan No 162 dated 4/6/01, and regulation of the CM of the Republic of Uzbekistan No 375 dated 10/31/02).

9. Regulation of the CM "On Approval of "Guideline on Investigation and Keeping Records of Accidents and Other Employee Health Impairments at Work" No 286 of June 6, 1997 (as amended by clause 7 of the attachment to regulation of the CM of the Republic of Uzbekistan No 338 dated 8/30/00, clause 21 of attachment 3 to regulation of the CM of the Republic of Uzbekistan No 162 dated 4/6/01, clause 1 of the attachment to regulation of the CM of the Republic of Uzbekistan No 141 dated 4/25/02, and clause 6 of attachment 7 to regulation of the CM of the Republic of Uzbekistan No 323 dated 7/10/04).

10. "Guideline on Development and Labor Safety Instructions by the Ministry of Labor and Social Protection of the Republic of Uzbekistan" of December 16, 1999.

11. Order of the Minister of Labor and Social Protection of the Republic of Uzbekistan "On Amendments to Model Guideline on Organization of Labor Safety Measures" No 9 of July 6, 2001. Registered with the Ministry of Justice of the Republic of Uzbekistan on July 21, 2001, with No 273-1.

Below is an overview of some Laws and Regulations of the Republic of Uzbekistan on labor safety and health.

Law of the Republic of Uzbekistan "On Health Protection" provides for protection of health of individuals engaged in certain professional activities. For the purposes of protecting health of people, and preventing infectious and professional diseases, employees of certain trades and those engaged in certain operations, the list of which is approved by the Healthcare Ministry of the Republic of Uzbekistan, are subject to compulsory pre-job medical inspections and periodic medical inspections. A person may be disqualified in respect of certain professional activities or activities connected with a source of extreme danger on a temporary or permanent basis. Such decision is to be based on the opinion of medical boards according to the list of medical contraindications, and may be appealed in court.

The list of medical contraindications in respect of certain professional activities or activities connected with a source of extreme danger is established by the Healthcare Ministry of the Republic of Uzbekistan in cooperation with the Ministry of Labor and Social Protection of the Republic of Uzbekistan (RU MLSP) and the Council of Trade Union Federation of the Republic of Uzbekistan at least once in five years.

Employers are responsible for timely passing of compulsory medical inspections by their employees, and for the consequences to people's health caused by issuing permits to work to the persons who did not pass the compulsory medical inspection according to the law.

On the basis of a medical opinion persons of retirement age are entitled to aftercare at the expense of the social security budget, funds of agencies of labor and social protection and at the expense of the enterprises, institutions and organizations according to the law.

Persons injured during an emergency event are entitled to receive free medical care and rehabilitation, hygienic and anti-epidemic assistance aimed at recovery from the consequences of an emergency event and at reducing the risk to their life and health.

In the events when harm is caused to health of people, the guilty parties must compensate the damage to the injured parties to the extent and under the procedure established by the law. Funds expended on medical aid to persons injured by wrongful acts are charged to individuals or legal entities responsible for the harm caused to their health.

Law of the Republic of Uzbekistan "On State Sanitary Supervision" governs relations in the field of ensuring sanitary and epidemic wellbeing and radiation safety of the population, establishes the right of a person to favorable environment and other related rights and guarantees of such rights.

State sanitary supervision refers to the activities of sanitary and epidemic agency aimed at prevention, identification and suppression of violations of sanitary law. According to this Law, each person is entitled to receive reliable information on the sickness rate, epidemic and radiation conditions, environmental condition and their influence on human health, as well as on the results of hygienic and other special expert reviews conducted. Also, each person is entitled to compensation of damage to their health caused by harmful chemical, physical, biological, and other environmental factors.

Governmental agencies, enterprises, institutions, organizations and associations irrespective of their legal form, as well as individuals, are required to do the following:

- ✧ comply with the duly approved sanitary norms, rules of hygienic standards;
- ✧ submit reliable and complete information on the accidents, sanitary-and-epidemic and radiation conditions to the agencies, institutions, and officials who conduct state sanitary supervision.

Governmental agencies, enterprises, institutions, organizations and associations irrespective of their legal form, as well as individuals that develop technical regulations are required to comply with the sanitary norms, rules, and hygienic standards aimed at protection of health, as well as sanitary-and-epidemic wellbeing.

Prior to implementing new chemical and biological substances, sources of ionizing radiation, and devices containing such sources, materials, processes, equipment and other products, the above agencies, enterprises, institutions, organizations, associations, and individuals must develop substantiated proposals with respect to the standards for ensuring sanitary-and-epidemic safety of the population, methods to control compliance therewith, techniques to be used in neutralization of harmful products and waste, and must submit them for approval to the Chief Sanitary Inspector of the Republic of Uzbekistan.

During the design, construction, and reconstruction of facilities, and upgrading or commissioning of enterprises, heads of enterprises, institutions, organizations and associations irrespective

of their legal form, as well as individuals must comply with the sanitary norms, rules and hygienic standards. Enterprises, institutions, organizations and associations irrespective of their legal form, as well as individuals must ensure that process and other equipment is operated, and the area, structures, production premises, amenities, workplaces, accommodation rooms, buildings of childcare, medical, educational, cultural, sporting and other institutions, as well as those for vehicles are maintained in compliance with the sanitary norms, rules and hygienic standards.

Enterprises, institutions, organizations and associations irrespective of their legal form, as well as individuals must comply with the sanitary norms, rules and hygienic standards that ensure sanitary-and-epidemic wellbeing of the population when storing, applying, neutralizing, recycling and burying chemical substances, biological agents and materials.

The use of new chemical substances, biological agents and materials, polymer and plastic masses, perfumes and cosmetics, and other chemical or biological agents is only permitted after the toxicological and hygienic assessment has been performed and hygienic standards have been established with consent of the Chief Sanitary Inspector of the Republic of Uzbekistan that is subject to approval by the CM of the Republic of Uzbekistan under the President of the Republic of Uzbekistan.

Governmental agencies, enterprises, institutions, organizations and associations irrespective of their legal form, as well as teams of employees and individuals must comply with the radiation safety norms and sanitary rules when working with radioactive substances and other sources of ionizing radiation, as well as with standards, specifications, and requirements of other regulations with respect to mining, obtaining, manufacturing, use, transportation, storage, recycling, and burial of radioactive substances and other sources of ionizing radiation.

According to the law of the Republic of Uzbekistan, enterprises, institutions, organizations and associations irrespective of their legal form, as well as executives and other persons are subject to disciplinary or administrative responsibility for the following:

- ✧ chemical, physical, biological and other pollution of soil, air, foodstuffs, ambient air of the work area, surface and ground water supply sources, water bodies and waterside areas of water-storage basins used by people for cultural and household purposes;
- ✧ development of technical regulations in the field of ensuring health protection, sanitary-and-epidemic wellbeing and radiation safety of the population without taking into account applicable sanitary norms, rules and hygienic standards;
- ✧ development of technical regulations in the field of implementing process equipment, tools and processes, manufacturing and use of new types of raw materials, sources of ionizing radiation, chemical substances and products without consent of the Chief Sanitary Inspector of the Republic of Uzbekistan;
- ✧ design, construction and reconstruction of enterprises, structures and buildings, vehicles, water supply systems, sewage and wastewater treatment, hydrotechnical and other facilities without consent of the state sanitary supervision agencies;
- ✧ using a land plot for new construction, reconstruction, or expansion of facilities without consent of the state sanitary supervision agencies;
- ✧ acceptance and commissioning of facilities without consent of the state sanitary supervision agencies;
- ✧ failure to ensure that the quality of water supplied by the centralized drinking water supply systems is in line with the hygienic requirements;

- failure to ensure that the quality of water in water bodies used for drinking and household purposes is in line with the sanitary norms and requirements;
- violation of sanitary rules for maintaining settlements and areas, accumulation, storage, transportation and recycling of industrial, agricultural, and household waste, including radioactive and toxic wastes;
- violation of sanitary norms, rules and hygienic standards in the field of air protection;
- violation of radiation safety norms and sanitary rules in handling radioactive substances, sources of ionizing radiation and in burial of radioactive waste;
- failure to take measures aimed at prevention of the spread of infectious, parasitic diseases, and at termination of such diseases;
- issuing permits to work to the persons who failed to pass a medical inspection or to those physically disqualified;
- failure by employees of certain categories to pass a compulsory medical inspection or untimely passing of such inspections;
- failure to perform the directions, opinions or regulations of the agencies and institutions that conduct state sanitary supervision;
- failure to submit the materials required to determine the sanitary-and-hygienic condition, epidemic situation and radiation conditions at a facility.

Regulation of the CM of the Republic of Uzbekistan "On Approval of Regulations Required to Implement the Labor Code of the Republic of Uzbekistan" No 133 of March 11, 1997 approved the following:

- guidelines for making an employment agreement (labor contract) and a Model Employment Agreement (Labor Contract) with the employees as per attachment No 1, and 2;
- list of employees of state-owned enterprises who may be exempt from the rules on limitation of joint service of relatives as per attachment No 3;
- list of employees working in special conditions, who have shortened working hours as per attachment No 4;
- procedure for making guarantee payments connected with performance by the employees of the public and social responsibilities, as well as with taking actions for the public interest as per attachment No 5;
- procedure for calculating average monthly salaries as per attachment No 6;
- procedure for granting sabbatical leaves and the duration periods of such leaves as per attachment No 7.

The Regulation also established the following:

- maximum working hours for employees engaged in operations with very harmful and very severe labor conditions as per attachment No 8;
- minimum duration of additional leave of the employees working in special, very harmful and very severe labor conditions of at least 12 working days.

2.2. International Conventions Entered into or Ratified by the Republic of Uzbekistan

The Republic of Uzbekistan joined the following international environmental conventions.

1. United Nations Framework Convention on Climate Change of 1992. The Republic of Uzbekistan joined this convention in 1993.

2. Kyoto Protocol to the Framework Convention on Climate Change signed on December 11, 1997 in Kyoto. The Republic of Uzbekistan joined this protocol in 1999.

3. The Vienna Convention on ozone layer protection. The Republic of Uzbekistan joined this convention in 1993.

4. Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal) of September 16, 1987. The Republic of Uzbekistan joined this protocol in 1993.

5. London (June 29, 1990) and Copenhagen (November 25, 1992) amendments to the Montreal Protocol on Substances Depleting the Ozone Layer. The Republic of Uzbekistan joined these protocols in 1998.

6. UN Convention on Biodiversity of 1992. The Republic of Uzbekistan joined this convention in 1995.

7. UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (Paris) of June 17, 1994. The Republic of Uzbekistan joined this convention in 1995.

8. Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel) of March 22, 1989. The Republic of Uzbekistan joined this convention in 1996.

9. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington) of March 3, 1973 and the Resolution on Seed Fish Protection thereto (Harare) of June 9-20, 1997.

10. Convention on migrating spices of wild animals, signed on June 23, 1998 in Bonn. The Republic of Uzbekistan joined this convention in 1998.

11. Convention on prohibition of military or any other aggressive destructive actions to the environment of 1998.

12. The UNESCO Convention on Wetlands of International Importance especially as Waterfowl Habitat, executed on February 2, 1971 in Ramsar. Protocol of amendments to Ramsar Convention of May 28, 1987. Protocol of amendments to Ramsar Convention dated December 3, 1982. The Republic of Uzbekistan joined this Convention and its protocols on 2/8/02.

The law of the Republic of Uzbekistan provides for a preventive operation of international treaties in respect of Uzbek national law. For instance, art. 53 of the Law of the Republic of Uzbekistan "On Protection of Nature" establishes that in the event if an international treaty entered into by the Republic of Uzbekistan sets any other rules than those contained in the Law or in any other environmental regulation of the Republic of Uzbekistan, the provisions of the international

treaty shall apply, except when the law of the Republic of Uzbekistan establishes more rigid requirements.

Below is a summary of key international treaties relating to environmental issues to which the Republic of Uzbekistan is a party.

Wetlands Convention. The objective of the Ramsar convention is the conservation and development of wetlands as a resource and a habitat of waterfowl. In this context the wetlands refer to the areas occupied with bogs, fans, peatlands, various water bodies that are no deeper than six meters during the low tide period. The specific natural feature of wetlands is, on the one hand, their higher bio-diversity, and, on the other hand, seasonal variability of their borders. At the same time, the waterfowl that are widely represented at the wetlands, are largely the migrating species, which places higher importance on the wetlands in international terms. In addition, the importance of this type of habitats is also in prevention of erosive processes.

The states that joined the Ramsar Convention bear the obligations to preserve, manage, and research the wetlands, rationalize their utilization, create natural reservations for waterfowl, ensure protection of their original habitats, develop and pursue a common policy aimed at development of both the wetlands, and the related flora and fauna. In this context the term "rational utilization" refers to the use of this type of lands for the good of the humankind helping conserve all the natural specifics and properties of this ecosystem. The Convention also provides for joint discussions, training of competent specialists, sharing knowledge and publications.

World Heritage Convention. The UNESCO Convention for the protection of the world cultural and natural heritage of 1972 is not directly classified as an environmental convention. Its subject-matter is the protection and popularization of the units of cultural and natural heritage (architectural ensembles, archaeological monuments, joint creations of man and nature, natural monuments created by physical and biological formations, etc.) of outstanding value for the humankind, whose heritage they represent. However, owing to the effective rules of protection of natural heritage, which include, but are not limited to, "geological and physiographical formations and highly restricted zones representing a natural habitat of endangered species of plants and animals of outstanding universal value in terms of science and conservation", this Convention can be included to a list of environmental documents.

The key obligation of the states that joined the Convention is to identify, protect, preserve, popularize and transfer to future generations the cultural and natural heritage located on their territory. Article 4 of the Convention emphasizes the priority of sole performance if this obligation by each state encouraging various options of cooperation, both in scientific, and in technical sphere. For this purpose the member-states establish governmental agencies for protection of cultural and natural heritage, conduct research and design work, take respective legal, scientific, technical, administrative and financial measures, encourage creation and development of related national and regional training centers, pursue the general policy aimed at inclusion of the issue of protection of cultural and natural heritage in general planning programs.

Convention on the Conservation of Migratory Species of Wild Animals. The Convention requires that the importance of conservation of migratory species be acknowledged, and that the states, where the natural habitats are located, coordinate measures, as reasonable and possible, paying special attention to the migratory species with unfavorable conservation status, as well as taking

reasonable measures, whether individually or in cooperation with each other, required to conserve such species and their habitats. The parties to the Convention acknowledge the need to take measures aimed to prevent extinction of migratory species. The Convention requires from Uzbekistan, being a party thereto, to perform a number of obligations, including, but not limited to:

- ✧ put in effort to ensure immediate protection of migratory species, as listed in Attachment I;
- ✧ put in effort to make Treaties for conservation of the migratory species listed in Attachment II, and for managing them.

Kyoto Protocol to the Framework Convention on Climate Change sets a goal to define targets of greenhouse emissions and to gradually reduce them. The obligation of the parties thereto is to pursue and/or further develop, given their national conditions, the policy and measures, aimed at the following:

- ✧ higher energy efficiency in certain sectors of national economy;
- ✧ protection and improved quality of absorbers and storages of greenhouse gas, not regulated by the Montreal protocol, given their obligations under the respective international environmental treaties;
- ✧ encouraging rational techniques of forest management, permanent forestation and forest renewal;
- ✧ encouraging sustainable forms of agriculture given the issue of a climate change;
- ✧ encouraging implementation of new designs, conducting research, development and wider use of new and renewable energies, technologies for absorbing carbon dioxide and innovative green technologies;
- ✧ gradual reduction or elimination of market disproportions, fiscal incentives, tax exemptions and subsidies that are in conflict with the Convention goal in all the economy sectors that represent sources of greenhouse emissions, and using market tools;
- ✧ encouraging proper reforms in the respective sectors in order to assist implementation of the policy and measures limiting or reducing greenhouse emissions not regulated by the Montreal protocol;
- ✧ measures limiting and/or reducing greenhouse emissions not regulated by the Montreal protocol;
- ✧ limiting or reducing methane emissions by recuperation and utilization during waste disposal, as well as in generation, transportation and distribution of energy.

The parties listed in attachment I to Kyoto protocol must separately or jointly ensure that their cumulative man-caused emissions of greenhouse gases like carbon dioxide (CO_2), as well as methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) in carbon dioxide equivalent are within the targets set for them and calculated in pursuance of their quantitative obligations relating to limitation and reduction of emissions, as listed in attachment B, and according to the provisions of this article, for the purposes of reducing total emissions of such gases by at least five percent as compared to 1990 levels over 2008-2012 period of obligations.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal defines the term of “hazardous wastes” and their categories, the terms “waste utilization”, “transboundary movement”, and “waste disposal”. According to the Convention, the “wastes” represent substances and objects that are being disposed of, are intended to be disposed of, or subject to disposal according to the provisions of the national law.

"Waste utilization" refers to collection, transportation and disposal of hazardous and other wastes, including follow-up control of disposal sites. "Transboundary movement of wastes" refers to any movement of hazardous and other wastes from the region within the national jurisdiction of one state to or through the region within the national jurisdiction of another state, or to or through the region without any national jurisdiction of any state, provided that such movement concerns at least two different states. "Waste disposal" refers to any operations defined in attachment IV to this Convention;

UN Convention on Biodiversity. The objective of this Convention is to conserve biodiversity, ensure sustainable use of its components, fairly and equally share the benefits connected with the use of genetic resources, including through provision of access to genetic resources, as required, and through proper transfer of respective technologies, given all the rights to such resources and technologies, and through provision of adequate funding. For the purposes of ensuring sustainable use of the components of biodiversity, the Convention provides for the following:

- ✧ discussing the issues of conservation and sustainable use of biological resources in the decision-making process at the national level;
- ✧ taking measures in the field of the use of biological resources aiming to prevent or minimize adverse impact on biodiversity;
- ✧ assisting local population in developing and implementing the measures aimed at remedying the situation in the affected regions, where biodiversity was reduced; and
- ✧ encouraging cooperation between governmental agencies and the private sector in the field of development of new techniques for sustainable use of biological resources.

2.3. HSE Issues Provided for in Production Sharing Agreement in respect of Kandym Filed Group Plot, Khauzak and Shady Plots, and Kungrad Plot between the Republic of Uzbekistan and Investors Consortium Consisting of OAO LUKOIL and NKH Uzbekneftegaz.

Pursuant to article 23.3 of the PSA, the Investor shall submit to the applicable law of the Republic of Uzbekistan governing the standards (norms, rules) of safe operations, protection of subsoil, environment and human health.

Attachment 6 of the PSA outlines the environmental strategy, which both the Investor, and the Governmental Authority are to follow.

Sub-committee for environmental protection shall develop the environmental policy, including the following:

- ✧ creation of an environmental monitoring system as part of oil and gas operations and establishing by the Management Committee of an environmental sub-committee;
- ✧ procedure for establishing and organizational pattern of the sub-committee for environmental protection shall be set out in OAO LUKOIL's letter of proposal submitted for approval to the MC. The sub-committee for environmental protection shall consist of the representatives of the Investor and the Authority, who, pursuant to a decision by the Authority, may be represented by executives of the State Environmental Committee of the Republic of Uzbekistan, other Governmental Authorities, and employees of research institutions;

- ✧ the sub-committee for environmental protection shall develop the Health, Safety and Environment Program;
- ✧ the sub-committee shall develop the above HSE Program only after an independent assessment of initial environmental condition of the Contracted area has been conducted. The HSE Program is to be reviewed and approved by the MC with consent of the State Environmental Committee of the Republic of Uzbekistan;
- ✧ The HSE Program shall be implemented on a stage-by-stage basis, according to the procedure and respective common stages of oil and gas operations (survey of initial condition, seismic survey, exploration drilling, field development, production, abandonment of wells and field decommissioning after oil production has been completed), and according to the approved operational programs and the budget.

Functions of sub-committee for environmental protection:

- ✧ Environmental monitoring:
  - ✦ develop and adjust the program of continuous operational environmental monitoring according to section 23.7;
  - ✦ coordination of the monitoring program;
  - ✦ review of results and making proposals on improvement of the monitoring program;
  - ✦ publication of annual report.
- ✧ Selecting research programs:
  - ✦ administration of environmental research programs;
  - ✦ allocating funds for this purpose, as per respective annual operational programs and budgets;
  - ✦ monitoring work progress;
  - ✦ publication of end products.
- ✧ Environmental management:
  - ✦ selecting and assessing performance of the selected environmental activities;
  - ✦ taking part in the development of programs for prevention and reduction of environmental impact caused by emissions and discharges from operational sites.

Environmental safety and control. The Operator shall perform oil and gas operations with due care, ensuring the level of efficiency and safety required by the applicable law of the Republic of Uzbekistan relating to safety, health and environment, as well as in compliance with the environmental standards of the international oil and gas industry (provided that such standards and expertise are not inconsistent with the law) relating to health, safety and environment.

The Operator shall make every reasonable effort pursuant to the laws and standards to minimize any potential environmental misbalance, including, but not limited to, surface, subsoil, air, lakes, rivers, flora and fauna, crops and other natural resources. The sequence of actions shall be as follows: safety of life, environmental protection, safety of property.

The Operator shall create an integrated control system covering all the aspects of safety, health and environment with respect to the measures taken in connection with oil and gas operations, provided that:

- ✧ The Operator shall develop the HSE Program for the Contracted area based on the analysis of initial environmental condition. Information on the environmental condition of the Contracted area shall be provided to the Operator by the Authority. Costs in connection with development and implementation of the HSE Program shall be classified as Costs of oil and

gas operations, and the Operator shall keep accounts of the above Costs separately for the Contracted area for development, and for the Contracted area for exploration.

- ✧ The Operator shall use the existing (applicable in the Republic of Uzbekistan) and develop new HSE standards, methods and techniques subject to approval by the State Environmental Committee of the Republic of Uzbekistan, which HSE standards, methods and techniques should be suitable for regulation of oil and gas operations. Also, the Operator shall develop instructions and analytical guidelines for controlling emissions, discharge and wastes. The HSE standards shall take into account environmental properties of the Contracted area and shall be based on the applicable HSE law of the Republic of Uzbekistan, and, as applicable, on the international oil and gas industry standards and expertise and on the practice of application of those in upstream operations in other regions of the world.

The standards and methods developed will take into account issues like the goal of environmental protection, technical feasibility, economic and commercial profitability. When new HSE standards and methods developed and approved by the State Environmental Committee of the Republic of Uzbekistan and the Operator come into effect under this Agreement, they shall supersede the previously developed methods and standards and shall subsequently apply to oil and gas operations under this Agreement.

Emergencies, environmental damage. In case of emergencies and accidents, including, but not limited to, explosions, emissions, leaks or other incidents that cause or may cause environmental damage, the Operator shall promptly notify the Authority and the Respective Governmental Authorities, including the State Environmental Committee of the Republic of Uzbekistan, of such circumstances specifying the approximate amount of emissions, and inform of the emergency response activities it has taken to remedy the situation, and of the outcome of such activities.

The Operator shall make every effort required to take prompt measures, gain control over the emergency situation and prevent casualties, damage to natural resources and environment, and loss or damage to property. The Operator shall report the measures it has taken to the State Environmental Committee of the Republic of Uzbekistan and to the respective supervisory authorities of the Republic of Uzbekistan.

Monitoring:

- ✧ Initial environmental information on the background pollution of the Contracted area shall be provided to the Operator by the Authority.
- ✧ The Operator or its contractor shall conduct production supervision within the framework of oil and gas operations.

Figure 2.1 is a schematic representation of the policy and functions of the cub-committee for environmental protection.

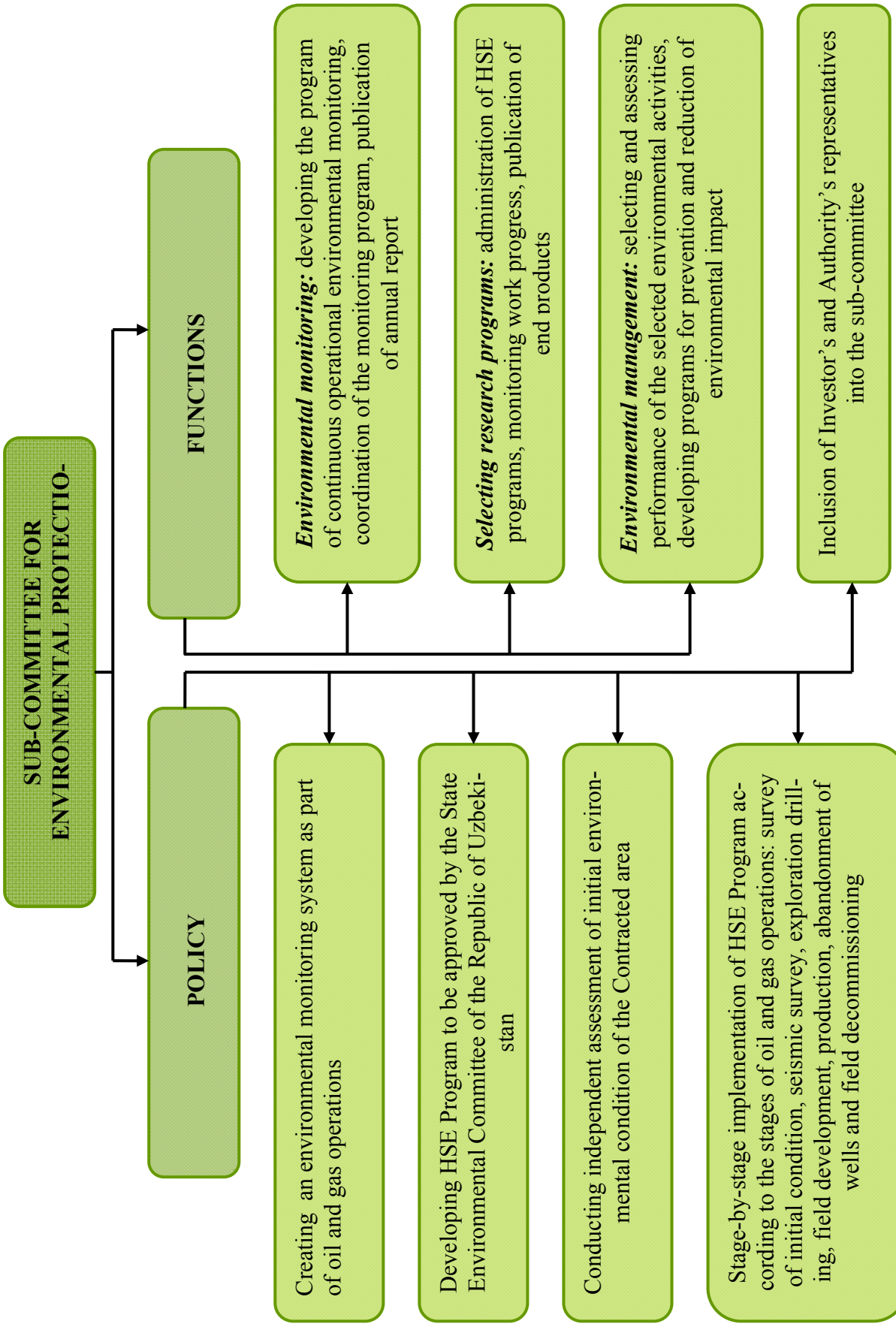


Figure 2.1 – **Policy and functions of sub-committee for environmental protection**

3. CLIMATE, GEOLOGY AND GEOGRAPHY OF CONTRACTED AREAS

3.1. General Physical and Geographical Description of Contracted Areas

3.1.1. Kandym and Khauzak Shady Field Group Plots

According to Physical and Geographical Zoning of Uzbekistan (L.N. Babushkin, N.A. Kogai), these plots are situated in the Lower Zeravshan region. This region includes four physical and geographical areas by landscape schemes: Gazly, Bukhara-Karakul, Sundukly and Kenimekh areas (Figure 3.1).

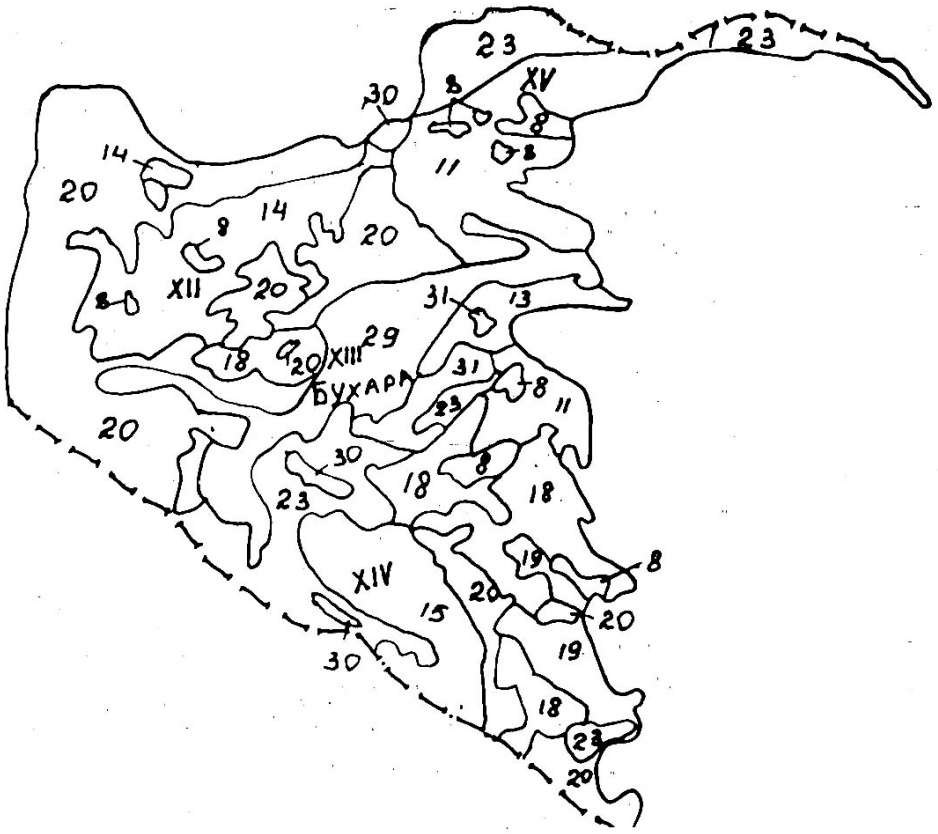


Figure 3.1 – **Lower Zeravshan Physical and Geographical Region**

The Zeravshan River's downstream is the region's central part. Nuratinsky ridge's brances and Kyzyl-Kum desert surround this in the north; and Zirabulak elevation surrounds the river's downstream in the south. Mountain systems primarily include ancient Ordovician and Silurian (Paleozoic) sediments. These predominantly include shale with dolomitic interlayers, dolomitized marbles and marbled lime stones. Younger sediments (Meso-Cainozoic) primarily include cretaceous

Neogene and Quaternary sediment loads that either cover massive crystalline rocks or border these as a narrow belt.

3-10 m loamy alluvium underlain with sands and sporadically containing scattered gravel with loamy interlayers forms the Karakul delta. Clays, loamy sands and fine sands interstratify the upper loams. Alluvium is underlain with Turanian suite sediments cropping out at Karakul neck of land. Therefore, alluvial sediments as if inserted into Turanian suite sediments are of low permeability which, combined with the delta's flat nature unfavorably impact ground water outflow from Karakul oasis.

Karakul plateau is a slightly rolling plain with gently bed-like hollows. Barchan sands occupy the north-western part of the plateau. Sands form cumulose and ridge barchans (exceeding 5m) or rarely dunes; they are locally stabilized with saxaul, heath, camel's-thorn and other vegetation. The remaining area is a detritus desert covered with Calligonum bushes followed by sand bars.

The Makhandarya's bed and the Gujeily's dry bed border the plateau in the north and in the south, respectively. The ledge bordering with the plateau is of the greatest height in the south and south-east reaching 15-20 m. Eolian sands locally covers this ledge (M.K. Grave and M.I. Alexandrova). The composition of the Makhandarya and Gujeily's alluvial beds correspond to deltaic sediments of Bukhara and Karakul deltas. These beds are inseparably connected to the current Zeravshan.

The Great Zeravshan's alluvial/deltaic plain adjoins the Zeravshan valley from the west and north-west. This plain is called South-Western Kyzylkums in literature. The plain has a very gentle slope from east to west. Sediments containing Quaternary fauna of alluvial, lake and deltaic genesis form this plain. Uch-Bash, Karakyr, Jusantepe, Takhnakyr and other flattened and rounded residual mountains sharply point out at slightly rolling alluvial and deltaic plain complicated with eolian sands. These residual mountains are approximately at the same level.

Flat-lying Pliocene and Quaternary rocks form such residual mountains. Toes of the slopes of these low elevations penetrate younger sediments forming the plain. The residual mountains are "buried" in loose sediments rising above the surrounding plain by only 10-15 m.

The area containing current and the Upper Quaternary alluvial and deltaic plains of the Kashkadarya River, Dengizkul plateau and local elevations known as "Katan Elevations" (A. Umarov) adjoins the Zeravshan downstream valley from the east and south east.

The area in question is a particular plot under research and is the eastern part of so called "Bukhara-Khivinsk" area (P.P. Chuenko) within which the Paleozoic base occurs at 1000-3000 m. The Paleozoic base's surface penetrates south-east on a step basis from the Kuljuktau's foot to Repetek region. Along with south-west penetration, the base penetrates lengthwise south-east i.e. to Hissar ridge foot (A.A. Borisov, V.G. Vasilyev, L.G. Zhukovsky, Yu.V. Kaesh, and V.V. Semenovich).

Bukhara-Karakul physical and geographical area occupies the central position within the Lower Zeravshan physical and geographical region. Bukhara and Karakul deltas represented by the Zeravshan's second terrace above the flood-plain mainly occupy the area. Its individual parts occur along the Zeravshan's current bed.

The water content of the Zeravshan River which is actively used for irrigation, evaporation and filtration purposes reduces near the town of Karakul. After passing the last irrigation fantail, the river bed called Taikyr ends in the salt drying lake of Dengizkul. Taikyr is used as an irrigation channel within Karakul oasis.

The area includes the following landscapes:

- ✧ Landscape of deltaic plains transformed due to eolian processes with Calligonum bushes growing on desert sand soils cover small sand area located on the deltoic plain between the town of Karakul and Sverdlovsky settlement (Zhondor).
- ✧ Landscape of deltaic plains with tamarisk bushes growing at meadow and takyr soils is characteristic of the Makhandarya, Gujeily and the fringes of Karakul delta that are periodically flooded with overflow water. These are formed by alluvial deltaic sediments including sandy loam and loamy deposits. Meadow, meadow and takyr saline soils form on such sediments. Residual saline lands, cumulose and hillocky sands occur as well. Overflow water from the Zeravshan into the Makhandaryan and the Gujeily ensures quite a high level of fresh and brackish ground water.
- ✧ The humanized landscape at deltaic plains with irrigated meadow alluvial soils is typical of Bukhara and Karakul deltas developed for irrigation farming. Sand, loamy sand and clay interstratified rocks underlain either by pebblestones (the central and northern part of Bukhara oasis) either pre-Quaternary rocks (south Bukhara oasis and Karakul oasis). Ground water is either fresh or sulphate or hydrocarbonate at surface-stream flows and at actively irrigated areas within Karakul oasis. Sulphate water becomes chloride-sulphate and sulphates-chloride while the distance from flows' beds increases. Ground water is saline and brackish within lower and poorly irrigated areas.

A continuously degrading natural drainage caused by irrigation is typical of Bukhara and Karakul oases. Hampered drainage and basin-type bedding is characteristic of ground water accelerating salinization. Water flow, evaporation and transpiration does not compensate for ground water recharge with irrigation water. This is steadily bringing closer the moment when the daylight's depth reaches the critical point. There is almost no natural vegetation in the oasis. It remains only at the Zeravshan bottomland. The steppe cedar, Aeluropus and halophytic vegetation grows at The Zeravshan bottomland within Karakul delta. The eastern and north-eastern border of the Lower Zeravshan region goes along the lower foot of light grey desert soil of the Kashkadarya and Middle Zeravshan regions.

As compared to the Central Kyzyl-Kum the eastern part of Bukhara-Khivinsk area is a downwarping area. Therefore, thicker cretaceous Neogene and Quaternary sediments are characteristic of this area. The area includes belts of relative elevations and depressions. Some of these structures bear oil and gas. Dengizkul depression (previously the lake) is one of such depressions. Currently, the western part of this depression is a huge saline land depression where drainage water flows from the upland province while the northern part is Bukhara-Karakul physical and geographical area characterized by specific climatic properties caused by wide-spread artificial irrigation.

The irrigation impact actively shows itself during the warm half-year period. This is the coolest area in summer among all the areas included into the region: the average temperature in July is relatively low (29,5°C); the absolute temperature maximum recorded during the monitoring period ((45°C); the lowest product of positive temperatures; weakest dry hot wind; only 30% of dry

hot wind day during the summer period. In addition to that, the average temperature in January is the highest (–0.5°); the product of negative temperatures is smaller; the percentage of vegetation winter is higher (52% of the total monitoring years) as compared to those parameters of Gazly area.

As compared to Gazly area the precipitation level is a bit higher though is remains small (120 mm) which damages the healthy growth and fruiting of agricultural crops under no irrigation conditions. The southern and south-western border is conditional: it matches the border with Turkmenia.

3.1.2. Kungrad Plot

According to physical and geographical zoning (L.N. Babushin, N.A. Kogai) this plot is included into the Lower Amudarya region that cover 350 km plain area from the Tuyamuyunsk narrow to the Aral Sea. The current Amudarya's delta and the Akchdarya alluvial plain with Beltau elevation occupy the northern part. The southern part covers Khorezm oasis. The area borders with the Aral Sea at the absolute level of 54 m in the north. The eastern border passes along Kyzylkum sand desert which is Kyzyl-Kum physical and geographical area. The southern and south-western border goes along the northern margins of Zaunguz Karakums. The north-western border matches with steep cliffs of Ustyurt desert plateau.

Flat relief is characteristic of this region that is located within desert area. Vertical zonality does not show itself there. However, there is the latitudinal zonality as the region extends from north to south. The region primarily includes to groups of areas i.e.: northern and southern. The northern group includes Chimbai-Kungrad and Beltau physical and geographical areas; while the southern group includes Khorezm area.

The Contracted plot covers Chimbai and Kungrad physical and geographical area and includes the Amudarya current delta and adjacent irrigation farming areas in the east and in the west. The Aral Sea washes the area in the north. Ustyurt cliffs borders with the area in the west; while the eastern border passes along the Beltau physical and geographical area. The area includes both automorphic and hydromorphic landscapes. The area's basic landscape is that of current delta covered with tugai vegetation (refer to Figure 3.2).

Deltaic plain landscape is wide spread mainly at the left bank of the Amudarya along Ustyurt cliffs; it sporadically occurs along the border with Beltau physical and geographical area. Plots with this landscape got beyond flood water impact and are formed by loamy and clayey sediments. Takyr soils are wide spread there. Such soils are of saline type.

The landscape of current delta and respective overflow lands grown with tugai vegetation on meadow and marsh flood-plain and alluvial soils is characteristic of the Sub-Aral delta of the Amudarya whose height values vary from 65-70 m in the south to 54 m in the north. This is a perfect plain gently descending north to the Aral Sea; the plain's surface is rich in active beds of the Amudarya and its numerous channels.

Lakes and marshes are wide spread. Interstratified sand, loamy sand, loam and clay rocks where meadow, marshy, flood plain alluvial soils are formed due to soil and ground overwatering

compose the current Amudarya delta. Reed, Asiatic poplar, oleaster, tamarisk bushes and etc. grow there.

The humanized landscape on deltaic plains and respective terraces with irrigated meadow alluvial soils covers the Amudarya alluvial and deltaic plains at the absolute depth mark of 100 m in the south to 66 m in the north. These elevated areas as compared to the current delta are at a considerable distance from the Amudarya. Therefore, ground water of these areas in indirectly connected to the main water artery. Ground water occurs close to the surface as is recharged with extensive irrigation network. Alluvial sands, loamy sands, loams and clays are the soil mantle matrix.

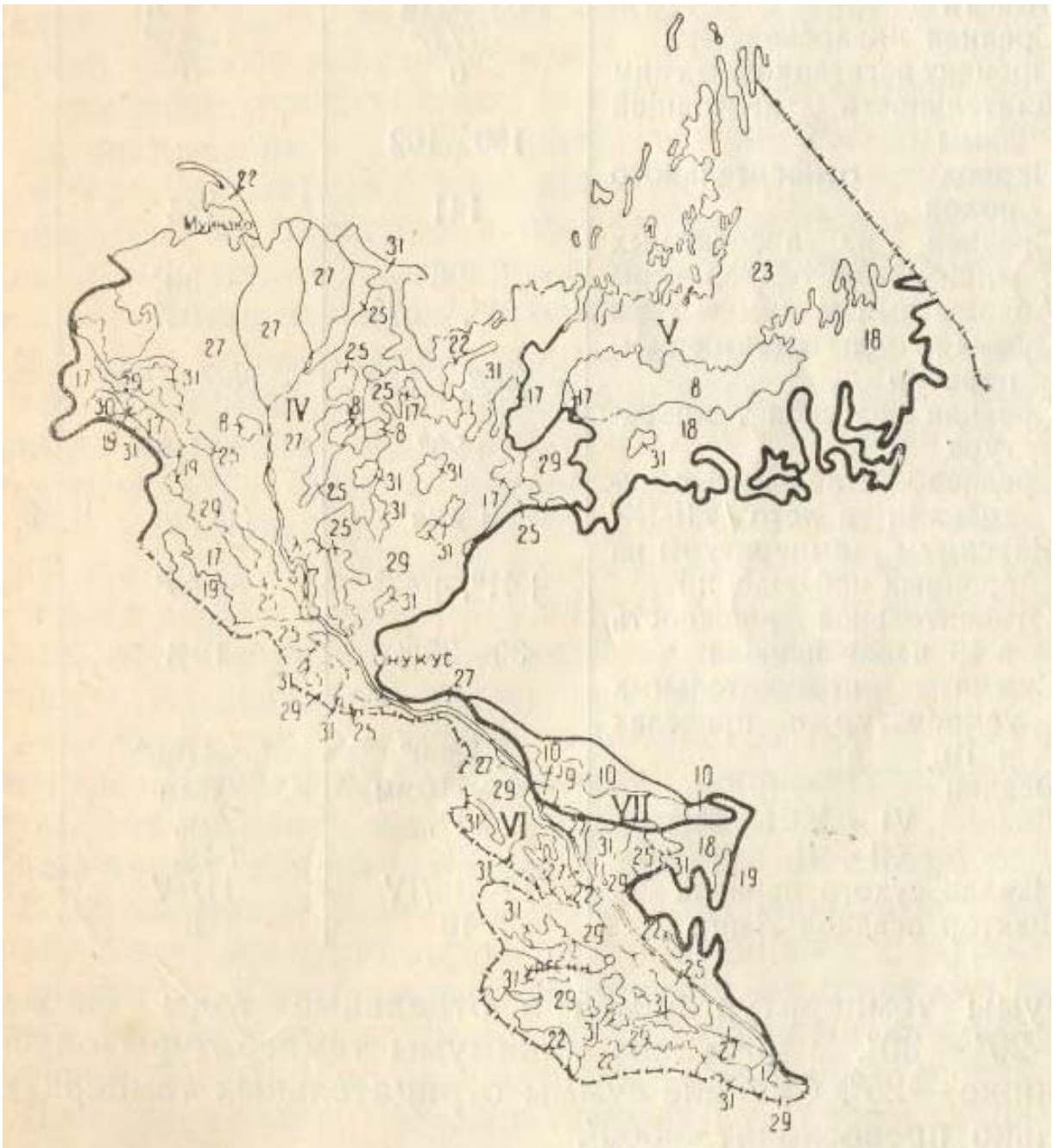


Figure 3.2 – **Lower Amudarya Physical and Geographical Region**

3.2. Climatic and Weather Conditions of Contracted Areas

Similar to the whole south-western part of Central Asia, Uzbekistan is situated within the sub-tropic belt of the north hemisphere. It is located in the central part of the extensive Eurasian continent far from its coastal line and characterized by the continental sub-tropic climate with great

air temperature ranges both on a daily and annual basis, a sharp precipitation frequency and precipitation winter/spring nature.

Uneven watering throughout the year and rapid temperature increase during the spring/summer shift account for specific water/heat conditions the most distinctive feature of which is two various hydrometeorogical and biological vegetation and soil formation phases i.e.: warm humid spring and hot dry summer.

By hydrothermal conditions Uzbekistan is classified into desert latitudinal zone with Turanian extra arid climate and three altitudinal belts with the following climatic conditions going bottom-upwards: arid, subhumid and humid-subniveal. Given the aurorelief dominance the climatic areas correspond to the following geomorphologic areas: Turanian lowland's plains; foothills with gentle sloping plains; and medium altitude mountains and highlands.

Huge temperature ranges on an annual and daily basis; very hot summer, slight cloudiness and low air humidity and low precipitation level are characteristic of the extra arid climate typical of Turanian deserts. The extra arid climatic area includes the largest Uzbekistan's oasis with well-established irrigated farming culture i.e.: Bukhara, Karakul, Lower Surkhandarya, Central Ferghana's oases and the Amudarya's lower reaches. A specific ground air micro climate is characteristic of these areas, in particular:

- ✧ evaporation from the soil level and transpiration;
- ✧ higher humidity and moderate air temperatures immediately above the soil level.

The whole Bukhara oblast's irrigated area (Kandym and Khauzak Shady group areas) lies in the desert, in particular, in the central and southern desert subareas while Kungrad area (Kungrad plot of the Contracted area) borders with sub-oreal (moderate) and sub-tropic (warm and humid) sub areas of Uzbekistan's desert areas.

A sharp continental nature; a low precipitation level; high summer and low winter temperatures are distinctive climatic features of this area. All the above parameters and a low relative air humidity and wide spread winds increase the water evaporation from the soil layer and promote soil salinization processes. Low winter temperatures cause frost penetration into the upper soil layer which deteriorates its water and physical properties and hampers flushing and treatment processes.

We used the long-time annual average data collected by weather stations in 1990—2000 and 2001-2003 basic climatic parameters monitored at Bukhara, Karakul and Kungrad weather stations to describe the climatic environment at the Contracted Areas.

3.2.1. Air and Soil Temperature

Figures 3.3-3.12 show monthly levels of air and soil temperatures respectively (by Bukhara, Karakul and Kungrad: the absolute maximum value; the average maximum value; the average value; the average minimum and the absolute minimum.

3.2.2. Precipitations

The average annual precipitation in Bukhara and Karakul oases is 208.6 mm and 162.0 mm, respectively. 114.9 and 76.8 mm precipitates at night; and 93.7 and 85.2 mm precipitates in the daytime. The maximum amount of precipitation per day is 23.1 and 188.8 mm by Bukhara and Karakul weather stations respectively or 66.6 and 39.4% of the average monthly precipitation rate.

The maximum amount precipitates in spring (42.5-52.6%); winter months account for 30.7-57.1%; autumn accounts for 1.4-16.1% and summer is almost rainless (0.5-3.1%). The ratio of winter/spring to summer/autumn precipitation is about 8.8:1. The average perennial spring frost periods cover the second decade of March (sometimes the third decade) and first autumn frosts occur in the early October. The average snow mantle depth is 4-5 cm; it is usually thin and unstable quick-melting snow though it may become rather thick in severe winters causing frost penetration into soil up to 50-60 cm.

The average annual amount of precipitation is 224.5 mm based on long-term data collected by Kungrad weather station. The maximum amount precipitates in the winter/spring period while autumn months account for only 7-19 % of the annual precipitation amount. Summer is almost rainless. Snow mantle is usually thin and unstable with the average depth of 5-8cm; therefore, frost often penetrates to soils starting from the second decade of December to the first decade of February. Frost sometimes penetrates into soil up to 70 cm within irrigated areas.

3.2.3. Relative Air Humidity

Relative air humidity accounting for the rate of water evaporation from the soil level is of great importance for soil mantle formation and salinization. Relative humidity depends on local conditions and actively impacts its irrigation, collecting and drainage networks, numerous small lakes, marshes and water bodies; irrigated fields, ground water levels and etc.

The average annual air humidity strongly varies over a wide range from 52-55% as recorded at Karakul weather station to 59-61% as recorded at Bukhara weather station. The highest relative humidity values of 74-85% occur in winter months; the lowest values of 33-45% occur in summer. The average air humidity at 1 p.m. in summer is 22-28%. The average annual number of days when relative air humidity does not exceed 30% is 12.8-17.0% while the average annual number of days with at least 80% humidity is 2.2-3.4%.

Small air precipitation, high air temperatures, active solar radiation, high relative air humidity are the reasons for intensive evaporation within oases. The annual evaporability is 1,750-2,040 mm. Over 80% of water evaporation falls on a warm half-year period. Humidity deficit is 1,580-1,770 mm. The amount of evaporating moisture exceeds air precipitation 40-45 times in summer. This promotes active soil salinization.

Highly active solar radiation observed within the desert area and associated high air temperatures, especially in summer, cause rapid evaporation of precipitated moisture. The bulk of solar energy in the desert is used to heat surface ground levels which transfer heat to lower air layers (turbulent heat exchange) that accounts for a rapid temperature increase within such layers. Some transferred heat evaporates in oases; therefore, air temperature is much lower.

Winter/spring months see the highest relative humidity values of 63-79 according to Kungrad weather station; summer months see the lowest values of 42-45%. The average monthly air humidity reduces to 15-20% in the daytime in summer; though it remains higher (30-35%) within seaside areas. The annual evaporability is 2,004 mm. Over 75-80% of water evaporation falls on a warm half-year period. Humidity deficit is 1,753-1,807 mm.

3.2.4. Wind Description of Contracted Areas

Both weak and intensive wind loading is characteristic of Kandym field group and Khauzak Shady plot. The average annual wind velocity is 3.8 and 2.9 m/s according to Bukhara and Karakul weather stations respectively; northern, north-eastern and north-western winds dominate. March, April and May see the strongest winds (16-20 m/s). The number of days with 15 m/s strong winds is 8-12 during this period; while the number of dust storm days is 18-24. The greatest number of strong wind days (>15 m/s) is in the winter/spring period. The average annual maximum wind velocity varies from 15.7 to 14.3 m/s depending on a weather station (Table 3.1).

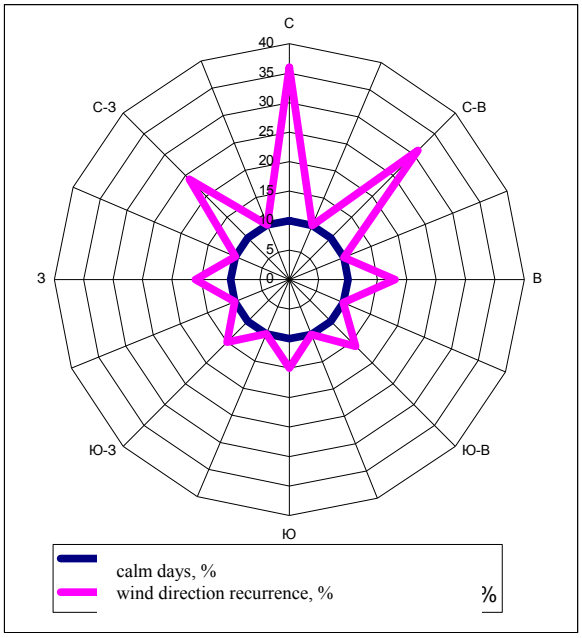
Table 3.1- **Average Monthly Wind Velocities by Contracted Plots' Weather Stations**

Month	Wind velocity by weather stations, m/s					
	Bukhara		Karakul		Kungrad	
	average	average maximum	average	average maximum	average	average maximum
1	2	3	4	5	6	7
January	3.4	13.0	2.6	13.0	3.6	16.0
February	3.7	18.5	3.0	14.0	4.2	16.5
March	4.5	18.5	3.0	16.0	5.0	21.5
April	4.1	18.0	3.1	15.0	5.4	18.0
May	3.6	16.0	2.8	15.0	4.4	18.5
June	4.3	19.5	3.3	16.5	5.1	22.5
July	4.4	16.5	3.3	16.0	4.3	19.5
August	4.2	13.0	2.9	11.0	3.4	17.5
September	4.0	14.0	2.9	12.5	3.8	20.0
October	3.1	16.5	2.5	13.5	4.0	18.0
November	3.0	12.5	2.6	11.5	4.0	16.0
December	3.3	12.0	2.8	13.0	3.9	18.5
Per year	3.8	15.7	2.9	14.3	4.3	18.6

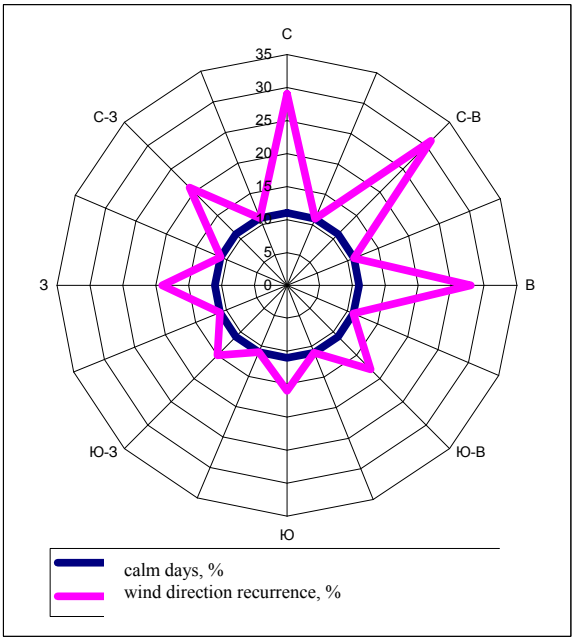
Strong winds are observed within Kungrad plot. The average annual wind velocity is about 4.3 m/s; north and north-eastern winds dominate. The number of strong wind and dust storm days is 16-25. Strong winds damaging saline lands located in the delta to the north of irrigated areas and locally; winds transport saline dust to irrigated fields; unstable cumulose and flat sands are deflated. These negative phenomena are a probable reason for a general environmental aridization in this region caused by drying of the Aral Sea.

Figures 3.13 show wind roses based on long-term data collected by Karakul and Kungrad weather stations per year and by indicative seasonal months i.e. January and July.

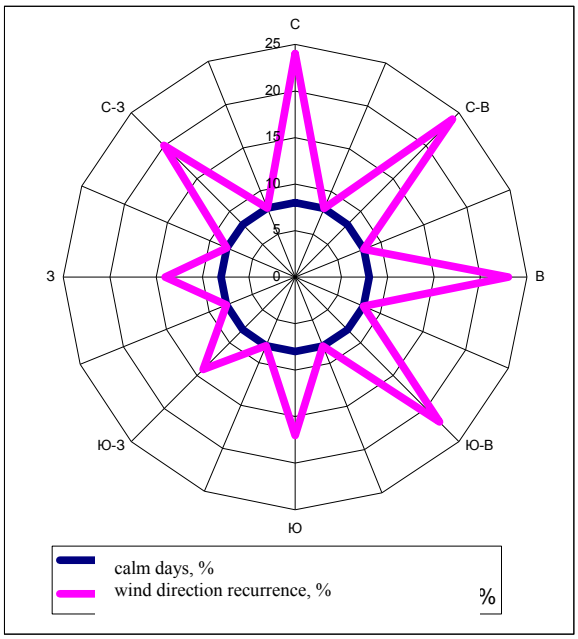
Karakul weather station



Kungrad weather station



per year



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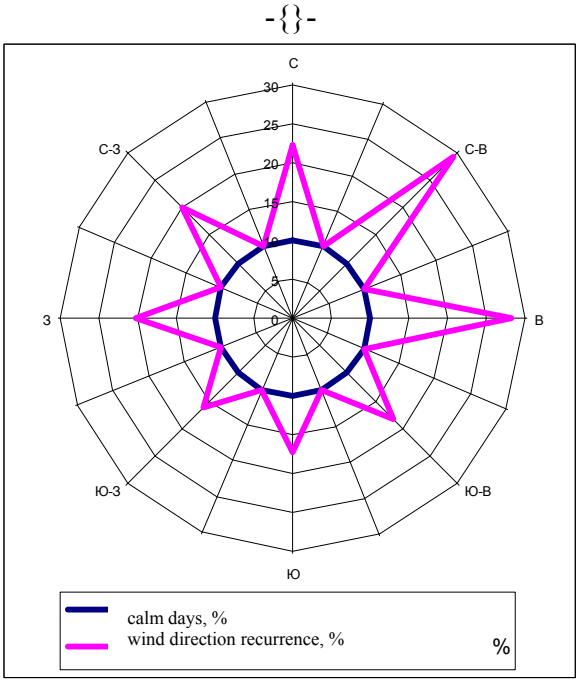
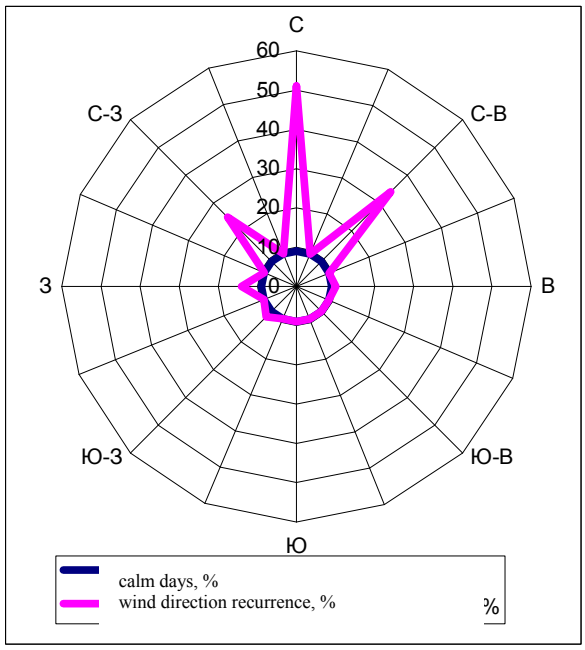
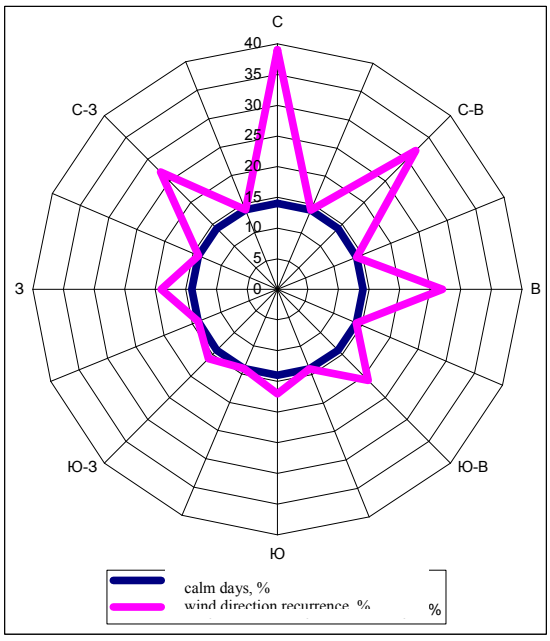


in January





in July

Figure 3.13 – **Wind Roses per Year and by Indicative Seasonal Months Developed by Karakul and Kungrad Weather Stations**

Figure 3.13 shows north winds prevail in summer, especially at Kandym field group and Khauzak-Shady plots. All the Contracted Areas see winds of similarly direction in winter except for south-western directions.

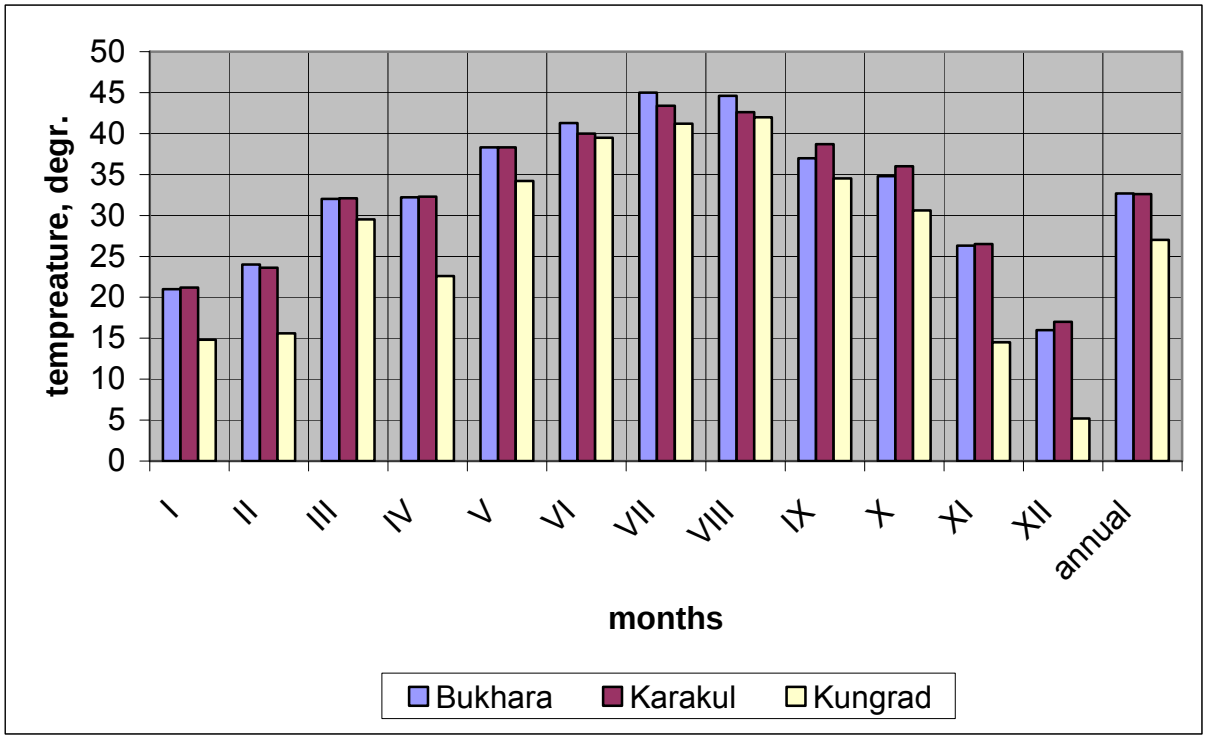


Figure 3.3 – **Air Temperature Absolute Maximum by Months**

Figures 3.3-3.12 show that the average annual air temperature at Kandym and Khauzak Shady plots varies within 16.1-16.4 ^{0}C; the average monthly temperature in the hottest month of July is 29.0-29.4^{0}C; the maximum day air temperature amounts to 43.4-45.0^{0}C, and the minimum winter temperature (in December) falls to –15,2-15,3^{0}C while the average monthly value is -4.8-5.5^{0}C. The average daily temperatures i.e.: maximum values are recorded in the late July and early August and minimum values - in January-December.

The average annual soil temperature varies 19.0-19.5^{0}C while the average annual maximum temperature amounts to 37.6 - 37.8^{0}C, and the minimum temperature is 7.5-8.2^{0}C. Summer sees very high soil level temperatures; the absolute maximum values reach 70-71^{0}C. It falls to –18-20^{0}C in winter; the annual soil temperature range is 45.2-49.2^{0}C.

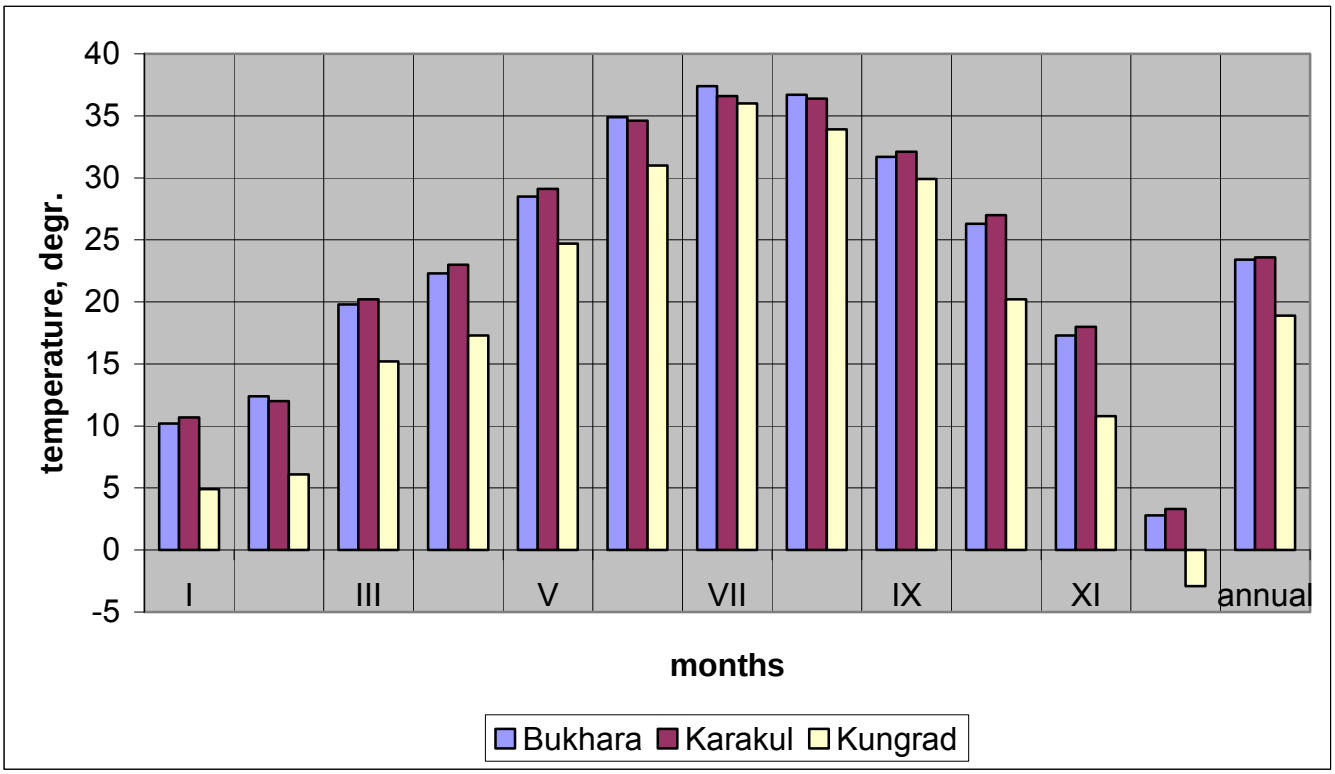


Figure 3.4 – **Air Temperature Average Maximum by Months**

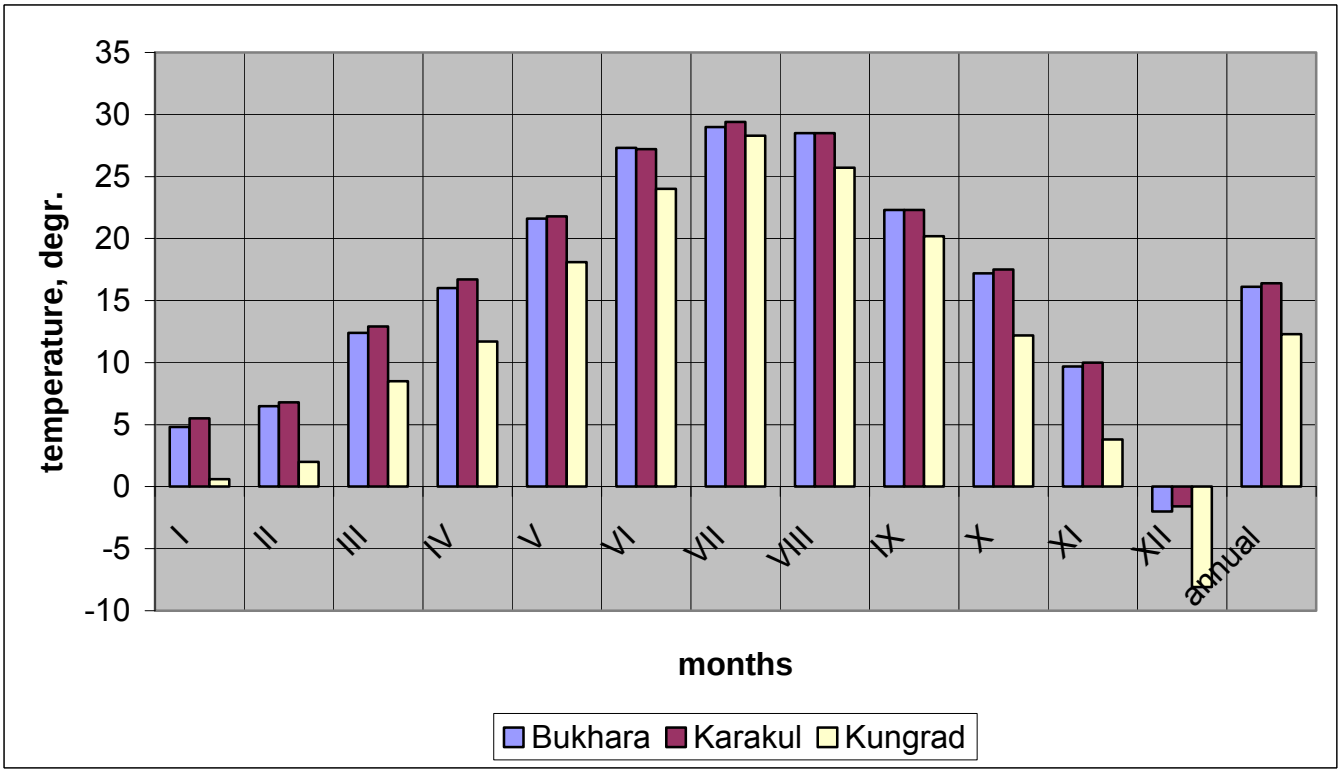


Figure 3.5 – **Average Monthly Air Temperature**

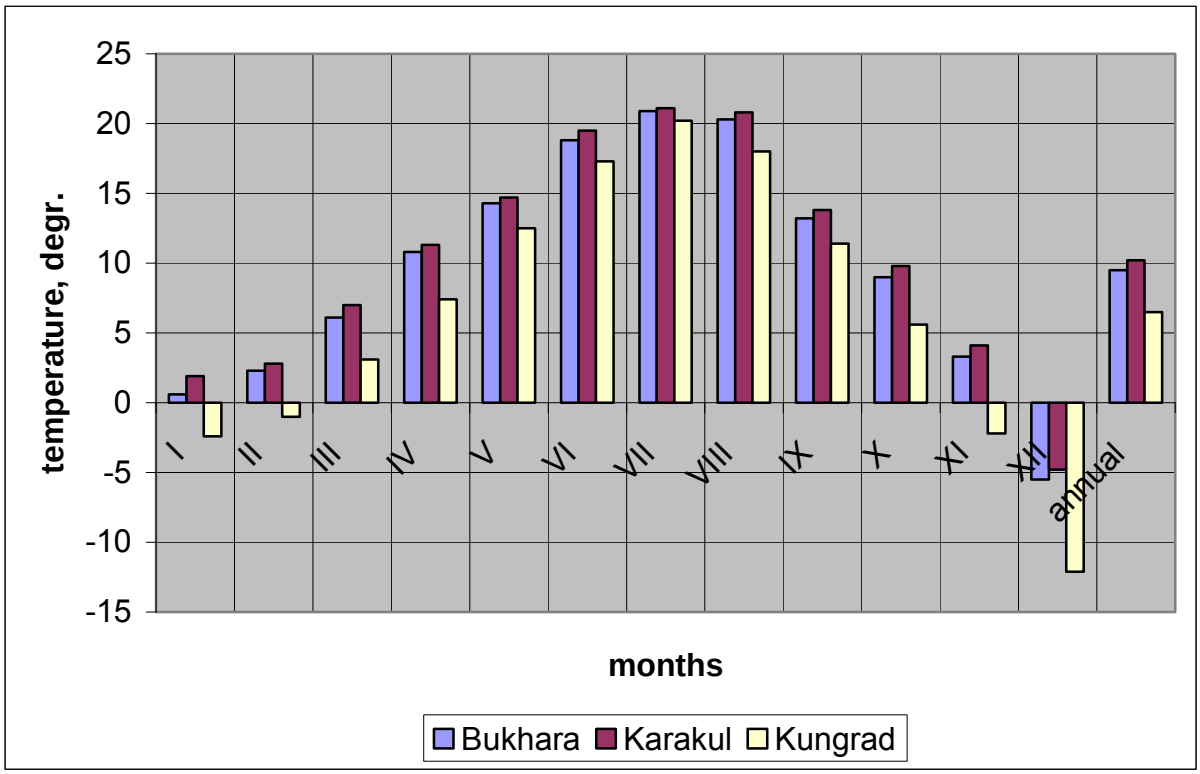


Figure 3.6 – **Air Temperature Average Minimum by Months**

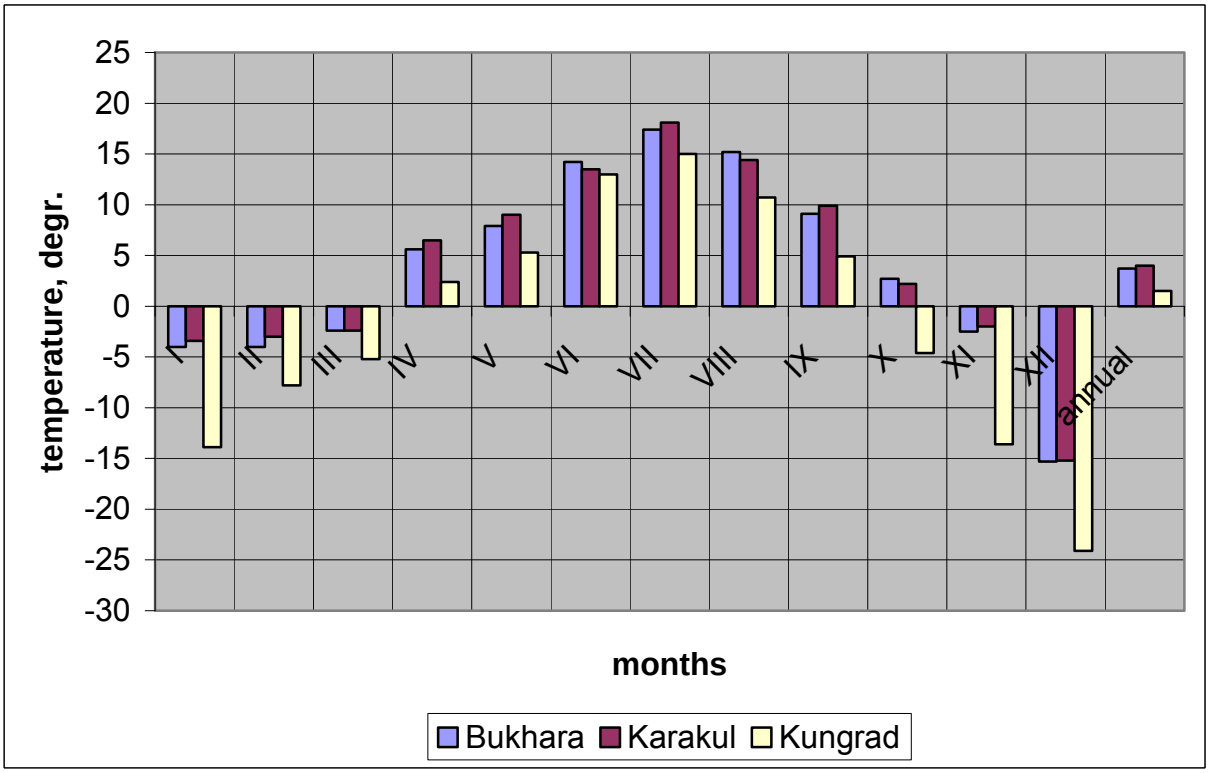


Figure 3.7 – **Air Temperature Absolute Minimum by Months**

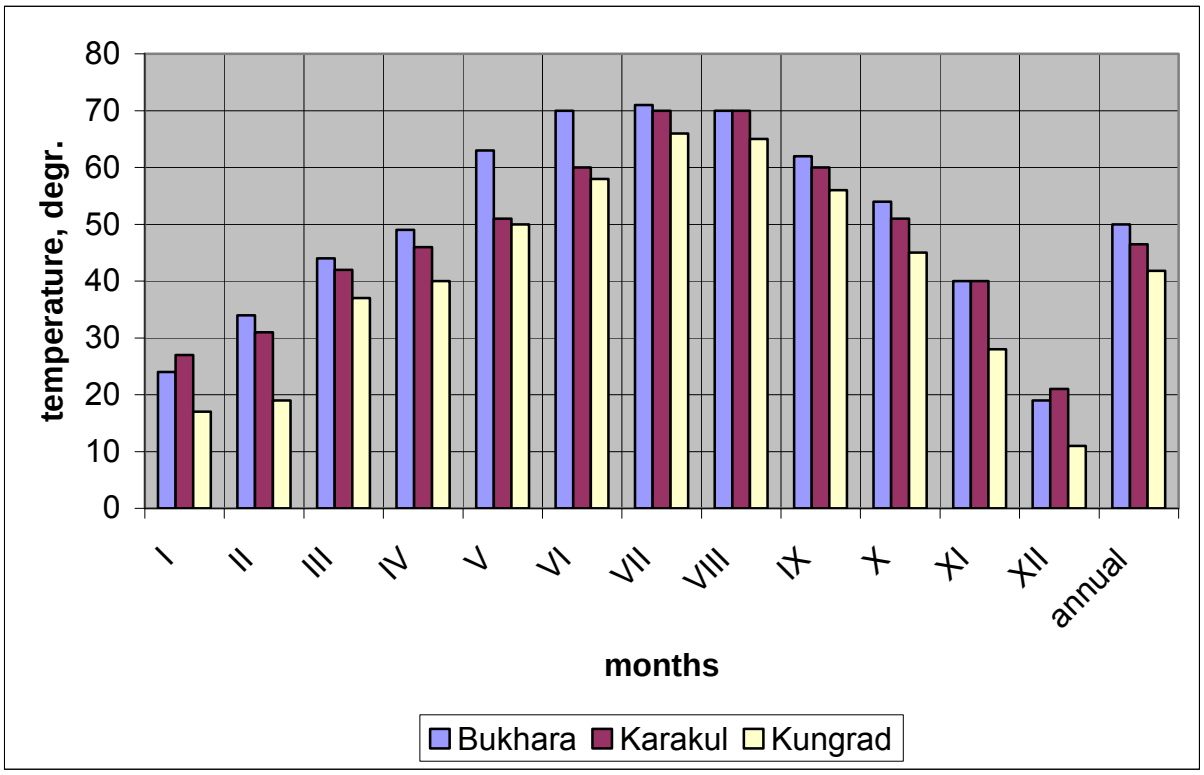


Figure 3.8 – **Soil Level Temperature Absolute Maximum by Months**

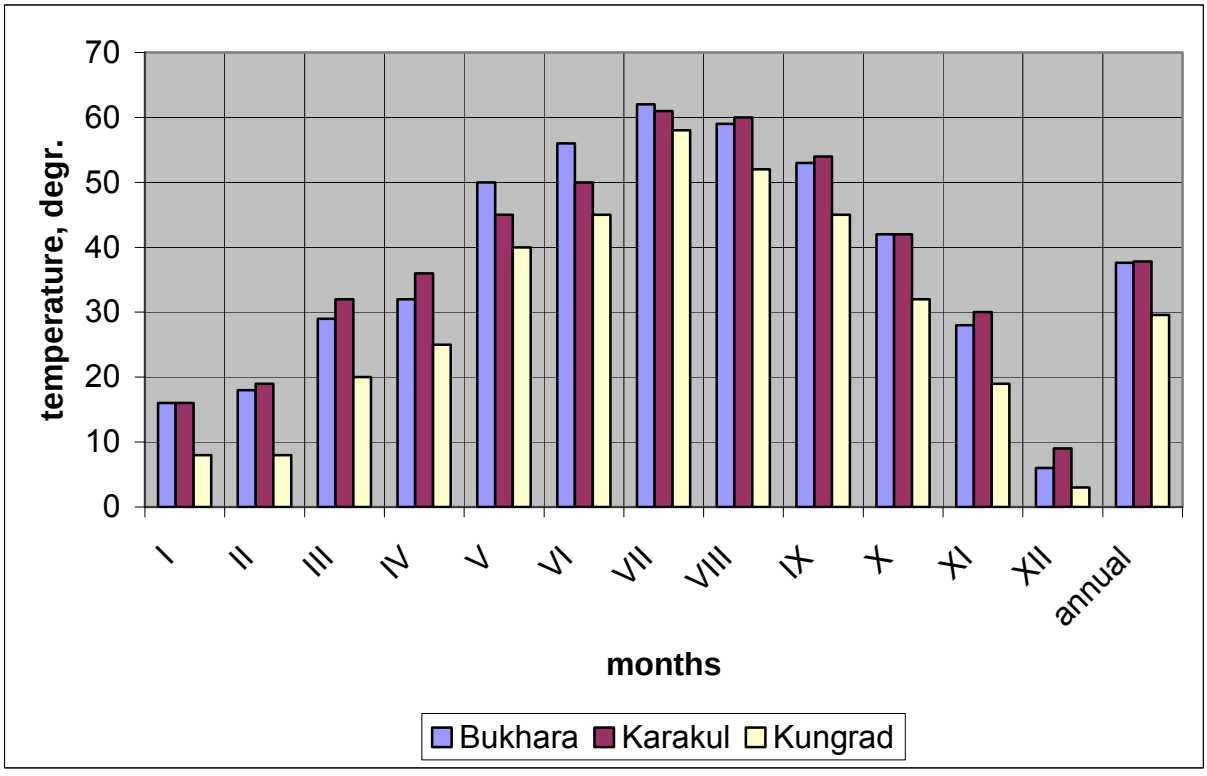


Figure 3.9 – **Soil Level Temperature Average Maximum by Months**

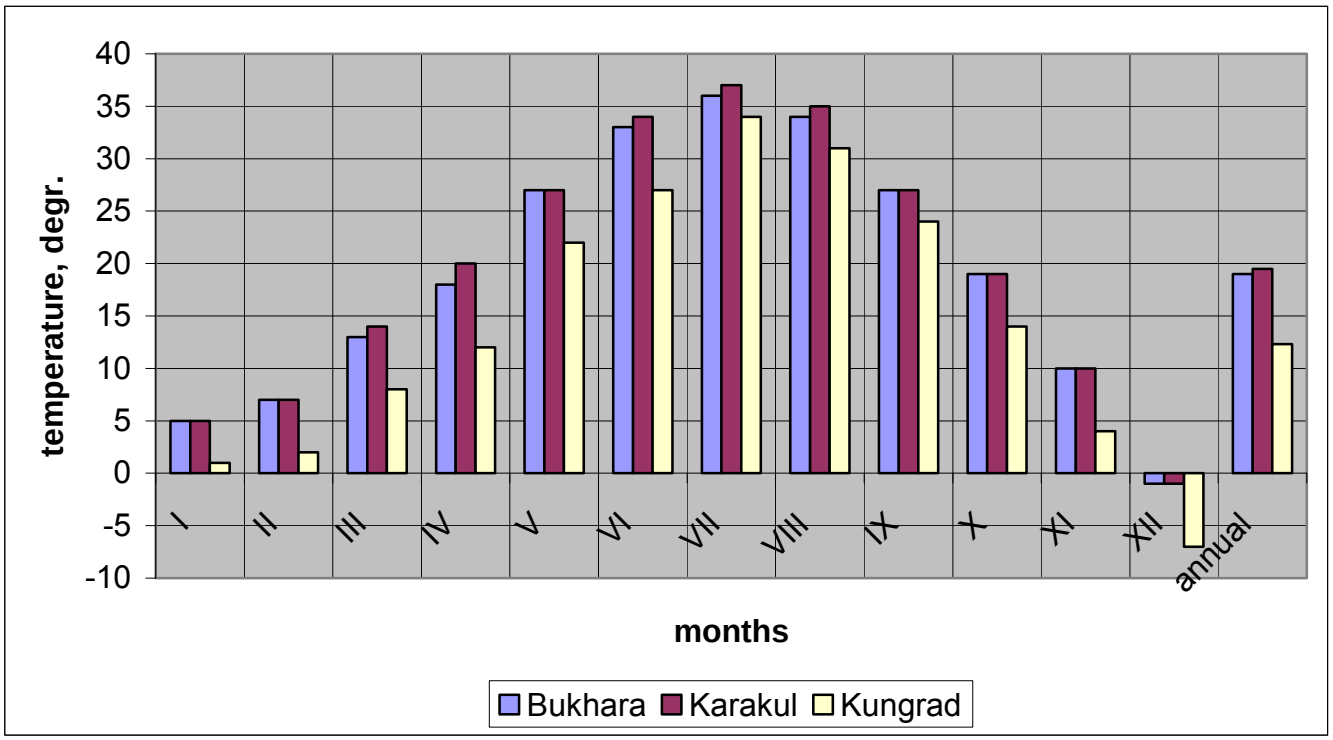


Figure 3.10 – **Average Monthly Soil Level Temperature**

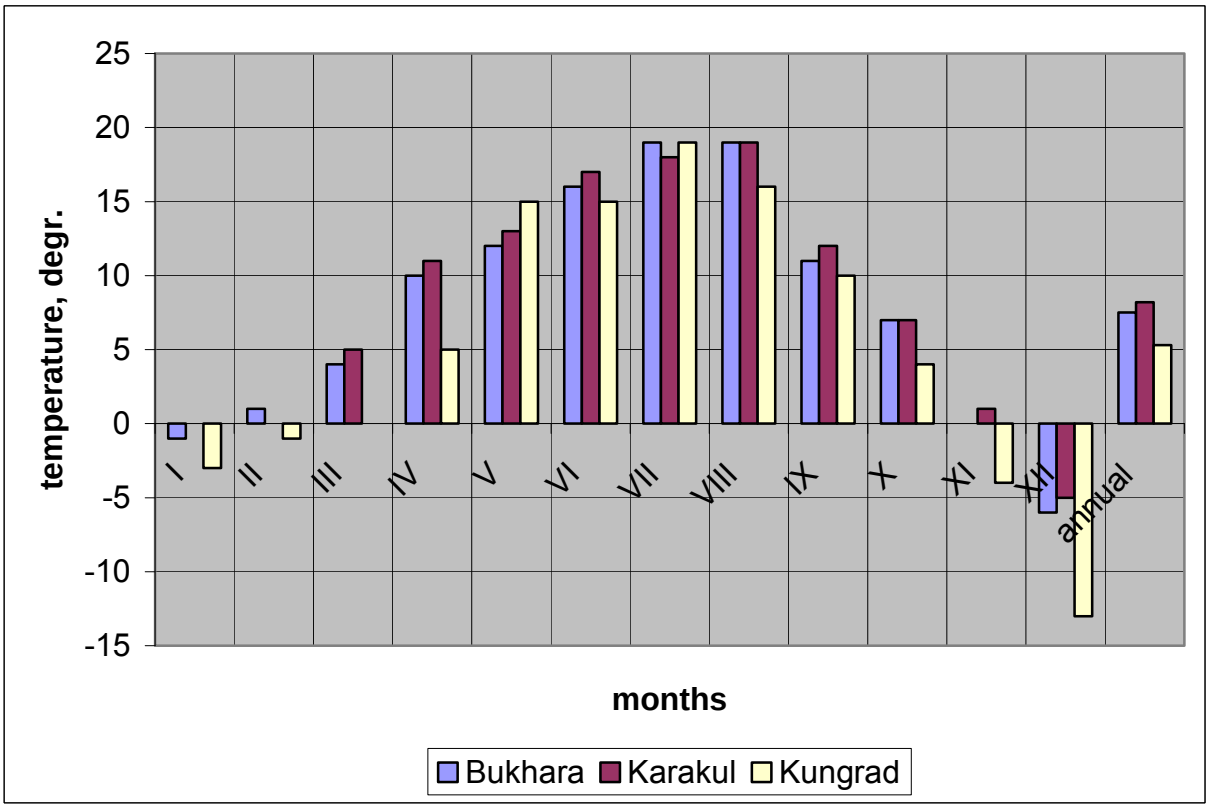


Figure 3.11 – **Soil Level Temperature Average Minimum by Months**

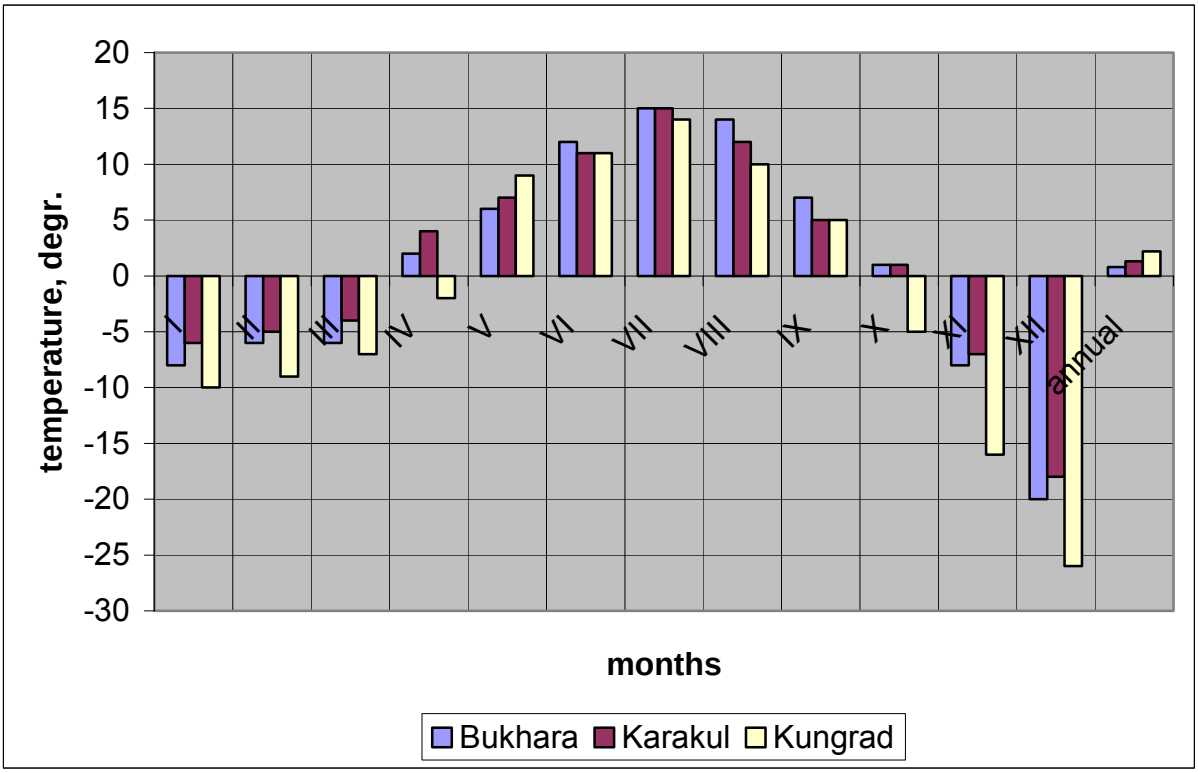


Figure 3.12 – **Soil Level Temperature Absolute Minimum by Months**

Kungrad plot belongs to the north sub-province of a warm sub-tropic desert area and characterized by a sharp continental climate. The average annual temperature is 12.3^{0}C; the average monthly temperature in December and in July is –8.1^{0}C and 28.3^{0}C respectively; the maximum temperature reaches 42.0^{0}C while the minimum temperature is –24.1^{0}C. The average daily temperatures i.e.: maximum values in the late July are 36.0^{0}C and minimum values in December are 12.1^{0}C. The average annual soil temperature is 12.3^{0}C while its maximum value amounts to 66.0^{0}C (July) and the minimum value is 26.0^{0}C (December).

3.3. Hydrogeology of Contracted Areas

Khauzak Shady and Kandym field group contracted areas lack the hydrographic system. There are only a well-developed drainage network and discharge canals. The largest discharge canal include Karakul Main Discharge Canal, Central Bukhara Discharge Canal (in Kandym plot), and South Dengizkul Discharge Canal (Khauzak-Shady plot). Flow rates of Karakul Main and Central Bukhara discharge headers vary within 0.98-7.3 cu. m/s and 1.66-3.82 cu. m/s respectively while that of South Dengizkul discharge header varies from 0.31 to 1.4 cu. m/s.

Drainage water salinity varies from 2.6-3.4 g/l in Central Bukhara discharge header to 10.9-13.7 g/l in South Dengizkul discharge header. The discharge lakes of Tuzkan (brine), Shurchar, Madankul, and Dengizkul contain brackish and salt water (the salinity degree of 5.-16 g/l). Table 3.2 show water groups classified by salt content.

Table 3.2 – **Lake and River Water Groups Classified by Salt Content [90]**

№№	Salt content, g/l	Water group
1	2	3
Lake water classified by salinity		
1.	< 1.0	fresh water
2.	1.0 – 25.0	brackish water
3.	25.0 – 50.0	salt water
4.	> 50.0	saline water
River water classified by salinity		
5.	< 0.2	lowly mineralized water
6.	0.2 – 0.5	medium mineralized water
7.	0.5 – 1.0	higher mineralized water
8.	> 1.0	highly mineralized water

Kungrad plot lies along the Amudarya's left bank; only its south-eastern part covers its right bank near the large settlement of Aspantay. The Amudarya is the largest Central Asian water artery recharged with glacier and snow water and flowing from the Pamir Mountains. The Amudarya's width within the Contracted plot was 600-2000 m and its depth varied from 2-3 m to 20-25 m in the late 70-s of the past century. Its current velocity was 4 m/s. According to the Hydro Meteorological Service the maximum Amudarya's flow rate of 2,610 cu. m/s was recorded at Kyzyljar water station during the period of May-June in 1971-1975. Since the 60s of the past century flow rates have tended to reduce upon the commissioning of Karakum canal in Turkmenia and Amu-Bukhara and Karshy canals in Uzbekistan.

The Contracted plot includes numerous lakes. These lakes are of various shapes, sizes and arrangements; the lakes are embedded at 0.5 -3.0 m and recharged with drainage water from irrigated areas. Sudochye, Karaten, Shegepol, Aidyn, Moshonkul and Karazhar lake system are the most important lakes. Lakes repeatedly dry out and recharge with water depending on the annual water content and the Amudarya's behavior. 2001-2002 saw a severe shortage of water in Karakalpakstan. There was no flow in the Amudarya, irrigation and drainage channels. Almost all the lakes and water storage basins dried out. However, dried lakes recharged with water in the high-water years of 2003-2004. Hydrophilous vegetation mantle i.e. reed and tamarisk began to grow. Lake water salinity varies from 2.5 to 5 g/l of the surface flow.

3.3.1. Dengizkul Lake

Lake Dengizkul of spring origin lies within Alat district, Bukhara oblast. Its history counts thousands of years. It was known as Borghini Farokh or Katta Kul in the Middle Ages. The tenth century's manuscripts mentioned Dengizkul as Korakul or Bukharayi Somzhan (Somzhan Kul). It is called Bakhr ul-Bukhoro (the Bukhara Sea) at the tenth century's map made by Ibn Khavkal, Arab geographer [85].

As noted above (refer to Section 3.1) the eastern part of Bukhara-Khivinsk area is a depression area as compared to Central Kyzyl-Kum. Dengizkul depression (previously the lake) is one of

such depressions. Currently, this depression is a huge saline hollow with the area of 267 sq. km and volume of 2,723.4x10^6 cu. m. It serves as a drainage water collecting body. The Taikir which the Zeravshan's primary channel and several drainage and runoff water channels flow into Lake Dengizkul located within the lower reach of the Zeravshan at the deepest point of a huge tectonic basin. Lake Dengizkul is a closed lake.

The lake's area and depth continuously undergo changes: the lake's area amounted to 110-120 ths ha; the water volume was 3-3.5 bln cu. m and the greatest depth was 25-30 m in high-water years. Currently, it occupies 50-60 ths ha. The lake contains salty water; its bottom is covered with 4-6 cm salt layer. Sewage and drainage water coming from Kiziltepa district, Navoi oblast charged with 25-28 cu. m/s drainage water coming from the settlements of Kogan, Bukhara, Zhondor, and Koraul were previously discharged into the lake. The lake's area increased; reed and cattail bushes began to grow at shallow water. In 1993 upon commissioning the Amudarya primary left-bank collecting body began to receive water from the central Parallel drainage canal.

In 1993-2003 the lake received only 150-230 bln cu. m instead of 480-550 bln cu. m discharged in 1985-1990. This amount of inflowing water does not compensate for evaporation losses; thus, there was a 60% decrease in the water volume. This entailed almost a two-fold decrease in the lake area; Figure 3.14 shows an exposed saline waterside. Water salinity increased by 5-8 times including: the content of chlorides, sulphates and nitrates increased by 8, 26 and 7 times, respectively; the biological oxygen demand (BOD) increased 6 times.

Reed mantle of 25-30% of the lake area promotes fish development and reproduction. Summer and autumn migration routes of birds pass through the lake; numerous bird species winter there. Commercial fish species also inhabit the lake.

The annual yield of Lake Dengizkul amounted to 400 tn of fish in 1986-1990. Since 1991 the fish yield has decreased 3-4 times; 1998 saw the yield of only 3.7 tn. By now Lake Dengizkul has practically lost all its natural wealth. Favorable natural conditions for fish and bird conservation and reproduction have been damaged. There are a number of reasons for fish extinction. The decrease in the lake surface level caused reed drying which, in its turn, decreased fish spawning areas. The content of mineral salts reached 20 g/l which is the critical level for fish reproduction. Only changes introduced into the regional irrigation policy may help to rehabilitate Dengizkul's ecosystem.

A

B

C

D

Figure 3.14 – ***Saline Land and Minerals (fig. B) at the Bank of Dengizkul Lake***

3.3.2. Interfluvial (Water Storage) and Sudochye Lake System

Interfluvial Lake System (Water Storage) The interfluve of the Amudarya (Ackdarya) and Kipchackdarya used to be one of the most largest flooded areas located within the natural depression between the Ackdarya and the Kipchackdarya's channel in the middle part of the delta containing numerous water bodies (the Great and the Little Zakirkukl, the Shege, the Koksu, etc.). This water body is a fresh water source for residents of Muynak district; it is also of fish commercial and environmental importance. Tugai forests sporadically grow along the bank being the habitat of rare flora and fauna species.

Late 60s saw the formation of a single water system occupying 25 ths ha after banking from the north and changing the river flow by diking the Amudarya at the crest level of 57.5 m. In the past the high floods used to damage the water storage's dam and its water discharge. The largest stretches i.e. Shege and Koksu preserve water during the low water period.

The purpose of the water storage is to regulate the Amudarya's delta flow and ensure water delivery to artificial and natural water bodies in the delta. Primary concerns associated with this water storage include anti-silting measures and flood water penetration into the tail-water. After the Interfluvial water storage has been constructed its capacity will be 900 mln cu. m. As the interfluve is being used as a water storage basin, its floor is gradually being silted and is shoaling. Deep canyon-like depressions of 8-15 m formed in the north-eastern part of the water storage at water passage areas during high flood periods (70-80ss).

After water has recharged the Interfluve (2002 summer) reed and partially cattail bushes began to restore and aquatic vegetation began to grow. The water salinity degree within the whole water area varies within 1.0-1.7 g/l depending on water volume and levels. The water body belongs to a chloride-sulphate group by the type of salinization. According to the fish commercial estimate of fish forage based on zoobenthos and zooplankton, the Interfluve is classified as a low forage water body. Unstable water conditions and high flowage hampers the development of fish forage and zooplankton.

Sudochye Lake System Sudochye lake system lie in the north-western part of the Contracted plot and covers Kungrad and Muynak districts, the Republic of Karakalpakstan. The water body's total area is 50 ths ha. Sudochye lake system is a large lake system located at the left bank of the Amudarya's reach. Sudochye system includes the lakes of Akushpa, Taily, Karatent (Western), Great Sudochye, Begdulla-Aidyn, Khoja Kultyk, etc.

Fish yield in the lake system was about 10 ths centners in the late 60s. The system included a number of stretches of different area connected by numerous channels. The lakes of Karaten (Western), Great Sudochye, Begdulla-Aidyn and Akushpa have the most distinctive borders. The system is flowing one recharged from various sources: the Amudarya's water, Suenly irrigation channel, drainage water from adjacent irrigated areas through Ustyurt channel and the Main Left-Bank Discharge Canal.

Lakes' depth levels are medium (2.5-5 m). The salinity degree spatially differs within Sudochye lake system. The shallow system part (Lake Akushpa) contains highly mineralized water (up to 6 g/l) while the salinity degree varies within 2-3 g/l in the deepest part (Lake Sudochye, Lake Begdulla Aidyn). The salinity type is a chloride/sulphate one. High vegetation is characteristic of

the system. Soft submergent vegetation covers up to 80-85% of the area of individual stretches. Reed and cattail belts stretch from the water edge for dozens of meters and reach the depth of 1.8-2.5 m (Figure 3.15).

A **B**

Figure 3.15 – **Reed and Cattail Belts and Sudochye Lake System's View from the Plateau**

Negative land forms may be flooded with water within the contracted plot to create basin irrigation areas. Reed used as cattle forage grows at such areas. The Contracted plot's landforms are rich in contrasts and combine desert facies and hydromorphic ecosystems that depend on the availability of irrigation resources. This causes substantial changes in natural conditions year in year out.

3.4. Soil and Ground Description of Contracted Areas

3.4.1. Khauzak Shady and Kandym Field Group Plot

Complex morphology, hydrogeology, and business activities account for the formation of numerous soil types. These soil formations are classified into a number of sub-formations depending on physical and geographical specifics. There are alluvial irrigated, virgin takyr,

takyr/meadow, meadow, marshy/meadow and marshy soils and saline lands in Karakul delta of the Zeravshan.

Meadow/oasis soils are the most wide-spread types in Karakul delta. The thickness of agricultural irrigation drifts does not exceed 1-1.5m. Meadow/oasis soils are formed under the influence of shallow ground water (1-3 m); irrigation recharging system; dominant salinization processes; such soils depend on ground water recharging, drainage and salinity degree. In this context, soils that are well formed in the delta's upper part and under more favorable conditions than those formed within the remaining area. Table 3.3 shows the general soil description.

Table 3.3 - **Outcomes of Karakul Delta Soil Water Extract Analysis; % to the Dry Soil Mass**

Depth, cm	Dissolved solids	Total alkalinity	Cl	SO_4	Ca	Mg	Na	K
1	2	3	4	5	6	7	8	9
0-46	0.174	0.015	0.045	0.055	0.021	0.007	0.022	0.003
46-70	0.274	0.012	0.038	0.110	0.017	0.016	0.031	0.002
70-156	0.420	0.015	0.066	0.208	0.027	0.034	0.050	0.002
156-180	1.876	0.015	0.447	0.708	0.119	0.125	0.260	0.003

Meadow alluvial irrigated soils are the most wide spread types at the area under research; ground water appears within 1.5-3 m; therefore, soils are continuously capillary-moistened. Soils are classified into long-term and newly irrigated soils depending on the irrigation period.

Karakul oasis's irrigated grey and brown soils lose their basic area soil properties (crust, blocky gypsiferous nature, etc.) due to long-term irrigation. Long-term irrigation with turbid water containing numerous suspended solids causes the accumulation of agricultural irrigation drifts in the soils. The thickness of agricultural irrigation drifts accumulated on long-term irrigated lands with grey and brown soils amounts to 100-120 cm; while the thickness of drifts accumulated on newly irrigated lands amounts to 50-80 cm; and that of drifts accumulated on non-irrigated lands is only 30-50.

Accumulated agricultural irrigation soils, on the one hand, prove the shift from the natural soil formation process to the man-induced soil formation process, and, on the other hand, the formation of soils different from virgin lands by their hydro/physical, physical/chemical and chemical properties and regimes i.e. automorphic soils change into eluvial/hydromorphic soils.

These soils contain a small amount of humus (0.4-0.8%). Nitrogen, phosphorus and potassium content is 0.030-0.042%; 0.035-0.13% and 0.350-1.95% respectively. They also contain a small amount of labile phosphorus 13-15.0 mg/kg) and metabolic potassium (130-150 mg/kg). They are formed in the influence of shallow ground water (1.5-2 m).

Saline lands are covered with 0.3-2 cm salt crust under which a loose sub-crust layer lies followed by a transient horizon consisting of complex sediments. Saline lands greatly vary by their mechanical composition. Saline lands are well formed on complex alluvial sediments of different mechanical composition. They contain small amounts of nutrients and humus (0.1-0.3%). Saline lands include sulphate/chloride and chloride types by salinization and calcium/magnesium and

magnesium/sodium by the cation classification. Table 3.4 shows the outcomes of saline land water extract analysis.

Table 3.4 - **Outcomes of Saline Land Water Extract Analysis; % to the Dry Soil Mass**

Depth, cm	Dissolved solids	HCO_3	CI	SO_4	Ca	Mg	Na+K
1	2	3	4	5	6	7	8
0-2	15,700	0.015	4.300	5.932	3.920	0.560	0.023
2-15	9,200	0.009	2.191	3.789	2.00	0.364	0.050
13-65	6,250	0.009	1.706	1.448	1.998	0.192	0.044
65-104	3,810	0.017	1.747	1.145	0.241	0.120	0.081
104-151	2,700	0.008	0.878	1.042	0.076	0.040	0.023
151-198	1,100	0.006	0.212	0.780	0.013	0.029	0.022

Genetic Specifics of Meadow Irrigated Soils. The primary specific of meadow irrigated soils is homogeneous genetic horizons caused by long-term human irrigation activity. Almost all meadow irrigated soil changes have common morphologic characteristics: agricultural irrigation layer; homogeneous humus layer grey color; relatively homogeneous porous nature, etc.

There is a homogeneous grey agricultural irrigation layer. Deltaic/alluvial sediments occurring in lower layers are interstratified with thick clay interlayers affecting hydro/physical drift properties. Sporadically horizontally distributed iron and manganese oxides are indicative of various ground water levels; and various distribution specifics of soil reduction-oxidation processes.

3.4.2. Kungrad Plot

Lithologically diverse mother rocks, substantially different ground water occurrence depth points and salinity degrees, human economic activities account for Kungrad plot's soil mantle specifics. Takyr soils and takyrs, desert sand, grey and brown soils (automorphic soils) combine with meadow, meadow/marshy, marshy soils and saline lands (hydromorphic soils) accounting for extreme distribution diversity throughout the area.

The current soil mantle of Kungrad district's irrigation area includes: meadow/takyr; takyr/meadow, meadow, marshy/meadow and grey and brown soils, sands and saline lands. These soils are classified into long-term irrigated, newly irrigated, newly developed, ready-for-amelioration, conditionally irrigated, virgin/fallow and virgin lands based on the development degree and irrigation period.

Meadow/takyr (residual) soils are formed at young desertifying lands on the left bank of the Amudarya's current delta. Ground water occurs at considerable depth (3-5) and slightly affect soil formation processes. Meadow/takyr soils include: newly developed, ready-for-amelioration, conditionally irrigated, virgin/fallow soils locally combined with saline lands.

Newly developed meadow/takyr soils are formed under the conditions of slight ground water moistening; the soil formation process preserved a semi-automorhpic nature. Agricultural

technological impact on these soils is greater than reclamative impact. The plough layer contains about 1.0% of humus while the next layer contains 0.9% of humus. The content of organic substance decreases to 0.6-0.7% with the depth. Newly developed meadow/takyr soils undergo both rapid and slight surface and profile salinization. The soil carbonated content is quite even (7-8%) despite soil layer nature by mechanical composition. Soils primarily contain calcium carbonates; the floor profile contains a small amount of humus (0.1-0.8%); though the humus content sometime sharply increases in upper highly salinized horizons (up to 1.5-4.6%). Soils show alkaline reaction (pH = 7.6-8.1).

Ready-for-amelioration and conditionally irrigated meadow/takyr soils are either ready-for-development or already developed soils but they are irregularly and partially irrigated due to irrigation water shortage. Similar to newly developed lands, such lands sporadically occur among virgin lands. The morphological profile of conditionally irrigated lands is similar to that of irrigated soils. However; as opposed to the latter, conditionally irrigated lands contains a smaller amount of organic substance (0.7-0.8%), nitrogen (0.03-0.04%) while their lower layers contain 0.2-0.3% of organic substance and 0.01-0.02% of nitrogen. These soils are extremely salinized alternating with saline lands.

Virgin/fallow meadow/takyr soils include virgin lands and old sediments overgrown with bushes and used as natural pastures. Only the morphological profile of the upper part of virgin meadow/takyr soils differs from that of newly developed lands. They include a 2-3 cm crust horizon that is dense, lowly porous, shiny with individual salt stains and a 3-4 cm sub-crust layer that is a partially formed river alluvium of various mechanical parameters.

Takyr/meadow soils are wide spread in the north-western, western and partially in central areas on old deserted lands in the Amudarya's current delta. Ground water occurs at 2.5-4 m accounting for semi-hydromorhpic soil moistening conditions. Takyr/meadow soils include: newly-irrigated, ready-for-amelioration, conditionally irrigated and virgin/fallow lands.

Similar to meadow/takyr soils, *newly irrigated takyr/meadow soils* are formed under weak semi-hydromorphic moistening conditions; though hydromorphic characteristics are continuously strengthening. The soil level is mainly weakly salinized and locally non-salinized (washed).

Ready-for-amelioration and conditionally irrigated takyr/meadow soils are similar to meadow/takyr soils.

Viring/fallow takyr/meadow soils adjoin irrigated hydromorphic or semi-hydromorphic soils. Ground water is recharged due to water infiltration from the irrigation network. Such soils are overgrown with dense vegetation including the camel's-thorn, shura, akbash, and cane. Tamarisk bushes also occur.

Meadow/alluvial soils are wide spread in the central and southern parts. Locally, they were formed a long time ago. Ground water occurs at 1-2.5m. Excessive moistening of the lower floor profile is associated with ground water elevation which account for anaerobic conditions, reduction-oxidation processes, and the formation of protoxidic and oxidic forms of sesquialteral oxides. Rusty red, brown and brown/black stains occur in the floor profile.

Long-term irrigated meadow alluvial soils occur sporadically. The plough horizon's thickness is 28-32 cm; it varies from light to heavy loamy soils by mechanical composition. 10-12 cm sub-plough horizon is denser as compared with plough horizons. Long-term irrigated meadow soils include washed, lowly and moderately salinized types. The content of humus, gypsum and carbonates is 0.8-1.5%, 0.1-0.3% and 6.6-9.1% respectively.

Newly irrigated meadow alluvial soils are the most wide-spread soil types throughout the area; they greatly vary both by salinization degree and mechanical composition. Soils of similar mechanical composition may differ by the salinization degree; they are heterogeneous by their mechanical composition and salinization both spatially and by the floor profile. The soils in question include absolutely washed, lowly, moderately and highly salinized soils. Sandy-loam/sandy and loamy/argillaceous differences also occur. The organic substance content in the plough horizon varies from 0.5-0.9 to 1.2-1.6% depending on mechanical composition with the content decreasing to 0.2-0.5% with the depth. The content of carbonates and gypsum is 6.7-8.3% and 0.2-0.5% respectively.

3.5. Geology of Contracted Areas

3.5.1. Geology, Lithology and Relief

Geomorphologically, the Zeravshan’s reaches are typical alluvial/deltaic plains formed by the debris cone. The plains are flat slightly sloped from north-east to south-west. The Zeravshan's vast alluvial/deltaic plain lies within the Mesozoic/Cainozoic highly eroded plateau with only small elevations preserved (Karakul plateau).

Alluvial/deltaic sediments primarily include pebblestones, rarely coarse sand and loamy soils (the thickness of 3-10 m) in the plain's eastern and central part. The thickness of such sediments reduces to 2.5 and gravel replaces pebblestones in the western part. The alluvial/deltaic plain’s periphery primary includes loams, loamy soils, sandy loams and sands. The Zeravshan’s alluvial/deltaic plain may be conditionally divided into the right-bank and left-bank parts.

The right-bank part has a south-western slope of 0.006; absolute pitches vary from 250 to 200 m. Such slope promotes the development of irrigation system. The western part thereof includes mounds that are denuded anticlinal folds (Tashkuduk, Charbakty, Karakyr, etc.).

The left-bank part is a slightly rolling plain unapparently merging with the Kashkadarya’s deltaic plain in the south. This plain is generally sloped to south-west with altitude pitches varying from 280-250 m to 220-215 m. The plain has an average slope of 0.008 which prevents soil losses.

The current land forms of the Zeravshan’s reaches were formed as affected by erosion/accumulation and eolian/denudation processes. These processes accounted for the formation of three large morphogenetic relief types: outwash/depositional plains, outwash plains and elevations and denuded/tectonic island mountains.

Outwash/depositional deltas occupy vast areas in the Zeravshan's reaches. They include current and ancient deltaic plains with lake and eolian plains. Current deltaic plains lie along the

Zeravshan's bed; they include Bukhara and Karakul oases. We consider the current Bukhara delta (Bukhara oasis) a flat of the Zeravshan's debris cone with a noticeable bulge in the centre. There are different terrace levels at the oasis surface.

The first terrace above the flood-plain stretches along the two banks of the Zeravshan. It vanished only at individual areas where the river immediately adjoins the second terrace. The first terrace's water line height is 1-1.5 m; its width varies from a couple of meters to 1.5-2 km. Previously active river channels that have been partially waterlogged by now show themselves at the terrace's surface (small distances).

The second terrace above the flood-plain occupies almost the whole Bukhara oasis rising to 2-5 m above the water line. The terrace's width reaches maximum 6 km at the eastern border of Bukhara oasis. The width increases westerly and reaches 50 km at Bukhara's meridian. The width decreases again westward of Bukhara and does not exceed 3-4 km near Yakatut station.

The third terrace above the flood-plain is a rolling alluvial plain i.e. the Zeravshan ancient plain bordering with the current plain with the current plain westerly and northerly.

The forth (original) terrace above the flood-plain that was formed the longest time ago includes the tertiary and quaternary sediments. It is slightly rolling Avtobachinsk, Kyzyltypa and Kuyamazar plateaus.

Geomorphologically, Karakul oasis is a flat alluvial/deltaic plain bordering with Karakul plateau in the north-east. The Zeravshan has two terraces above the flood-plain within Karakul plateau. The first terrace occupies a narrow 200 m belt along the river and rises to 0.5-1.0 m above the water line. The second 2-3 km terrace above the flood-plain rises to 2-3 m above the water line in the western part of Karakul oasis. Its surface is a flat debris cone. The Zeravshan's bed is relatively narrow i.e. its width varies from 30-40 to 60-70 m.

A vast alluvial desert plain (an ancient deltaic plain) merging into Kukzhuktau's submontane shelves lies southward, westward and northward of Bukhara and Karakul oasis. It includes the Zeravshan's ancient alluvia being a roaming area. The absolute pitches of 256-284 m and 174-179 m prevail in the east and in the west, respectively. Silty, loamy and sandy rocks of the upper Turanian suite of alluvial/lake and deltaic genesis containing quaternary fauna are often exposed at the surface.

North-westerly, alluvial/deltaic sediments are gradually replaced with anisomerous sands containing the conglomerate of pebbles and loamy lens and interlayer formed under the influence of changeable deltaic water flows. This thickness lies on Turanian suite's eroded surface. The ancient deltaic plain includes:

- ✧ Slightly wind-eroded plains containing recent signs of river roaming.
- ✧ Considerably wind-eroded (small sand bars) slightly affected by ancient river beds and containing takyr patches.
- ✧ Pebbled plains with sands occurring near bushes and small hollows.
- ✧ Plains with takyrs, residual mountains, shallow though extensive eroded hollows and ancient beds.

Ancient slightly eroded alluvial plains containing recent river roaming signs lie in the eastern part of the Zeravshan's ancient delta and occupy vast Kokcha steppe's parts northward of Jilvanaryk. This part of the ancient alluvial plain include slightly rolling landforms containing numerous river beds only slightly affected by arid denudation. Despite numerous dried meanders, horns, channels and roaming fantails they are obviously stretches from the south-east to the north-west. The width of individual beds reaches 50-100 m. The depth is small as the beds were periodically buried under sands and further eroded by changeable flows.

Pebbled plains with sands occurring near bushes include slightly rolling land forms and are formed by the Zeravshan's ancient debris cone. As compared to the ancient delta's eastern and central parts, the thickness of alluvial sediments is small (about 2-2.5 m). These sediments include loamy sands, sands and rarely loams covered with pebbles and small lime nodules. Wind erodes sand rich in stony particles from the upper pebblestone. Pebbles covering the plain hamper further deflation. Therefore, sand formations occur sporadically near tamarisk, Kandym and other bushes.

Plains with takyrs, residual mountains and shallow though extensive eroded hollows and ancient beds occupy the area southward of Kuljuktau. The ancient alluvial plain is an uneven surface with numerous residual mountains rising to 2-3 m. It includes loessian loamy sands and loams interstratified with sands. Residual mountains alternate with numerous depressions with takyr and saline lands. These depressions are usually shallow with flat bottom where sediments are washed away from slopes.

Eolian plains occupy vast areas in the Zeravshan's reaches. Alluvial sediments are eroded and contain almost no signs of ancient beds. Eolian plains include within the area under research the following formations: Sunkukly, Kemirekkum sands, and Bukhara oasis' north-western border.

Kemirekkum sands are classified as barchan chains. Bukhara oasis's barchan sands include two morphologically different sands i.e. individual barchans and barchan chains. Fine ridge and cumulose sands are wide spread throughout the area. These are individual ridges stretching 100-200 or even 300 m; the width is 15.5-20m; the height is 0.5-3m; the inter-ridge distance is 10-40 m. Ridges stretches in a meridian direction. Inter-ridge depressions include sand mounds rising to 0.1-0.5 m. Individual barchans occur mainly on saline and takyr lands.

Outwash Plains and Elevations Outwash plains and elevations include structurally denudated and structurally deflated plains.

Structurally denudated plains lying within the Zeravshan's reaches include elevated bedded plains, anticlinal ridges and isolated inter-plain elevations. Karakul plateau is an elevated bedded plain. It is a tectonically deformed rolling plain locally covered with sands. There are large barchan accumulations in the north-western part of the plateau. The remaining area is represented by a detritus desert covered with Calligonum bushes followed by sand bars. The plateau's surface is sporadically covered with concretionary sandstones and limestone debris eroded and covered with desert patina. They armor the plateau.

Structurally deflated plains include Dengizkul plateau lying within the interfluve of the Taikyr and Kashkadarya. The plateau is a slightly rolling structure sloped north-westerly and north-easterly: ridge sands stretching southerly and south-easterly are characteristic of the plateau.

Denuded Tectonical Mountains These landforms include Island Mountains and out-wash/proluvial submontane plains. Island Mountains rise outside the Contracted Plots; though they considerably impact the formation of alluvial/deltaic plains lying within the Zeravshan's reaches.

3.5.2. Stratigraphy of Contracted Plots

3.5.2.1. Khauzak Shady

No exploratory well has been drilled into Paleozoic sediments at Dengizkul field. According to the data collected based on the combined rectilinear wave technique and electrical prospecting, the bed occurs at 3,500-3,700 m in the crest of Dengizkul fold and at 4,000 in the crest of Khauzak fold.

Jurassic System Numerous exploratory wells were drilled into Jurassic sediments at Khauzak Shady. These sediments include three formations based on lithology and bottom-up formation: terrigenous, carbonate and sulphate/halogenous. The Lower, Middle and Upper Jurassic (the lower Callovian) terrigenous sediments occur immediately at the Paleozoic bed.

The Middle Callovian/Oxford. Thick limestones occur at the Jurassic terrigenous sediments; geophysically, lithologically and petrographically they include four members bottom upwards: XVI, XV-PR (sub-reef), XV-R (reef), and XV-NR (above-reef) horizons.

XVI horizon includes dark grey loamy limestones of low permeability. Its thickness is 55-70 m. Lithologically, XV-IIR horizon includes two members. The lower member of 40-50 m occurring immediately on XVI horizon includes primarily aphanite limestones with algal limestone and ballstone layers and lenses. The above lying member of 80 m includes aphanite loamy limestones. The thickness of XV-IIR horizon sediments is 100-120 m.

XV-R horizon is divided into three zones based on rock formation conditions i.e.: reef, closed shelf and deep-water zones. Khauzak Shady plot lies within the second (pre-reef) zone. It is a stratified formation with tight alternating tight and porous limestones. Lithologically, algal limestones and ballstones prevail; the horizon’s thickness is 80-100 m. XV-NR horizon include mainly limestones. The interlayers of porous differences occur betweent tight limestones.

The Kimmeridgian/Tithonian. The Jurassic section ends with the Kimmeridgian/Tithonian sediments including a thick sulphate/halogenous formation lithologically divided into five members. “Lower” grey anhydrite formations of 10-20 m occur immediately on limestones. The thickness of "lower” anhydrite formation increases to 100 m in within the deep-water zone.

This member is followed by the halogenous formation including mainly halites (“lower” salts) of 43-170 m. The above-lying member of 20-73 m includes alternating layers of salts and anhydrites ("intermediate" anhydrites). The rock salt formation ("upper” salts) of 200 m occurs above the member in the north-western part of Khauzak field. The thickness of the Kimmeridgian/Tithonian sediments varies from 332 to 630 m.

The **Lower and Upper Cretaceous** deposits mainly include marine sediments. The Palaeogene sediments include: marine limestones occurring in the lower part (Palaeocene) and marine loams occurring in the upper part (Eocene). A continental molasse Neogene/Anthropogen formation occurs on the eroded Eocene loams.

Tectonics. Dengizkul field including Khauzak and Shady areas lies in the central part of Dengizkul swell-like elevation of sublatidudinal strike which is a large structural component of Charjou tectonic terrace. A sharply contrasting positive structural landform occurring in the field's eastern part (Dengizkul plateau) actually continues Urtabulak structure.

Structurally, the top of the Upper Jurassic sub-salt carbonate formation at Khauzak and Shady areas does not practically differ from that of the Jurassic sediments. In addition, according to seismic prospecting data, a small dome-shaped fold occurs at the south-western depression of Khauzak including both sub-salt and the Lower Cretacious sediments. Khauzak Shady fold's slope angle is 6-8 degrees (Figure 3.16-3.19).

3.5.2.2. Kandym

Kandym's geology includes the Mesozoic/Cainozoic complex occurring at the eroded Palaeozoic bed. By lithology and sediment formation conditions, the Jurassic sediments include three formations: terrigineos, carbonate and salt/anhydrite.

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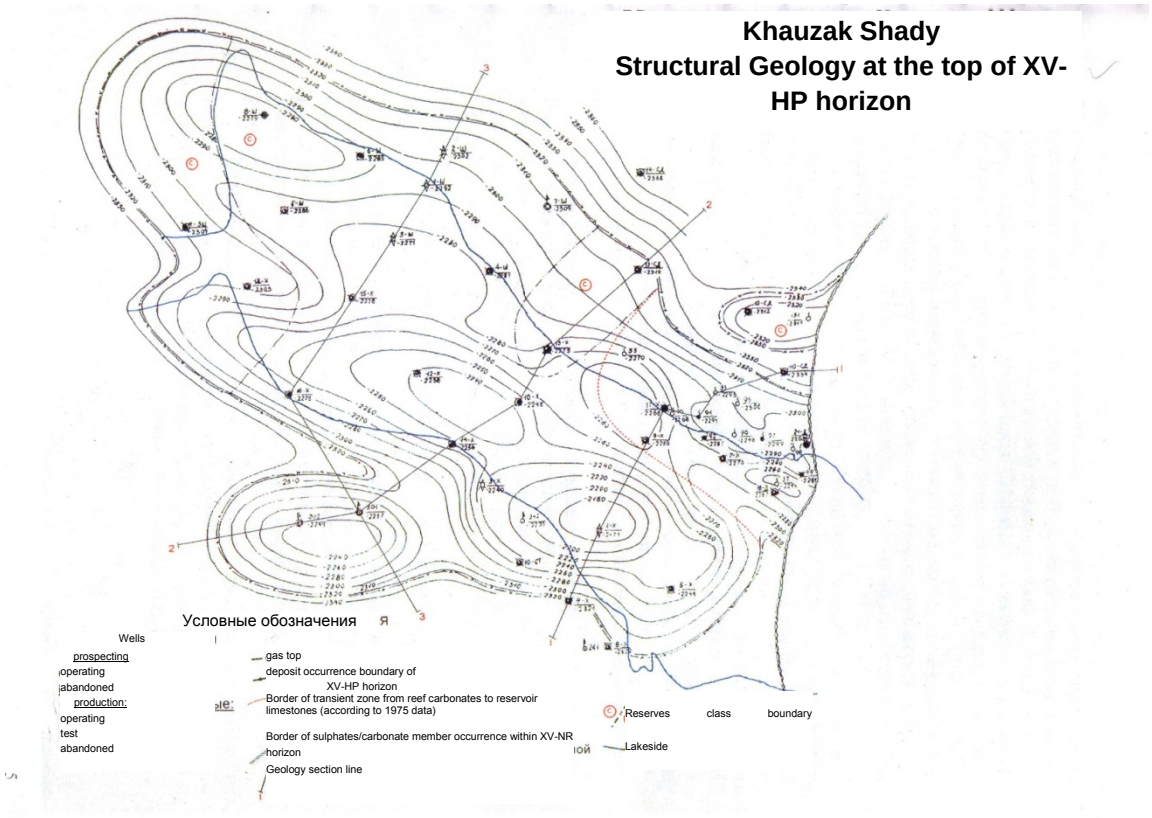


Figure 3.16

Khauzak Shady
Pay Thickness Geological Section along Well Line
(1-1):4h-1h-9h-17h-91-35-10sd-1sd-5sd-3sd

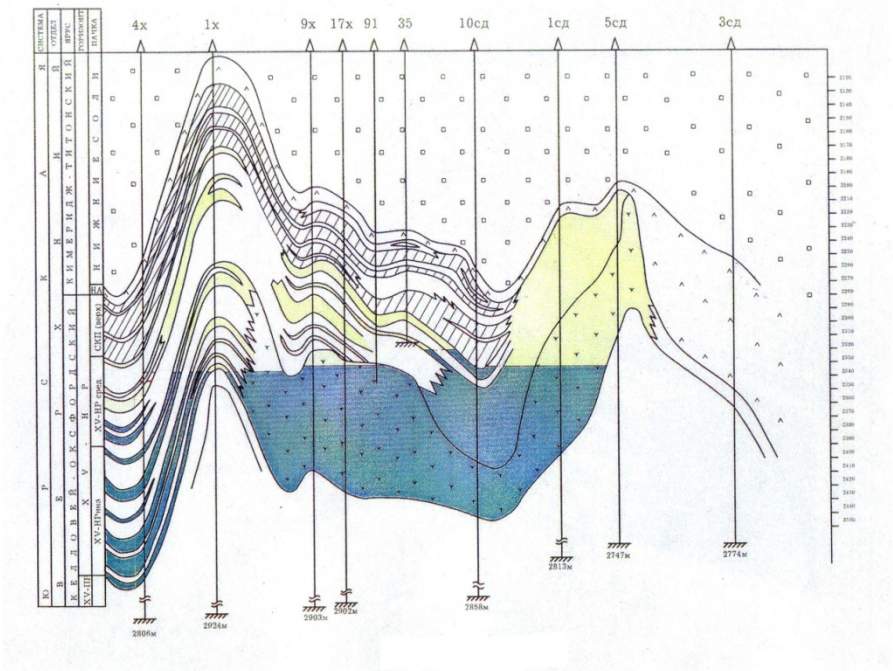


Figure 3.17

Khauzak Shady
Pay Thickness Geology Section along Well Line (2-2):302, 301,14-H,10-H,13-H,13-SD

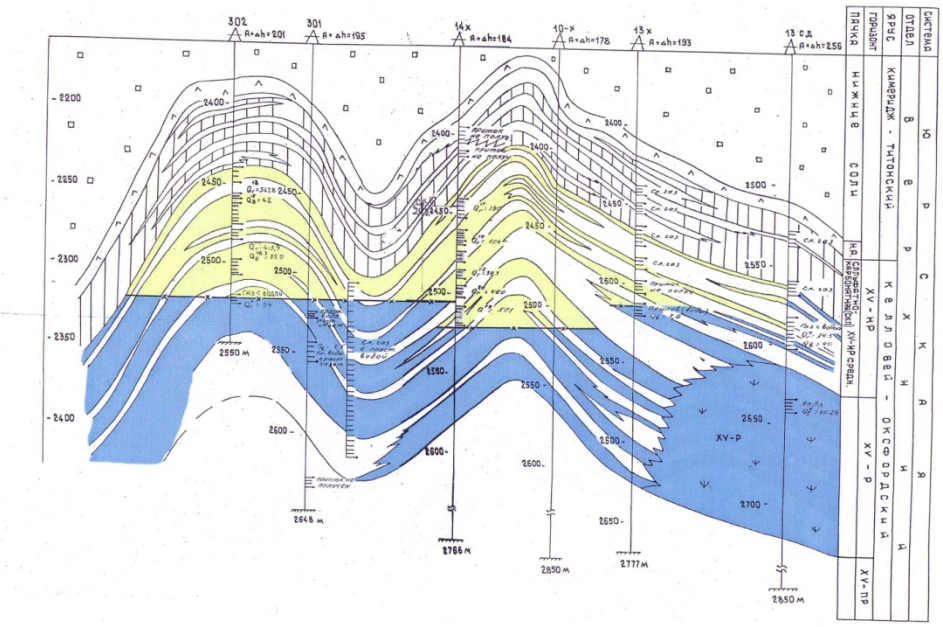


Figure *3.18*

Khauzak Shady
Pay Thickness Geology Section along Well Line (2-2):302, 301, 16-H, 15-H, 3-III, 2-III, 1-III

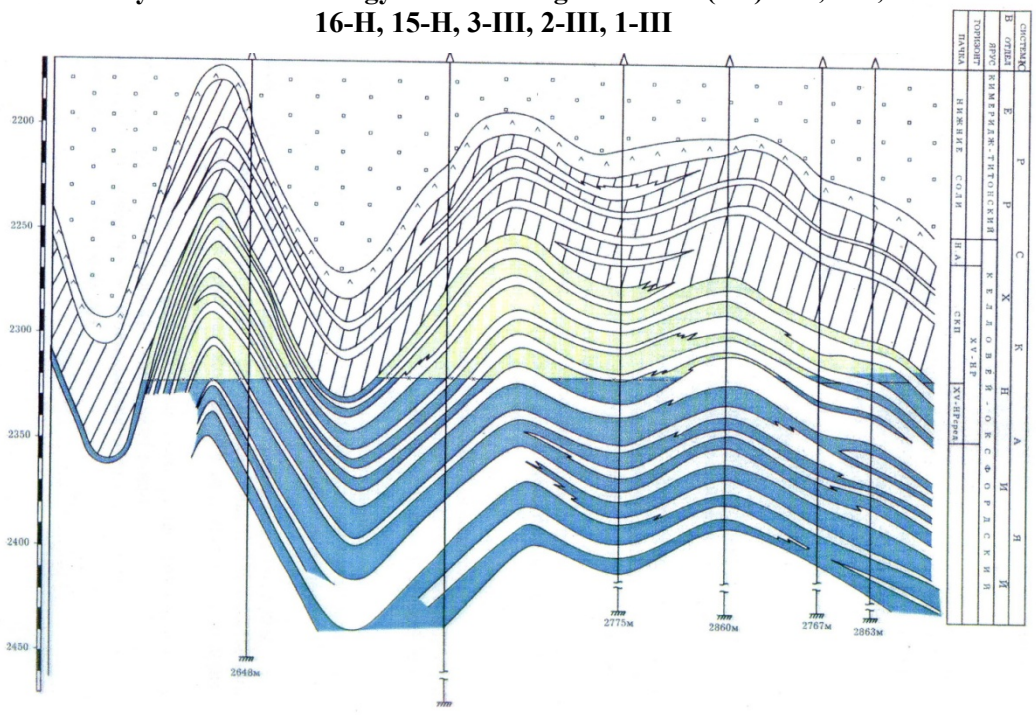


Figure 3.19

Middle and Upper Jurassic Sediments Terrigenous sediments occur throughout Kandym field. These sediments include argillites with loamy, siltsone, sandstone and gravelite interlayers and limestones occurring in the upper part. Well 22 drilled in the eastern depression of the structure penetrated into the thickest formation (274 m). The thickness decreases to 61 m toward the crest (Well 2).

Upper Jurassic Sediments *The Middle Callovian-Oxford (Hissar suite)* Physically and lithologically, Hissar suite's thick carbonate formation includes two members. The lower member mainly include tight loamy rarely porous limestones interlayered with loams and siltstones. These sediments are classified as XVI horizon with thickness of 44-64 m. The upper part of the carbonate formation include XV-3, XV-2 and XV-1 horizons. XV-4 horizon includes dolomitic limestones with anhydrite and loam interlayers.

The thickness varies from 99 to 128 m. The thickness of XV-2 horizon that includes dolomitic limestones with small anhydrite and dolomite interlayers varies from 71 to 87 m. That of XV-1 horizon including grey dolomitic and silty limestones with thin dolomite, anhydrite, sandstone and siltstone interlayers is 28-35 m. The total thickness of carbonate formation varies from 297 (well 17) to 327 m (well 22) across the field area.

Kimmeridgian/Tithonian Sediments (Gaurdak Suite) Compositionally, Gaurdak suite include four layers. The rock member (up to 7 m) including interstratified sandstones and loams occurs at the toe. The upper member i.e. an overlapped Kimmeridgian/Tithonian member includes loams and sandstones interstratified with anhydrites, marls and dolomites. Its thickness varies from 6 to 23 m. The total thickness of Kimmeridgian/Tithonian sediments varies from 108 to 40 m decreasing north-westerly.

Cretaceous System. *Lower Cretacious Sediments. Neocomian Superstage.* The Neocomian superstage includes terrigenous sediments i.e. interstratified sandstones, loams and siltstones. The Neocomian superstage include XIV-1, XIV-2 and XIII porous horizons. The total thickness of the Neocomian sediments varies from 266 to 292 m.

Lower Cretaceous Sediments. Aptian Stage. The Aptian sediments include sandstones interstratified with loams and siltstones. the Aptian sediments includes the greatest part of XII horizon (except for the upper rock member of 6-13 m). The thickness of Aptian sediments varies from 88 to 102 m.

Lower Cretaceous Sediments. Albian Stage. The Albian stage's sediments including mainly loams with grey sandstones and siltstones includes XV horizon of 110-125 m. The total thickness of the Albian sediments varies from 290 to 312 m.

Upper Cretaceous Sediments. Cenomanian Stage. The Cenomanian sediments include sandstones and siltstones interstratified with dark grey marls. The Cenomanian sediments include X and IX horizons. The thickness of Cenomanian sediments varies from 270 to 292 m.

Upper Cretaceous Sediments. Turonian Stage. The Turonian sediments originally includes sandstone and siltstone member which the upper part of IX horizon. Generally, the Turonian section includes loams. The upper part of Turonian sediments includes VIII horizon composed of

sandstones with loam interlayers. The total thickness increases from 238 to 262 m from the south-east to the north-west.

Upper Cretaceous Sediments. Cenonian Stage. Cenonian sediments include interstratified loams, siltstones and sandstones with individual interlayers of shell deposits. The thickness of these sediments is 410-445 m.

Palaeogene System. *Palaeocene Stage. Bukhara Layers.* Palaeocene sediments occur on the Cenonian sediments with a stratigraphical break. They include highly calcareous sandstone interstratified with limestones and gypsum. The thickness is 40-50 m.

Eocene Stage. Suzak Layers. Eocene sediments include loams with thin marl interlayers occurring in the upper and middle parts within Kandym field. The thickness of Suzak layers varies from 35 to 43 m.

Alay Laers. Lithologically, they include a marl mergel with pyrite accumulations. The thickness is 26-35 m.

Upper Eocene Stage. Upper Eocene sediments include a continuous loam formations with individual sandstone and siltstone interlayers. The thickness is 147-230 m.

Neogene Sediments. Neogene sediments occur at eroded Upper Eocene loams. They include alternating sandstones, loams and siltstones. The thickness is 40-162 m.

Quaternary Sediments. Lithologically, these sediments include Aeolian sands and rarely alluvial formations. The thickness is 3-15 m.

Tectonics. Kandym field lies across a large assymetric brachy-anticlinal spreading from the south to the north. It is located in the north-western part of Charjou tectonic terrace.

The greater northern part is dome-shaped; its diameter is 15 km. The southern part spreads north-westerly for 27 km. The slope angles vary from 5° in the eastern part to 15° in the south-western part. The structure's height amounts to 100 m. Structurally, it does not greatly vary with the depth up to the top of Jurassic sediments. The structural geometry of the Jurassic carbonate formation is greatly different. Only the crest position which is a 19x13.5 km large individual (central) dome with the height of 113 m (based on 1,940 mclosing isohypse).

The dome crest lies near well 2 in the same way that underlying sediments occur. The dimensions of Kandym structure calculated based on 1,980 closing isohypse are as follows: 35 km lengthwise; 24 km widthwise; and 150 height wise. The slope angle of the eastern dome is up to 3°; that of the western dome is up to 1° (Figure 3.20 and 3.21).

Kandym
STRUCTURAL GEOLOGY AT THE TOPE OF XV-1b HORIZON

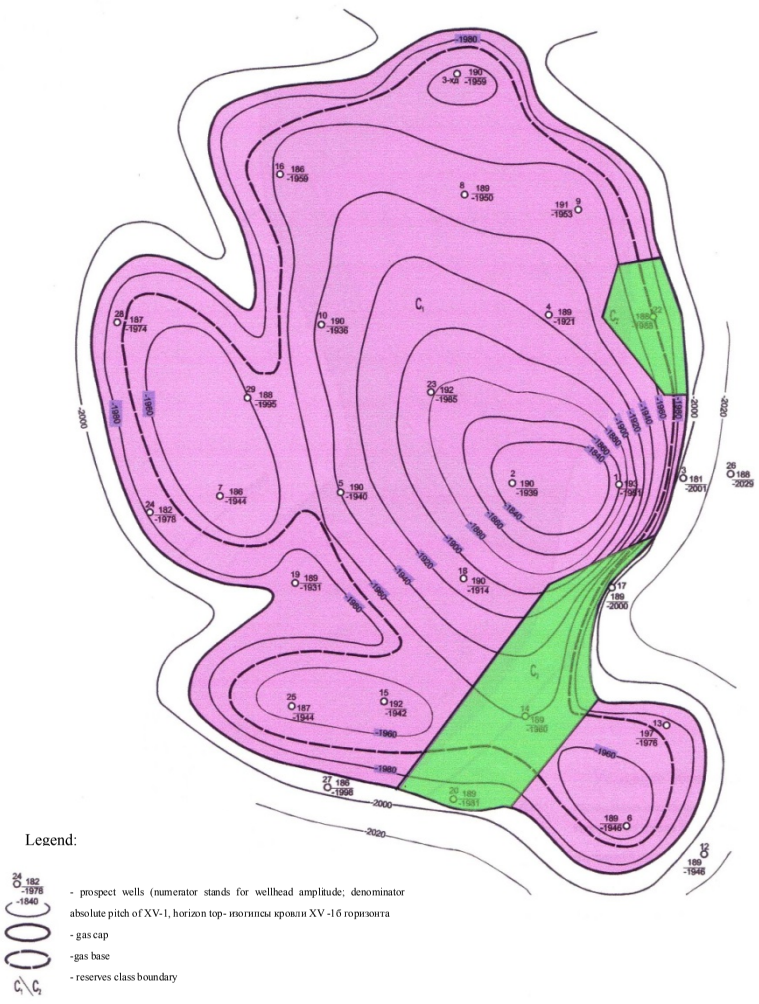


Figure 3.20

Kandym
Pay Thickness Geological Section along Well Line 24,7,5,2,1,3,26(II)

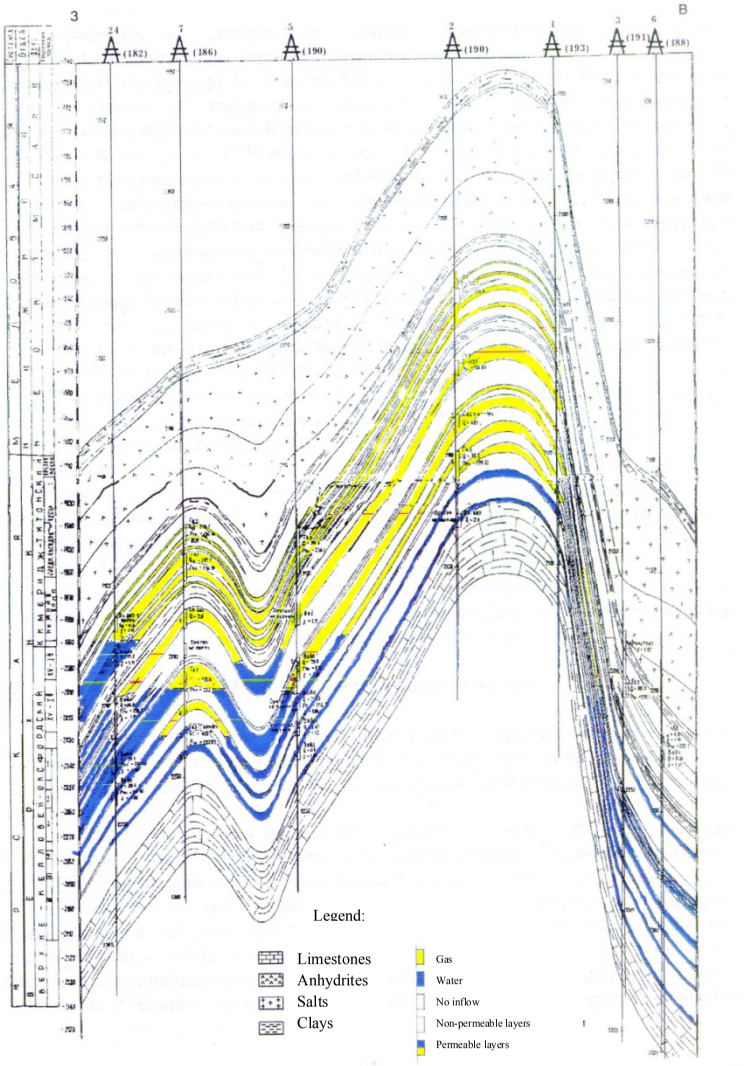


Figure 3.21

3.5.2.3. Akkum

Mesozoic and younger formations have been penetrated into across the area. Quite thick terrigenous Jurassic sediments occur on the Palaezoic rocks. Terrigenous sediments include two members: the lower member mainly includes non-carbonate grey sandstones, siltstones and mudstones; sandstones are interstratified with gravels in the lower part of this member. The thickness of this member increases from 43 to 200 m from the south-west to the north-east.

The upper member includes tight grey loams, siltstones, fine sandstones and shaly highly fissured limestones. The thickness of the upper member varies from 143 to 178 m. The total thickness of terrigenous sediments varies from 186 m (well 1) to 454 m (the first well drilled at adjacent Parsankul field).

The Callovian Oxford carbonate formation mainly includes various limestones with rare loam and anhydrite interlayers. Grey and dark grey tight shaly aphanite limestones (XVI horizon) of 62-77 m occur in the lower part of this carbonate formation. The upper part includes XV-3, XV-2 and XV-1 horizons. These horizons are composed of grey highly dolomitic fissured limestones separated by non-porous layers of anhydrites and shaly aphanite limestones. The thickness of the carbonate formation's upper part varies from 231 to 284 m. The total thickness is 283-361 m.

The Kimmeridgian/Tithonian salt/anhydrite formation overlaps the carbonate formation. The salt/anhydrite formation starts with 6 m anhydrite member followed by lower salts (45 m) and underlying white gypsified clays. The total thickness of Kimmeridgian/Tithonian sediments varies from 36 to 90 m.

The Neocomian/Aptian section starts with brown, light brown and tile-red sandstones, siltstones and loams and ends with grey and dark grey loams and sandstones. The Neocomian/Aptian rocks include XIV, XIII, and XII productive horizons. Their thickness westerly increases from 251 to 278 m.

The lower part of the Albian stage includes grey and blue grey clays; while its upper part is composed of sandstones and siltstones interstratified with loams and marls (XI horizon). The thickness of Albian sediments is 284-311 m. The Cenomanian section (302-336 m) includes X and IX horizons composed of sandstones and siltstones with thin marl and loam interlayers.

The Turanian section starts with blue grey clay formations. Grey sandstones interstratified with siltstones occur in the upper part. Sandstones belong to VIII horizon. The thickness of Turanian sediments is 255-271 m.

The Palaeogene section starts with calcareous sandstones overlapped with sandy limestones and gypsum formations. These rocks are called Bukhara layers of 16-17 m. Eocene sediments includes loams, siltstones, marls and sandstones. Their thickness varies from 259 to 398 m. Neogene eroded sediments occur on various Palaeogene horizons and include yellowy/grey sandstones interstratified with siltstones and clays. The thickness is 16-93 m.

Quaternary sediments include loose sands and loose alluvial sediments with the total thickness of 5.-10 m.

Tectonics. The top of Bukhara Palaeocene layers as part of Akkum anticlinal is a 9x6 km dome-shaped structure with small slope angles (20-30%) with the amplitude of 12 m. The fold's geometry becomes more complicated within Jurassic productive horizons. The brachy anticlinal is divided into two domes along the top of XV-1 horizon. The first dome occurs near wells 1-a, 4-a; and the second one occurs near wells 3-a and 8-a (western and eastern domes). A shallow depression (under 10 m) separates these domes. Slope angles amount to 1^0. The structure's size has the following dimensions by 1,900 m isohypse: 13 km lengthwise; 3.5-8 km widthwise, and 28 m height-wise. The western dome has the following dimensions by 1,900 m isohypse: 6.5x4.7 km with the height of 15 m. The eastern dome has the dimensions of 4.5x3.5 km with the height of 10 m (Figures 3.22 and 3.23).

3.5.2.4. Parsankul

Palaezoic formations include Polymictic sandstones. The Mesozoic group starts with Middle Jurassic terrigenous sediments including sandstones and siltstones with clay and gravelite interlayers in the lower part and mudstones, siltstones and limestones in the upper part. The thickness of terrigenous sediments is 454 m.

The Middle Callovian Oxford stage includes sandy and straight limestones. The carbonate formation's thickness varies from 290 to 328 m. The carbonate formation includes XVI, XV-3, XV-2, and XV-1 productive horizons. The Kimmeridgian/Tithonian salt/anhydrite formation includes anhydrites with individual thin interlayers of gypsified clays and sandstones. The thickness is 36-50 m.

Cretacious sediments start with Neocomian/Aptian terrigenous formations including brown, tile-red sandstones, siltstones and clays in the lower part and grey sandstones, siltstone and clays with gypsum and marl interlayers in the upper part. The Neocomian/Aptian rocks include XIV, XIII, and XII horizons. The thickness of these sediments is 295-320 m.

The Albian stage includes grey clays in the lower part and grey sandstones, siltstones, marls and clays in the upper part (XI horizon). The thickness of Albian sediments varies from 284 to 311 m. The Cenomanian section includes sandstones and siltstones of 300-350 m. The Turonian stage includes grey clays occurring the lower part and sandstones, siltstones interstratified with clays occurring in the upper part. The Turonian stage's thickness is 255-271 m.

Bukhara layers composed of coarse tight massive calcareous sandstone interstratified with limestone and white gypsum occur on the Cenonian sub-stage including sandstones, siltstones and clays with limestone interlayers (388-414m). The thickness is 16-40 m.

Akkum, Parsankul fields
Structural Geology at the Top of "B" Formation Member of XV-1 Horizon

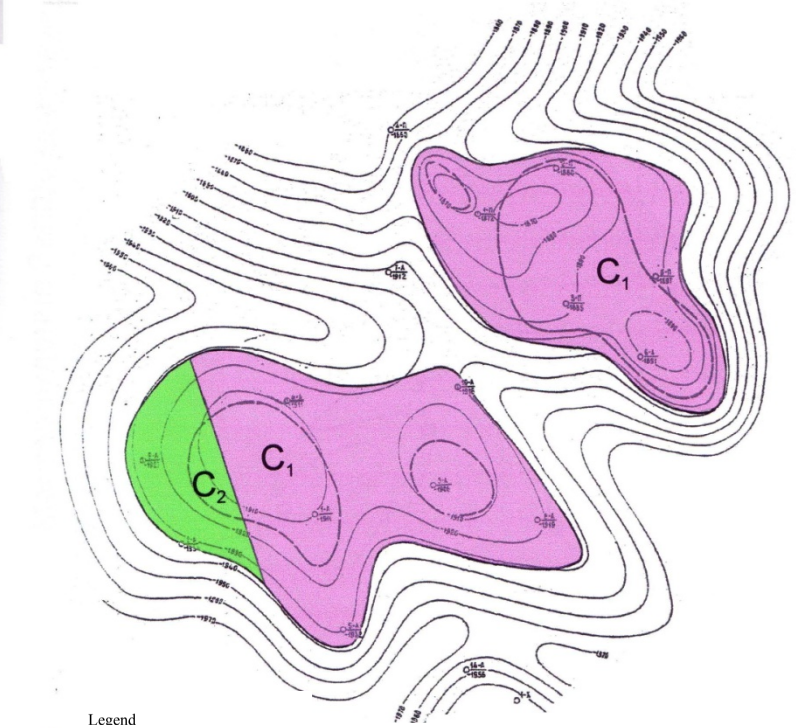


Figure 3.22

Pay Thickness along Well Line 4-P, 1-P, 3-P, 6-A
Parsanku, Akkum Fields

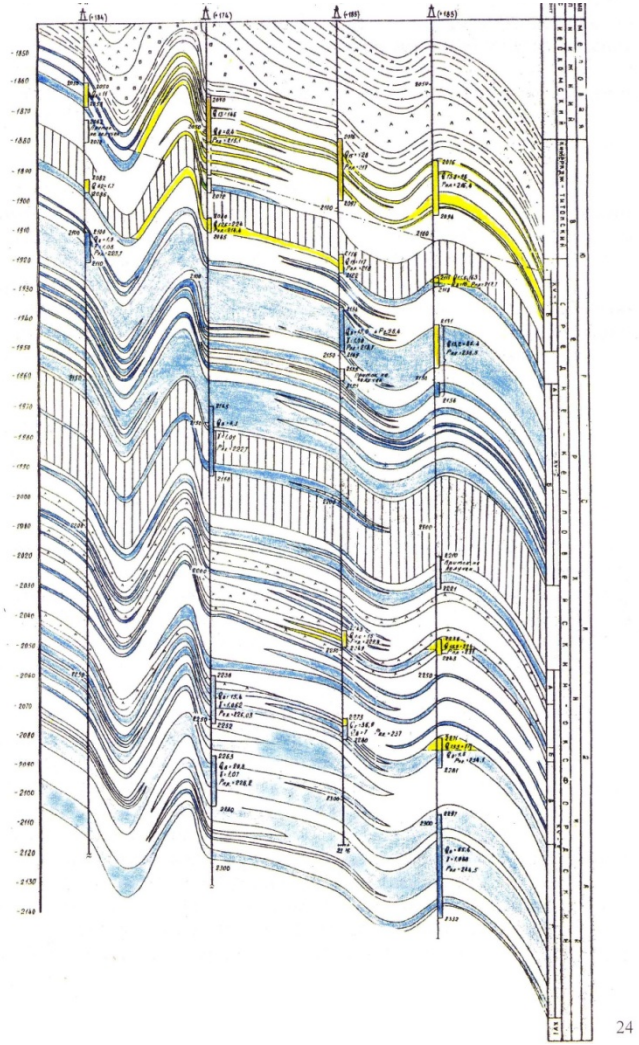


Figure 3.23

Neogene yellowy/grey sandstones overly eroded Eocene rocks. Their thickness varies from 15-90 m. Quaternary sediments are composed of 5-10 m loose sands.

Tectonics The top of Bukhara layers occurring within Parsankul structure is a structural nose spreading south-easterly. Its structural geometry greatly differs at deeper horizons. The structural nose includes two separate small domes: near wells 6-a and 1-p. The structure's dimensions based on 1,900 isohypse are as follows: 13 km lengthwise; 9 km widthwise and 25 m height-wise (refer to Figures 3.22 and 3.23).

3.5.2.5. Western Hodgi

Table 3.5 contains the structure's dimensions calculated by 2,000 m closing isohypse during exploration at Western Hodgi.

Table 3.5 – **Western Hodgi's Dimensions**

Fold	Dimensions		
	length, km	width, km	height, m
1	2	3	4
Main dome	9.0	6 5	26
Southern dome	6.0	3.0	15
Dome near well 12-3h	2.5	1.5	10
Dome near well 14-3h	3.5	2.0	15

Tectonics. The pay thickness has a complex structural geometry. There are a number of dome-shaped folds different by size and amplitude throughout the area. The largest fold i.e. Western Hodgi fold occurs in the eastern part. A local fold occurs near wells 13 and 14 as only XV-1 horizon is a gas-bearing one while deeper horizons are productive at Akkum and Parsankul immediately adjoining this area (Figure 3.24 and 3.25).

3.5.2.6. Hodgi Field

Geologically, Mesozoic/Cainozoic sediments belonging to the upper structural stage and Palaezoic metamorphized rocks occur at Hodgi.

Mesozoic Sediments Mesozoic sediments include stratigraphically and angularly non-conform and Jurassic cretaceous rocks occurring on the Palaezoic bed. The Jurassic part includes three formations based on lithology and facial deposition conditions i.e.: terrigenous, carbonate and salt/anhydrite.

Western Hodgi
Structural Geology at the Top of XV Horizon

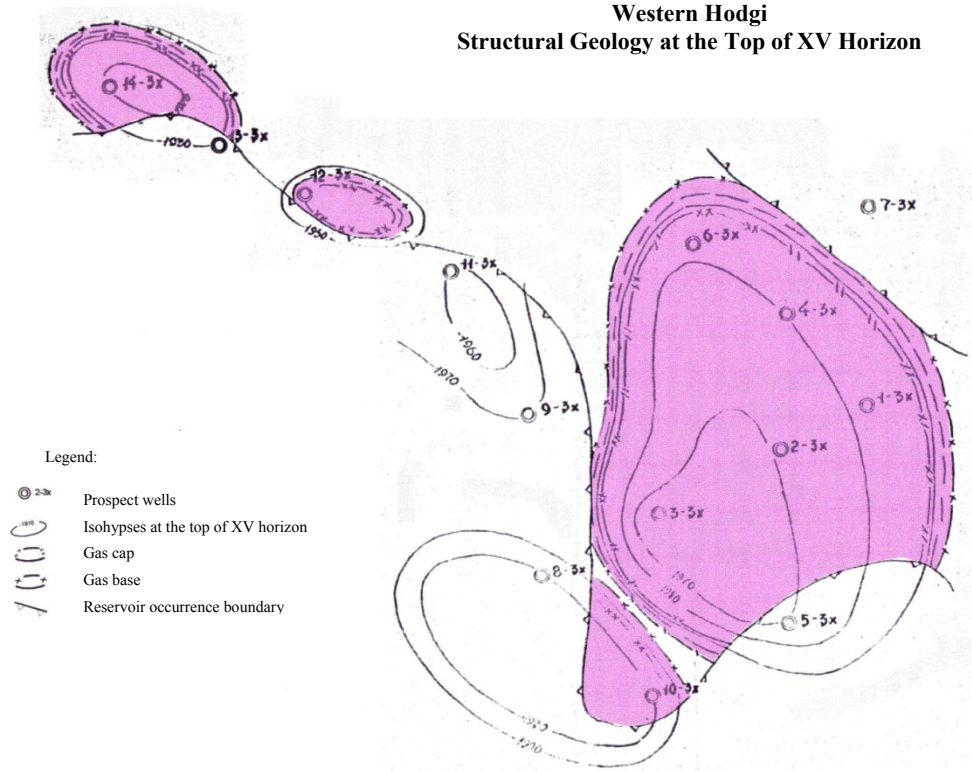


Figure 3.24

Western Hodgi
I-I Line Geological Profile

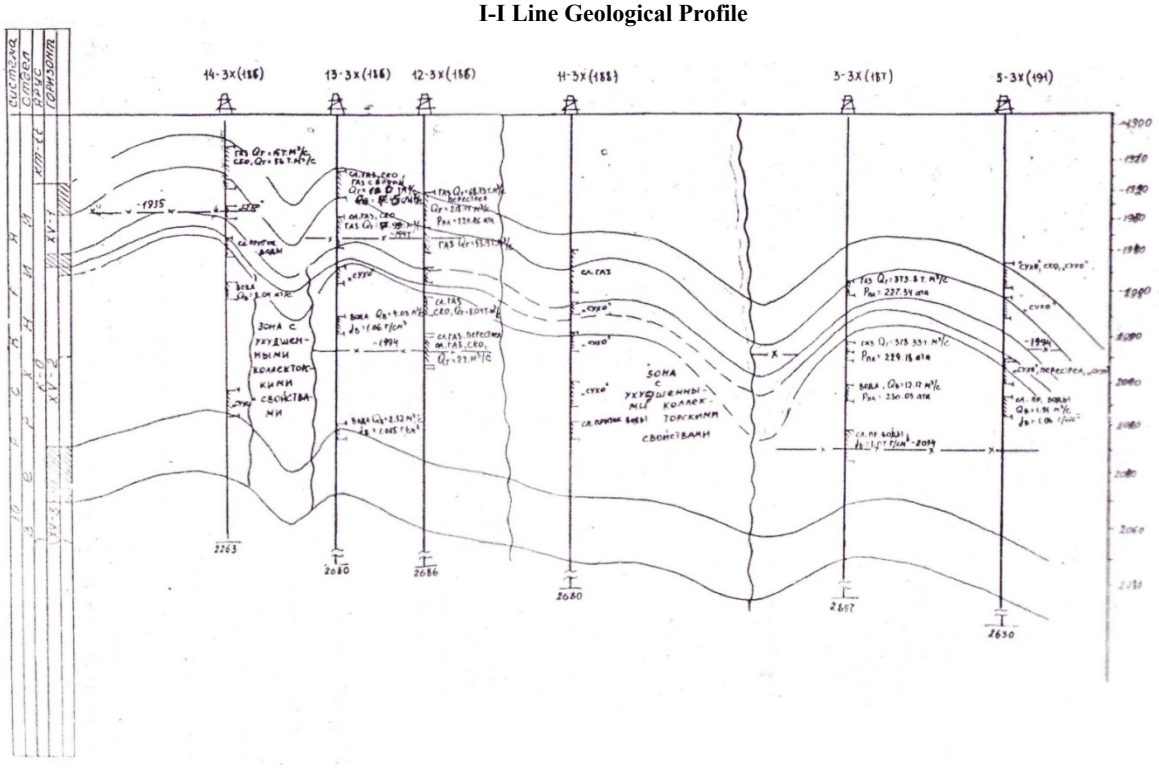


Figure 3.25

Terrigenous sediments occur throughout Hodgi and include mudstones with clay, siltstone, sandstone, gravelite and upper limestone interlayers. The total thickness of Jurassic terrigenous formation varies from 410 to 568 m. A thick (up to 337 m) upper Jurassic carbonate formation occurs on Middle/Jurassic terrigenous sediments. This carbonate formation includes two members.

The lower member includes tight loamy rarely porous limestones interlayered with clays and siltstones. This part belongs to XVI horizon whose thickness varies from 47-65 m. The carbonate formation's upper part includes three production horizons: XV-3, XV-2 and XV-1.

Limestones with anhydrite and clay interlayers occur within XV-3 horizon. Its thickness varies from 130 to 1430 m. XV-2 horizon includes carbonate rocks with sporadic anhydrite and terrigenous rock interlayers. This horizon is divided into five distinctive members across the field. These members are interstratified with tight non-porous limestones with clay accumulation of 15-20 m. The horizon's thickness is 76-81 m.

Kimmeridgian/Tithonian sediments have a distinctive four-layered geometry. A 2-4 m high-gamma rock member composed by alternating shaly sandstones, clays and siltstones occurs within XV-1 horizon. The other part of Kimmeridgian/Tithonian sediments includes salty/anhydrite formation composed of: 12-20 m lower salts; 10-12 m middle anhydrites, 6-12 m intermediate salts and 2-3 m upper anhydrites. The total thickness of Kimmeridgian/Tithonian sediments varies from 32 to 47 m.

Cretacious System. *Lower Cretacious Sediments.* The Neocomian section includes terrigenous sediments i.e. interstratified sandstones, loams and siltstones. The section is divided into XIV-1, XIV-2 and XIII horizons. The total thickness of Neocomian sediments is 272-285m. Sandstones with clay and siltstones interlayers occur within Aptian sediments. Aptian sediments include the greatest part of XII horizon (except for the upper rock member of 3-10 m). Their thickness is 93-102 m. The Albian stage's sediments including mainly clays with grey sandstones and siltstones includes XI horizon of 120-125 m. The total thickness of Albian sediments varies from 282 to 314 m.

Upper Cretaceous. Upper Cretaceous Sediments. Cenomanian sediments include sandstones and siltstones interstratified with dark grey marls. Cenomanian Sediments include X and IX horizons whose thickness varies from 183 to 194 m and from 144 m to 155 m respectively. The total thickness of Cenomanian sediments varies from 262 to 285 m. Turonian sediments start with sandstone member that occurs in the upper part of IX horizon. Generally, the Turonian section includes loams. The upper part of Turonian sediments includes VIII horizon composed of sandstones with clay interlayers. The horizon’s thickness is 68-83 m. The total Turonian thickness is 255-268 m. Cenonian sediments include alternating clays, siltstones and sandstones with individual shell deposit interlayers. The Cenonian sediments' thickness varies from 409 to 430 m.

The total thickness of the Cretaceous sediments varies from 1614 to 1645 m.

Cainozoic Sediments. *Palaeocene Stage*. Palaeocene sediments occur on the Cenonian sediments with a stratigraphical break. They include highly calcareous sandstones interstratified with limestones and gypsum. The thickness is 30-41 m.

Eocene Stage. Suzak layers include clays with marls interlayers and pyrite accumulations occurring across the field. Their thickness is 37-50 m. Alai layers include tight massive marls with fine-crystalline pyrite accumulations. Their thickness is 27-32 m. Upper Eocene sediments include continuous loam formations with individual sandstone and siltstone interlayers. The Upper Eocene's thickness varies from 239 to 263 m.

Neogene sediments occur on eroded Upper Eocene loams. They include alternating sandstones, loams and siltstones. Their thickness varies from 115 to 130 m. Quaternary sediments include Aeolian sands and rarely alluvial sediments. The thickness of Quaternary sediments is 3-15 m.

Tectonics Hodgi fold borders westward with submeridionally spreading synclinal followed by the saddle isolating Hodgi structure from Western Khoghy fold (Figures 3.26 and 3.27). Hodgi fold has the following dimensions based on 1,930 m isohypse i.e.: 6x9 km with the height of 12 m. The top of Callovian Oxford limestones and subsequent benchmarks include two individual domes controlled by minus 1,970 m isohypse. Generally, a sublatidudinally spreading shallow mould (about 10 m) isolates Hodgi from Kandym.

Hodgi
Structural Geology at the Top of XV Horizon Limestones

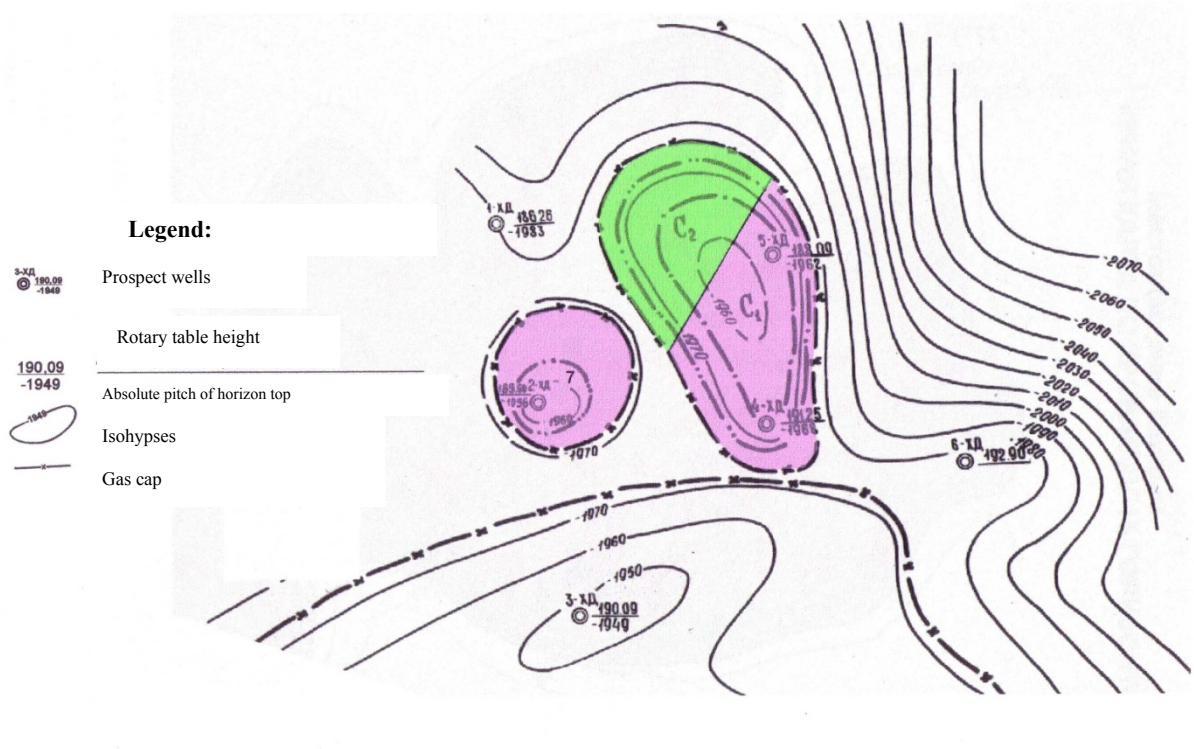


Figure 3.26

3.5.2.7. Alat Kuwachi

Geologically, the field includes Palaezoic foundation sediments and Jurassic, Cretaceous, Neogene and Anthropogene systems. Wells 2, 3 and 7 have been drilled into Palaezoic rocks within

Alat structure. Their maximum thickness is 34 m. Palaezoic sediments include grey effusive stone rocks.

Jurassic System. Bottom-upwards, Jurassic sediments include three differently facial formations: terrigineos, carbonate and salt/anhydrite. Terrigenous sediments include two lithologically different formations: The lower one is similar to Degibadam suite; it occurs immediately on the Palaezoic sediments and includes alternating black coaly mudstones interstratified with siltstones and sandstones composing 3-10 m reservoirs. This thickness belongs to XVIII horizon.

The upper formation is similar to Baisun suite and includes clays, siltstones, grey and dark grey sandstones in the upper part and green grey marls interstratified with shell deposits, carbonate sandstones and siltstones. The whole thickness is rarely interstratified with 3-5 m sandstones composing a reservoir belonging to XVII horizon. The suite's total thickness is 163-177 m.

Upper Jurassic sediments include Kugitang and Gaurdak suites. Bottom-upwards, Kugitang suite includes XVI, XV-3, XV-2 and XV-1 horizons. Kugitang suite's total thickness is 329-344 m. Gaurdak suite includes four lithologically alternating members. The total thickness is 200-210 m. A white crystalline rock salt (lower salt) member of 27-46 m occurs within the toe followed by intermediate light grey tight anhydrites (20-36 m). An light pink rock salt member (85-114 m) with dark brown pelite accumulations overlies intermediate anhydrites. An overlying member of siltstones, clays and anhydrites (20-30 m) occurs within the top of salt/anhydrite formation. The member is the final component of the whole Jurassic system. The total thickness of Jurassic sediments is 540-610 m.

Cretaceous System. Cretaceous sediments include two sections i.e. the lower and upper ones.

The *lower section* includes the Neocomian substage and Antian and Albian stages. Sandstones, siltstones, limestones, dolomites, marls and clays compose Neocomian sediments (265-270 m). They include XIV and XIII horizons. Aptian sediments (100-1-6 m) belong to XII horizon and include grey and dark grey marls, clays, siltstones with limestone interlayers occurring in the upper part. Albian sediments (280-300 m) include a thick clay formation occurring in the toe; sandstones, limestones, and siltstones belonging to XI horizon occurring in the middle part and marls occurring in the upper part.

The Cretaceous upper section includes Cenomanian, Turonian and Cenonian sediments. Sandstones, clays, siltstones compose the Senomanian lowe part; dark grey chalky silstones and pelites compose the middle part, and 55-60 m sandy/limestone member composes the top. Turoninan sediments (260-280 m) mainly include a homogeneous clayey formation with rare siltstone and sandstone interlayers; a sandstone member (up to 50 m) belonging to VIII horizon occurs in the upper part. The Cenonian substage (260-470 m) includes alternating siltstones, sandstones and clays.

Palaeogene System Palaeogene sediments (230-330 m) includes three sections. Light grey limestones and dolomites compose the lower (Palaeocene) section (30-60 m). Mudstones, marls, and clays compose the middle (Eocene) section (185-225 m). The upper (Oligocene) section includes a member of alternating loose sandstones, sands, clays and siltstones of various colors (25-50 m).

Neogene System Neogene sediments (20-60 m) include light brown sandstones, clays and siltstones.

Anthropogene System. The section ends with 3-20 m sedimentary mantle including Aeolian sand member, yellowy/grey lake and river formations. The sedimentary mantle's total thickness is 2,750-2,823 m within Alat field.

Tectonics Kuwachi and Alat folds occur in the south-eastern part of Charjou elevation which south-westwardly borders with Kandym graben which is a component of Amudarya's flexural/rupture zone. The eastern border goes along Karakul depression. The elevation adjoins Dengizkul elevation through a narrow downfold.

The top of Palaeocene Bukhara layers of Alat fold is a brachyanticlinal spreading northwesterly whose dimensions based on 1,900 closed isohypse are as follows: 10x3.7 km with the height of 20 m; the wing slope angle does not exceed 1°. The top of XV-1 horizon of Alat dome rises to 80 m; it spreads 11 km lengthwise and 7.5 km widthwise. Kuwachi dome has the following dimensions: 10x8 km with the height of 75 m (Figures 3.28 and 3.29).

3.5.2.8. Kungrad Plot

Geologically, Kungrad plot includes Palaezoic and Mesozoic/Cainozoic sediments. Palaezoic sediments compose a folded basement while Mesozoic/Cainozoic sediments compose the upper sedimentary mantle (Table 3.6).

Palaezoic Sediments According to geophysical and gas/oil prospective drilling data, the Palaezoic basement occurs stepwise at 1,500-2,000 m depressing northerly to the Aral sea. Palaezoic sediments include erupted rocks and metamorphized terrigenous sediments.

Permian and Triassic Systems These eroded and angularly non-conform sediments occur on the Palaezoic basement. They include clays of various color and siltstones. According to P.V. Florensky, these rocks are tight, non-broken and occur flatly; therefore, they may be classified as a platform mantle.

Hodgi
Pay Thickness Geological Section
along Well Line 1-2-3-Hodgi and Candym

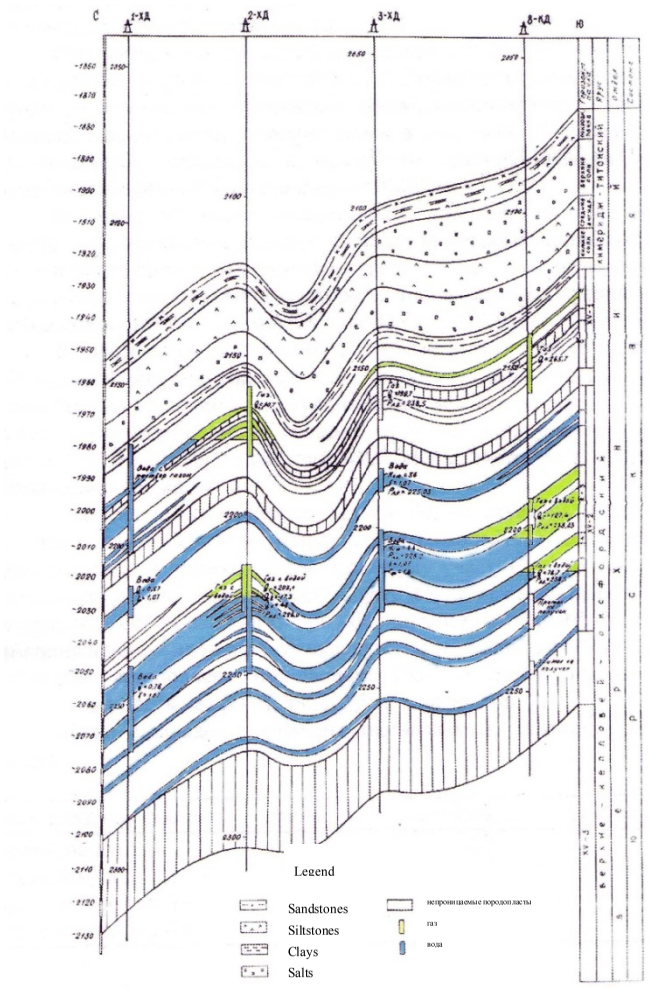


Figure 3.27

Kuwachi Alat
Structural Geology at the Top of Reservoir, XV-2 Horizon

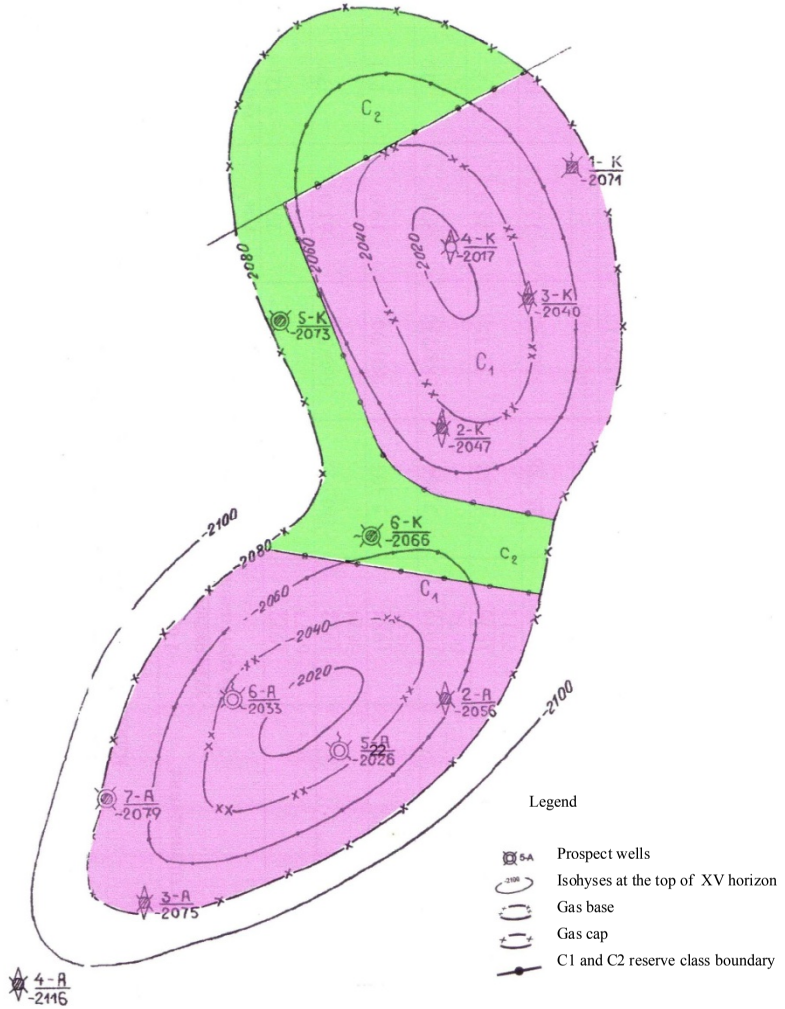


Figure 3.28

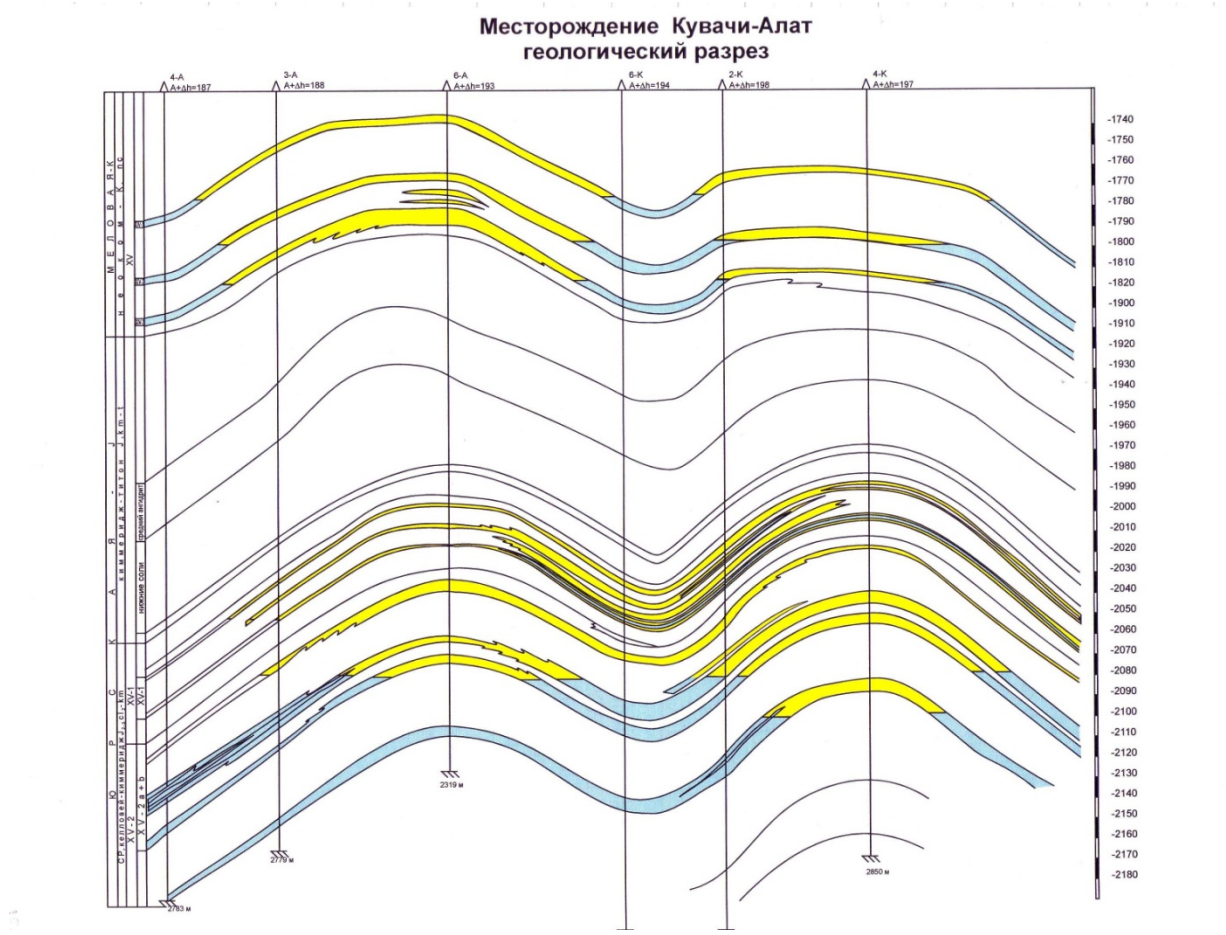


Figure 3.29

Table 3.6 – **Stratigraphical Breakdown of Wells Drilled within Kungrad plot, m**

Rock	Area			
	Kungrad	Raushan	Arka Kungrad	Takhtakair
1	2	3	4	5
Quarternary sediments	0-60	0-107	0-186	0-153
Neogene - N	n/a	n/a	n/a	n/a
Palaeogene-P	60	107	-	-
Danian sediments - K_2d	692	610	-	-
the Cenonian– K_2sn	706	640	-	-
The Turonian– K_2t	1071	1008	-	-
The Senomanian– K_1cm	1245	1199	-	153
The Albian – K_1al	1415	1362	-	290
The Aptian – K_1a	1725	1701	-	707
The Neocomian – K_1nc	1900	1866	186	875
The Upper Jurassic – J_3	2390	2351	461	1460
The Middle Jurassic – J_2	2710	2651		
The Lower Jurassic – J_1	not exposed	n/a		

Table 3.6 continued

1	2	3	4	5
The Lower/Middle Jurassic – J_{1+2}	not exposed	-	1140*	1990*
The Permian/Triassic – P-T	not exposed	n/a		
The Upper Palaezoic - P_2	not exposed	3162		
Bottomhole, m	3200	3267	4705	3800

* Note: the Table shows an undivided thickness as there is no clear border between J_2 and J_1.

Jurassic System. Non-conform Lower Jurassic sediments occur on Permian/Triassic deposits and include light grey sandstones interstratified with inferior light grey clays and siltstones. The Lower Jurassic exposed thickness is 221 m. Middle Jurassic sediments include mudstones, clays, sandstones and gravelites with coal and carbonaceous shale interlayers. The thickness is 485 m. The upper section includes continuous grey clays, siltstones and sandstones. The thickness of these sediments is 318 m.

Cretaceous System. These sediments include Lower Neocomian, Aptian, and Albian clays, sandstones and siltstones. Lower Cretaceous rocks occur at 300-1740 m. Their thickness amounts to 1100 m. The Upper Cretaceous section includes Cenomanian, Turonian, Conkian, Santonian, Komnanian and Maastrichtian sediments. Sands, inferior clay, siltstone, rarely limestone and marl interlayers prevail within the section. Upper Cretaceous sediments get exposed at Kyzyljar elevation. Wells penetrate into these sediments within depressed areas at 50-1,400 m. Their thickness is 900-1,000m.

Palaeogene System. Palaeogene sediments occur throughout the Contracted Area. They include palaeocene light grey marls; tight massive 10-70 m eocene limestones, marls and clays of 300 m; Oligocene homogeneous blue green tight massive marls. The maximum thickness of Palaeogene sediments is 800 m in the Sudochye downfold.

Neogene System Neogene sediments occurring at the Contracted Area include Miocene and Upper Pliocene rocks. Miocene sediments occur only on Ustyurt. *Tortonian Stage.* Tortonian sediments are exposed within Ustyurt's eastern gypsum formation; all the wells drilled on the plateau penetrated into these sediments. Tortonian sediments in lower and middle parts include sands, sandstones and clays. Sands, marls, limestones and gypsum deposits occur in the upper part. The thickness varies from 21-30 to 70 m. *Sarmatian Stage.* Sarmatian sediments compose the whole Ustyurt plateau. Lower Sarmatian sediments include light grey gypsified marls with limestone and clay interlayers. The detritus and shell limestones with marl and clay interlayers occur in the upper part. The thickness of these sediments is 30-35m.

Neogene sediments occurring at the delta include non-conform Upper Pliocene rocks (Akchagylian stage) that occur at Palaeogene rocks within the Amudarya's alluvial/deltaic plain. These sediments include alternating brown, yellowy/grey loose sandstones and sands and inferior clays and siltstones. The thickness of these sediments varies from 4.5 to 49.0 m.

Quaternary System. The Amudarya's alluvial/deltaic sediments are wide spread within the Contracted Area.

Drilled wells penetrated into Lavak suite's ***lacustrine sediments*** at 8-20 m. These include brown/grey clays with ochreous, blue and darks stains and rare gypsum accumulations. The thickness of these sediments varies from 7.5 to 19.0 m.

Upper Pleistocene and Holocene sediments are lithologically diverse. They include bed alluvium composed by fine, micaceous, polymictic grey sands and flood, old river bed and lacustrine sediments where loamy sands, loamy soil and clays prevail. Aeolian sediments covering Kyzyljar include fine well-assorted silica sands. These sands form small 1-3 m ridges.

Tectonics Tectonically, Kungrad structure belongs to southern parts of Sudochye downfold and Takhtakair bar.

Sudochye downfold spreads for over 150 m sublatitudinally from the Central Ustyurt shifts in the south to Kassarmin bar in the north. It borders with Kuanysh-Koskala bar in the west and Takhtakair bar in the east. Generally, Sudochye depression include complete stratigraphical succession of sedimentary mantle with prevailing Jurassic (over 3.0 km), Cretaceous (1.6-1.8 km) and Palaeogene (up to 0.7 m) sediments. The top of Cretaceous Sudochye downfold is asymmetric with steeper eastern and gently sloping western edges. Sudochye downfold borders with Kuanysh-Koskala bar in the west. This bar spreads sub-meridionally from the Central-Ustyurt shifts in the south to Aktutumsuk shifts in the north. Its dimensions are 160 x 30 km based on its current geometry.

Takhtakair bar borders with deep breaks with the amplitude of 0.4-0.8 km in the east and in the west. Taldyk downfold where the sedimentary mantle is forecasted adjoins Takhtakair bar. Middle and Upper Devonian terrigenous sediments firstly occur at 3.8 km; Upper Lower Devonian and Middle Carbonian sediments occur at 3.3-3.5 km; and Jurassic terrigenous sediments occur at 1.9-2.0 km.

3.5.3. Contracted Area Oil/Gas Content

3.5.3.1. Khauzak Shady Oil/Gas Content

XV-R horizon testing at South Khauzak yielded commercial gas inflows at the flow rate of 140-450 ths cu. m per day. XV-NR horizon testing yielded commercial gas inflows at the flow rate of 28-381 ths cu. m per day. As there is only an assumed border between XV-R and XV-NR formations the accumulation occurring within this interval is deemed to be a uniform, crest-like one. The top of gas deposit includes Kimmeridgian/Tithonian sulphate/halogenous sediments whose thickness varies from 200 to 506 m. Reservoir pressure is assumed to be 277.3 kg/sq. cm; and temperature is 98^0C.

Formation gas at Khauzak and Shady includes the following components: 88.15% methane; 1.38% ethane; 0.32% propane; 0.17% butane; 0.52% pentane and C_{6+}; 4.25% hydrogen sulphide; 4.3% carbon dioxide; 0.31% nitrogen;density is 0.769 kg/cu.m. Gas is methane and dry. One cubic meter of gas contains 56.6 g of sulphur. Fields contain heavy high-sulphur condensate that includes gasoline and kerosene fractions. Condensate is of methane/aromatic/napthenic type by group hydrocarbon composition of gasoline fractions.

3.5.3.2. Kandym Field Group Gas Content

Kandym. Kandym includes two productive horizons i.e. XV-1 and XV-2. XV-1 horizon is divided into two individual targets: formations a and b. A total of 38 horizons were tested within XV-1 horizon; well flow rates identified during XV-1 horizon testing vary from 90 to 372 ths cu. m per day. 92 horizons were tested within XV-2 horizon. XV-2 horizon includes six individual formations: I, II + III, IV, V, VI, VII with various Gas/Water Contacts. I, II+III, IV, V formations occurring at 2,056-2,140 m are commercially gas bearing formations. Gas flow rates vary from 65 to 624 ths cu. m per day.

Kandym field gas is of hydrogen sulphide/carbon dioxide/hydrocarbon type. Formation gas contains high amount of methane (92-94 vol. %). Ethane and butane content varies is 2.55-3.02% and 0.39-0.72% respectively. Hydrogen sulphide content in gas is high i.e.: 2.51% within XV-1 horizon; 1.43% within XV-2 horizon which corresponds to 34.00 and 19.35 g of sulphur per one cubic meter (under normal conditions).

Kandym contains light methane/aromatic, sulphureous, gasoline condensate. The condensate specific weight is 0.784-0.798 g/cu. m; yield of fractions boiling off under $+200^0$C is 55-67%. Gasoline fractions contain 32.7-36.3% of aromatic hydrocarbons and 33.5-37.8% of methane hydrocarbons.

Akkum. XV-3, XV-2 and XV-1 horizons contain commercial gas deposits. The field's gas is of hydrogene sulphide/carbon dioxide/hydrocarbon type. Formation gas contains high amount of methane (89-92 vol. %). Ethane and butane content varies is 3.31-4.17% and 0.71-0.85% respectively. Hydrogen sulphide content is assumed 0.53% or 7.17 g of sulphur per 1 cu. m of gas (under normal conditions).

The field contains light, aromatic, low-sulphureous, highly gasoline condensate. The condensate specific weight is 0.780-0.799 g/cu. m; yield of fractions boiling off under $+200^0$C is 60-90%. Gasoline fractions contain 39.1-60.0% of aromatic hydrocarbons and 32.1-38.3% of methane hydrocarbons.

Parsankul. Commercial deposits found and explored at Parsankul are as follows:

- ✧ that occurring within XV-1 horizon at the fold crest, members A and B;
- ✧ that occurring within XV-2 horizon at the southern and northern domes; member A;
- ✧ that occurring within XV-3 at the southern dome, member B.

Formation gas contains high amount of methane (89-92 vol. %). Ethane and butane content varies is 3.31-4.17% and 0.71-0.85% respectively. Hydrogen sulphide content is assumed 0.53% or 7.17 g of sulphur per 1 cu. m of gas (under normal conditions).

Western Hodgi. Testing yielded 7 commercially gas bearing deposits occurring within XV-1 and XV-2 (members A and B) Upper Jurassic horizons. The average occurring depth varies from 2,113 to 2,217 m. These deposits have various (horizontal) GWC varying from 1,935 to 2,037 m. Well flow rates ranged from 156 to 259 ths cu. m per during the testing of gas bearing intervals. (the reservoir drawdown of 55-115 kg/sq. cm). Well flow rates varied from 65 to 231 ths cu. m per day during the testing of XV-2 horizon's gas bearing intervals (68-189 kg/sq. cm reservoir drawdown).

The field's gas is dry, average condensate, high-sulphureous and low-nitric. The gas analysis did not prove any substantial changes neither in components nor area nor section. Methane content is high (91.63-94.92%). Gas contains 0.79-2.79% ethane; 0.38-0.57% propane; 0.19-1.61% nitrogen; 0.44-5.13% (2.95% on average) hydrogen sulphide corresponding to 39.707 g of sulphur per 1 cu. m of gas (under normal conditions).

The average potential condensate content in formation gas is 19.0 g/cu. m. Condensate is heavy, sulphureous, low-gasoline naphthenic/aromatic by gasoline fractions and methane/petrolic/aromatic by kerosene/oil fractions. Condensate mainly contains fractions boiling off at 200-250°C and 250-300°C. Gasoline fractions contain 42-41.5% of aromatic hydrocarbons while methane fractions contain 19.2-43.5% of these hydrocarbons.

Hodgi. XV-16 and XV-2(2+3) horizons occurring at 2,155-2,216 m are gas bearing ones. Well flow rates vary from 1.5 to 200 ths cu. m per day. Initial reservoir pressures at both horizons are equal to 229.0 kg/sq. cm; reservoir temperature amounts to 93^0C.

Hodgi's gas is dry, average condensate, and low-nitric. Formation gas occurring at XV-1 and XV-2 productive horizons contains 94.4-91.5% methane; 2.78-2.14% ethane; 0.63-0.32% propane; 0.50-0.11% butane; 0.82-0.11% of heavy hydrocarbons. Nitrogen content varies from 1.15 to 0.48%. The analysis of how the above gas components are distributed across the deposit's area and section showed changes in hydrogen sulphide concentration in formation gas. XV-1 horizon's eastern dome contains 0.28-0.30% of hydrogen sulphide; while its content increases to 1.80% in the western dome. The average hydrogen sulphide content is 0.793±0.06% corresponding to 8.9±0.32 g of sulphur per 1 cu. m of gas under normal conditions.

The field contains light, methane/aromatic, sulphureous, gasoline condensate. Its specific weight is 0.784-0.798 g/cu. cm. The yield of fractions boiling off under +200°C is 36.0%; gasoline fractions contain 30.0% of aromatic hydrocarbons.

Alat Kuwachi. There are two commercially gas bearing horizons i.e. XV-1 and XV-2a+b occurring at 2,110-2,280 m characterized by different GWC and flow rates ranging from 8 to 290 ths cu. m per day at the reservoir drawdown of 123-173 kg/sq. cm. All deposits are are fully composed of reservoirs; they are arch-like and have the following initial values: 236.7-239.6 kg/sq. cm formation pressure; +94-95°C formation temperature.

Gas occurred in Upper Jurassic deposits (XV-1, XV-2 horizons) are of carbon dioxide/hydrogen sulphide/hydrocarbon type; it belongs to methane dry gases by methane content (88-92%). Ethane and butane content varies is 1.86-3.59% and 0.06-0.21% respectively. Hydrogen sulphide content is assumed 4.52% or 60.84 g of sulphur per 1 cu. m of gas (under normal conditions). The average potential condensate content in formation gas is 15.0 g/cu. m. The field's Upper Jurassic deposits contain heavy high-sulphurous condensate (the specific weight of 0.8006-0.8273 g/cu. cm; sulphur content of over 0.4%). The boiling point is over +34°C. The content of gasoline and kerosene fractions is 45-61% and 31-35% respectively.

3.5.3.3. Kungrad Plot Oil/Gas Content

Deep-hole drilling in stratigraphically diverse rocks (from the Upper Paleozoic to the Upper Jurassic inclusive) proved commercial oil/gas deliverability in Ustyurt region.

Kungrad Plot covers southern parts of highly prospective tectonic structure proven to be oil/gas bearing i.e. Sudochye downfold and Takhtakair bar bordering with Kuanysh-Koskala bar in the west where both Jurassic and early Carbonian deposits have been found. Therefore, geologically, Kungrad Plot is likely to include two oil/gas content stages i.e. the Jurassic and Upper Paleozoic ones.

3.6. Hydrogeology of Contracted Areas

3.6.1. Khauzak Shady and Kandym Field Group Plots

Based on the age and lithological differences characteristic of ground water the above plots include the following hydrogeological groups: (water bearing; locally water bearing; water permeable though arid and water proof; water bearing fractured zones). Refer to Figures 3.30 and 3.31.

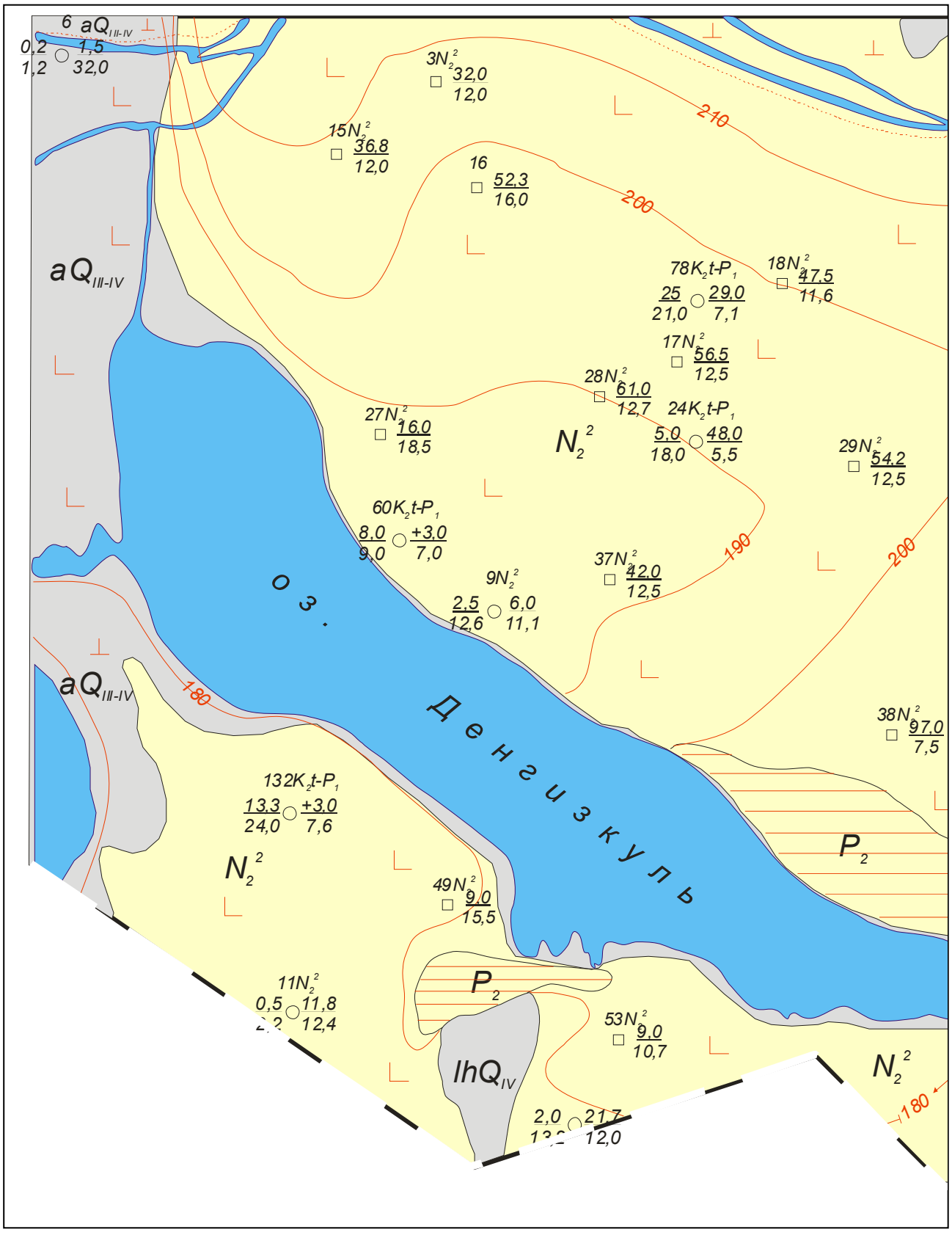


Figure 3.30 – **Hydrogeological Map of Khauzak Shady Plot**

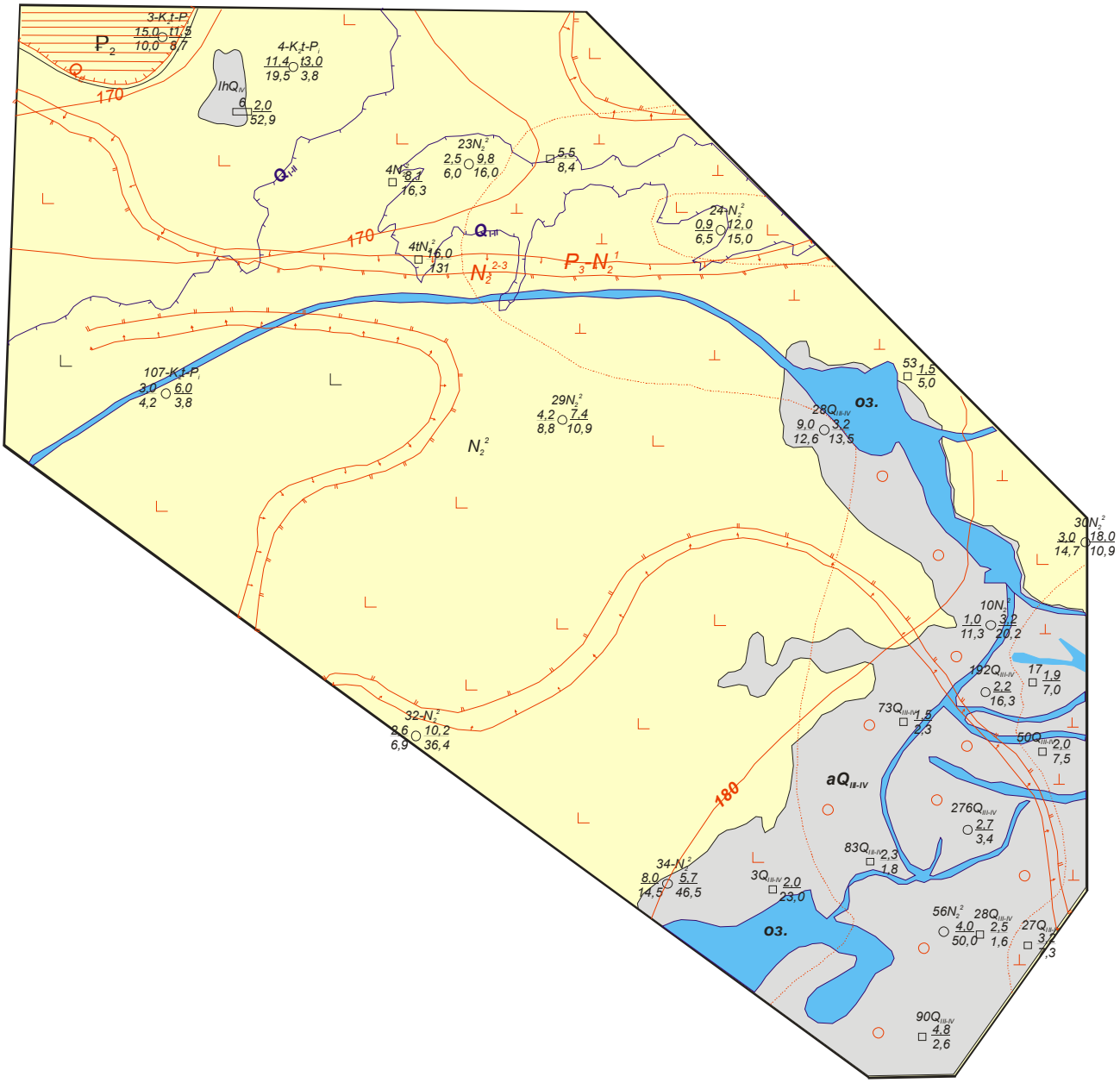
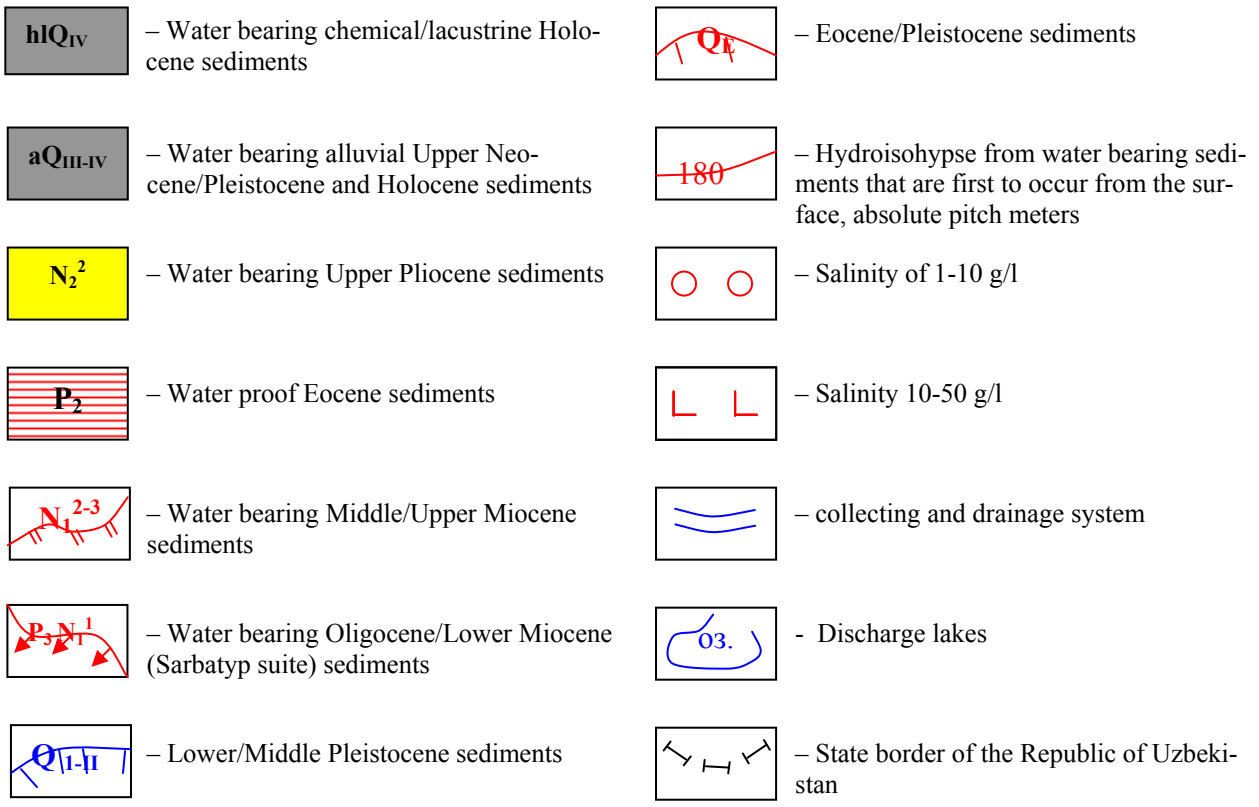


Figure 3.31 – **Hydrogeological Map of Kandym Field Group Plot**

LEGEND, FIG. 3.30 and 3.31



Water bearing chemical/lacustrine Holocene sediments occur only within Karangshor depression in the peripheral north-western Kandym area and at the bottom of Tuzkan depression (currently, this depression if filled with discharge water) adjacent to Kandym Plot. The ground water level ranges from a number of centimeters to 1.0-1.5 m. Its thickness is under 2 m. Sediments are of low water permeability; leakage factor is under hundredth liter parts per day. Karangshor's underground water is weak brine; its salinity is 86.4 g/l; chemically, it is of chloride/sodium type.

Water bearing alluvial Upper Neocene/Pleistocene and Holocene sediments occur within outlying areas of the Zeravshan and Kashkardarya's deltas in Karakul oasis whose south-eastern and north-western parts belong to Kandym and Khauzak Shady plots. There, water bearing Upper Pleistocene and Holocene alluvium is first to occur from the daylight level.

Underground water has a free surface. Ground water occurs at 1.2-3.7 m; the water surface greatly depends on relief and recharging conditions. Ground water occurs at 1-3 m within irrigated lands; it occurs at 5-7 m within non-irrigated ones. The level amplitude within irrigated areas may reach 1.5-2 m (given the surface maximum position in April-May and its minimal position in October-November). Level amplitudes do not exceed 0.5 m in the outlying delta areas, within non-

irrigated areas remote from irrigation channels. Thus, ground water level variations prove hydrodynamic links of the latter with irrigation water and surface water supply.

Water salinity is low (based on total dissolved solids of 1.2-1.7 g/l) within irrigation channels and irrigated areas. Water is of sulphates/sodium type. Water salinity increases to 8-12 g/l within fallow irrigated lands and to 23-32 g/l within outlying oasis's areas. Chemically, it generally belongs to chloride/sodium type. The vertical section demonstrates the similar regular pattern. Note that there is almost no fresh water within the distribution of water bearing complex. Vertical water exchange prevails there due to weak natural underground water outflow.

Underground water is mainly recharged through leakage from irrigation systems and irrigated areas (up to 95% of inflow). It both evaporates (up to 89%) and drains (10%).

Water bearing Upper Pliocene (Sayat and Dengizkul suites) sediments occur throughout the area. The water bearing complex is first to occur from the daylight level within considerable areas at Kandym plot. It is also first to occur in the peripheral north-western area overlapped with drained Lower and Middle Neocene/Pleistocene sediments. The water bearing complex underlies water bearing alluvial Upper Neocene/Pleistocene and Holocene sediments at Khauzak Shady. The Upper Pliocene water bearing complex underlies similar sediments within the south-eastern Kandym area. The Upper Pliocene water bearing complex is first to occur from the daylight level along Dengizkul's northern and southern banks.

The water bearing complex has a free surface within the greater distribution area; the established level is at 4-16 m. Upper Pliocene, Upper Neocene/Pleistocene and Holocene underground water are hydraulically linked within Karakul oasis. The level of the second (Upper Pliocene) occurs at the same depth with ground water or slightly lower. Upper Pliocene water becomes pressure water within deep section intervals. The water bearing complex's surface is gently sloping from the west north-westwards. Its absolute pitches range from 190 m to 170 m in the same direction. Its thickness is 200-220 m.

Generally, underground water belongs to brackish and salty water. Its salinity varies from 8-12 g/l often reaching 38-46 g/l. Individual wells penetrate into water of 3.-5 g/l. Chemically, water is of sulphates/sodium or chloride/sodium type. Upper Pliocene underground water is recharged due to precipitation leakage and water underground water coming from upper and middle parts of the Zeravshan and Kashkadarya's deltas within Karakul oasis and partially due to surface water leakage. Water is discharged in numerous closed depressions including current Lake Dengiskul's depression. The ground water level is of desert type. The level amplitude (0.3-1.0 m) is low reaching its maximum value in spring and minimum value in autumn.

Water proof Middle/Miocene (Agitma suite) sediments occur within Kandym plot while Agitma suite's sediments are eroded within Khauzak Shady. The water proof complex's section includes heterogeneous red clays, siltstones that are often gypsified. The water proof rocks' thickness is 20-100 m. The water proof complex's top occurs at 10-219 m.

Similar to the overlying water proof sediments, *locally water bearing Oligocene/Lower Miocene (Sarbatyr suite) sediments* are wide spread within Kandym plot. It occurs at 100-220 m. The locally water bearing complex's section includes alternating clays, siltstones, sands and sandstones with the latter occurring within the upper interval of Sarbatyp complex.

Well injection rates characteristic of rock water content ranges from 2.5 to 8.8 l/s with the level recession by 5-14 m (specific rates are 0.5-0.63 l/s). Underground water is brackish and salty with salinity varying from 4 to 31 g/l; chemically it is of sulphate/sodium and chloride/sodium types. Underground water contains 1-4.87x10^{-5} uranium g/l; 0.016 molybdenum g/l; 0.016 arsenic mg/l; 24 strontium mg/l; 0.00001 beryllium mg/l. Underground water is recharged due to precipitation leakage at the exposure area of water bearing rocks; and water overflow from the Upper Pliocene water bearing complex provided that there is no water proof formation within the area.

Water proof Eocene sediments are wide spread. Rocks get exposed to the daylight surface along Lake Dengizkul's northern bank and immediately underlie drained Eocene/Pleistocene sediments occurring north-westward of Kandym plot and Khauzak Shady's Upper Pliocene (Lake Dengizkul's southern bank).

Hydrologically, clays, siltstones, marls compose a regional water proof complex dividing the hydrogeological section into the upper part where ground water prevails and the lower part where pressure conform water and brines occur. The top of the water proof complex gets exposed at 50-150 m within depressed area of the plot under review. The Eocene water proof complex's thickness is 240 m.

Water bearing Turonian/Palaeocene sediments occur throughout the Contracted Areas. The complex underlies the regional water proof complex; it gets exposed to the daylight surface northward of Kandym plot at Gazly structure. Palaeocene and Turonian/Maastrichtian sediments were tested separately within Kandym plot and jointly at Khauzak Shady.

Wells penetrated into the water bearing complex's top at 150-200 m. Water bearing rocks include fissured limestones with gypsum interlayers; calcareous sandstones and clays occurring in the Upper Palaeocene section and alternating clays, sandstones, siltstones, and limestones occurring in the Lower Turonian/Maastrict part of the section. The total thickness of water bearing rocks amounts to 700-800 m decreasing to 200-400 m in brachyanticlinal crests.

Turonian/Palaeocene underground water is mainly brackish; its salinity is 3.2-7.6 g/l rarely increasing to 8.9-11.6 g/l. Palaeocene water is more saline than Turonian/Maastrichtian water. Chemically, underground water belongs to sulphates/sodium and chloride/sodium types. Water contains small amounts of lithium, strontium, chromium, and lead that are considerably lower than their assumed minimum commercial concentrations. Water is of thermal type; its mouth temperature is 36-45^{0}C.

The Turonian/Palaeocene water bearing complex is recharged due to underground inflow coming from surrounding mountains and from the exposure area of water bearing rocks, in brachyanticlinal crests; it is recharged due to precipitation leakage within underground water transit area. Underground water is discharged into numerous drainless depressions and by flowing into overlying water bearing complexes through breaks. Turonian/Palaeocene underground water is of high practical importance. It is one of basic pasture irrigation sources. Water is widely used to supply process water for oil/gas prospecting purposes.

Cenomanian water bearing sediments occur throughout the area. Oil wells penetrated into the complex top at 800-1,000 m under Turonian/Maastrichtian sediments. Lower Turonian clays

and siltstones of 80-100 m isolate the Cenomanian water bearing complex from the overlying Turonian/Palaeocene complex. Water bearing rocks include alternating sandstones, limestones, clays, and siltstones. The thickness amounts to 400 m.

The deeper water bearing rocks occur, the more saline underground water becomes increasing from 4.-8.1 g/l at Gazly area to 52 g/l at Alat area. Chemically, water belongs to sulphates/sodium and chloride/sodium types. Underground water is recharged with underground channel from surrounding mountains. It is discharged by outflowing and flowing into overlying water bearing complexes through broken areas. Water is thermal with the temperature ranging from 40 to 68^0C.

Water bearing Albian sediments occur throughout the Contracted Areas. The water bearing complex's top occurs at the depth ranging from 970-1,200m to 1,400-1,700m. A water bearing stratum includes sandstones, clays interstratified with sands, siltstones, and limestones. Its thickness is 160-450 m. Water salinity ranges from 8-12 to 60 g/l. Chemically, water is mainly of chloride/sodium type. Underground water contains 0.5-15 iodine mg/l; 15-113 bromine mg/l. Water is thermal; its temperature reaches 70^0C.

The water bearing complex is recharged with an underground inflow coming from surrounding mountains. It is discharged by outflowing and flowing into overlying hydrogeological structures through breaks. Albian water is of no practical importance.

Berriasian/Aptian water bearing sediments occur throughout the Contracted Areas. Wells penetrated into the complex's top at 1,080-2,000 m. Water bearing rocks include alternating sandstones, clays, siltstones isolated by gypsum, limestone and dolomite interlayers with total thickness ranging from 220-275m to 380-450m. Water salinity varies from 4 to 42 g/l at the adjacent area in the north; it increases to 50-220 g/l within the plots. Chemically, water is mainly of chloride/sodium type. Water contains 142 iodine mg/l; up to 370 bromine mg/l. Water temperature is 60-80^0C. Iodine and bromine may be produced from this water on a commercial basis.

Jurassic water bearing sediments occur throughout the Contracted Areas. The top composed of water proof Kimmeridgian/Tithonian saliferous sediments, galites, anhydrites, gypsum occurs at 1,200-3,000m. Terrigenous Lower and Middle Jurassic carbonaceous sediments and carbonate sediments (upper based on commercial classification) combine XV, XVI, XVII, and XVIII water bearing horizons isolated by water proof clays, siltstones, and mudstones. The thickness of the Jurassic water bearing complex is 1,500 m.

Jurassic underground water is higly saline. XV horizon's water is brines with the salinity ranging from 113.1-159.3 to 88.6 g/l at Kandym and Khauzak respectively. Chemically, water is of chloride/calcium type (according to V.A. Sulin). Jurassic underground water is thermal with the temperature ranging from 99 to 107^0C (at Khauzak Shady). The Jurassic water bearing complex contains commercial amounts for iodine and bromine (over 10 and 200 mg/ l respectively given their joint concentration in water).

Table 3.7 shows a summary description of locally water bearing, water proof complexes and fracture areas at Khauzak Shady and Kandym Field Group.

Table 3.7 – **Description of Underground Water at Khauzak Shady and Kandym Field Group Plots**

Ser. No.	Water bearing complex	Top occurrence depth, m	Maximum thickness, m	Water salinity, m	Water type	Water temperature, °C	Ingredients content, mg/l	
							J	Br
1	2	3	4	5	6	7	8	9
1.	Water bearing chemi-cal/lacustrine Holocene sediments – *hlQlv*	1-1.5	2	86.4	Chlo-ride/sodium	-	-	-
2.	Water bearing alluvial Upper Neocene/Palaeocene and Holocene sediments – aQ_{III-IV}	1.2-3.7	20	1.2-32	Sul-phate/sodium	-	-	-

Table 3.7 continued

1	2	3	4	5	6	7	8	9
3.	*Water bearing Upper Plio-cene (Sayat and Dengizkul suites) sediments* – N_2^2	4-16	220	8-46	Sul-phate/sodium or chlo-ride/sodium	-	-	-
4.	Water proof Middle/Upper Miocene (Agitma suite) sediments – N_1^{2-3}	10-119	100	10-50	Sul-phate/sodium or chlo-ride/sodium	-	-	-
5.	Locally water bearing Oli-gocene/Middle Miocene (Sarbatyr suite) sediments – P_3-N_1^1	100-220	100	4-31	Sul-phate/sodium or chlo-ride/sodium	-	-	-
6.	Water proof Eocene sedi-ments – P_2	50-150	240	10-20	Sul-phate/sodium or chlo-ride/sodium	-	-	-
7.	Water bearing Tu-ronian/Palaeocene sediments – K_2t-P_1	150-200	800	8.9-11.6	Sul-phate/sodium or chlo-ride/sodium	36-45	-	-

8.	Water bearing Cenomanian sediments– K_2sn	800-1000	400	4-52	Sul-phate/sodium or chlo-ride/sodium	40-68	-	-
9.	Water bearing Albian sedi-ments – K_zal	970-1700	450	8-60	Chlo-ride/sodium	70	-	-
10.	Water bearing Berri-asian/Aptian sediments – $K_1в$-a	1080-2000	450	4-220	Chlo-ride/sodium	60-80	142	370
11.	Water bearing Jurassic sediments - J	1200-3000	1500	88.6-159.3	Chlo-ride/calcium	99-107	10	200

3.6.2. Kungrad Plot

Kungrad Plot lies at the junction of two artesian basins isolated by Aral-Kyzylkum bar: Barsakelmes and the Southern Sub-Aral basins. The structural geometry of the Southern Sub-Aral region promotes the formation of pressure middle water in the lower section part; and free-surface water bearing horizons interlinked with each other and surface water in the upper part (refer to Figure 3.32).

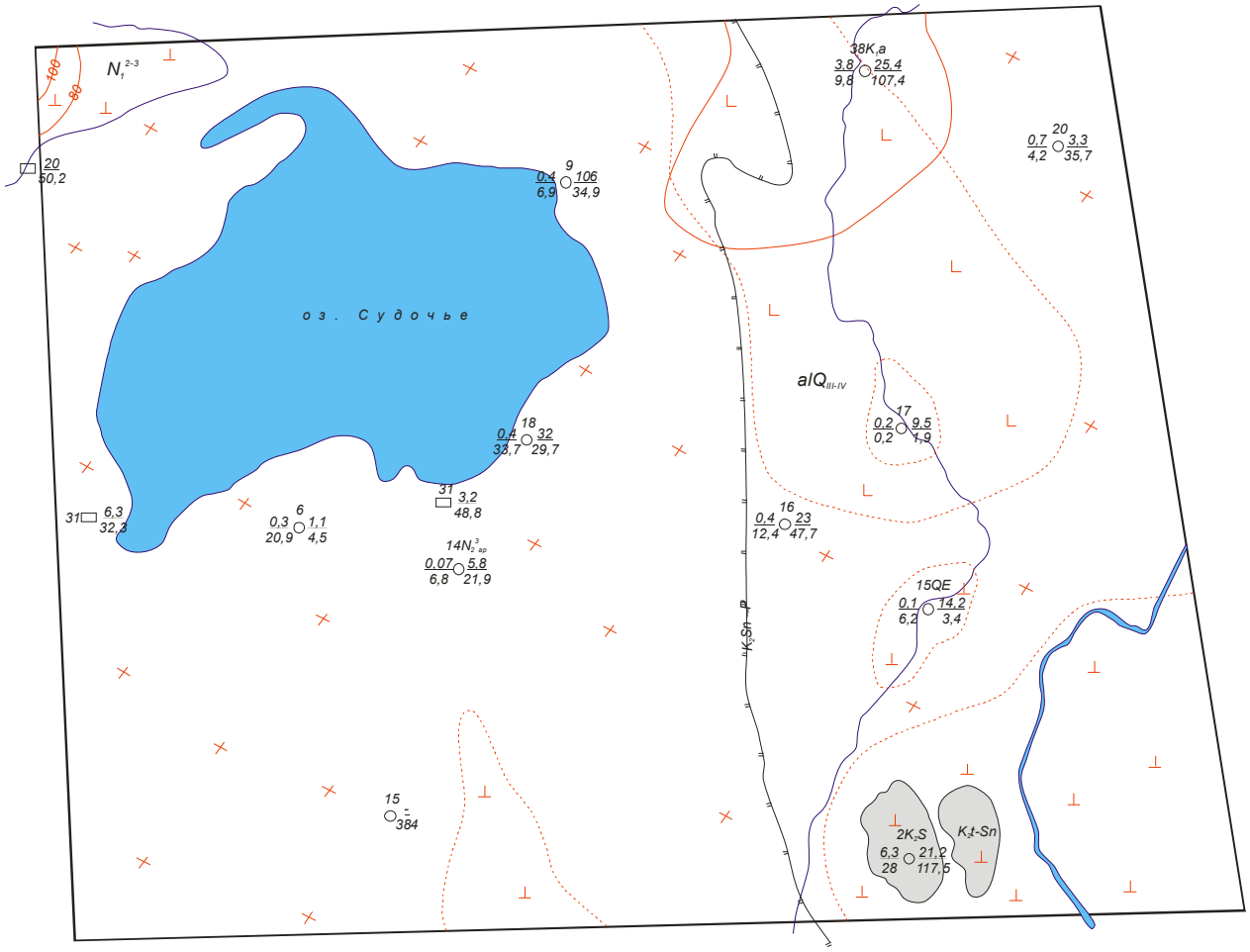
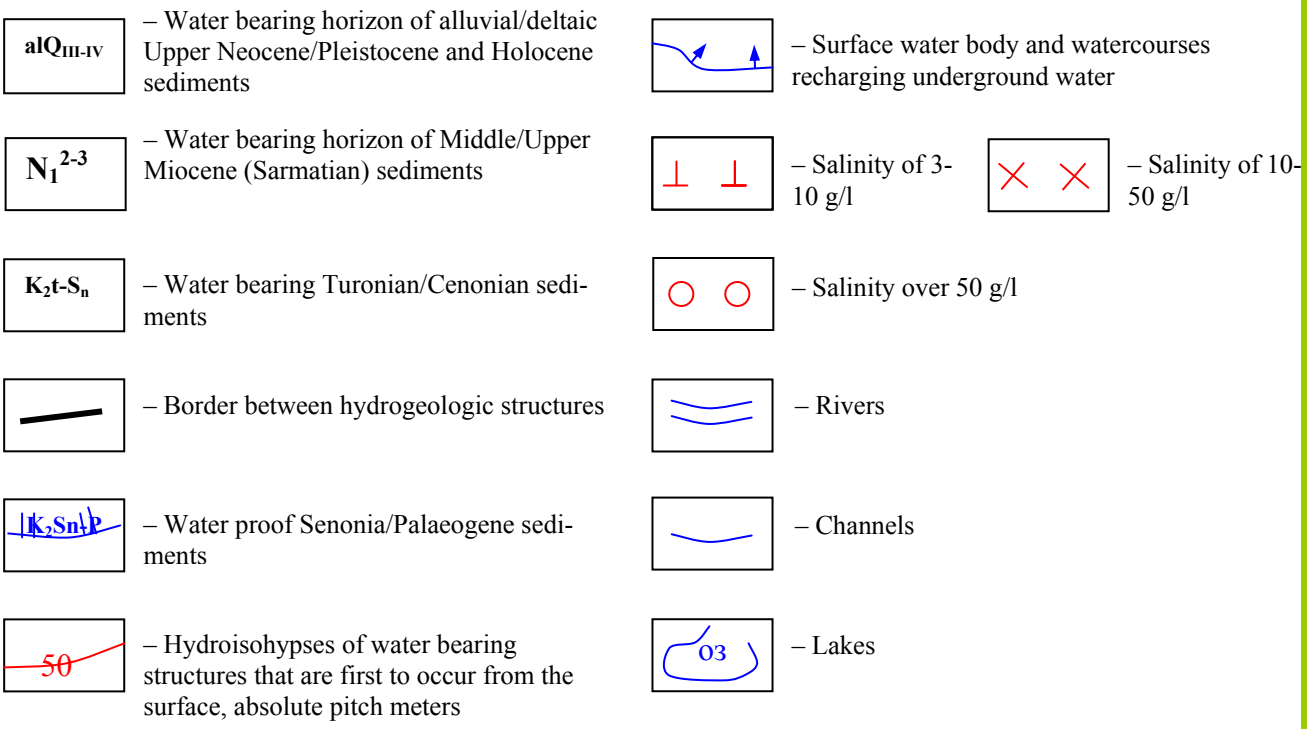


Figure 3.32 – **Kungrad Plot Hydrogeological Map**

The water bearing Upper Neocene/Pleistocene and Holocene alluvial sediments occur in the Amudarya's delta along the bars, large channels and washes. Bed sediments taper out into flood plain/lacustrine sediments. Water bearing rocks include grey fine and small grained sands with loamy soils and clay interlayers of 0.3—2.5 m Chemically, ground water occurring within bed sediments belongs to various types i.e.: from hydrocarbonate/calcium to chloride/sodium. Its salinity also varies from 0.6-0.7 g/l to 14-15 g/l.

Water bearing alluvial/deltaic Upper Neocene/Pleistocene and Holocene sediments occur throughout the Amudarya's delta and are first to occur from the surface. Eocene/Pleistocene sediments underlie the water bearing complex; Lavak suite's clays underlie the complex along the Amudarya's left bank. Rocks include loamy sands, brown/grey, brown, and red/brown loamy soils with 5.5 m interlayers of grey fine and small grained sands. The total thickness of alluvial/deltaic sediments is 5.-48 m.

LEGEND, FIG. 3.32



Chemically, ground water occurring within alluvial/deltaic sediments is of sulphates, sodium, and calcium types. Water salinity ranges from 2-3 to 5-10 g/l under irrigated areas increasing to 15-20 g/l with the depth. The highest ground water salinity is recorded at saline lands exceeding 40 g/l.

Ground water is mainly recharged due to surface water leakage, channels, and irrigation channels, with discharged drainage water, by field flushing and irrigation within the occurrence area of alluvial/deltaic sediments. Ground water evaporates, transpirates, tapers out into discharge headers and lakes, outflow into other water bearing horizons and outside the area in question. Alluvial/deltaic water is of no practical importance.

Water Proof Lacustrine Lower/Middle Neocene/Pleistocene Sediments. These sediments occur between Ustyurt cliff and Aral Kyzyl-Kum bar at the depth ranging from 8 to 20 m. They include Lavak suite's brownish/grey clays with ochreous, blue and darks stains and rare gypsum crystals. The thickness is 7.5-19.0 m.

Water bearing Eocene/Pleistocene sediments occur throughout the Amudarya's delta. They are second to occur from the surface except for small areas where they are either exposed to the surface or lack. Water bearing rocks include sands and loose sandstones with clay and siltstone interlayers. Akchagyl sediments, Neogene clays and marls underlie these sediments while Neocene/Pleistocene sediments overlie them. The thickness of these sediments varies from 4.5 to 49.3 m.

Chemically, underground water is mainly of chloride and sodium types. Water salinity ranges from 0.73 to 60.8 g/l. The water bearing horizon is recharged with outflows coming from overlying sediments. It outflows outside the area in question to discharge areas. Eocene/Pleistocene water is of no practical importance.

Sarmatian Water Bearing Horizon. This water bearing horizon occurs only in the Contracted Plot's western part i.e. Ustyurt plateau. Water bearing rocks mainly include fissured and karst limestone interstratified with loose and fissured marls. Tortonian rocks including gypsum, fissured marls, fine grained and durable sandstones underlie Sarmat water bearing sediments. There is a water proof interval and hydraulic link between Sarmatian and Tortonian sediments. Sarmatian underground water salinity ranges from 9.3 to 16.3 g/l within the given area. Water is of chloride/sodium type.

Tortonian Water Bearing Horizon. This horizon underlies Sarmatian sediments; its toe corresponds to the Palaeogene eroded surface. The horizon's thickness varies from 25 to m. The horizon's salinity ranges from 7.3 to 35.3 g/l. Chemically, Tortonian water is of chloride/sodium type with higher sulphates content. Tortonian water is of no practical importance.

Turonian/Lower Cenonian Water Bearing Complex: Turonian/Lower Cenonian sediments get exposed to the surface at Kyzykjar elevation in the peripheral south-eastern part. The thickness does not exceed 140.5 m. Underground water salinity is generally low ranging from 2.0 to 16.0 g/l. Water is of chloride, sodium and sulphates/sodium types. Its temperature is 35,5-38^{0}C.

Water Bearing Albian/Turonian Sediments. Wells penetrated into the water bearing complex at the depth of 830 and 1,400m. Sediments include alternating fine grained sandstones, siltstones, and clays. This water is pressure nature; pressure heads amounts to 1,000m. Water salinity varies from dozens of g/l to 166.2 g/l. Water is of chloride/sodium type. Its temperature is 71^{0}C. The content of microcomponents in underground water is as follows: 15 iodine mg/l; 247 bromine mg/l.

Neocomian/Aptian Water Bearing Complex. Wells penetrated the complex at 1,400m. Its thickness is 650 m. Chemically, water is of chloride/sodium and calcium types; water salinity ranges from 42.5 to 181 g/l. Water temperature is 107^{0}C. The content of microcomponents is as follows: 33 iodine mg/l; 200 bromine mg/l.

Water Bearing Upper Jurassic Sediments. Wells penetrated the Upper Jurassic complex at 2,050m. The complex includes alternating limestone, sandstone, and clays; the total thickness is 400 m. Water salinity varies from 116.7 to 163.2 g/l; water temperature is 103-123^{0}C. The content of iodine and bromine is 12-28 mg/l and 340-645 mg/l respectively.

Water Bearing Middle Jurassic Sediments. Wells penetrated the complex at 2,450 m. The lower part of water bearing complex's section mainly includes continental sandstones, fine and small grained clays, siltstones, and mudstones with numerous coal interlayers. The complex's maximum thickness is 542 m. Water is highly saline (111.4-370.5 g/l), chloride/sodium; it contains up to 20 iodine mg/l and 207 bromine mg/l. Water temperature is 112-129^{0}C.

Water Bearing Lower Jurassic Sediments. Wells penetrated the complex at 3,000m. It includes grey, argillaceous clays and siltstones. The thickness of sediments is up to 161 m. Water is highly saline (178.1 g/l); its temperature is 144^{0}C. Chemically, water is of chloride/sodium type and contains 20 mg of iodine per liter and 395 mg of bromine per liter.

Table 3.8 shows the summary description of water bearing, locally water bearing, water proof complexes and fractured zones within Kungrad plot.

Table 3.8 – **Description of Underground Water at Kungrad Plot**

Ser.No.	Water bearing complex	Top occurrence depth, m	Maximum thickness, m	Water salinity, m	Water type	Water temperature, °C	Ingredients content, mg/l	
							J	Br
1	2	3	4	5	6	7	8	9
1.	Water bearing alluvial Upper Neocene/Palaeocene and Holocene sediments – aQ_{III-IV}	1-3	30	from 0.6-0.7 to 14-15	from hydro-carbon-ate/calcium to chlo-ride/sodium	-	-	-
2.	Water bearing alluvial Upper Neocene/Palaeocene and Holocene sediments – aQ_{III-IV}	1-10	48	from 2-20 to over 40	from chlo-ride/sulphates /sodium to sul-phates/calciu m	-	-	-
3.	Water proof lucistrine Lower/Middle Neo-cene/Pleistocene sediments – lQ_{I-II}	8-20	19	1-50	Chlo-ride/sodium	-	-	-
4.	Water bearing horizon of Eocene/Plastocene sedi-ments	15-25	49	0,7-60,8	Chlo-ride/sodium	-	-	-

Table 3.8 continued

1	2	3	4	5	6	7	8	9
5.	Sarmatian water bearing ho-rizon – N_1^{2-3}	22-38	13	9,3-16,3	Chlo-ride/sodium	-	-	-
6.	Tortonian water bearing ho-rizon – N_1^{1-2}	50	52	7,3-35,3	chlo-ride/sodium with higher sulphide con-tent	-	-	-

7.	Water proof Senonian/Paleogene sediments – K_2sn-P	0-140	960	7-25	chloride/sodium with higher sulphide content	-	-	-
8.	Turonian/Lower Cenonian Water Bearing Complex – K_2t-sn	150	140	2-16	Sulphate/sodium or chloride/sodium	35,5-38	-	-
9.	Water bearing Albian/Turonian sediments – K_1al-K_2t	830-1400	570	20-166,2	Chloride/sodium	60-71	15	247
10.	Neocomian/Aptian Water Bearing Complex – K_1nc-c	1400	650	42,5-181	Chloride/calcium	95-107	33	200
11.	Water bearing Upper Jurassic complex – J_3	2050	400	116,7-163,2	Chloride/sodium	103-123	20	493
12.	Water bearing Middle Jurassic sediments – J_2	2450	542	111,4-370,5	Chloride/sodium	112-129	20	207
13.	Water bearing Lower Jurassic complex – J_1	3000	161	178,1	Chloride/sodium	144	20	395

3.7. Seismic Behavior of Contracted Areas

4 basic seismic parameters determine seismology and geology of the area: spatial earthquake frequency i.e. Energy-based earthquake occurrence frequency pattern (E), seismic activity level A, maximum possible earthquake in the area under research (K_{MAX}) and earthquake temporal distribution (t, R).

Log/log occurrence plots illustrate the dependence of frequency (N) on energy E.

$$\gamma = \frac{\Delta lqNk}{\Delta lqE},$$

characterized by ≈ 0.5 average factor assumed for the Earth.

There is no enough data available on the earthquake frequency pattern within the Contracted Areas; therefore, calculations used characteristics of only 10 earthquakes based on the seismic activity maps. The value of γ determined for these Uzbekistan's regions greatly exceeds average long-term values of γ calculated for other regions. It is γ=0.60±0.03.

3.7.1. Seismic Activity

Seismic activity maps A(=A_{10}) illustrate activity distribution. A number of maps are available for Western Uzbekistan at the area within 63-68.5 East longitude and 37-44^0 North latitude. All these maps used only representative earthquakes with K of 0?13 and the average long-term value γ of 0.6. Activity contour lines are dotted due to the lack of enough epicenters.

Activity contour lines characteristic of the Contracted Areas spread northward and northwestward; A = 0.05-0.01 and it is the lowest value of those determined for plains and low-hill terrains within Bukhara-Khivinsk oblast (Table 3.9). Two local activity maximum of 0.02 are recorded within Central Kyzylkum. Note that this part of Western Uzbekistan was mapped based on insufficient earthquake data which accounts for a rough seismic activity description.

Table 3.9

K_{MAX}	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5	13.0
A_1	0.026	0.033	0.043	0.054	0.069	0.088	0.112	0.143	0.182	0.232	0.295

One of critical seismic zoning parameters is K_{MAX} i.e. maximum possible earthquakes that might occur within the Contracted Areas. K_{MAX} calculation techniques are based geophysical and geological data and on correlations between an average long-term seismic activity and the energy of maximum earthquakes observed. The correlation plot of K_{MAX}=f(A) was constructed for Western Uzbekistan's region within 34-47^0 North latitude and 62-69^0 East longitude based on the activity map with constant accuracy N_E=8 (Figure 3.33).

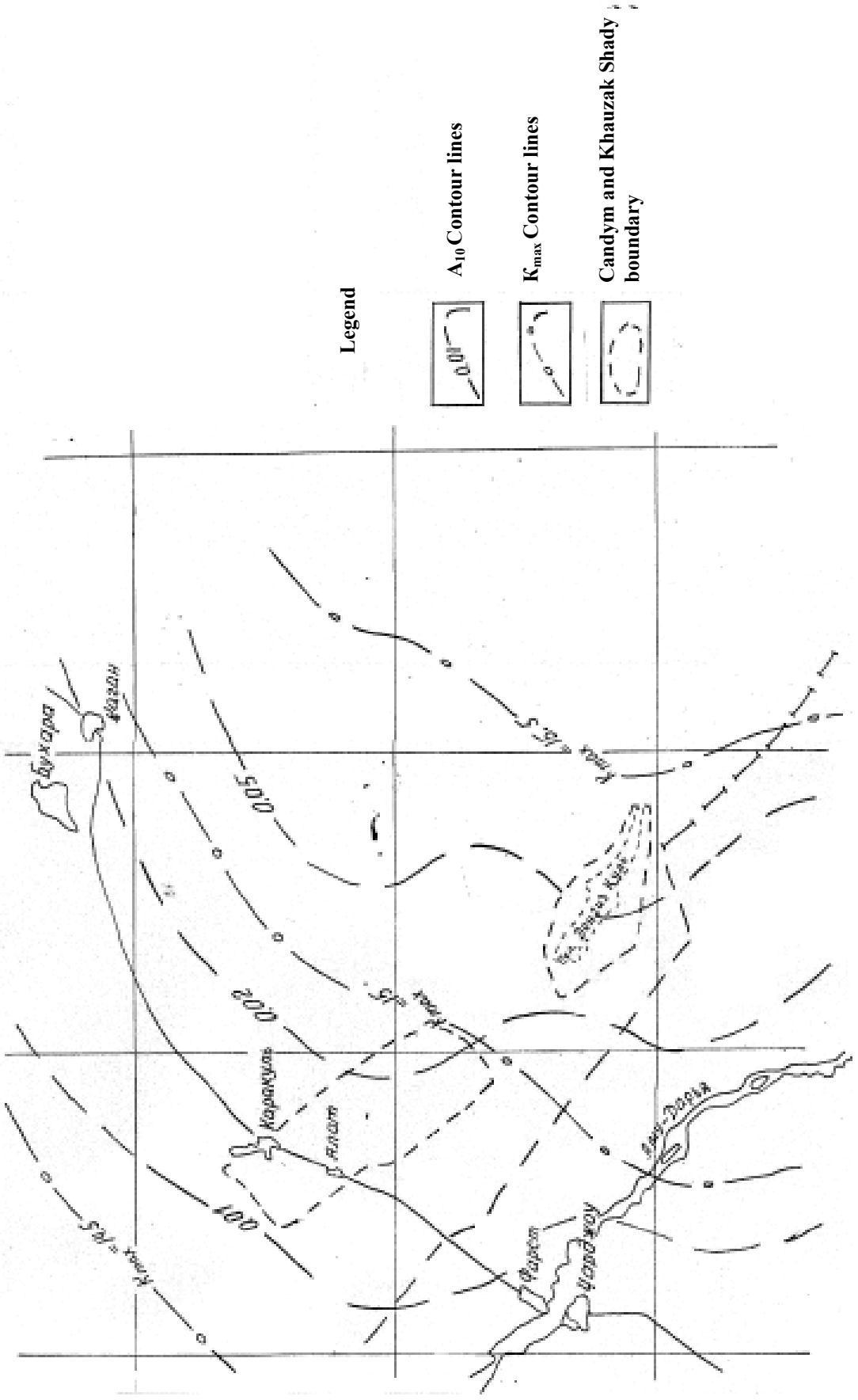


Figure 3.33 – **Kandym and Khauzak Shady Seismic Activity and K_{MAX} Maps**

K_{MAX} map shows almost the same configuration of seismic activity contour lines (refer to Figure 3.33). According to the seismic shaking map (a long-term average frequency of seismic shakings of given intensity J), Kandym group and Khauzak Shady belong to the 7-point zone. Earthquake intensity shown in the seismic zoning map is assessed based on the date on seismic zones and average shaking frequency within each intensity zone. Average earthquake frequency periods applicable to the 7-point last 100 to 1,000 years.

Conclusions to Chapter Entitled "Climate, Geology and Geography Description of Contracted Areas"

1. Karakul plateau is a slightly rolling plain with gently bed-like hollows. Barchan sands occupy the north-western part of the plateau. Sands form cumulose and ridge barchans (exceeding 5m) or rarely dunes; they are locally stabilized with saxaul, heath, camel's-thorn and other vegetation. The remaining area is a detritus desert covered with Calligonum bushes followed by sand spits.

2. Dengizkul depression (ex lake) is a huge saline land depression where drainage water flows from the upland province while the northern part is Bukhara-Karakul physical and geographical area characterized by specific climatic properties caused by wide-spread artificial irrigation.

3. Kungrad plot covers Chimbai and Kungrad physical and geographical area and includes the Amudarya modern delta and adjacent irrigation farming areas in the east and in the west.

4. Huge temperature ranges on an annual and daily basis; very hot summer, slight cloudiness and low air humidity and low precipitation level are characteristic of the extra arid climate typical of Turanian deserts.

5. The whole Bukhara oblast's irrigated area (Kandym and Khauzak Shady group areas) is in the desert, in particular, in the central and southern desert sub-areas while Kungrad area (Kungrad plot of the Contracted area) borders with sub-oreal (moderate) and sub-tropic (warm and humid) sub areas of Uzbekistan's desert areas.

6. A sharp continental nature; a low precipitation level; high summer and low winter temperatures are distinctive climatic features of this area. All the above parameters and a low relative air humidity and wide spread winds increase the water evaporation from the soil layer and promote soil salinization processes. Low winter temperatures cause frost penetration into the upper soil layer which deteriorates its water and physical properties and hampers flushing and treatment processes.

7. Khauzak Shady and Kandym field group contracted areas lack the hydrographic system. There is only a well-developed drainage network and tail drains. The largest tail drains include Karakul Main Tail Drain, Central Bukhara Tail Drain (in Kandym plot), and South Dengizkul Tail Drain (Khauzak-Shady plot).

8. Kungrad plot lies along the Amudarya's left bank. The Contracted plot includes numerous lakes. These lakes are of various shapes, sizes and arrangements; the lakes are embedded at 0.5 -3.0

m and recharged with drainage water from irrigated areas. Sudochye, Karaten, Shegepol, Aidyn, Moshonkul and Karazhar lake system are the most important lakes. Lakes repeatedly dry out and recharge with water depending on the annual water content and the Amudarya's behavior.

9. Meadow/oasis soils are wide spread in Karakul delta. The thickness of agricultural irrigation drifts does not exceed 1-1.5m. Meadow/oasis soils are formed under the influence of shallow ground water (1-3 m); irrigation recharging system; dominant salinization processes; such soils depend on ground water recharging, drainage and salinity.

10. The modern soil mantle of Kungrad district's irrigation area includes: meadow/takyr; takyr/meadow, meadow, marshy/meadow and grey and brown soils, sands and saline lands. These soils are classified into long-term irrigated, newly irrigated, newly developed, ready-for-reclamation, conditionally irrigated, virgin/fallow and virgin lands based on the development degree and irrigation period.

11. Geomorphologically, the Zeravshan's reaches are typical alluvial/deltaic plain formed by the debris cone. The plains are flat slightly sloped from north-east to south-west. The Zeravshan's vast alluvial/deltaic plain lies within the Mesozoic/Cainozoic highly eroded plateau with only small elevations preserved (Karakul plateau).

12. Deep-hole drilling in stratigraphically diverse rocks (from the Upper Palaeozoic to the Upper Jurassic inclusive) proved commercial oil/gas deliverability in Ustyurt region. Kungrad Plot covers southern parts of highly prospective tectonic structure proven to be oil/gas bearing i.e. Sudochye downfold and Takhtakair bar bordering with Kuanysh-Koskala bar in the west where both Jurassic and early Carbonian deposits have been found. Therefore, geologically, Kungrad Plot is likely to include two oil/gas content stages i.e. the Jurassic and Upper Palaeozoic ones.

13. Based on the age and lithological differences characteristic of ground water the above plots include the following hydrogeological groups: (water bearing; locally water bearing; water permeable though arid and water proof; water bearing fractured zones).

14. Kandym group and Khauzak Shady lie within the 7-point zone. Average earthquake frequency periods applicable to the 7-point last 100 to 1,000 years.

4. DESCRIPTION OF BIOLOGICAL RESOURCES AT CONTRACTED AREAS

4.1. Laws Passed by the Republic of Uzbekistan and International Treaties on Protection and Use of Biological Resources

The law on fauna and flora protection in the Republic of Uzbekistan includes: the Law "On Protection of Nature"; the Law "On Protection and Use of Fauna"; the Law on “Protection and Use of Flora”; the Law "On Protected Natural Areas”; regulations passed by the Government of the Republic of Uzbekistan; Rules on Fishing and Hunting in the Republic of Uzbekistan and other regulations.

The Law of the Republic of Uzbekistan “On Protected Natural Areas”:

Article 3. Protected natural areas are classified as follows by their intended use and regime:

- state nature reserves;
- complex (landscape) wildlife preserves - these are the most urgent issues in terms of Environmental Audit as there are two wildlife preserves at the contracted areas;
- nature parks;
- state natural sanctuaries;
- areas used to preserve, reproduce and rehabilitate individual natural sites and complexes;
- protected landscapes;
- areas used to manage individual natural resources.

Article 21. The Cabinet Council of the Republic of Uzbekistan shall decide on establishing complex (landscape) wildlife preserves in the form of state natural institution as advised by socially authorized state authority. Complex (landscape) wildlife preserves shall be governed by respective regulations approved by the Cabinet Council of the Republic of Uzbekistan.

Article 22. Any and all activities shall be prohibited in complex (landscape) wildlife preserves except for research and recreation activities, environmental monitoring and farming to meet the needs of people living within protected areas.

Uzbekistan signed a number of international Conventions on protection and efficient management of biological resources: the Convention on Biological Diversity; the Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention); the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention); Agreement on the Conservation of African and Eurasian Migratory Water Birds; The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Convention on Biological Diversity:

Article 26. Each Contracting Party shall, in accordance with its conditions and abilities, provide, as far as possible and as appropriate, for measures aimed at the conservation and sustainable use of biological diversity as part of respective sectoral and intersectoral plans, programs and policies.

Article 8. Each Contracting Party shall, as far as possible and as appropriate:
a) Establish a system of protected areas to conserve biological diversity;
d) Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings;
f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species...

Convention on Biological Diversity; the Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention):

Article 2, Clause 6. Each Contracting Party shall consider its international responsibilities for the conservation, management and wise use of migratory stocks of waterfowl…

Article 4, Clause 1. Each Contracting Party shall promote the conservation of wetlands and waterfowl…

Article 4, Clause 2. Where a Contracting Party in its urgent national interest, deletes or restricts the boundaries of a wetland included in the List, it should as far as possible compensate for any loss of wetland resources…

Article 4, Clause 4. The Contracting Parties shall endeavor through management to increase waterfowl populations on appropriate wetlands.

Convention on the Conservation of Migratory Species of Wild Animals (*Bonn Convention):*

Article 2, Clause 1. The Parties acknowledge the importance of migratory species being conserved and of Range States agreeing to take action to this end whenever possible and appropriate, paying special attention to migratory species the conservation status of which is unfavorable, and taking individually or in co-operation appropriate and necessary steps to conserve such species and their habitat.

Article 2, Clause 2. The Parties acknowledge the need to take action to avoid any migratory species becoming endangered.

Article 2, Clause 3. In particular, the Parties: shall endeavor to provide immediate protection for migratory species…

Agreement on the Conservation of African and Eurasian Migratory Water Birds:

Article 2, Clause 1. Parties shall take coordinated measures to maintain migratory waterfowl species in a favorable conservation status or to restore them to such a status. To this end, they shall apply within the limits of their national jurisdiction the measures prescribed in Article III, together

with the specific actions determined in the Action Plan provided for in Article IV, of this Agreement.

Article 3, Clause 1. The Parties shall take measures to conserve migratory waterfowl, giving special attention to endangered species as well as to those with an unfavorable conservation status.

Article 3, Clause 2. To this end, the Parties shall:

a) accord the same strict protection for endangered migratory waterfowl species in the Agreement Area…;

b) ensure that any use of migratory waterfowl is based on an assessment of the best available knowledge of their ecology and is sustainable for the species as well as for the ecological systems that support them;

c) identify sites and habitats for migratory waterfowl occurring within their territory and encourage the protection, management, rehabilitation and restoration of these sites, in liaison with those bodies listed in Article IX, paragraphs (a) and (b) of this Agreement, concerned with habitat conservation.

4.2. Human Impact Indicators

The Law of the Republic of Uzbekistan "On Protection and Use of Fauna" binds to take measures to prevent mortality of wild animals caused by business activities; take measures aimed at conserving habitats and animal reproduction conditions as part of area development.

Human activity, development of new previously "wild" areas, construction of irrigation canals, collector water storages, and facilities emitting harmful substances into air and water reduce the number of animal species and cause extinction of some species. This damages environmental conditions in the area. This causes substantial changes in natural conditions. Xerophilous species whose natural habitat is deserts are forced out.

The impact of human business activity on the environment is one of the most urgent issues. Landscape transformation, depletion of water and land biological resources, damaged natural fertility, environmental pollution with industrial and agricultural waste…These are just some human impact consequences.

Decrease in water flow causes desertification to one extent or another. Salt covers land that was previously afloat. Desertification is a rapid process. Soil and vegetation mantle undergoes directional changes. Alluvial/meadow or marshy/meadow soils become meadow/takyr or meadow/desert. Changes in chemicals contained in water or air contaminations negatively impact the environment as well.

Desertification and salt accumulation caused mass mortality of 800 ths ha of reed; 1.3 mln. ha of relict tugai woodlands are on the brink of extinction. There is a sharp increase in animal species. Hygrophilous animal species immediately response to changes in hydrological conditions of water bodies. Water body shoaling reduces the number of diving duck and increases that of dabbling ducks.

Changes in the number of water hens clearly demonstrate consistent degradation of water bodies. Drying of water bodies causes a sharp increase in the number of water hens or even extinction thereof. After hydrological conditions have began to restore rapid restoration of vegetation resources i.e. plankton and algae resulted in decrease in the number of driving ducks and increase in the number of dabbling ducks, swans and water hens.

Changes in soil and water composition account for changes in vegetation mantle and, consequently, changes in fauna composition. Intensive negative impacts accelerate such changes which show themselves as extinction of some fauna and flora species. Gradual slight changes in soil and water composition account for slow changes in vegetation and animal communities though such noticeable morphological signs are characteristic of such process. Anyway, this is an undesirable disastrous impact on regional biological diversity.

Hydro-chemical conditions in the above water bodies are unstable and fully depend on water volume and quality. 2000-2001 drought impacted the quality of water in Sudochye lake system where water changed into salt brine that further dried into saline lands due to insolation. This entailed changes in vegetation mantle and, consequently, animal communities.

Lake phytoplankton includes 271 algae species (47% accounts for diatomaceous driftweed, 28% account for blue-green algae and 20% for green algae). Zooplankton includes 94 species (35 species of chironomid larva, 12 species of dragonfly and beetle larva each; 7 species of Diptera larva, bugs, shellfish - 5 species each, 2 species of caddis worm and 2 species of mayfly). Phytoplankton and zooplankton is basic forage for fish and other water animals and for some species of waterfowl and semi-aquatic fowl. Gradual water mineralization reduces the number of zooplankton species, changes and decreases the species composition of phytoplankton. Freshwater flora depletes and changes into brackish sea flora. High mineralization produced a disastrous impact on numerous species of mosquito larva which served as forage for multiple animal species.

Conservation and improvement of habitats of wild animals and wild plants fully depend on hydrological conditions. Improvement of environmental situation in water bodies requires stable source of low-mineralized water. Reed and cattail bush productivity depends both on abiotic (water mineralization, wind, soil and other) and biotic factors.

Disturbance is a basic factor limiting wildlife habitation; primarily those that temporarily inhabit a given area (reproducing and wintering species). As hunting is prohibited in wildlife preserves; disturbance demonstrates itself as human economic activity accounting for changes in fauna habitats i.e. changes in hydrological conditions in water bodies, construction of industrial facilities near the wildlife preserves, shot operations and other. Given the fact that Dengizkul and Sudochye are places of mass rest of waterfowl during transmigrations, and their breeding places while Dengizkul Lake is also the place of mass waterfowl wintering elimination of disturbance is the most urgent issue.

4.3. Biological Resources of Contracted Areas

4.3.1. Bukhara Oblast

The Contracted Areas include ridge and barchan sands of semi-stable state (Kandym plot, Alat district) and the area where the huge lake of Dengizkul is situated (Khauzak Shady plot, Karakul district).

4.3.1.1. Vegetation

Soil composition and humidification account for the development of vegetation mantle. Sand plots mainly includes: saxaul, some suzerain (Ammodendron Conollyi, Ammodendron Karelini, Ammodendron Lehmannii and Kandym species (Calligonum caput Medasae, Calligonum oriopodum) mixed with saltwort (Salsola Richteri), sandhill wattle, locoweed (Astragalus villosissimus).

Kandym formations are noticeable among Alat district sand plants creating one of the most wide-spread landscapes. 3 of 34 species (Calligonum rubesurs, Calligonum setosum, Calligonumeriopodum) are endemic of the area under research and 3 of them are listed in the Red Book (Calligonum palefzkianum, Calligonum molle, Calligonum matteianum).

Figure 4.1 - **Locoweed**

Figure 4.3 – Karelinia

Figure 4.5 – Glasswort

Figure 4.2 – Threeawn

Figure 4.4 – Glasswort

Various species of Egnatioides are characteristic of takyr soils: with psammophyte bushes (Convolvulus hamadae, Salsola Richteri, Aristida Karelinii, Aristida pennata); Ephemeridae that in addition to wormwood (Artemisia kemrudica and Artemisia diffusa) include Poa bulbosa, Carex pachystylis, Bromus sp.sp., and the camel's-thorn represented by Calligonum sp.sp., Astragalus unifoliatus. Ephemeridae and halophytic vegetation is wide-spread on saline lands including Salsola sclerantha, Anabasis turkestanica, Carex pachystylis, Poa bulbosa and Girgensohnia oppositiflora.

Figure 4.7 - **Pragmatist**

Figure 4.6 – **White Saxaul**

Canal and lake banks are mainly covered with tamarisk (Tamarix hispida, Tamarix laxe, Tamarix litvinovii) mixed with Alhagi canescens and glasswort (Salsola turcomanica, Salsola foliasa, Halimocnemus villosa, Halocnenum strobilaceum). The bloomy poplar (Populus pruinose), downy poplar (Populus diversitolia) and branchy horsetail (Eguisetum ramosissimum) grow along water bodies. Reed (Phragmites cmmunis), blackamoor (Tupha lafifolia), meakin, bladderwort and other plants grow in water bodies.

The Contracted Areas' flora includes 13 endemic species, 3 species listed in the Red Book, 14 rare species, and 19 minority species.

4.3.1.2. Mammals

The Contracted Areas' fauna includes 27 mammal species, 17 reptile species and over 160 bird species. 3 mammal species, 24 bird species, 2 reptile species and 7 arthropoda species are listed in the Red Book. White-toothed shrew (Crocidura suaveolens P.) and sand shrew (Diplomesodon pulchellum L.) are wide-spread species at this area. They are most active in night time; though they appear in daytime in autumn. They strongly vary in number.

Eared hedgehog (Hemiechinus auritus G.) is a wide-spread species throughout the area. This is a burrowing animal. Its forage is diverse and includes: ground beetles, darkling beetles, lamellicorn, acridoid grasshoppers, caterpillars, beetles and other. It also eats vertebrates, lizards and small birds and vegetable food.

Brandt's hedgehog (Hemiechinus hypomelas B.) appears more rarely than the eared hedgehog and lives under the same conditions. It is listed in the Red Book. The European free-tailed bat (Tadarida teniotis R.) is a sensitive rare bat species listed in the Red Book.

The tolai hare (Lepus tolai P.) is a wide-spread species. Its habitat includes semi-stable and stable sands. It lives in semi-stable pit-and-mount sands with saxaul, Kandym, and glasswort near Dengizkul Lake. The greatest population appears in wormwood associations on stable sands. Its forage includes suffruticous and grass vegetation. It reproduces twice a year i.e. in spring and autumn. Tolai hare is a sports hunting target.

The long-clawed ground squirrel (Spermophilo-psis leptodactylus L.) is a common species living in unstable, pit-and-mount, and ridge sands. Habitations of the yellow ground squirrel (Citelius fulvus L.) are of local types in stable sands; his distribution area depends on a human factor. Its habitats include pastures, kishlaks and temporary settlements mainly with weed vegetation such as Peganum harmala, Goldbachia laevigata, Chorispora tenella and other. It prefers meadow grass bulbs, wormwood and sand sedge juvenile leaves. The ground squirrel hibernates during 8 months a year. It is active from February to the middle June in the morning and in the evening. It keeps close to its burrow.

Figure 4.8 - **Ground Squirrel**

Severtsov's jerboa (Allactage severzove V.) is an endemic burrowing species; it prefers underground parts of geophytes (Poa pulbosa, Astragalus rytilobus, Ferula assa-foetida, Carex physodes, Artemisia sp., Allium caspium and other). It feeds at night. It eats meadow grass seeds during the ripening period. Sometimes it eats acridoid grasshoppers. Ground squirrel strongly varies in number.

Other species of ground squirrels include: the little jerboa (Allactaga elater L.), lesser five-toed jerboa (Alactagulua acontion P.) is a common species, mainly lives in takyr and stable sands. This is a burrowing animal. Its forage includes plants mainly underground parts; Lichtenstein's Jerboa (Eremodipus lichtensteini V.) is a species small in number and active at night; combed-toed jerboa (Paradipus) is a rare species; hairy-footed jerboa (Dipus sagitta P.).

The significant number of the midday gerbil (Merionis meridianus P.) lives in the pit-and-mount, non-stable sands near Lake Dengizkul. It lives in minute colonies in saltwort, Kandym and ephedra bushes. Its basic forage includes plants. It reproduces several times a year. Its number includes10-15 individuals per 1 ha.

The Libyan jird (Merionis liducus L.) is the most flexible species living under various conditions. It is a colonial species. Its forage includes plants such as Poa pulbosa, Astragalus rytilobus, Astragalus rubramarginatus, Astragalus maveranagri, Nigella integrifolia, Suadae arcuata, Reamuria turcestanica and other. It prefers mature seeds. It stocked forage for winter period. Libyan jirds strongly vary in number. Winter usually sees the increase up to 10 individuals per 1 ha. Female individuals have several broods during the year.

The giant gerbil (Rhombomys opimus L.) is the most wide-spread species. It lives in huge colonies. Its usual habitats include areas with diverse vegetation mantle. It avoids continuous wormwood, cousinia and harmel bushes. Usually it eats plants growing near the habitat of the colony. Its forage includes green plant plants and unripe seeds. It creates colonies at the slope of cloughs, hillocks, ridges and other relief roughness. Gerbils vary in number increasing 3-4 times as compared with spring.

The fox (Vulpes vulpes flavescens G.) is a bit smaller and lighter than those inhabiting other areas. The fox primarily feeds with giant gerbils in winter. The distribution density is 3.5-4 individuals per 10 km2. Their number depends on the availability of feed. Basic feed includes the most mass and easy-to-catch species of animals. Arthropoda species (42%), mammals (21%) and reptiles (19%) is basic forage of the fox. Quantitative ratio varies throughout the year due to seasonal changes in biomass of food items. Rodents account for 90% of mammals. Vegetable food is of slight importance for foxes. During the year the fox eats green grass sprouts mainly ephemers to compensate the lack of vitamin food.

Figure 4.9 - **Fox**

The corsac (Vulpes corsak turkmenicus) is a rare species at this area as due to its biological specifics it prefers solid ground and appears rarely in unstable and semi-stable sands. The corsac's primary habitats include uneven foothills, argillaceous plains and takyrs. Generally, it is a nocturnal animal. The corsac is an extremely active animal which helps it to get jerboas, birds, reptiles and other species. The corsac's diet varies based on the season. Basic diet elements include arthropods 50%, reptiles 21% and mammals 16%. Mammals included into the corsac's diet are represented only by rodents. The reptile component includes turtles and their eggs, sometimes agamas, lizards and toad agamas. The corsac also eats ephemer sprouts.

The African wild cat (Felis libyea murgabensis) inhabiting the Contracted areas is of relatively small size. It inhabits sand, argillaceous and saline deserts. The African wild cat is primarily a nocturnal animal. Its forage includes rodents, mainly giant gerbils (40%), Libyan jirds (25%), and jerboas (15%). It often feeds on reptiles i.e. agamas, lizards and snakes. It may feed on small birds

and rarely on acridoid grasshoppers, phalanxes and ephemer green sprouts. It is listed in Annex II to CITES.

The marbled polecat (Vormela peregusna) is a species small in number. It inhabits sand and argillaceous deserts, semi-stable and ridge sands. The marbled polecat uses burrows made by rodents. Its forage mainly includes rodents (giant gerbils and Libyan jirds), reptiles and sometimes insects. The marbled polecat is active throughout the year; primarily at night. The Russian polecat (Mustela eversmanni) is a rare species at this area. Primarily, it is a nocturnal animal. Mainly, it hunts jerboas and giant gerbils whose burrows it is able to access.

The goitered gazelle (Gazella subgutturosa) used to be a wide-spread species in the desert situated within the Contracted Area. Goitered gazelles have become a rare species and have been included into the Red Book due to intensive development of desert lands, animal breeding.

4.3.1.3. Birds

The bird fauna research revealed 160 bird species inhabiting the Contracted Areas and 40 nestling bird species. 24 species are listed in the Red Book. Numerous species appear in the region during seasonal transmigrations. Typical inhabitants include: skylarks, finches, chats, sand grouses, small bird of prey, waterfowl, and semi-aquatic birds.

The European white pelican (Pelecanus onocrotatus L.) is a migratory species small in number listed in the Red Book that is about to become sensitive. Sometimes it spends summer at the area. It flocks; however it merges with great cormorants and Dalmatian pelicans during the hunting period.

Figure 4.10 - **European White Pelican**

The Dalmatian pelican (Pelecanus crispus) is a rare species small in number and listed in the Red Book; it is included in Annex I to CITES. It appears at Lake Dengizkul during transmigration, nestling and wintering.

Little cormorant (Phalacrocorax pygmaeus) is a sensitive migratory nestling species listed in Uzbekistan's Red Book and in the Red List of the International Union for Conservation of Nature (IUCN). The common heron (Egretta cinirea cinirea L.) is a common species inhabiting the Central Asian water bodies. It nestles in colonies on reed fractures and trees.

The mute swan (Cygnus olor) and the whooper swan (Cygnus Cygnus L.) listed in the Red Book appear in the area during transmigrations. They rarely spend summer in the area. The lesser white-fronted goose (Anser erythropus) is a rare migratory species listed in the Red Book. The migratory number varies year in year out and reaches up to 2 thousand individuals.

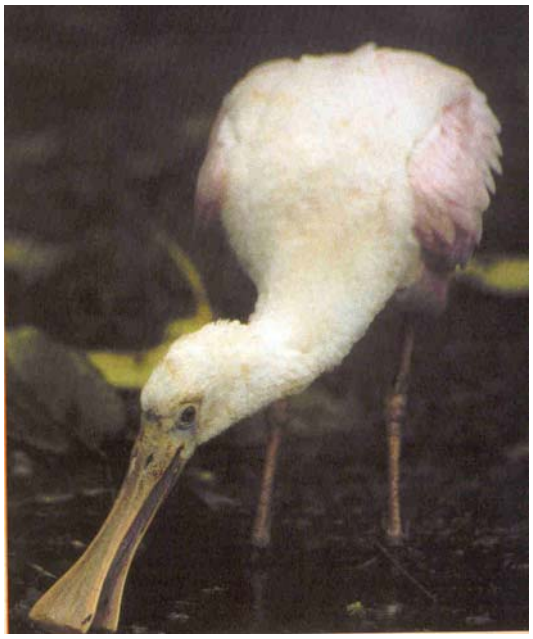


Figure 4.11 - **Spoonbill**

The spoonbill (Platalea leucorodia) is a sensitive reducing species listed in the Red Book; it is included into Annex II to CITES. It appears during transmigration and nestling.

The red-breasted goose (Rufibrenta ruficollis) is a rare migratory species listed in the Red Book. Primarily, it appears during wintering periods.

Sheldrakes include three species: the great-crested grebe (Podiceps cristatus), the red-necked grebe (Podiceps griseigenus), and the little grebe (Podiceps ruficollis). These are mainly birds of passage; only a minor number of sheldrakes nestle within the area.

Anatides include over 20 species. The most noticeable are:

- ✧ the stifftail (Oxyura leucocephala); an endangered species. It has recently appeared during the wintering period (up to 1 thousand of individuals) at Lake Dengizkul. It is listed in Uzbekistan's Red Book and IUCN Red List; listed in Annex II to CITES.
- ✧ the marbled teal (Marmaronetta angustirostris) is an endangered migratory species listed in Uzbekistan's Red Book and IUCN Red List; primarily it appeared along the Amudarya River during transmigrations. Recently it has been noticed at Lake Dengizkul during the wintering period.
- ✧ the wild duck (Anas platyrhynchos L.) is the most wide-spread duck species. It appears during seasonal transmigrations almost at all water bodies; it is a common anatide species. A minor part of ducks stays for a wintering period. A small number of ducks nestles within the area. It is a popular sports hunting target.
- ✧ the European teal (Anas crecca crscca L.) is a mass migratory species. The spring passage occurs in March; the autumn one occurs in August-September. It keeps to shallow water bodies with vegetation. It is a sports hunting target;
- ✧ the white-eyed pochard (Aytnya ferina) is listed in Uzbekistan's Red Book and IUCN Red List. It appears during spring-autumn passage in March and September-October. This species is small in number and flies in small flocks;

- the ruddy shelduck, the common shelduck (Tadorna ferruginea) appears in small flocks or, oftener, in pairs. It is a migratory and nestling species. It nestles in burrows;
- the red-crested pochard (Netta rufina) and the porchard (Aythya ferina L.) are mass species of passage. The huge number of these birds stays for a wintering period. Pochards are the most mass species after water hens in terms of passage and wintering at Lake Dengizkul;

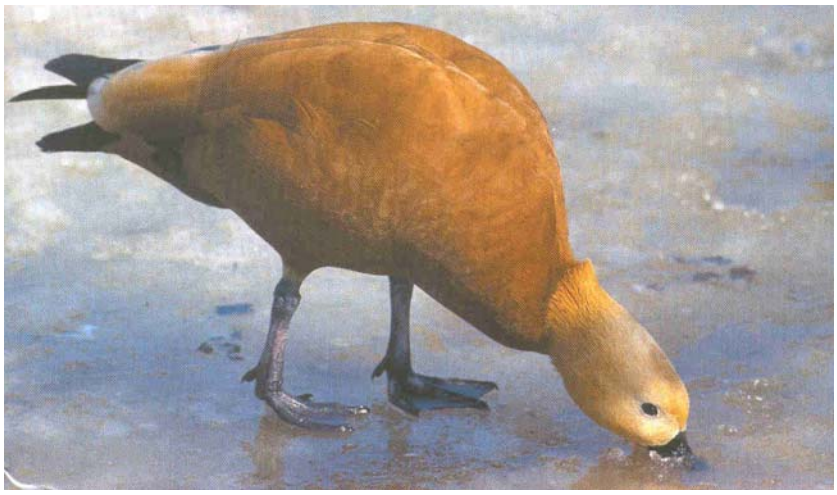


Figure 4.12 - **Ruddy Shelduck**

The water hen (Fulica atra L.) is a numerous migratory and nestling species. A huge number of water hens appear at Lake Dengizkul and other small water bodies during seasonal transmigations. Water hens account for over 80% of all migratory birds during the autumn passage. Thousands of water hens stay for wintering at Lake Dengizkul (about 70% of all birds wintering at the lake). Numerous birds stay for nestling. It is a popular sports hunting target.

There is a huge group of charadriiformes including: the collared pratincole (Glareola pratincola), the little ringed plover (Charadrius dubius), the greater sand plover (Charadrius leschenaultii), the snowy plover (Charadrius alexandrius), the green plover (Venellus venellus), the dunlin (Calidris alpina alpina), the little stint (Calidris minuta), the redshank (Tringa totanus L.), the green sandpiper (Tringa ochropus L.), the wood sandpiper (Tringa glareola L.), the common sandpiper (Tringa hypoleucos L.), the European curlew (Numenius arguata orientalis), the black-winged stilt (Himatopus himatopus himatopus L.), the herring gull (Laras argentatus), the black-headed gull (Laras ridibundus ridibundus), the common tern (Sterna hirundo hirundo), the little tern (Sterna albifrons albifrons), the gull-billed tern (Gelochelidon nilotica). Gulls, terns, pratincoles and black-winged stilts stay for nestling.

Birds of prey include numerous hawk and accipitral species:

- the duck hawk (Ciscus asruginosus) and http://www.multitran.ru/c/m.exe?a=110&t=3620753_2_1&sc=3Montagu's harrier (Circus pygargus), the long-legged buzzard (Buteo rufinus rufinus) are common bird fauna species inhabiting steppe, argillaceous and sand deserts. Its basic forage includes rodents;
- the black vulture (Aegypus monachus L.), the neophron (Neophron percnopterus percnopterus L.) and other species. These are migratory and nestling birds;
- Pallas' sea eagle (Haliaeetus leucoryhus) is an endangered migratory species listed in Uzbekistan's Red Book, IUCN Red List; and Annex II to CITES. It appears at Lake Dengizkul during wintering periods;
- the white-tailed sea eagle (Haliaeetus albicilla) is an endangered migratory species listed in Uzbekistan's Red Book, IUCN Red List; and Annex I to CITES. It appears at Lake Dengizkul during wintering periods.

- the pale harrier (Haliaeetus leucoryhus) is an endangered migratory species listed in Uzbekistan's Red Book, IUCN Red List; and Annex II to CITES;
- the tawny eagle (Aguila rapax Temminck) is a sensitive migratory species listed in the Red Book and Annex II to CITES;
- the imperial eagle (Aguila heliaca Savigni) is a sensitive migratory species listed in the Red Book and Annex II to CITES;
- The saker falcon (Falco cherrug) is a sensitive migratory and nestling species listed in the Red Book; it is included into Annex II to CITES.

The eagle owl (Bubo bubo L.) appears throughout the Contracted Areas. It nestles at bluff formations, rocks, fractures and breakthroughs. The eagle owl's forage includes mammals, mainly rodents, and hedgehogs, hares, reptiles, birds (small birds, ducks and water hens). Eagle owls also eat invertebrates.

The common crane (Grus grus L.) appears at the area during autumn/spring transmigration. Huge flocks of common cranes including several hundreds of birds stay in steppe to rest and to feed. Common crane flocks often fly with demoiselle crane (Anthropoides vigor L.). Once it has been recorded that the white crane (Grus leocogeranus Pallas) listed in Uzbekistan's Red Book and IUCN Red List flew with demoiselle cranes.

The dikkop (Burchinus oedicnemus astutus) is a nestling bird small in number. It inhabits areas with watering places, sands with saxaul, Kandym and saltwort bushes, and saline lands. It nestles on the ground.

The quail (Coturnia coturnia coturnix L.) appears during migrations; it winters rarely at this area. The greatest number of quails appears during spring passage. A small number of these birds stay for nestling. It prefers areas with grass vegetation. It is a sports hunting target. The Zerafchanic pheasant (Phasianus colchicus zerafchanicus) is a non-migratory subspecies listed in the Red Book.

The houbara bustard (Otis undulata macguensii G.) is listed in the Red Book. The houbara bustard appears in desert areas during passages. A small number of these birds stay for nestling. It prefers takyrs, stable sands; it appears in loessial plains with ephemiric and wormwood vegetation. It avoids developed lands. The houbara bustard flies in small flocks of 6-15 birds each during the passage. It stays for wintering in warm winters. The number of birds is small throughout the area. The houbara bustard's forage includes vegetation and animal food. The spring forage primarily includes fresh grass and some insects. The summer forage includes insects (beetles, locusts, termites and other insects), lizards (toad agamas and racerunners).

The turtle dove (Streptopelia turtur) inhabits desert prairie areas. It nestles in tamarisk bushes and http://www.multitran.ru/c/m.exe?a=110&t=3919961_2_1&sc=30haloxylon deserts. The pintail (Pterocles alchata caudacutus) is a rare nestling species listed in the Red Book. It inhabits loessian deserts, stable and ridge sands.

The black-bellied sandgrouse (Pterocles orientalis orientalis) is a nestling species appearing in stable and ridge sands, loessian plains and hills. It forms small flocks. Everyday it flies to the watering place in the morning and in the evening. It stays for wintering in warm winters. The saxaul desert jay (Podoces panderi) is a non-migratory species appearing in sands covered with saxaul, Kandym, sandhill wattle and other bushes.

Furthermore, a great number of other bird species appear at the Contracted Areas: the Corvidae, coraciiformes, starlings, finches, skylarks, wagtails, warblers, thrushes and other species.

4.3.1.4. Reptiles

The Central Asian tortoise (Testudo horsfildi) inhabits loessian, sabulous and sand areas of plains and foothills. A huge number of tortoises used to appear early throughout the area. However, after the development of new lands has begun, local farmers treated them as agricultural vermins eating green crop shoots. Therefore, they started to kill tortoises within the agricultural area. Tortoises dehibernate in March and start to feed actively. Their activity lasts on average till mid-May. It depends on herbage. They are active 2-3 hours in the morning and 1.5-2 hours in the evening. This is an exploited species. It is listed in Annex II to CITES.

The steppe agama (Agama sanguinolents P.) is a wide-spread common species inhabiting this area. It prefers thinned vegetation. It uses rodents' burrow as a shelter. In the hot midday it hides either in burrows or in bushes where it is cooler than on the ground. Its basic forage includes invertebrates: beetles, phalanxes, acridoid grasshoppers, insects, ants, caterpillars and etc. Numerous predators feed on the agama.

The toad agama (Phrynocephalus interscapularis) is a common, wide-spread species. It prefers open sands sporadically covered with sandhill wattle bushes and thin herbage. It feeds on invertebrates: spiders, phalanxes, insects, beetles and etc. Desert monitor (Varanus griseus) is a species small in number listed in the Red Book and Annex I to CITES.

Numerous other reptiles inhabit the area under research; they may be both rare and numerous depending on their biological specifics i.e.: the eared toad agama (Phrynocephalus mystaceus P.), the takyr toad agama (Phrynocephalus helioscopus), the plate-tailed gecko (Teratoscincus scincus), the racerunner (Eremias velox), the lined racerunner (Eremias lineolata), the medium-sized racerunner (Eremias intermedia), the regal racerunner (Eremias grammica), the plate-tailed gecko (Teratoscincus scincus), the transversely striated whip snake (Coluber kareline), the corn snake (Coluber tyria), (Psammophis linedatus) etc.

The Central Asian cobras (Naja oxiana) listed in the Red Book were also recorded and phoorsas ((Echis carinatus). The Eastern boa (Sryx tataricus) inhabits stable and semi-stable sands. Its length reaches 1 m. Large boa feeds on racerunners and gnawer beetles.

4.3.1.5. Insects

34 cicada species belonging to 10 families are recorded in Karshi Steppe: (Hysterofterum asiaticus, Cicodatra gulrula, Paophilus nebulosus, Pseudophlepsius binotatus, Eremophlepsius bexnotatus, Platymeyoplus albus, Platymeyoplus pardalis, Cicadatra gulrula). Cicadas primarily feed on steppe plants mainly the camel's-thorn and wormwood (Artemisia annus).

4.3.1.6. Amphibias

Amphibias inhabiting the area under research include the green toad (Bufo viridis) and the lake frog (Rana ridibunda).

4.3.1.7. Ichthyofauna

Lake Dengizkul's fish fauna primarily includes commercial fish species: the European carp (Cyprinus carpio L.), the pike-perch (Stizostedion lucioperca), the asp (Aspius aspius), the sheatfish (Silurus linnaeus), the royal fish (Chalcalburnus chalcoides aralensis), the bream (Abramis brama), and the mud fish (Channa argus warpa.chowskii). Other non-commercial fish species also inhabits the lake being an integral part of the lake's fish fauna and of significant importance in terms of biological diversity.

4.3.2. Kungrad District

The Kungrad plot primarily includes wetlands with the following lands: Sudochye, Akushpa, Karaten, Begdulla-Aidyn and other small water bodies. These are the Sudochye lake system. Lake Sudochye is one of the largest in the Sub-Aral region; it produced 40% of the total fish yield till 1960.

Despite the drying of the Aral Sea Lake Sudochye is one of the least damage environmental areas where genetic and environmental flora and fauna diversity is conserved and maintained. The lake is the nestling, passage and wintering place for numerous waterfowl species. The lake is of fish commercial importance. The musquash which is a valuable fur-producing animal is reared there. Furthermore, the lake is of great importance for local population as it produces game, fish and is used as a cattle pasture. People use other plants in addition to reed i.e.: tamarisk as a fuel and construction material; the camel's-thorn as livestock forage; and the harmel as a medicine.

4.3.2.1. Vegetation

The lake system's coastal vegetation includes 71 higher plant species. The greatest number of species grows within the coastal area. The coastal vegetation includes three environmental vegetation types: mesophytes, xerophytes and halophytes. The botanic diversity of the coastal vegetation is based on diverse landscapes and environmental conditions. Water-salt soil regime is an important factor.

The coastal vegetation structure is as follows: 1 tree species; 15 bush species; 6 sub-shrub species; 32 permanent grass species and 17 annual grass species.

Vegetation mantle reveals the human impact. The tree and shrub tugai has been exterminated as a fuel or for plowed fields. Currently, meadow large grass associations with salt-tolerant plants are being formed on hydromorphic soil with a relatively small salt content: licorice, reed and etc.

The following meadow and marsh plants grow within bottomlands covered with stagnant water: reed, cane, and macereed. Macereed and reed associations are the most wide spread species.

Figure 4.13 – **Jingil Bushes**

Figure 4.14 – **Tamarisk Bushes**

In the course of silting depressions dry and marsh meadow aquipratas replace marsh vegetation. Salt goes to the upper soil horizons as the surface dries. Communities with salt- and drought-tolerant edificators replace meadow aquipratas. Saxaul vegetation, Salsola rigida, tamarisk (Tamarix hispida, Tamarix tlongata, Tamarix rammosimia and Tamarix laxa), other bushes, the glasswort and camel's-thorn grow within the areas between water bodies.

Water plants include 11 plant species belonging to 5 families: the water horsetail (Chara tomentosa), the fennel-leaved pondweed (Potamogeton pectinatus), the morass-weed (Ceratophyllium demersum), the threadlike naias (Najas marina), the sea grass (Ruppia maratima), the stonewort (Chara polyacantha), the Southern reed (Phragmites australis), the narrow-leaved cat's-tail (Typha angustifolia), Kazakhstan cane (Scirpus kasachstanicus), etc.

4.3.2.2. Ichthyofauna

The fish fauna of Sudochye lake system include over 30 fish species primarily belonging to the cyprinoid family. The European carp (Cyprinus carpio L.), the crucian carp (Carassius auratus),

the mud fish (Channa argus warpachowskii), the Aral roach (Rutilus rutilus aatensis), the silver carp (Aristichtis nobilis), etc. prevail. The lakes' fish fauna included 22 fish species in 1999. However, only 18 fish species inhabited the lakes in 2002.

The European carp (Cyprinus carpio L.) is one of the primary commercial fish species. It is wide spread almost in all water bodies. This is one of the most adapted and highly productive fish species. The silver carp (Aristichtis nobilis) primarily inhabits collectors' mouths. It starts migrating upstream in April and May. The Amudarya is the silver carp's spawning ground.

The mud fish (Channa argus warpachowskii) is one of the most wide spread fish species. It ranks the first in terms of commercial yield. As compared to other fish species this is the most adapted to modern complex environmental conditions; it has almost replaced the pike in terms of the lakes' fish fauna.

The crucian carp (Carassius auratus) is a common limnophilic species. Currently, it is one of primary commercial fish types; it appears almost in all water bodies. Recently, the crucian carp's size has considerably increased proving favorable living conditions for its development. The Aral bream (Abramis sara aramis) and Turkestan barbell (Barbus capito conocephalus) are listed in the Red Book.

4.3.2.3. Birds

According to available estimates, over 110 hydrophilic bird species belonging to 8 orders and 13 families inhabit Kungrad plot. 57 bird species nestles at Sudochye lake system. Based on aerial census data in 1987 the most mass bird species included: the red-crested pochard (Netta rufina) accounting for 36 % of the total recorded bird number; the wild duck (Anas platyrhynchos L.) accounting for 27%; and the water hen (Fulica atra L.) accounting for 25%.

A total of 230 bird species belonging to 17 orders were recorded during the whole period of environmental monitoring at water bodies included into Sudochye lake system. The species composition varies year in year out and based on the season. The greatest number of species appears in spring (Table 4.1).

Table 4.1 – **Bird Species Appearing at Water Bodies Belonging to Sudochye Lake System**

Bird species	Years and seasons						
	1999	2000		2001		2002	
	autumn	spring	autumn	spring	autumn	spring	autumn
1	2	3	4	5	6	7	8
Sheldrakes	4	3	5	4	3	2	2
Copepods	3	4	4	4	2	4	4
Ciconiiformes	7	10	5	6	2	7	5

Anseriformes	18	17	17	16	12	19	17
Diurnal birds of prey	14	17	11	11	12	14	11
Gallinaceae	1	1	2	1	1	1	1
Cranes	4	4	3	3	1	3	2
Charadriiformes	22	40	22	38	8	36	16
Columbidae	2	6	3	3	4	3	5
Owls	2	2	3	1	1	1	1
Coraciiformes	-	4	2	3	-	2	2
Passeriformes	33	53	39	39	33	35	34
Total hydrophilic species	58	78	56	72	28	71	45
Total species	110	164	116	133	79	130	103

Table 4.1 shows that Passeriformes (finches, thrushes, warblers, weaver finches, shrikes, skylarks, yellowhammers, swallows, etc.), charadriiformes (gulls, terns, sandpipers), anseriformes (ducks, geese), diurnal birds of prey (harriers, kites, eagles, buzzards, and falcons) prevail. Water body shoaling and water ecosystem degradation in 2000-2001 changed the bird fauna. 24 endangered bird species 13 of which are listed in the International Red List and 18 of which are included into Uzbekistan's Red Book appear within Sudochye lake system. 9 species are migratory ones while 14 are nestling species.

The European white pelican (Pelicanus onocrotalus) and the Dalmatian pelican (Pelicanus crispus) listed in the Red Book are nestling species. The Dalmatian pelican's nestles are more stable; however, the European white pelicans outnumber Dalmatian pelicans. The little cormorant (Phalacrocorax pygmaeus) used to have huge colonies at Lake Sudochye; however, its number began to reduce. Currently, its number is small and unstable. The little cormorant is listed in the Red Book.

The little heron (Egretta garzetta L.) and the spoonbill (Platalea leucorodia L.) appear very rarely. They keep to the colonies of great egrets. The glossy ibis (Plegadis falcinellus) also nestles in colonies at Lake Sudochye. These species are listed in the Red Book.

In 2000 the stifftail (Oxyura leucocephala) was included into IUCN Red List as an endangered species. It is listed in Uzbekistan's Red Book. Significant stifftail communities appear at the lakes.

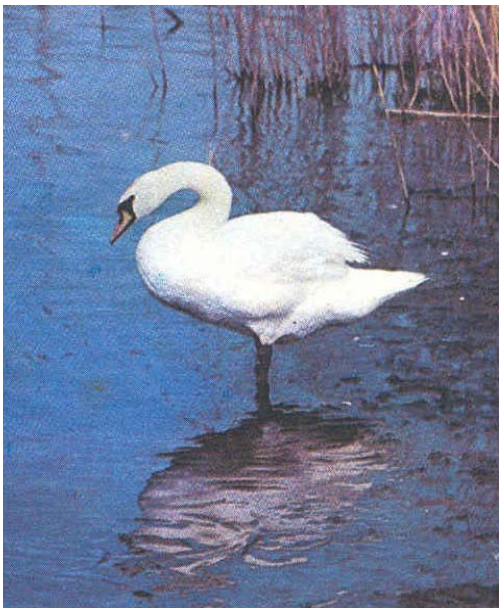


Figure 4.15 – **Mute Swan**

The mute swan (Cygnus olor) has been nestling at Sudochye lake system for a long time. The number of nestling birds reaches 100 pairs. It is listed in Uzbekistan's Red Book.

The white-eyed pochard (Aythya nyroca) used to be a common nestling species. Currently, it is a rare species. It is listed in Uzbekistan's Red Book and IUCN Red List. The flamingo (Phoenicopterus roseus) is a rare migratory species listed in Uzbekistan's Red Book. It appears in the beginning of drought period in spring and summer.

The white-tailed sea eagle (Haliaeetus albicilla) nestles in the area. A pair of these birds appeared at the lakes during several years. It is a sensitive species listed in Uzbekistan's Red Book and IUCN Red List. The slender-billed curlew (Numenius tenuirotris) is on the brink of extinction and listed in Uzbekistan's Red Book and IUCN Red List. It appears during transmigration. The Asian scolopacid godwit (Limnodromus semipalmadus) and the black-winged pratincole (Glareola nordmanni Nordmann) are rare species listed in Uzbekistan's Red Book and IUCN Red List. They appear during spring transmigration and in summer.

2-year's water body drying negatively impacted Sudochye lake system. Ratios of primary ornithological environment indicators underwent changes as well. However, the lake system generally remains an important recreation place for migratory and nestling bird species. Stable colonies of hydrophilic bird species fully depend on the stability of water conditions.

Birds of prey (falcons, harriers, eagles, buzzards), Gallinaceae (the Amudarya pheasant), Columbidae (turtle-doves, sandgrouses, doves), coraciiformes (rollers, bee-eaters, hoopoes), Passeriformes (finches, thrushes, warblers, weaver finches, shrikes, skylarks, yellowhammers, swallows, etc.) primarily inhabit land areas of this area.

4.3.2.4. Mammals

Mammals include 25 species belonging to 6 orders 52% of which account for rodents; 20% accounts for predators; 12% - for cloven-hoofed animals; 8% - for insectivore; hares and cheiroptera account for 4% each. Only the goitered gazelle of all mammals is listed in the Red Book.

Cheiroptera: the common pipistrelle (Pipistrellus pipistrellus) is a species small in number.

Insectivore: the eared hedgehog (Hemiechinus auritus G.) is a species small in number. The white-toothed shrew (Crocidura suaveolens P.) generally is a numerous species; however, the irruption may occur under favorable conditions. It inhabits reed and cattail bushes.

Hares: the tolai hare (Lepus tolai P.) ihabits desert areas adjacent to lakes. It is small in number. Its population varies year in year out based on the availability of forage.

Rodents include:

- the yellow ground squirrel (Citelius fulvus L.), Severtsov's jerboa (Allactaga severzovi V.), the little jerboa (Allactaga elater L.), the pest rat (Nesokia indica), серый хомячок (Crecetulus migratorius), the midday gerbil (Merionis meridianus P.), the Eastern mole vole (Ellobius tancrei), Kirghiz vole (Microtus kirgisorum) and etc. are species small in number.
- the great jerbil (Rhombomys opimus L.). Its population varies on a natural cycle basis with the common cycle time of 3-5 years. The average population is 0.2 individuals per 1 ha.
- the musquash (Ondatra zibethicf) acclimatized in Uzbikistan in 1994; it is mainly a water animal. This is an exploited fur species. Over 1 mln musquash skins were stocked in the late 50s - early 60s in Kara-Kalpak. After 1973 musquash yield began to reduce due to water body drying. 2000-2001 drought sharply reduced the number of musquashes. Currently, its population is restoring.

Cloven-hoofed animals:

- the wild boar (Sus scrofa) is a common wetland species. It is a numerous species feeding on vegetable forage mainly reed roots. It is capable of digging substantial areas. It also feeds on animal food found on the coast.
- the goitered gazelle (Gazella subgutturosa)is listed in Uzbekistan's Red Book and IUCN Red List.
- the saiga (Saiga tatarica) appears at the area under research mainly in winter. It used be a numerous commercial species thousands of heads of which were stocked for meat purposes. Currently, poachers put a high pressure on the saiga. Due to high demand for the saiga horns male saigas are being shot of which damages the population structure. Its number is rapidly reducing. It appears near water bodies in winter.

Predators:

- the wolf (Canis lupus) is a common predator. Wolf trails are regularly recorded near cliff foot. It damages livestock breeding.
- the jackal (Canis aureus) is a common species. It easily overcomes both water barriers and thick reed and cattail bushes. Its basic forage includes birds (76%) and rodents.
- the fox (Vulpes vulpes flavescens G.) is a common animal. It is wide spread throughout the area. Its basic forage includes the most mass and easy-to-catch species of animals (rodents, reptiles, invertebrates). Quantitative ratio varies throughout the year due to seasonal changes in biomass of food items. It is a sports hunting target.

- ✧ the badger (meles meles) is a dominant species. It is the most wide spread near cliffs as it is easier to hide burrows. The badger is lowly active in autumn. Its basic forage includes invertebrates and reptiles.
- ✧ the jungle-cat or chaus (Felis chaus) is a species small in number. It is a good swimmer. It is listed in Annex II to CITES.

Figure 4.16 - **Badger**

Compositionally and environmentally diverse land vertebrate animals inhabiting the Contracted plot are of great importance for desert biocenose, agricultural and public health care. Numerous species of mammals, birds and reptiles are sports and commercial hunting target. Rodents are the most mass animal species that are of great significance for public health care as they carry dangerous human and animal diseases. Figure 4.17 shows the pictures of animals made at the Contracted areas during field studies.

Table 4.2 contains the list of animals inhabiting the Contracted area that are listed in the Red Book.

4.4. Habitat Conditions of Living Organisms Inhabiting Contracted Areas. Nature Reserves and Wildlife Preserves Located at Contracted Areas.

There are two environmentally protected sites at the areas under research i.e. Dengizkul and Sudochye State Nature Reserves where wild animals and their habitats are preserved according to their status.

The Law of the Republic of Uzbekistan "On Protected Natural Areas" establishes that the State Nature Preserves shall be classified as protected areas where any activities that may damage individual natural sites and complexes are prohibited except for research, recreation, environmental monitoring and agricultural work to meet the needs of local residents (refer to Section 2.1 and 4.1).

Table 4.2 – **List of Animal Species Included into Red Book and Inhabiting Contracted Areas**

Species	Contracted plot:		
	Kandym Field Group	Khauzak and	Kungrad

		Shady	
1	2	3	4
Mammals			
Brandt's hedgehog (Hemiechinus hypomelas B.)	X	X	
The European free-tailed bat (Tadarida teniotis R.)	X	X	
The goitered gazelle (Gazella subgutturosa)	X	X	X
Birds			
The Zerafchanic pheasant (Phasianus colchicus zerafchanicus)	X	X	X
The houbara bustard (Chlamydotis undulata)	X	X	X
The pintail (Pterocles alchata)	X	X	
The pale harrier (Circus macrourus)	X	X	X
The imperial eagle (Aguila heliaca Savigni)	X	X	X
The hawk eagle (Hieraaetus fasciatus)	X	X	
The saker falcon (Falco cherrug)	X	X	X
The European white pelican (Pelicanus onocro-lus)		X	X
The Dalmatian pelican (Pelicanus crispus Bruch)		X	X
The little cormorant (Phalacrocorax pyg-maeus)		X	X
The little heron (Egretta garzetta L.)		X	X
The mute swan (Cygnus olor)		X	X
The whooper swan (Cygnus cygnus)		X	X
The spoonbill (Platalea leucorodia)		X	X
The marbled teal (Marmaronetta angusti-rostris)		X	
The white-eyed pochard (Aythya nyroca)		X	X
The stifftail (Oxyura leucocephala)		X	X
The osprey (Pandion haliaetus)		X	X
Pallas' sea eagle (Haliaeetus leucoryhus)		X	
The red-breasted goose (Rufibrenta ruficollis)		X	
The lesser white-fronted goose (Anser erithro-pus)		X	X
The white-tailed sea eagle (Haliaeetus albicilla)		X	X
The steppe eagle (Aguila rapax Temminck)		X	
The great black-headed gull (Lanis ichthyaetus)		X	X
The pond heron (Ardeola rallodes)			X
The glossy ibis (Plegadis falcinellus)			X
The flamingo (Phoenicopterus roseus)			X
The white-eyed pochard (Aythya nyroca)			X
The greater spotted eagle(Aguila clanga Pallas)			X
The steppe kestrel (Falco naumanni Fleischer)			X

Table 4.2 continued

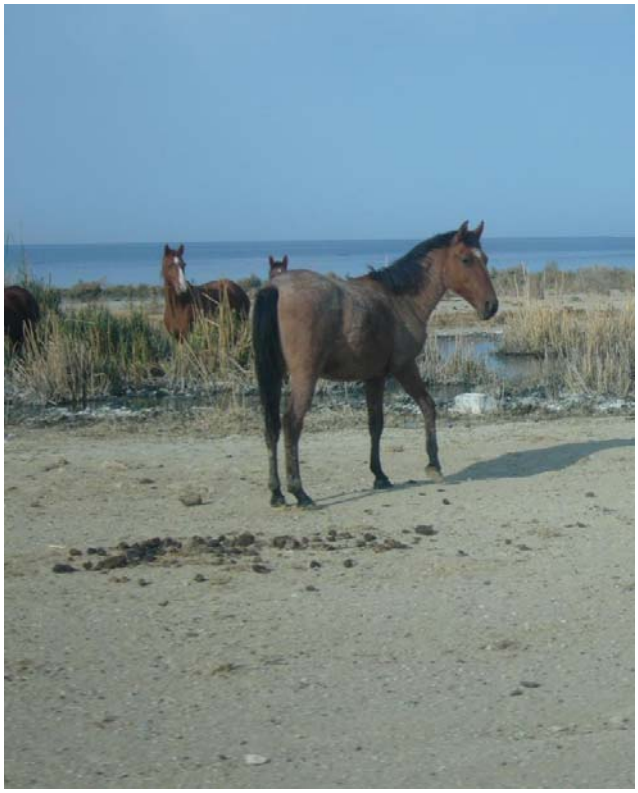
1	2	3	4
The peregrine falcon(Falco peregrinus Tunstall)			X
The black-winged pratincole (Glareola nordmanni Nordmann)			X
Sociable plover (Chettusia gregaria)			X
The slender-billed curlew (Numenius tenuirostris)			X
The Asian scolopacid godwit (Limnodromus semipalmadus)			X
The steppe kestrel (Falco naumanni Fleischer)			X
Reptiles			
The Central Asian cobra (Naja oxiana)	X	X	
The desert monitor (Varanus griseus)	X	X	
The Afghan lytorhynchus (Lythorhinchus rigewayi Boulenger)	X	X	X
The Khentaus toad agama (Phrynocephalus rossikowi Nikolsky)			X
Arthropods			
Pavlovsky's kohlia (Kohlia pavlowski)	X	X	
Laphiragogus kohlii	X	X	
Larra transcaspica F.	X	X	
Eremochares mirabilis	X	X	
Laothoe philerema	X	X	
Streblote fainae	X	X	
Glaucopsyche charibdis	X	X	
Fish			
The Aral bream (Abramis sara aramis)			X
Turkestan barbell (Barbus capito Conocephalus)			X

4.4.1. Dengizkul National Bird Preserve

1973 saw the establishment of Dengizkul National Bird Preserve in Bukhara oblast at the area of 50 ths ha by Regulation No. 530 of the Government of the Republic of Uzbekistan. Later, the preserve's term was extended by Decision No. 157/11 of June 26, 900of Bukhara Regional Executive Committee. The preserved is aimed at conserving and reproducing migratory water fowl species. Each year, hundred thousands of waterfowl and semi-aquatic birds including those listed in the Red Book i.e. pelicans, spoonbills, little cormorants etc. rest and reproduce in the preserve. Lake Dengizkul is the most mass waterfowl wintering place in Uzbekistan. Primary wintering species include diving ducks and water hens.

Lake Dengizkul is of international importance; it is included in the list of water bodies under Ramsar Convention on Conservation of Wet Lands which the Republic of Uzbekistan joined in

2001. This lake meets the requirements of Bonn Convention on the Conservation of Migratory Species of Wild Animals signed by the Republic of Uzbekistan in 1998. Uzbekistan also signed the International Agreement on the Conservation of African and Eurasian Migratory Water Birds. The preserve's border passes along the lakeside. Note that the area adjacent to the lake is of great importance as well as huge crane flocks rest there during seasonal transmigrations. White cranes (Grus leucogeranus) included into IUCN Red List and Uzbekistan's Red Book were recorded among common cranes (Grus grus) and demoiselle cranes (Anthropoides virgo).



A

B

Figure 4.17 – **Pictures of Animals Shot at Khauzak A and Kungrad B Plots during Field Research**

35 mammal species, 120 bird species, 24 reptile species, 2 amphibia species and 24 fish species inhabit Lake Dengizkul. 27 species (2 plant species, 2 mammal species, 2 reptile species and 21 bird species) of which are listed in the Red Book; 8 species of which are included in IUCN Red List and 12 species are included into Annex 2 to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) ad 12 endemics (1 mammal and 12 plant species). All these species are highly sensitive to environmental changes.

Human economic activities entailing changes in natural environment and ecosystem of Lake Dengizkul and adjacent area shall be prohibited within the state preserve. According to local researchers, disturbance and habitat changes may cause the disappearance of animals (primarily wintering and reproducing species) from these areas.

Figure 4.18 – **Dengizkul Lake**

4.4.2. Sudochye National Bird Preserve

The Contracted Area, in particular Kungrad Plot include Sudochye National Bird Preserve established by the Resolution of the Government of Karakalpakstan in 1991 to conserved migratory and nestling waterfowl species at Lake Sudochye covering 50 ths ha.

Lake Sudochye is one of the largest water bodies in the Sub-Aral region and the nestling, passage and wintering place for numerous waterfowl species. The lake saw about 230 bird species belonging to 17 orders 100 species of which are hydrophilic species. Up to 100 thousand of hydrophilic bird individuals rest at Lake Sudochye during seasonal migrations. Over 20 rare and sensitive bird species many of which are common species were recorded at the lake. Lake Sudochye saw 25 mammal species belonging to 6 orders and 24 fish species 13 of which are acclimatized species.

Sudochye National Bird Preserve is also of international importance; it is listed among the water bodies included in Ramsar Convention on the Conservation of Wetlands and meets the requirements of Bonn Convention on the Conservation of Migratory Species of Wild Animals. The Annex to CITES includes many of animal species recorded at the lake.

Note that the National Bird Preserve includes only lake Sudochye; however, Sudochye lake system (Karaten, Sudochye, Akushpa, Begdulla-Aidyn and other water bodies) covering 90 ths ha is of great interest to the conservation of biological diversity. This is implied by the Convention on the Conservation of Biological Diversity signed by the Republic of Uzbekistan in 1995.

Figure 4.19 – **Sudochye Lake System**

The hydrological conditions of water bodies i.e. the water inflow and its mineralization is the basic limiting factor for Sudochye State Preserve and Sudochye lake system in general that might impact the ecosystem. Please, note that ***any unadvised human intervention in the ecosystem may entail irreversible negative consequences.***

A

B

Figure 4.20 - **Pictures of Wintering and Migratory Birds Shot at Lakes Dengizkul and Sudochye during Field Research**

Given the fact over 50 species winter and nestle at lakes Dengizkul and Sudochye and over 100 species passes these lakes during spring/autumn migrations (most of these species are listed in the Red Book) large-scale earthwork, for instance pipeline laying, may take place only in summer when these lakes are conditionally “desolate”. Figure 4.20 shows the pictures of wintering and migratory birds shot at lakes Dengizkul and Sudochye during field research.

Conclusions to Chapter Entitled “Description of Biological Resources at Contracted Areas”

1. The law on fauna and flora protection in the Republic of Uzbekistan includes: the Law "On Protection of Nature"; the Law "On Protection and Use of Fauna"; the Law on “Protection and Use of Flora”; the Law "On Protected Natural Areas”; regulations passed by the Government of the Republic of Uzbekistan; Rules on Fishing and Hunting in the Republic of Uzbekistan and other regulations.

2. Uzbekistan signed a number of international Conventions on protection and rational use of biological resources: the Convention of Biological Diversity; the Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention); the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention); Agreement on the Conservation of African and Eurasian Migratory Water Birds; The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

3. Phytoplankton and zooplankton is primary feed for fish and other water animals and for some species of waterfowl and semi-aquatic fowl. Gradual water mineralization reduces the number of zooplankton species, changes and decreases the species composition of phytoplankton. Freshwater flora is currently depleting and changing into brackish sea flora. High water mineralization harms numerous maggots which multiple animal species feed on within the biocoenosis system.

4. Conservation and improvement of habitats of wild animals and wild plants fully depend on hydrological conditions. Improvement of environmental situation in water bodies requires stable source of low-mineralized water. Reed and cattail bush productivity depend both on abiotic (water mineralization, wind, soil and other) and biotic factors.

5. Despite the drying of the Aral Sea Lake Sudochye is one of the least damage environmental areas where genetic and environmental flora and faun diversity is conserved and maintained. The lake is the nestling, passage and wintering place for numerous waterfowl species. The lake is of fish commercial importance. The musquash which is a valuable fur-producing animal is reared there. Furthermore, the lake is of great importance for local population as it produces game, fish and is used as a cattle pasture. People use other plants in addition to reed i.e.: tamarisk as a fuel and construction material; the camel’s-thorn as livestock forage; and the harmel as a medicine.

6. There are two environmentally protected sites at the areas under research i.e. Dengizkul and Sudochye State Nature Reserves where wild animals and their habitats are preserved according to their status. Pursuant to the Law of the Republic of Uzbekistan "On Protected Natural Areas" State

Preserves shall be protected areas where any activities that might damage individual natural sites and complexes are prohibited.

7. Lake Dengizkul is the most mass waterfowl wintering place in Uzbekistan. Lake Dengizkul is of international importance and included in the list of water bodies under Ramsar Convention on Conservation of Wet Lands which the Republic of Uzbekistan joined in 2001. This lake meets the requirements of Bonn Convention on the Conservation of Migratory Species of Wild Animals signed by the Republic of Uzbekistan in 1998. Uzbekistan also signed the International Agreement on the Conservation of African and Eurasian Migratory Water Birds. The preserve's border passes along the lakeside.

8. Given the fact over 50 species winter and nestle at lakes Dengizkul and Sudochye and over 100 species passes these lakes during spring/autumn migrations (most of these species are listed in the Red Book) large-scale earthwork, for instance pipeline laying, may take place only in summer when these lakes are conditionally "desolate".

5. SOCIO-ECONOMIC CONDITIONS OF THE CONTRACTED AREAS

Republic of Uzbekistan is a sovereign, democratic, and rule-of-law state. Administratively the Republic is divided into velayats (former "oblasts") and Republic of Karakalpakstan, which are in their turn divided into tumans (former "districts"). Executive authorities in the regions are represented by Hokimiyats, headed by oblast, district and city Hokims.

The area of the Republic of Uzbekistan is 447.7 ths sq. km, and the population (as of 1995) totals 22.6 mln people. Tashkent with 2.1 mln inhabitants (as of 1998) is the capital of the Republic.

In the north-west, north and north-east Uzbekistan borders on Kazakhstan, in the east - on Kirgizia, in the south-east – on Tajikistan, in the south - on Afghanistan and in the south-west - on Turkmenia. The full length of the border of the Republic of Uzbekistan reaches 6,221 km, including that with Kazakhstan - 2,203 km, with Kirgizia - 1,099 km, with Tajikistan - 1,161 km, with Afghanistan – 137 km and with Turkmenia - 1,621 km.

The Contracted Areas of Kandym and Khauzak-Shady field groups are located in Bukhara oblast partially in Alat and Karakul districts, while Kungrad plot takes up a part of Kungrad and Muinak districts of the Republic of Karakalpakstan.

All the laws, including those determining the rights and obligations of citizens and their social security, are uniform for the entire Uzbekistan. The Uzbek language is the state language of the Republic, while they also speak the Karakalpak language in the Republic of Karakalpakstan.

Hiring and termination of employment are regulated by the Labor Code of the Republic of Uzbekistan, which legally establishes guarantees and benefits for certain employee categories (women, youths, etc.). What's more, different programs focusing upon improvement of the population's welfare are being implemented in Uzbekistan.

5.1. Historical and Ethnographic Description of the Contracted Area that Includes the Kandym Field Group, Khauzak-Shady and Kungrad Plots.

5.1.1. Archaeological Sites Located in the Contracted Areas

Geographically the Kandym Field Group Plot, Khauzak-Shady Contracted Plots belong to the Karakul oasis in Bukhara oblast, while the Kungrad Plot belongs to Kungrad District of the Republic of Karakalpakstan (the Amudarya's left bank).

5.1.1.1. Karakul Oasis in Bukhara Oblast

In 1950-51, 1953-54 and 1960-64 Mokhandaryinsk archaeological expedition conducted excavations for 10-15 years in Zamonbobo near Dengizkul lake. The aforesaid excavations resulted in discovery and research of sites belonging to the Paleolithic, Neolithic, Eneolithic, and Bronze Ages, as well as to Antiquity.

All the sites of the early periods are located on wind-blown sands in the immediate proximity of lakes and water bodies. Water level differences often caused ancient people to move from one habitat to the other, which is why all of the Neolithic sites were discovered along the northern and north-eastern banks of the Great Tuzkan saline that used to be a lake. It is only in in one district of the ancient water body Great Tuzkan (now a saline) alone that archaeologists studied over 30 sites of the primitive Neolithic hunters and fishermen. Shelter houses built using timber framing and covered with reed indicate that heavy reedbeeds and wild tugai trees were abundant on the banks of water bodies.

Since the vegetable soil was destroyed, archaeological remains that are indicative of the fact that the area was densely populated by primitive farmers and cattlemen can be found everywhere. All the material remains in the existing oases are buried under crop irrigation channels, whereas traces of the primitive and antique cultures were destroyed during excavation. The area of Dengizkul lake, where the medieval layer is inefficient, and the upper layer is to a large extent wheathered, used to serve as an agricultural network of the medieval irrigated cropping. Here one can find the remains of, possibly Zamonbobo type, houses represented by a bunch of fragments of household utilities.

The characteristic feature of the next stage (end of II – beginning of I millennium B.C.) is assimilation by Zamonbobo inhabitants of the culture and household traditions of the arrived tribes of Andronovo culture, dissemination of farming and invention of small local offtakes. Use of big irrigation channels helped to cultivate the lands located in the lower reaches of the powerful Zaraf-shan channel.

During the Bronze Age life moved a little up Gudzheyli channel in Zamonbobo-1, Zamonbobo-2 and Kaptarlikum regions as well as to the northern part of the upper Dengizkul site. Archaeologists discovered a burial ground and multiple grave sites in catacombs without external burial mounds or any other indications. Catacombs were filled with female, male and children bodies with rich burial accessories, including pottery, fairy stones, stone beads, bronze mirrors and various innerwear items.

A statue of the earth-goddess, as well as beads of the Badakhshan stone, pottery and other items belonging to the tribes inhabiting the southern part of Turkmenia, which were found in one of the burial sites, are indicative of the development of cultural and economic ties with the population of other tribes. Besides, this region was also inhabited by the tribes of Kaltaminar culture. Andronovo culture was very wide-spread.

Generally, the ancient history of Zamonbobo locality (15 km to the north-east of Karakul) can be divided into three periods:

- ✓ 1st period: inhabitation of Darvozakir and its surroundings by primitive hunters and fishermen;

- ✓ 2nd period: inhabitation of Zamonbobo and its surroundings by primitive peasants and cattle-men;
- ✓ 3d period: arrival of stock-raising population from the north. These people settled down and mixed in with the native population.

5.1.1.2. Kungrad Region of the Republic of Karakalpakstan

In 1938-40, 1954-56 and 1965-75 excavations were carried out on the left bank of the Amu-darya. The excavations resulted in discovery of materials and collection of information belonging to/about the inhabitants of the downstream Amudarya and Sub-Aral area, belonging to the antique and medieval history of Khorezm. The aforementioned expeditions studied such towns as Urgench, Tashkala, Shemakhala, Shekhrlik, Erbakrkala, Zamakhshar, Shokhsanam, Manzhakli, Bugrokhon, as well as Tuprokkala and Ketenler sites. In 1973-78 and 1981 scientists also conducted a detailed study of Ustiurt caravansary of Bulok, Uchkuduk and Kushbulak.

Many remains of artificial irrigation networks, as well as those of rural housing, belonging to ancient and medieval periods, were found during the study of Tuprokkala 1 site located on the Amudarya's left bank. Pottery, coins and many other items were found in the remains of housing. These remains of sites located in open areas among trees were not protected by any fortifications.

One of the famous Obushyrkal sites is located near Kungrad. It was studied by the Khorezm archaeological expedition in 1964, and was identified to belong to the IV century B.C. The site's area reached 10 ha, and the walls on three sides are very well preserved. The length of the eastern wall is 120 m, that of the northern wall is 412 m, and that of the western wall is 260 m. The height of the eastern and western walls reaches 6.1 m. Entrance is located in the centre of the western wall, and the gates are fortified using a complex device.

Having studied this unique archaeological site, M. Mambetullayev concluded that its history can be divided into 3 periods. The first period covers V-III centuries B.C., the second period - I-VI centuries A.C. and the third period - XI century.

Figure 5.1 shows photos of the burial sites taken on the territory of the Contracted Area during the field research work in December 2004.

5.1.2. Political and Ethnographic Description of the Contracted Areas

5.1.2.1. Karakul Oasis in Bukhara Oblast

Political history of the region is closely linked with the history of Bukhara. In the first millennium B.C. the region was a part of Sogdiana, and then later was under control of the state of Turkic khagan and ephthalites. Before the attack of Arabs (VI century) city Paikend was established here, which later became the capital of the state of esphalites. It was located 15 kilometers to the north-east of Karakul. In the early 8th century Arabs seized Paikend.

In IX-X centuries the territory was part of the Samanid state, and in XI-XII centuries - of the Kara-Khanid state. In XIV-XV centuries the territory was controlled by the Timurid state. Starting from the XVI century the district became a part of the Khanate of Bukhara, and then from the mid XVIII century – a part of the Emirate of Bukhara. In 1920-24 Karakul tuman was formed (part of Bukhara People's Soviet Republic). After the establishment of the Uzbek SSR, in 1925, the region became part of Karakul district of Bukhara oblast, which was retained as the political division up until the beginning of the XXI century.

Remains of Zamonbobo locality (archaeological site) and those of the town of Paikend can still be found near Kandym field group plot. Besides such ancient settlements, as Great Tuzkon, Small Tuzkon, Darvozakir, Odilkuduk, Uchbosh, Kaptarlikum, Akrabat, Nargizkala, were also found on this territory.

Kandym Plot and its adjacent area were mostly populated by Uzbeks. In the late XIX - early XX century the territory's population consisted mostly of such ethnicities, as Bayats, Bayrins, Durmens, Jalayirs, Mangyts, Sarais, Sogdians, Kungrads, Karakuls and other Uzbek clans and tribes. Turkmen, Tatars and Russians also live here.

Mangyts were the biggest, most powerful and united Uzbek tribe in Bukhara. In 1924-25 population of this tribe totaled 8000 individuals living in the lower reaches of the Zarafshan river. As for the origin of Mangyts, it is known that there was a significant group of Magnyts among the Mongols of the time of Chingizkhan that supposedly took part in his expansionist marches on the territory of modern Central Asia and Afghanistan. Thus Mangyts can be considered to have appeared in Movaraunnahr (Mesopotamia) around the beginning of the XIII century. In the XVI century they participated in Sheibaninkhan's march on Samarkand.

Just like many other small groups, their future power and influence was based on their ability to unite different Turkic tribes, both local and strangers. Mangyts' influence was especially great in the mid XVIII century, when the tribe defeated Kungrads in the political fight within the Khanate of Bukhara, so that Bukhara emirs (in 1753-20) could be elected out of Mangyts. Caid Alimhon (1881-1944) was the last emir of Bukhara.

Figure 5.1 – **Burial Sites at Kungrad Contracted Plot; "D" – Taila Ruins**

Kungrads are the second largest Uzbek group in Bukhara. There are a lot fewer Kungrads in Karakul Oasis, than there are in Bukhara - 2670 persons (as of 1924). Some of the Karakul Kungrads resettled to the Armudarya's left bank. A total of 540 people are registered there in the area of old Charjui. It is well known that Khivin khans are born Kungrads, so they were supported by the

tribe in their fight against other Uzbek tribes and Turkmen. Uzbeks-Kungrads are not a single tribe, but rather a union of tribes and clans of different origin.

Sarais are one of the largest Uzbek clans (tribes) of Western Bukhara. 205 Sarais lived in the Paikend region.

According to Muhammed Khaidar, Mongols of Jogat settlement (Chigat settlement) divided into Moguls and Chagatais, who were constantly at war with each other. Chagatais referred to Moguls as "jeste" which is the Mongolian for "foul person, idler". In the first quarter of the XX century Karakul Oasis was inhabited by 565 Chagatais.

335 representatives of Karaul tribe lived on the territory of Karakul Oasis (1925). One of the kishlaks in Karakul tuman is named after Karaul.

300 representatives of Sayat tribe lived on the territory of Karakul Oasis (1925). Currently 150 Sayats are registered on the Bukhara Oasis at Khairabad aryk. One of the existing large kishlaks of the Karakul district is named after the Sayat tribe.

155 representatives of the Jalayir tribe are registered on the territory of Karakul Oasis. The Kazakhs of the Jalayir tribe that was part of the Great Horde represent a union of tribes of Turk and Mongol origin which united in the XIII century under the rule of Chingizkhan's sons around the parts of the Mongolian Jalayir clan. The whole union was named after Jalayir. However, only the main core of Jalayirs populate the territory of Bukhara, because Jalayir Bukhara Uzbeks are not divided into sections and have successfully preserved their main type.

665 representatives of Durmen tribe lived on the territory of Karakul Oasis (1925). Durmen is a tribe of Mongolian origin, which was already known under Chingizkhan's rule and took part in marches on the south-eastern part of Turkestan. In XII-XIII centuries representatives of this tribe settled down in Bukhara.

665 descendants of khodjas, sayids and sheikhs (475 khodjas, and the rest – sheikhs) lived in Karakul Oasis. 165 sayids lived in Paikend. Kishlak Khodzhalar exists on the territory of Karakul district today.

In the end of XIX beginning of XX century lake Dengizkul Region's ethnic composition was represented by Arlats (Alats), Bayats, Bayrins, Mangyts, Sayats, Chendirs, Kungrads and other tribes and clans belonging to the Uzbek people. A part of them were also Turkmen.

Arlats are first mentioned in the history of the Emirate of Bukhara and in the conquest of Samarkand. The representatives of the tribe took part in enthronement of Bukhara khans (emirs) and, for the most part, lived in Karakul Oasis. 225 representatives of the tribe were registered in 1924-25. Alat tuman and the city of Alat are named after this tribe (Arlot).

Several groups referring to themselves as Uzbeks, but named after Turkmen tribes and clans were registered in Amudarya valley, in Karakul Oasis and, partially in Alat district in 1924-25. Representatives of these groups are registered in the same localities, as representatives of Turkmens. Around one thousand chandirs are registered in Karakul Oasis (Alat district). Jandar settlement, now a city and the regional center of Jandar tuman, was named after Chandirs. Several kishlaks in Alat, Karakul and Shafirkan tumans also carry the name Chandir.

In the beginning of XX century one small group of bakhrins consisting of 75 people was registered in Karakul Oasis, primarily in Alat tuman. A representative of this tribe along with three others (Arlat, Batash, Ming) participated in enthronement of Bukhara khans by lifting them on a felt mat. This is viewed as a historical significance of bakhrins, since despite their small number, they played a remarkable part at least in local political life.

Around 150 people living in Bukhara Oasis think of themselves as belonging to the small part of the tribe of Bayat. However the majority of Uzbeks - Bayats (1460 people living along Khairabas aryk, and primarily, in Karakul Oasis) are not anyhow associated with bakhrins and are related to Turkmen.

In 1925 1835 Uzbeks of the Khidir-Eli tribe were registered in Karakul Oasis and 7730 - in Amudarya valley, primarily on the left bank in Farab district close to Karakul.

5.1.2.2. Kungrad Region of the Republic of Karakalpakstan

Sites belonging to Kaltaminar and Tozabagiap cultures were discovered on the territory of Kungrad. In the ancient time these territories were populated by the tribes of Massagets and Saks. In the beginning of II-III centuries B.C. the territory was populated by the tribes of Kanga, in II-IV centuries A.C. - by the tribes of Khunna, and in VI-VIII centuries – by the Turk tribes. The local population mixed in with these tribes, and then in the early Middle Ages, based on this ethnic foundation, the peoples of Sub-Aral - Bezhanka (Pecheneg) and Uguza were formed.

Political history of this territory starts in the first millennium B.C. In VII-VI centuries B.C. Khorezm state was considered one of the largest and most powerful states. Even before A.C. Khorezm managed to unyoke from Iranian Akhmanids, who conquered all of Central Asia. Some sources contain references to Farasman - a ruler of the independent state of Khoresm, who entered into agreement with Alexander the Great.

From III century B.C. until III century A.C. the Sub-Aral area, the lower reaches of the Amudarya and Khorezm Oasis were under the influence of Kang and Kushon states. From the beginning of IV century and until 995 the territory of Khorezm was under the rule of Afrigids. After the conquest by Arabs in 712, Arab Emirate was established on the left bank of Amudarya. The right bank stayed under the rule of Afrigids.

Political struggle in the end of X century resulted in establishment of the rule of Mamunids, and later Saljukids. Starting XI century, prior to Mongolian invasion, Khorezm and the Contracted Area were ruled by Anushtegins. The state of Anushtegins was considered the strongest and most powerful state in entire Asia. Many sites belonging to that period were preserved in Ancient Urgench and its surroundings.

While under the rule of Mongols, North Khorezm and the territory of Kugrad were under the influence of Jochi and his descendants. This is evidenced by archaeological sites located around Kungrad, as well as by written sources dating back to that period. From the beginning of XIV and until the beginning of XV century Kungrad territory and the rest of Khorezm were ruled by Te-

murids. From 1505 until 1510 the region was conquered by Shaibanids, while from 1510 until 1511 – by Iranids.

In 1512 a new independent state called Khivin Khanate was established in Khorezm. Inhabitants of the Sub-Aral area, Kungrad and Karakalpakia played an important social and political role in the history of Khivin Khanate. Change in the Amudarya's course in the second half of XVI century influenced the economic and political life of the territory. From the beginning of XVIII century political influence of the Kungrad tribe in Khivin Khanate became greater. In 1770 the actual power, and in 1804 the official power passed into the hands of Kungrads. They ruled Khivin Khanate until 1920.

The Kungrad Fortress played a great role in fortification of the northern borders of Khivin Khanate. It was at the time when Karakalpaks began to settle down around Kungrad and form as a people. After some time the town of Kungrad became an independent state. However, as a result of a 3-year-long war, Khivin khan, a representative of the Kungrad tribe, conquered Kungrad and destroyed the walls of the fortress.

In the time of the Russian Empire Khivin khan became a vassal. According to administrative division, in 1920-24 Kungrad was part of Khorezm People's Soviet Republic. As a result of the new administrative division in 1924 Kungrad territory became a part of Karakalpakia Autonomous Republic.

Karakalpaks. In II-VIII centuries A.C. the Sub-Aral steppes were populated by a number of Turk tribes. These ethnic foundations gave birth to Sub-Aral tribes of Bizhanaka (pecheneg) and Oguza. Bizhanaks are the ancestors of today's Karakalpaks. The process of Karakalpak's foundation as a nation commenced in VIII-X centuries. The today's territory of Karakalpakia is their ancient homeland. The process of formation of Karakalpak nation ended in XVI century.

The majority of population around Kungrad are Uzbeks, which include the tribes of Kungrad and representatives of the other Uzbek tribes. Kungrad tribe is considered to be one of the major tribes making up the Uzbek nation. In the beginning of XX century Kungrads lived in the southern part of Uzbekistan, including the valley of Zeravshan, Khorezm and Karakalpakia. Some groups of Kungrads also belong to Kazakhs, Karakalpaks, Kirghizs, Bashkirds, Nugais and other Turk tribes. Today the territory being reviewed is, apart from Uzbeks and Karakalpaks, populated by Turkmen, Kazakhs, Koreans, Russians and representatives of other nations.

5.2. Social and Economic Description of the Contracted Areas

Objective and subjective issues typical of the transition period produced a negative effect primarily on the social sphere, more specifically - on employment of citizens and growth of unemployment. According to the official figures, unemployment level in the republic reaches 0.4-0.5%, however unofficially latent unemployment level is around 10%, and in some regions to even more. The reasons behind the unemployment are complex processes observed in the economy of the Republic of Uzbekistan and formation of market relations. Around half of the unemployed are young

people (up to 30 years of age), the majority of whom did not receive any professional education [68].

The retirement age for men in Uzbekistan is 60, whereas women retire at 54. The country's legal tender is the sum. Minimum wages for the republic as of November 2004 amount to 6 530 sums, with the exchange rate established by the National Bank for October 25, 2004 being 1,054 sums per 1 US dollar.

Despite the fact that Uzbekistan implements the policy of social protection of women, has a system of benefits associated with the protection of the rights of mothers and legal employment equality guarantees, in reality, the sex of the employee, his/her marital status and having kids can be perceived as negative aspects in employment. Formation of market relations in Uzbekistan resulted in strengthened discrimination against women in terms of employment. As of the beginning of 2003 women accounted for 50.1% of the population, however the percentage of women in the overall number of those engaged in economic activities was only 44% [56].

Increase in the number of human resources that are not engaged in economic activities resulted in an increase of immigration flows to countries that are more favorable in terms of earnings. Citizens of Uzbekistan leave the country for Russia, Kazakhstan and Kyrgyzstan, as well as for other foreign countries.

5.2.1. Socio-Economic Conditions of Alat District

The area of Alat district reaches 3.2 ths sq. km with the population density of 24.6 people per 1 sq. km. Around 21% of the population live in the center of the district i.e. Alat city. The district is primarily populated by Uzbeks - 96.7% (76.6 ths Uzbeks from the total of 79.2 ths people of the district's total population). The ethnic composition of the rest of the district's population is made up of the following percentages: Kazakhs – 0.63%, Turkmen – 0.5%, Russians – 0.38%, Ukrainians – 0.13%, Tajiks – 0.38%, Tatars – 0.38%, Bashkirs – 0.38%, Azerbaijani – 0.25%, Belarusians – 0.25%. The Uzbek language is used for communication and workflow. Around 42% of the population speak Russian, with the majority living in Alat.

As the official statistics has it, 43.56% of the able-bodied citizens are employed. Average monthly salary amounts to 22.5 ths sum, average monthly pension is 17.1 ths sum. The average monthly income per capita amounts to 16.8 ths sum. The problem of employment is rather pressing for the district. The unemployed are mostly youths and women.

According to the official unemployment figures, on average 60.8% of the unemployed are women. The percentage of young people who are unemployed is also rather high. Table 5.1 shows employment exchange data on employment of youths. As seen from Table 5.1, the unemployment level of youths remains high, irrespective of the increase in their percentage in the overall population.

Table 5.1 – Data on Employment of Youths in Alat District

Indicator	Year		
	2001	2002	2003

1	2	3	4
% of population in the age 15-25	18.5	18.6	19
% of unemployed among youths (14-30 years of age)	40	40	40

There are neither official figures as to the number of people working abroad, nor on migration processes. Unofficially, migration processes today are insignificant, and no more than 4-5 families leave annually. There are virtually no newcomers in the district.

Annual population growth for the district amounts to 15.8 people per 1,000 individuals. Such a high indicator is accounted for by the natural birth rate.

5.2.2. Socio-Economic Conditions of Karakul District

The area of Karakul district is 9.9 ths sq. km. The population density is 12.7 people per 1 sq. km. The population totals 125.3 ths people. Around one fifth of the population live in the administrative center of the district i.e. the town of Karakul.

The native population are Uzbeks. The state Uzbek language is used for communication and workflow. Around 44% of the population speak Russian, with the majority of them living in Karakul. The ethnic composition of the district's population reveals itself in the following proportions: Uzbeks – 98.48%, Tatars – 0.56%, Russians – 0.33%, Turkmen – 0.196%, Ukrainians – 0.05%, Tajiks – 0.05%, Kazakhs – 0.067%, Azerbaijanians – 0.04%, Belarusians – 0.01%, other – 0.2%.

The average wages in the district amount to 34.1 ths sums, with the average monthly pension being 12.7 ths sums. The average monthly income per capita amounts to 18.9 ths sums. According to these indicators, Karakul district has a more favorable position than Alat district.

The number of officially registered jobs in the district with the population of 125.3 ths people, is 22.4 ths. At the same time, as the official figures have it, the unemployment rate in the district does not exceed 3%, which apparently does not correspond to reality. However, in the last four years the growing unemployment trend in the district wasobvious. Figure 5.2 shows the official unemployment curve for Karakul district.

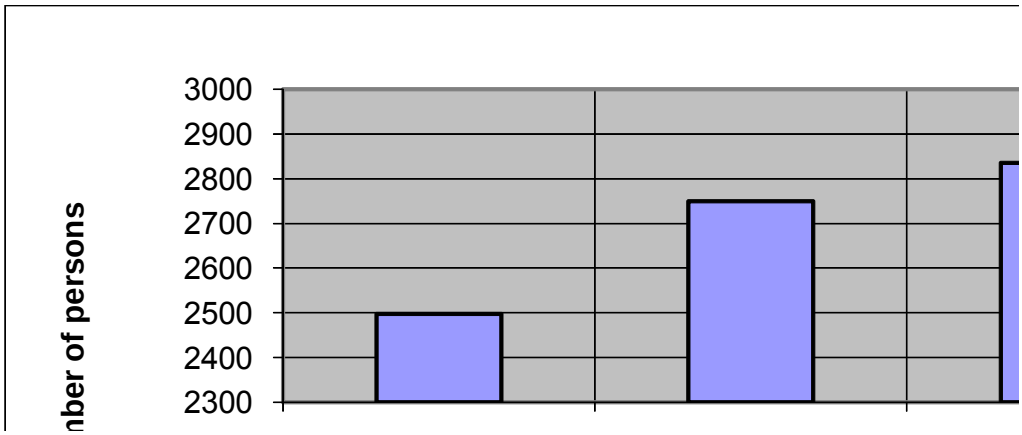


Figure 5.2 - **Official Unemployment Curve For Karakul District.**

Population growth is accounted for by high birth rates of 21.4 people annually per 1000 people. However, despite quite a high birth rate, a tendency towards a decrease in the number of youths in absolute units is observed. This can be explained by a high death rate among children (this is not indicated in the data of the health care) or by the fact that a lot of youths leave home for different reasons, including social issues.

5.2.3. Socio-Economic Conditions of Kungrad and Muinak Districts

The Republic of Karakalpakstan is located in the north-western part of Uzbekistan and takes up a third of the country's entire area, with the population of the Republic amounting to only 7.6 % of the country's population. The Republic has 15 administrative districts and 9 cities. The capital of the Republic is the town of Nukus. The following are the major contributors to the Republic's GDP: industry - 6.9%, construction industry - 10.6%, agriculture - 26.6%, trade public catering - 7.0%, other productive industries - 25.1%, non-productive industries - 17% and taxes - 6.8%.

As of October 01, 2004, the permanent population of the Republic of Karakalpakstan totals 1,564.6 ths people. The natural population growth for 9 months of 2004 amounted to 18.8 people per 1000 individuals. At the same time, the birth rate for 9 months calculated per 1000 individuals was 21.3 individuals, with the death rate being 5.2 individuals. Table 5.2 shows demographic data of the natural population growth in Kungrad and Muinak districts for the respective periods in 2003-2004.

Table 5.2 - Demographic Data Indicative of Natural Population Growth in Kungrad and Muinak Districts

Indicator	**Districts**	
	Kungrad	**Muinak**
	Period of Study	**Period of Study**

	9 months 2003	9 months 2004	9 months 2003	9 months 2004
1	2	3	4	5
Death rate per 1,000 individuals	6.9	5.8	6.3	6.0
Birth rate per 1,000 individuals	22.4	24.4	20.1	21.8
Natural population growth per 1,000 individuals	15.5	18.6	13.8	15.8

As seen from Table 5.2 both the districts see a high natural population growth, primarily due to the high birth rate.

Table 5.3 shows employment data for the entire Republic of Karakalpakstan and for Kungrad and Muinak districts separately.

Table 5.3 – Employment Data for the Republic of Karakalpakstan

Indicator	Total for the Republic of Karakalpakstan	For Kungrad District	For Muinak District
1	2	3	4
Permanent population as of October 1, 2004, ths people	1564.8	113	28.6
Able-bodied population in the working age as of October 1, 2004, ths people	833.3	60.3	15.4
Employed population as of October 1, 2004, ths people	524.6	37.9	9.6
Percent of employed population from the total able-bodied population, %	63.0	62.9	62.3

Average monthly salary of those on the payroll in the Republic of Karakalpakstan for January-September 2004 amounted to 35.5 ths sums, including 72.2 ths sums for Kungrad district and 27.8 ths sums for Muinak district. Apparently, the income of the population in Kungrad plot of the Contracted Area is several times higher than that of the population living close to the Contracted Plots of Kandym and Khauzak field groups.

The tendency of the negative population migration balance is registered both, for the districts under review and for the entire Republic of Karakalpakstan. Table 5.4 shows comparative data indicative of changes in the migration balance taking place in 2003-2004

Table 5.4 – **Population Migration Balance for the Republic of Karakalpakstan and Contracted Districts**

Indicator	Total for the Republic of Karakalpakstan		For Kungrad District		For Muinak District	
	9 months	9 months	9	9	9	9

	2003	2004	months 2003	months 2004	months 2003	months 2004
1	2	3	4	5	6	7
Number of immigrants per 1,000 individuals	5.8	6.1	0.9	1.1	3.0	2.5
Number of emigrants per 1,000 individuals	13.4	15.4	6.1	13.5	18.7	16.7
Migration balance per 1,000 individuals	-7.6	-9.3	-5.2	-12.4	-15.7	-14.2

The aforementioned aspects of the socio-economic development of the regions covering the Contracted Areas lead us to the conclusion that their socio-economic development level is almost the same and is characteristic of the entire country of Uzbekistan.

Unemployment, migration processes, relatively low levels of education and healthcare - all of that is a result of complex and painful processes observed in Uzbekistan's economy during the first years of independence, with such processes being inseparably linked with the processes of market relations formation in the post-Soviet states.

The Uzbek government is currently undertaking various measures aimed at eliminating the negative tendencies taking place in the economy and social sphere. Accelerated economic development in the recent years is taking place under the conditions of balance between the state funds, monetary circulation system and foreign trade sector, which helped ensure the overall stability of macroeconomics and increase in the gold and foreign currency reserves of the country.

Active policy in the labor market, aimed at creating jobs, especially in the line of small businesses, providing employment and professional training to the unemployed, to a certain extent facilitates growth of the population employment and reduces the unemployment.

At the same time, there is a certain disproportion between the demand and supply of labor force in the regional labor markets and in the markets of economic sectors. Such a disproportion aggravates the problem of employments of workers, who are dismissed as a result of structural transformations and administrative reforms.

Efforts on improving the management and funding system, as well as strengthening the primary healthcare system continue in the field of healthcare. Measures are taken on principal improvement of facilities and equipment and provision of cutting edge tools for medical and preventative treatment facilities. New medical units opened in the majority of the regions under study, including villages. This facilitates a decrease in the children's and maternal mortality.

Solving the issue of efficient economic development using internal resources and attracting foreign investments, results in creation of conditions for self-development and self-affirmation of the social status and financial wellbeing of the population. 2004 results indicate that the priority areas of the economic reforms established by the President of Uzbekistan are being efficiently implemented. Introduction of the national currency's convertibility and structural changes in the country contribute into economic growth.

Activity of business entities is also increasing, just like their share in the domestic and foreign markets. A favorable investment climate attracts foreign and domestic investors. The system of

state and economic management is undergoing improvements. All of this helps create new jobs, increase income and improve the life of the population.

Construction of new industrial facilities positively reflects on employment of the population in general and on improvement of the social level of the population in the regions under study [31].

Conclusions to Chapter Entitled "Socio-Economic Conditions of the Contracted Areas"

1. Archeologically the Contracted Areas are of a certain interest. Excavations carried out earlier helped discover sites belonging to the Paleolithic, Neolithic, Eneolithic, Bronze Ages and Antiquity in Karakul Oasis, as well as the remains of the cultural community that dates back to the Bronze Age (first half of II millennium B.C.) near the Zamonbobo river (Kandym field group plot).

2. Ruins of the Zamonbobo locality (archaeological site) and Obushyrkal archaeological site (Kungrad plot), that date back to IV century B.C. are currently preserved in Kandym Field Group Plot.

3. The Uzbek language is the state language of the Republic. Apart from the Uzbek language, the Republic of Karakalpakstan also uses the Karakalpak language.

4. All the laws, including those determining the rights and obligations of citizens and their social security, are uniform for the entire Uzbekistan. Employment and termination of employment are governed by the Labor Code of the Republic of Uzbekistan that legally establishes guarantees and benefits provided to certain categories of employees (women, youths, etc.).

5. Different programs aimed at improving population's welfare are being implemented in Uzbekistan. Annual State Programs („Healthy Generation", "Mother and Child", etc.) are one of the events aimed at contributing into social security. 2004 was the „Year of kindness and goodness".

6. The territory of the Contracted Areas covers four administrative districts (tumans) of the Republic of Uzbekistan: Alat and Karakul districts in Bukhara region (vilayat); Kungrad and Muinak districts in the Republic of Karakalpakstan.

7. The average monthly salary for Alat, Karakul, Kungrad and Muinak districts amounts to: 22.5, 34.1, 72.2 and 27.8 ths sums respectively, with the exchange rate of sum to hard currency established by the National Bank of Uzbekistan as of October 25, 2004 being 1054 sums per 1 US dollar.

8. The territories including the Contracted Areas are characterized by unemployment, migration processes (the migration balance for the past three years tends to negative growth), low level of education and healthcare, which is linked with the formation of market relations. Attracting foreign investments that can change the infrastructure of the aforementioned regions is viewed as one of the primary solutions for the above challenges.

6. FIELD AND LABORATORY SURVEYS TO ASSESS INITIAL STATE OF CONTRACTED AREAS

The primary objective of any environmental condition assessment is *to forecast quantitative or qualitative material, chemical, biological and social and economic effects of business activities and revise techniques and technologies intended to maximize positive effects and minimize adverse ones.* Environmental conditions assessment is based upon:

- Law of the Republic of Uzbekistan "On Protection of Nature" of December 9, 1992 as amended by the Laws of the Republic of Uzbekistan of 05/06/1995, 04/25/1997, 12/25/1998, 05/26/2000 and 08/31/2000.
- Law of the Republic of Uzbekistan "On Protected Natural Areas";
- GOST R ISO 14040 – 1999. "Environmental Management Systems. Lifecycle Assessment".
- GOST R ISO 14031 – 2001. "Environmental Management Systems. Assessment of Environmental Performance".

Comprehensiveness of data and depth of analysis need to be consistent with the sensitivity of the environment planned for development and their main focus should be upon the most likely impact elements. It is necessary, prior to collection and analysis of such data, to have an understanding, that the environment is made up of three components:

- physical and chemical environment (also known as the abiotic environment) that comprises the following subcomponents:
  - abiotic components i.e. energy, climate, atmospheric/aquatic/land conditions;
  - abiotic substances i.e. soil, sediments, mechanical impurities, dissolved organic substances, nutrients occurring in water systems or inactive organic phase found in terrestrial systems;
- the biosphere can also be divided into:
  - generators that represent the foundation of the energy absorbing system i.e. primarily vegetation;
  - consumers that feed on vegetation or other consumers, and digesting them;
- anthropogenic environment:
  - theoretically, man can be classified to be a part of the biosphere. However his extensive activities affect other environmental components, therefore he is normally categorized into a separate group. Assessment of Social Effects stands aside.

6.1. Field Surveys Conducted in Khauzak-Shady, Kandym Field Group and Kungrad Plots to Assess Initial Environmental Condition of Contracted Areas and Take Samples for Subsequent Laboratory Analyses

The Program for Environmental Audit of Contracted Areas comprising Khauzak-Shady, Kandym Field Group and Kungrad plots involved performance in October – December 2004 of field surveys in Khauzak-Shady, Kandym Field Group and Kungrad Contracted Areas. Please refer to the photo album attached to the report on the Environmental Audit of the Contracted Areas.

Expeditions included representatives of Russian, Uzbek and Azerbaijani enterprises:

- ✧ OOO "LUKOIL-VolgogradNIPImorneft" (Russia, Azerbaijan) – general supervision of surveys;
- ✧ OAO "UzLITINEFTEGAZ" (Uzbekistan) – management of surveys;
- ✧ OOO «EKOTEXPROYEKT» (Uzbekistan) – organization of field work, assurance of availability of specialized equipment during the expeditions;
- ✧ State Specialized Inspectorate for Analytical Control (Uzbekistan) – field measurements, air, water and soil sampling for laboratory analyses;
- ✧ Pilot Plant of the Nuclear Physics Institute of the Uzbek Academy of Sciences (Uzbekistan) – background radiation measurements, taking of samples to determine their radionuclide content;
- ✧ Gosbiocontrol of the State Environmental Committee (Uzbekistan) (State Biological Supervision Department at the State Environmental Committee of the Republic of Uzbekistan) – catching of fauna and collection of flora specimens for ecotoxicological and pathomorphological analyses.

Expeditions also included representatives of the Bukhara Oblast Environmental Committee and Karakalpakastan's Environmental Committee, with respective certificates being executed to this extent (refer to Attachments 2, 3 and 4).

The number of sampling stations set up in the Khauzak-Shady, Kandym Field Group and Kungrad Contracted Areas during the part of the expeditions that involved use of GPSMAP 76CS, a navigator that enables one to determine one's location coordinates to the nearest of 7 meters and has an in-built electronic compass, barometer, altimeter and makes it possible to automatically plot the route and record one's traveling ways, was 50, 50 and 49 respectively.

Tables 6.1-6.3 and Figures 6.1-6.3 show the coordinates and locations of the sampling stations within the Contracted Areas and nature of work carried out in such areas: background radiation measurements, taking of air, water or soil samples to conduct laboratory analyses to determine certain parameters. Please note additional smaller scaled location plans of sampling stations for individual areas: Fig. 6.1 «A» and 6.1 «B» – for the Khauzak-Shady plot; Fig. 6.2 «A», 6.2 «B» and 6.2 «C» – for the Kandym Field Group plot; Fig. 6.3 «A», 6.3 «B», 6.3 «C» and 6.3 «D» – for the Kungrad plot.

Table 6.1 – **Locations of Sampling Stations and List of Operations Conducted as Part of Field Surveys (Khauzak-Shady Plot)**

Sampling station No.	Coordinates		Height above the sea level, m	Sampling station's location	Operations carried out at the station
	northern latitude	east longitude			
1	2	3	4	5	6
1	$39^{0}02'908$	$64^{0}11'957$	170	South-western lakeside of Dengizkul	Sampling of: ✓ water for physicochemical analysis; ✓ water for microbiological analysis;

					✓ bottom sediments for physicochemical analysis; ✓ bottom sediments for microbiological analysis
2	39^{0}02’810	64^{0}11’830	176	next to well No. 8 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
3	39^{0}02’512	64^{0}11’276	184	The sheepyard next to the artesian well (Khauzak)	Background radiation measurements, sampling of: ✓ drinking water for physicochemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for determination of its radionuclide content
4	39^{0}03’431	64^{0}10’213	174	next to well No. 4 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
5	39^{0}04’638	64^{0}11’045	170	South-western lakeside of Dengizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis
6	39^{0}05’113	64^{0}08’831	181	next to well No. 242 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content

Table 6.1 continued

1	2	3	4	5	6
7	39^{0}05’332	64^{0}09’295	170	Western lakeside of Dengizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
8	39^{0}05’628	64^{0}08’281	172	next to well No. 3 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

9	39^{0}05’657	64^{0}08’348	170	Western lake-side of Den-gizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
10	39^{0}06’075	64^{0}07’745	170	Western lake-side of Den-gizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
11	39^{0}06’000	64^{0}07’688	179	next to well No. 14 (Khauzak)	Background radiation measurements, sampling of: ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
12	39^{0}06’011	64^{0}07’699	179	Artesian well located next to well No. 14	Sampling of: ✓ drinking water for physicochemical analysis
13	39^{0}05’241	64^{0}06’668	176	Sheepyard	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
14	39^{0}05’035	64^{0}05’590	178	next to well No. 301 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
15	39^{0}04’015	64^{0}04’851	177	Between wells 301 and 302	Sampling of: ✓ groundwater at the depth of 2.5 m for physicochemical analysis;

Table 6.1 continued

1	2	3	4	5	6
16	39^{0}04’944	64^{0}04’053	174	next to well No. 302 (Khauzak)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
17	39^{0}04’765	64^{0}02’818	180	Crossroads	Background radiation measurements
18	39^{0}04’090	64^{0}03’356	183	Next to the Contracted Area’s western	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for phys-

				border	icochemical analysis
19	39^{0}03’912	64^{0}02’184	185	Border of the Contracted Area	Sampling of: ✓ soil at the depth of 0.3 m for physico-chemical analysis
20	39^{0}05’806	64^{0}01’790	175	Khauzak	Background radiation measurements, sampling of: ✓ soil at the depth of 0.3 m for physico-chemical analysis; ✓ soil for determination of its radionuclide content
21	39^{0}06’730	64^{0}01’025	181	Khauzak	Sampling of: ✓ soil at the depth of 0.3 m for physico-chemical analysis
22	39^{0}07’931	64^{0}00’378	180	Khauzak	Background radiation measurements
23	39^{0}08’198	64^{0}00’435	181	Next to the Contracted Area’s western border	Sampling of: ✓ soil at the depth of 0.3 m for physico-chemical analysis
24	39^{0}07’382	64^{0}03’517	178	On Dengiz-kul’s lakeside, next to water-sealed well No. 16 (Khauzak)	Sampling of: ✓ soil at the depth of 0.3 m for physico-chemical analysis
25	39^{0}09’215	64^{0}12’548	244	Next to the Contracted Area’s eastern border	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
26	39^{0}08’781	64^{0}11’065	195	Next to the artesian well	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
27	39^{0}08’792	64^{0}11’077	195	Artesian well	Sampling of: ✓ drinking water for physicochemical analysis

Table 6.1 continued

1	2	3	4	5	6
28	39^{0}08’481	64^{0}09’609	173	Next to well No. 7 (Shady)	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ groundwater at the depth of 3 m for physicochemical analysis; ✓ groundwater for microbiological analysis;

					✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
29	39^{0}08’078	64^{0}09’442	170	Eastern lake-side of Den-gizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
30	39^{0}09’305	64^{0}08’621	174	Next to well No. 4 (Shady)	Background radiation measurements, sam-pling of: ✓ air; ✓ soil at the depth of 0.3, 1 and 6 m for phys-icochemical analysis; ✓ groundwater at the depth of 2 m for phys-icochemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
31	39^{0}09’264	64^{0}08’718	170	Eastern lake-side of Den-gizkul	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
32	39^{0}12’005	64^{0}07’488	190	Next to well No. 2 (Shady)	Sampling of: ✓ soil at the depth of 0.3 and 6 m for phys-icochemical analysis
33	39^{0}11’990	64^{0}07’151	170	North-eastern lakeside of Dengizkul	Sampling of: ✓ air
34	39^{0}11’397	64^{0}07’498	176	Next to well No. 1 (Shady)	Background radiation measurements, sam-pling of: ✓ air; ✓ groundwater at the depth of 4 m for phys-icochemical analysis; ✓ soil at the depth of 0.3 m for physico-chemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for determination of its radionuclide content

Table 6.1 continued

1	2	3	4	5	6
35	39^{0}12’828	64^{0}06’507	187	Up to 1 km off well No. 6 (Shady)	Sampling of: ✓ air; ✓ groundwater at the depth of 1.5 m for phys-icochemical analysis; ✓ soil at the depth of 0.3 and 6 m for phys-icochemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for microbiological analysis
36	39^{0}12’367	64^{0}06’179	170	Northern lake-side of Den-	Sampling of: ✓ air; ✓ water for physicochemical analysis;

				gizkul	✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
37	39^{0}13’532	64^{0}05’497	190	Up to 1 km off well No. 8 (Shady)	Background radiation measurements, sampling of: ✓ groundwater at the depth of 1 m for physicochemical analysis; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for determination of its radionuclide content
38	39^{0}13’515	64^{0}01’911	172	Next to the discharge channel	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
39	39^{0}13’526	64^{0}01’921	170	Discharge channel	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
40	39^{0}13’535	64^{0}02’212	170	The channel’s inflow into Dengizkul lake	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis
41	39^{0}14’913	64^{0}02’576	185	Contracted Area’s border	Sampling of: ✓ soil at the depth of 0.3 m for physicochemical analysis

Table 6.1 continued

1	2	3	4	5	6
42	39^{0}12’504	64^{0}09’310	245	Contracted Area’s border	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
43	39^{0}11’501	64^{0}09’235	250	Next to the artesian well (Shady)	Background radiation measurements, sampling of: ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

44	39^{0}10’964	64^{0}09’971	255	Contracted Area’s border	Background radiation measurements, sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
45	39^{0}10’953	64^{0}09’960	254	Collecting channel	Sampling of: ✓ drinking water for physicochemical analysis; ✓ water for microbiological analysis
46	39^{0}07’839	64^{0}13’578	195	Dengizkul Gas Processing Plant	Sampling of: ✓ air
47	39^{0}01’452	64^{0}13’960	175	Southern lakeside of Dengizkul	Sampling of: ✓ air
48	39^{0}00’038	64^{0}31’243	213	Urta-Bulak camp	Sampling of: ✓ air
49	39^{0}04’266	64^{0}04’762	180	Khauzak	Sampling of: ✓ drinking water for physicochemical analysis
50	39^{0}12’782	64^{0}06’039	175	Shady	Sampling of: ✓ drinking water for physicochemical analysis

Table 6.2 – **Locations of Sampling Stations and List of Operations Conducted as Part of Field Surveys (Kandym Field Group Plot)**

Sampling Station No.	Coordinates		Height above the sea level, m	Sampling station’s location	Operations carried out at the station
	northern latitude	east longitude			
2	3	4	5	6	7
1	39°24’850	63°48’826	180	Alat settlement	Sampling of: ✓ air

Table 6.2 continued

1	2	3	4	5	6
2	39°28’047	63°40’586	180	Kuvvachi settlement	Sampling of: ✓ well water at the depth of 4 m for physicochemical analysis; ✓ well water at the depth of 4 m for microbiological analysis; ✓ soil for microbiological analysis
3	39°28’248	63°41’204	185	Kuvvachi settlement	Background radiation measurements and sampling of: ✓ air ✓ groundwater at the depth of 4.5 m for phys-

					icochemical analysis; ✓ groundwater at the depth of 4.5 m for microbiological analysis; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
4	39°33'815	63°31'719	173	New collecting channel, 1st border control station	Sampling of: ✓ surface water for physicochemical analysis; ✓ surface water for microbiological analysis; ✓ bottom sediments for physicochemical analysis; ✓ bottom sediments for microbiological analysis
5	39°34'129	63°32'234	174	New collecting channel, 1st border control station	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
6	39°33'986	63°26'921	171	Next to well No. 1 (Kandym)	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
7	39°33'976	63°26'911	171	Artesian well located next to well No. 1 (Kandym)	Sampling of: ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis
8	39°33'981	63°26'916	171	Next to well No. 1 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
9	39°21'802	63°40'114	175	Jamadzhar channel	Sampling of: ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis

Table 6.2 continued

1	2	3	4	5	6
10	39°21'791	63°40'103	177	Bridge across Jamadzhar channel	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
11	39°29'036	63°38'320	183	Dzhigachi settlement, a well next to the mill	Background radiation measurements and sampling of: ✓ air; ✓ well water at the depth of 4 m for physicochemical analysis;

					✓ well water at the depth of 4 m for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
12	39°21’185	63°37’386	175	Alat	Background radiation measurements and sampling of: ✓ soil for determination of its radionuclide content
13	39°34’143	63°25’282	175	Next to well No. 245 (Kandym)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
14	39°34’259	63°24’523	178	Next to well No. 244 (Kandym)	Sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
15	39°34’254	63°24’518	178	well No. 244 (Kandym)	Sampling of: ✓ well’s topsoil for physicochemical analysis
16	39°34’671	63°20’023	179	Next to well No. 7 (Kandym)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
17	39°35’698	63°21’603	180	Next to the no name well (Kandym)	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

Table 6.2 continued

1	2	3	4	5	6
18	39°37’328	63°24’700	175	Next to the artesian well (Kandym)	Background radiation measurements and sampling of: ✓ air ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

19	39°40’996	63°24’690	173	Next to the artesian well	Background radiation measurements and sampling of: ✓ air ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis ✓ soil for determination of its radionuclide content
20	39°44’783	63°21’725	173	Next to well No. 3 (Western Hodgi)	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
21	39°46’918	63°14’700	175	Next to well No. 9 (Western Hodgi)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
22	39°47’211	63°11’238	181	Next to the bridge over the collecting channel	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
23	39°47’823	63°02’306	174	Next to well No. 1 (Akuum)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content

Table 6.2 continued

1	2	3	4	5	6
24	39°51’530	63°03’384	178	Artesian well	Background radiation measurements and sampling of: ✓ air ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for phys-

					icochemical analysis; ✓ soil for microbiological analysis ✓ soil for determination of its radionuclide content
25	39°51’766	63°08’594	172	Next to well No. 3 (Parsankul)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
26	39°46’661	63°21’178	175	Next to well No. 1 (Hodgi)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
27	39°26’021	63°35’521	179	Collecting channel	Sampling of: ✓ air; ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ bottom sediments for microbiological analysis
28	39°23’848	63°41’284	177	Alat, well	Background radiation measurements and sampling of: ✓ air ✓ groundwater for physicochemical analysis; ✓ groundwater for microbiological analysis; ✓ soil for determination of its radionuclide content
29	39°47’365	62°59’043	178	Next to well No. 2 (Akuum)	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
30	39°47’914	62°59’978	170	Artesian well	Background radiation measurements and sampling of: ✓ drinking water for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

Table 6.2 continued

1	2	3	4	5	6
31	39°45’100	63°05’519	177	Next to well No. 14 (Akuum)	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
32	39°37’028	63°24’962	180	well No. 312	Sampling of:

				(Kandym)	✓ well's topsoil for physicochemical analysis
33	39°37'464	63°24'658	175	well No. 217 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
34	39°37'526	63°23'595	179	well No. 216 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
35	39°37'582	63°22'801	181	well No. 215 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
36	39°35'254	63°24'606	183	well No. 237 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
37	39°34'623	63°24'862	184	well No. 321 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
38	39°34'727	63°23'355	183	well No. 320 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
39	39°34'091	63°23'691	181	well No. 243 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
40	39°34'179	63°22'958	183	well No. 242 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
41	39°34'115	63°27'203	184	well No. 160 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
42	39°33'649	63°23'930	185	well No. 324 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
43	39°33'537	63°23'176	185	well No. 246 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
44	39°33'021	63°25'009	182	well No. 251 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
45	39°33'101	63°24'236	183	well No. 250 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
46	39°32'972	63°23'477	185	well No. 327 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
47	39°32'673	63°22'657	184	well No. 253 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
48	39°32'285	63°23'316	182	well No. 257 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis

Table 6.2 continued

1	2	3	4	5	6
49	39°32'280	63°22'967	183	well No. 256 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis
50	39°31'589	63°22'337	185	well No. 329 (Kandym)	Sampling of: ✓ well's topsoil for physicochemical analysis

Table 6.3 – **Locations of Sampling Stations and List of Operations Conducted as Part of Field Surveys (Kungrad Plot)**

pling Sta-tion	Coordinates	above the sea level	Sam-pling sta-tion's loca-tion	Operations carried out at the station

	northern latitude	east longitude			
2	3	4	5	6	7
1	43°07’733	58°43’469	46	Nest to Maily-bay village, Koskupir bridge	Sampling of: ✓ air; ✓ drinking water from the channel for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
2	43°10’641	58°44’597	47	Next to Erkin settlement	Sampling of: ✓ air; ✓ groundwater at the depth of 6 m for physicochemical analysis
3	43°14’958	58°43’906	49	Sudagi station	Background radiation measurements and sampling of: ✓ soil for determination of its radionuclide content
4	43°22’714	58°38’127	44	Southern lakeside of Sudochye	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ bottom sediments for microbiological analysis
5	43°22’009	58°37’795	44	Southern lakeside of Sudochye	Sampling of: ✓ air, ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ bottom sediments for microbiological analysis
6	43°16’253	58°37’013	48	Next to Saranchaaul settlement	Sampling of: ✓ air; ✓ groundwater at the depth of 3 m for physicochemical analysis; ✓ drinking water for physicochemical analysis

Table 6.3 continued

1	2	3	4	5	6
7	43°10’354	58°35’123	52	Outskirts of Raushan settlement	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
8	43°09’824	58°34’705	50	Outskirts of Raushan settlement	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content

9	43°10'070	58°59'205	52	Contracted Area's border	Sampling of: ✓ air; ✓ drinking water from the well for physico-chemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
10	43°09'801	58°34'238	50	Raushan settlement	Sampling of: ✓ groundwater at the depth of 8 m for physicochemical analysis; ✓ groundwater for microbiological analysis
11	43°12'298	59°07'861	40	Next to Aliaul settlement on the Amu-darya's bank	Sampling of: ✓ air; ✓ groundwater at the depth of 9 m for physicochemical analysis; ✓ drinking water for physicochemical analysis; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis
12	43°11'625	59°01'335	57	Next to Arka Kungrad well	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
13	43°15'182	59°03'308	59	Between Akbashly and M1 bridges	Background radiation measurements and sampling of: ✓ air; ✓ drinking water from the well for physico-chemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
14	43°26'554	58°59'691	65	Next to the bridge over the Karazhar channel	Background radiation measurements and sampling of: ✓ soil for determination of its radionuclide content
15	43°27'824	58°59'422	56	Takhtakair stratigraphic well	Sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis

Table 6.3 continued

1	2	3	4	5	6
16	43°29'402	59°01'424	54	Water well next to the farm	Sampling of: ✓ air; ✓ groundwater at the depth of 18 m for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
17	43°29'952	59°01'988	51	next to well Shege 1	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide

					content
18	43°31’000	59°02’811	54	next to well Shege 2	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
19	43°36’298	58°59’824	58	Bridge over the Tikuzek channel	Sampling of: ✓ air; ✓ drinking water for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
20	43°34’422	59°05’489	54	Kyzylzhar settlement on the Kypcharkarya’s bank and on the lakeside of Shegekul	Background radiation measurements and sampling of: ✓ air; ✓ groundwater at the depth of 8 m for physicochemical analysis; ✓ drinking water from the river for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
21	43°33’837	59°09’000	49	Shege settlement, the Kypcharkarya’s bank	Sampling of: ✓ air; ✓ groundwater at the depth of 8 m for physicochemical analysis; ✓ drinking water from the river for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
22	43°36’033	59°06’949	44	Muikanaksk fishery’s area	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis

Table 6.3 continued

1	2	3	4	5	6
23	43°34’067	58°55’587	52	Next to Ustyurtgeofisika base	Background radiation measurements and sampling of: ✓ air; ✓ groundwater at the depth of 9 m for physicochemical analysis; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
24	43°32’675	58°47’890	44	Western out-	Background radiation measurements and sampling of:

				skirts of Kazhar village	✓ air; ✓ groundwater at the depth of 9 m for physicochemical analysis; ✓ drinking water from the water well for physicochemical analysis; ✓ drinking water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
25	43°35’988	58°42’917	39	Contracted Area’s border	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
26	43°34’658	58°45’411	35	5-6 km westward of Kazhar settlement	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil at the depth of 0.3 and 6 m for determination of its radionuclide content
27	43°13’260	58°31’284	51	Next to Raushan well	Sampling of: ✓ soil at the depth of 0.3 m for physicochemical analysis
28	43°06’117	58°28’945	99	Ust-Yurt plateau	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
29	43°09’257	58°26’695	47	Raushan – Soda Plant road	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content

Table 6.3 continued

1	2	3	4	5	6
30	43°09’819	58°32’064	50	Raushan – Soda Plant road	Sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
31	43°12’916	58°31’761	51	Next to Raushan well	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content

32	43°14’130	58°27’607	48	Contracted Area’s border	Sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis
33	43°16’931	58°26’884	53	Contracted Area’s border	Sampling of: ✓ air; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis
34	43°31’457	58°22’554	118	Ust-Yurt plateau	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil at the depth of 0.3 and 6 m for determination of its radionuclide content
35	43°34’407	58°30’098	144	Ust-Yurt plateau	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
36	43°07’709	59°05’515	60	Southern part of Kyzylzhar upland	Sampling of: ✓ soil at the depth of 0.3 m for physicochemical analysis; ✓ soil for microbiological analysis
37	43°06’110	59°09’785	38	Floodplain of the Armudarya, ferry crossing	Sampling of: ✓ water from the river for physicochemical analysis; ✓ drinking water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis

Table 6.3 continued

1	2	3	4	5	6
38	43°05’919	59°10’123	43	Floodplain of the Armudarya, ferry crossing	Background radiation measurements and sampling of: ✓ air; ✓ groundwater at the depth of 6 m for physicochemical analysis; ✓ water for microbiological analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
39	43°09’503	59°14’846	45	Contracted Area’s border	Background radiation measurements and sampling of: ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide

					content
40	43°15’426	59°09’829	41	Northward of Aspantai settlement	Background radiation measurements and sampling of: ✓ air; ✓ soil at the depth of 0.3, 1 and 6 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
41	43°22’015	59°08’489	45	Water well	Background radiation measurements and sampling of: ✓ air; ✓ groundwater at the depth of 5.5 m for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for determination of its radionuclide content
42	43°29’009	58°51’549	42		Background radiation measurements and sampling of: ✓ soil at the depth of 0.1 and 3 m for determination of its radionuclide content
43	43°17’502	58°57’159	51	Southern outskirts of Dustlik settlement	Background radiation measurements and sampling of: ✓ air; ✓ drinking water from the water well for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis; ✓ soil for microbiological analysis; ✓ soil for determination of its radionuclide content
44	43°14’110	58°57’026	51	Water well in the shepherds’ summer encampment	Sampling of: ✓ groundwater at the depth of 8 m for physicochemical analysis; ✓ soil at the depth of 0.3 and 1 m for physicochemical analysis

Table 6.3 continued

1	2	3	4	5	6
45	43°23’420	58°28’606	44	Southern lakeside of Sudochye	Sampling of: ✓ air; ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
46	43°31’215	58°22’714	44	Northern lakeside of Sudochye	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis;

					✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
47	43°33’810	58°29’913	44	Northern lake-side of Sudo-chye	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
48	43°34’523	58°43’030	44	Lakeside of Sudochye	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis
49	43°22’858	58°29’093	44	Main left col-lecting channel	Sampling of: ✓ water for physicochemical analysis; ✓ bottom sediments for physicochemical analysis; ✓ water for microbiological analysis; ✓ bottom sediments for microbiological analysis

Another additional expedition organized in 2004 focused on capturing the coordinates of wells previously drilled in the plots, as well as recording their condition, and that of the environment. Soil samples were taken immediately in the wellhead areas to be used in laboratory analyses to determine the content of pollutants that could form in the course of hole drilling and accumulate in the soil.

Table 6.4 and Figures 6.4 and 6.5 show the coordinates of the wells and their location in the Khauzak-Shady and Kandym Fields Group plots (for smaller scaled drawings thereof please refer to Fig. 6.4 «A» and 6.4 «B» – location of wells in Khauzak and Shady fields; Fig. 6.5 «A» and 6.5 «B» – location of wells in Kandym and Akkum, Parsankul and Hodgi fields).

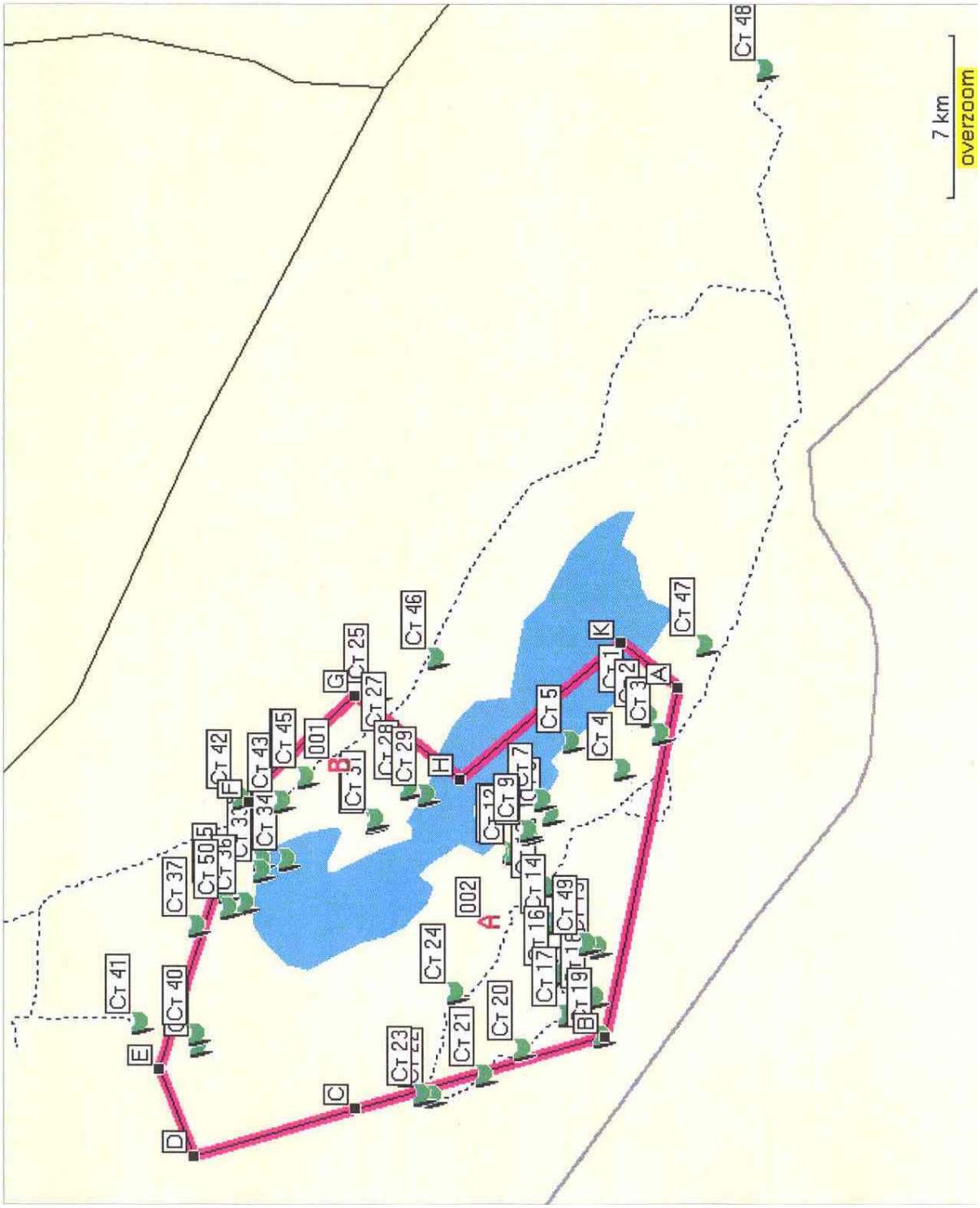


Figure 6.1 – **Location of sampling stations in the Khauzak- Shady plot**

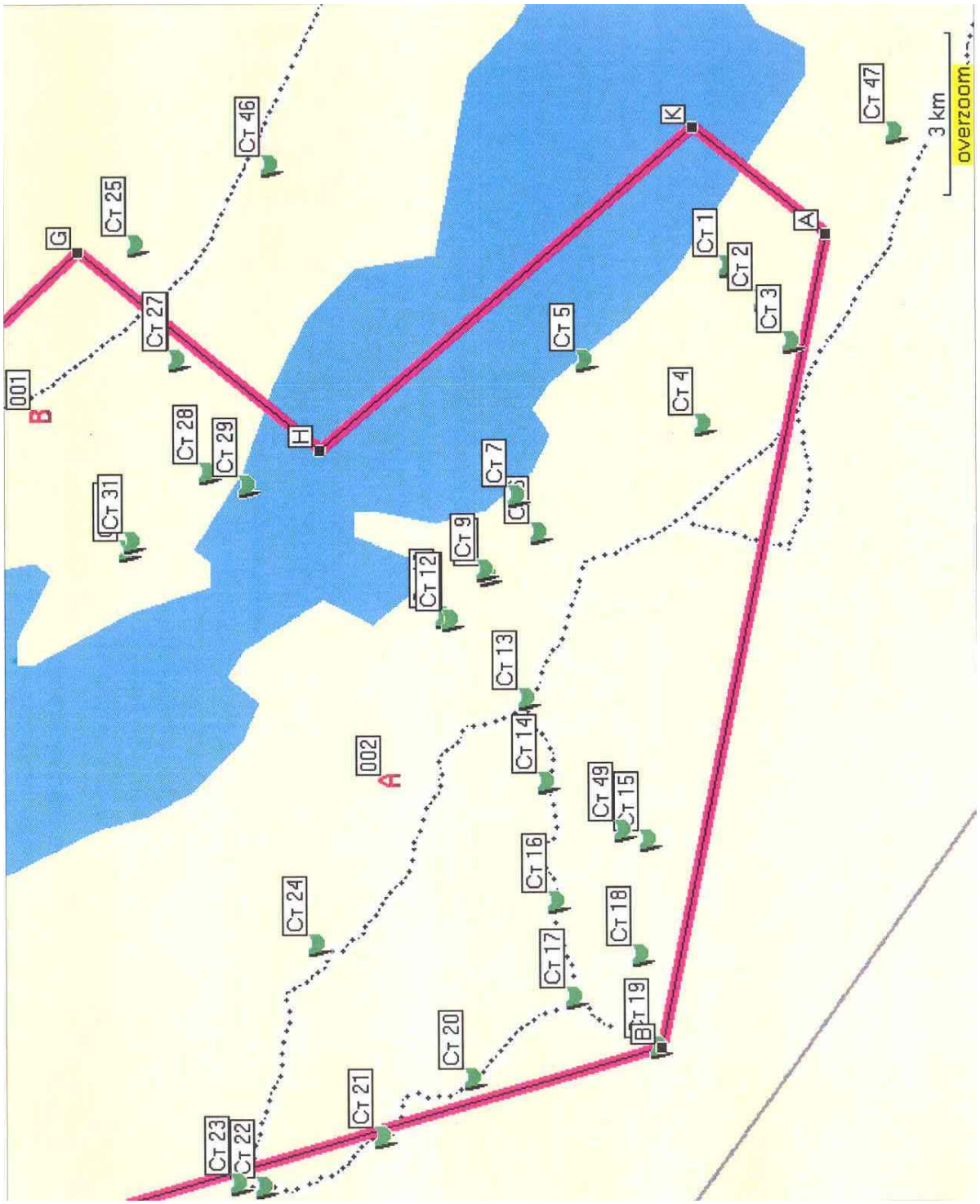


Figure 6.1 "A" – **Location of sampling stations in the Khauzak- Shady plot (southern part of the Contracted Area)**

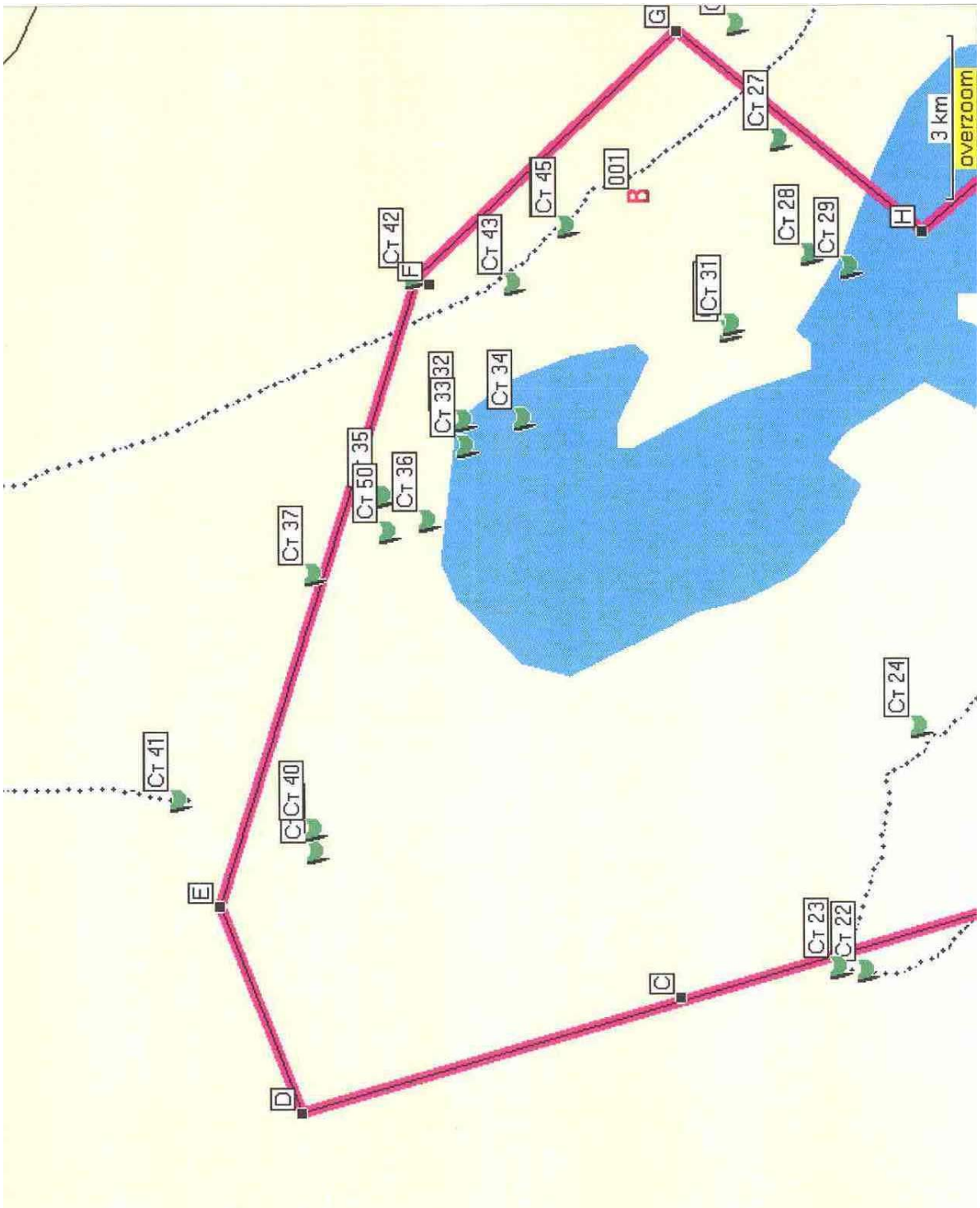


Figure 6.1 "B" – **Location of sampling stations in the Khauzak- Shady plot (north-eastern part of the Contracted Area)**

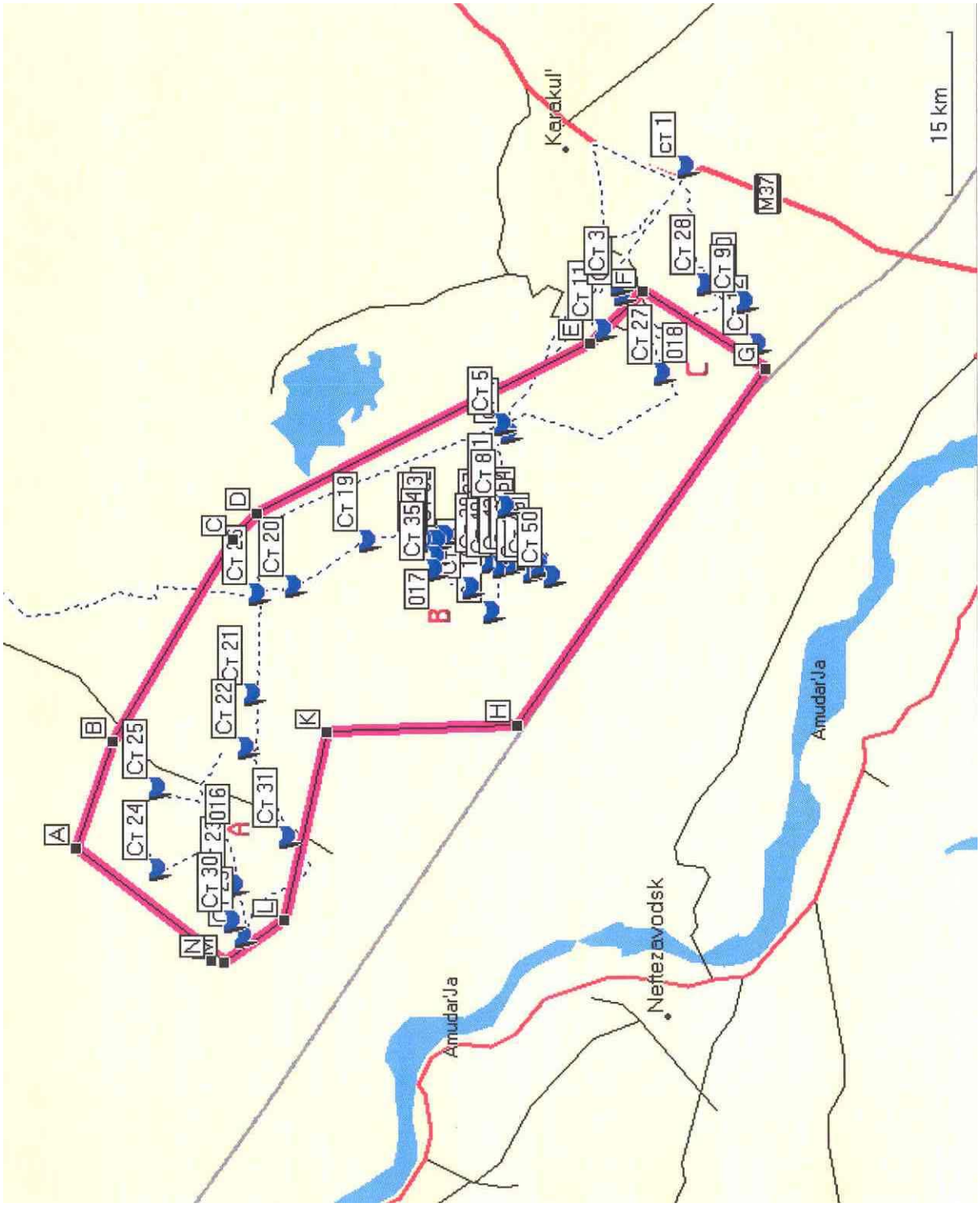


Figure 6.2 – **Location of sampling stations in the Kandym Group plot**

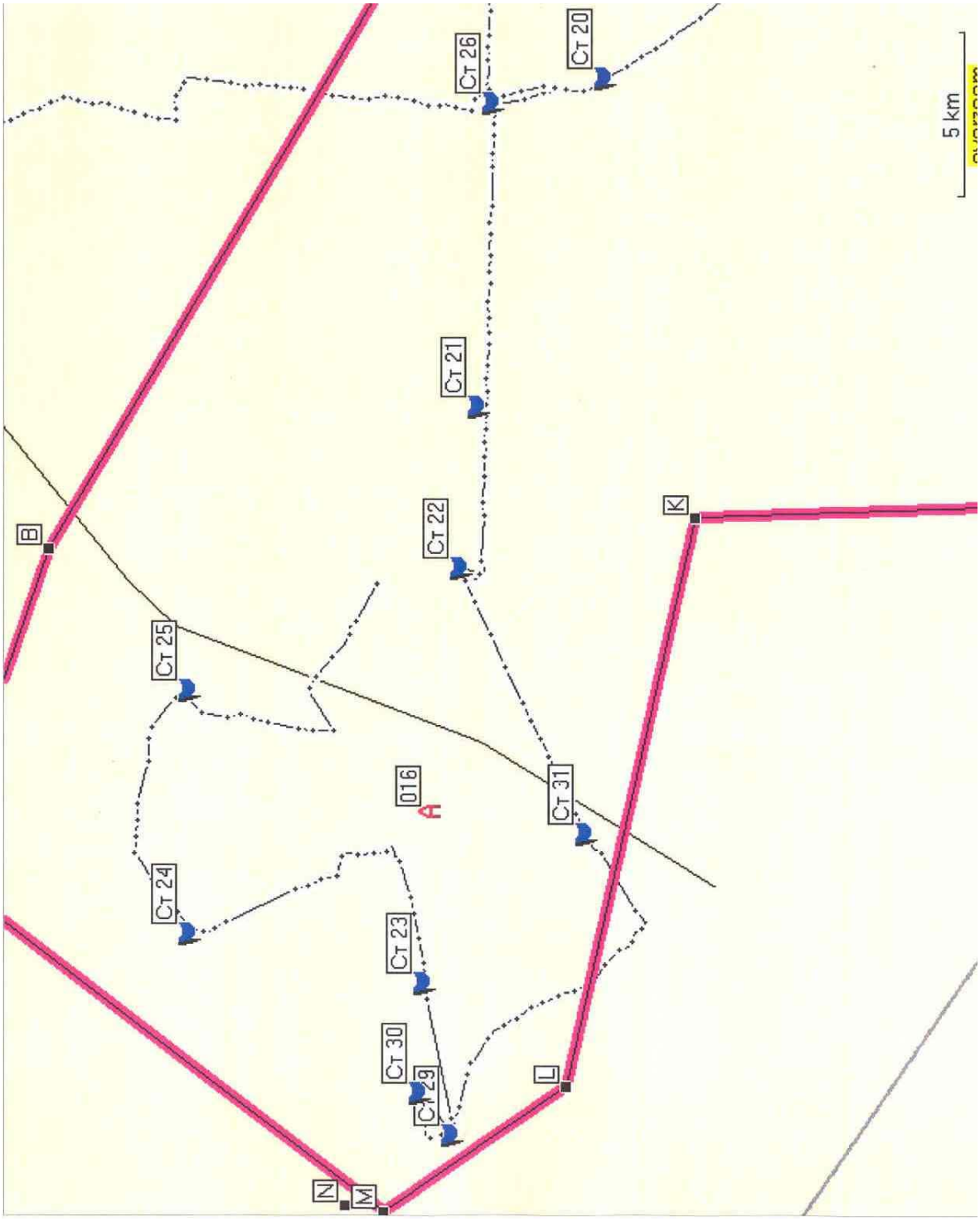


Figure 6.2 "A" – **Location of sampling stations in the Kandym Group plot (north-eastern part of the Contracted Area)**

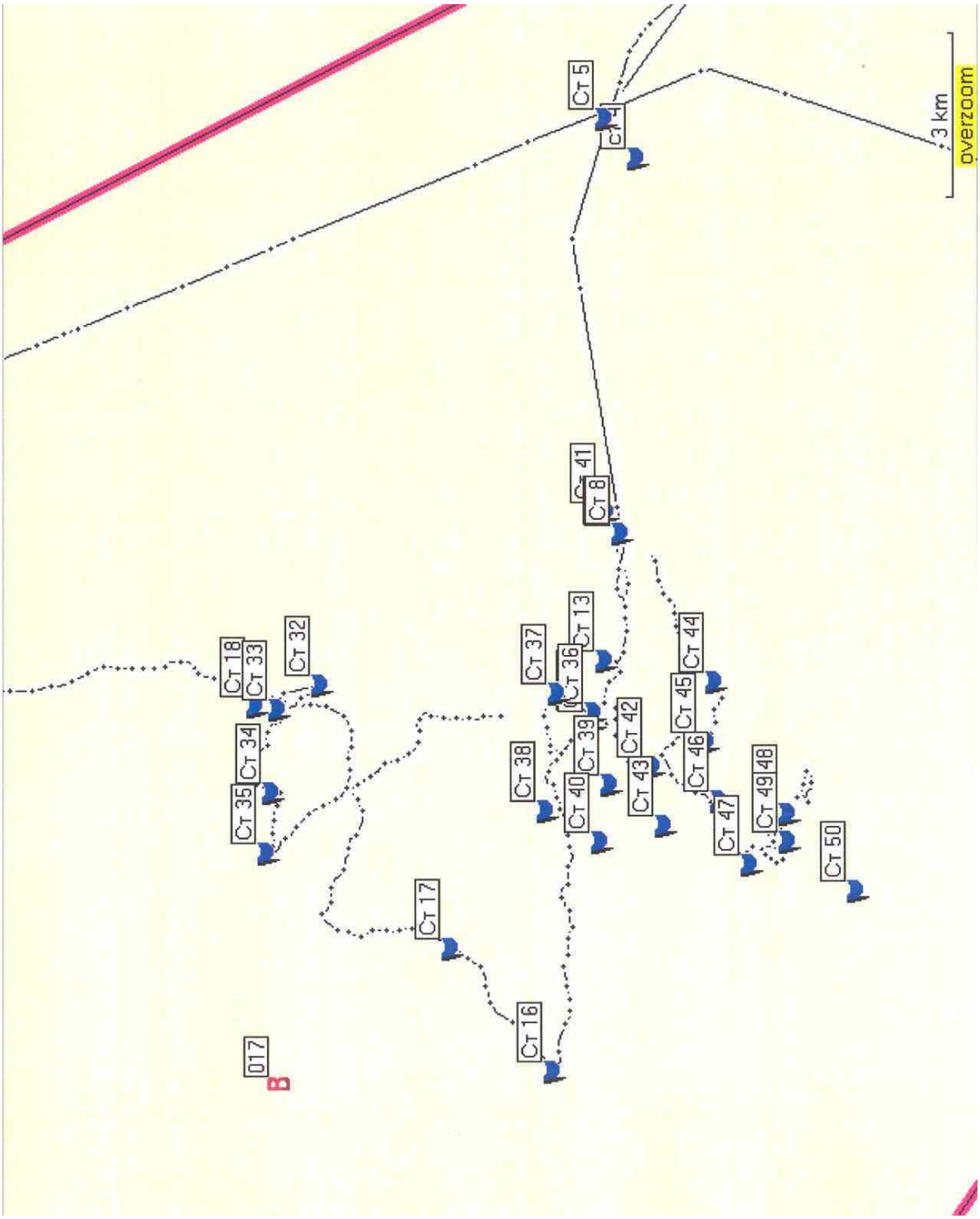


Figure 6.2 "B" – **Location of sampling stations in the Kandym Group plot (central part of the Contracted Area)**

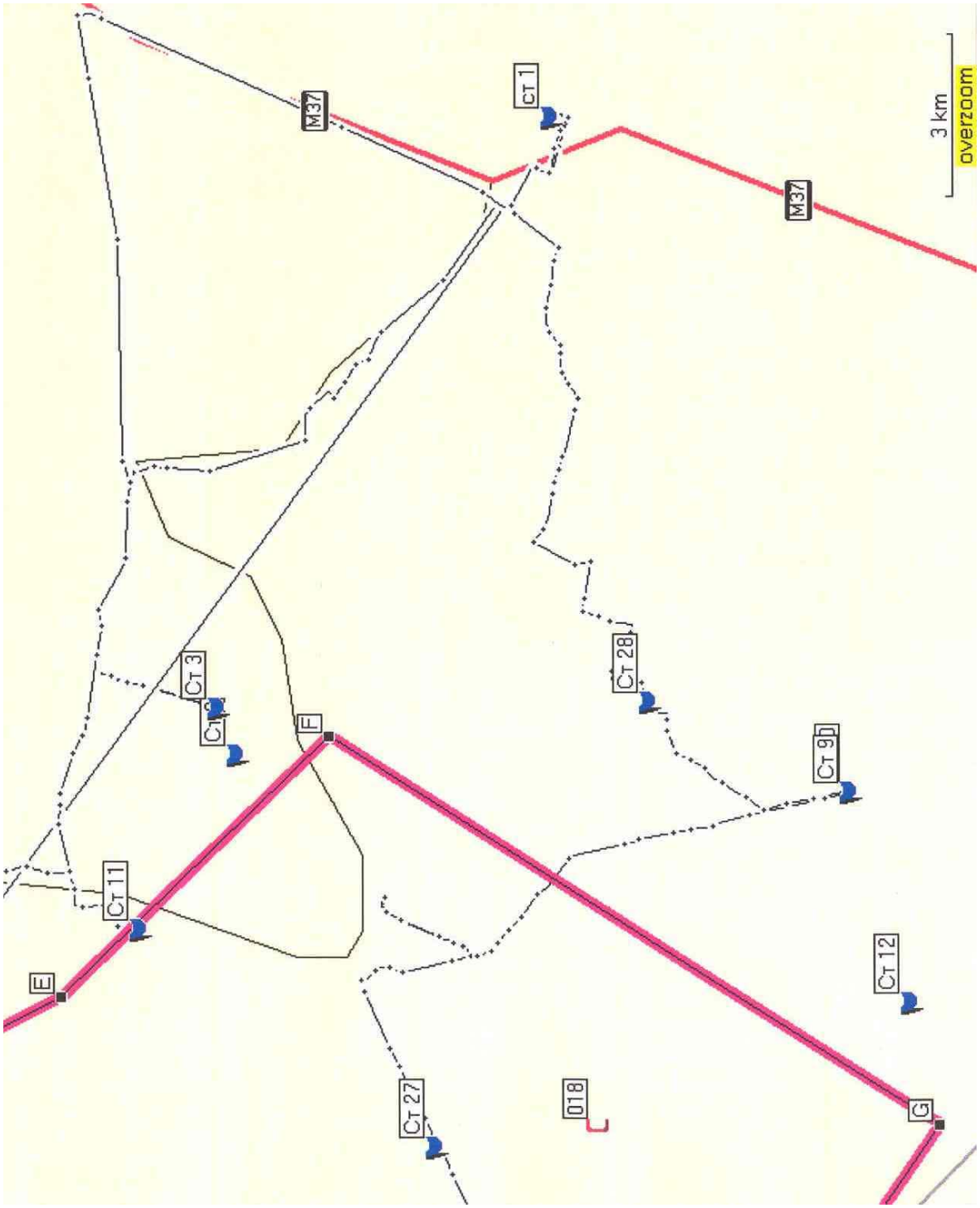


Figure 6.2 "B" – **Location of sampling stations in the Kandym Group plot (south -western part of the Contracted Area)**

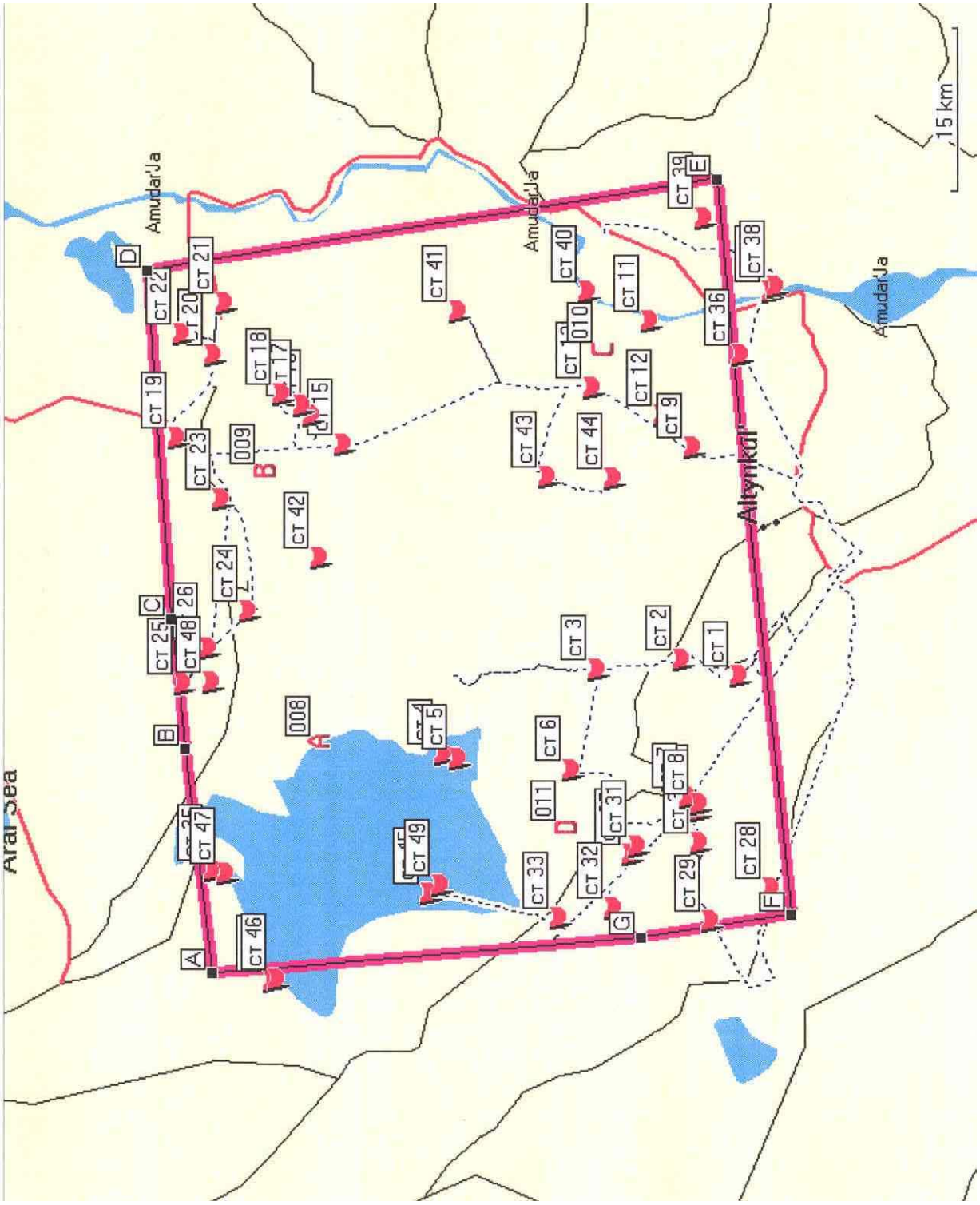


Figure 6.3 – **Location of sampling stations in the Kungrad plot**

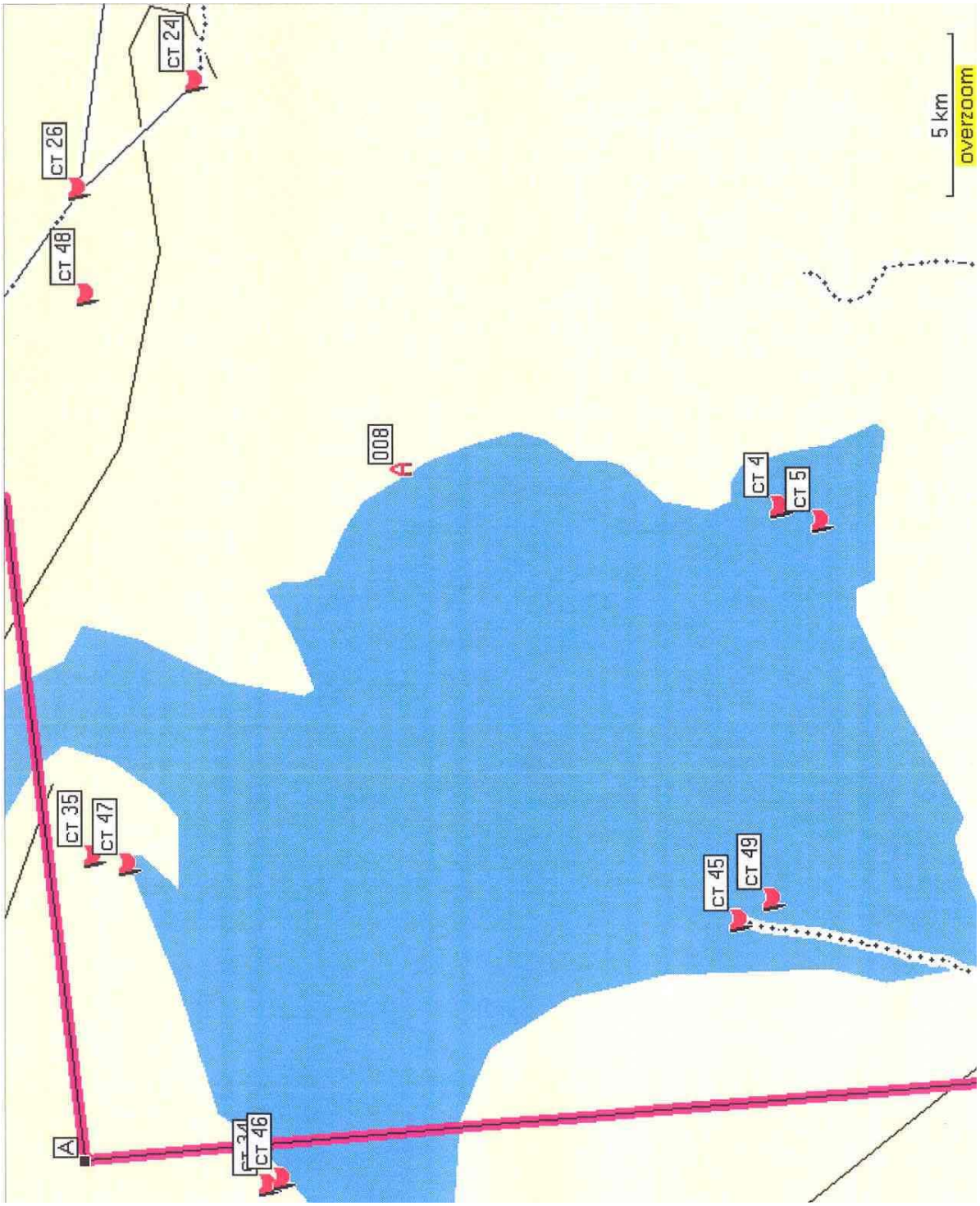


Figure 6.3 "A" – **Location of sampling stations in the Kungrad plot (north-western part of the Contracted Area)**

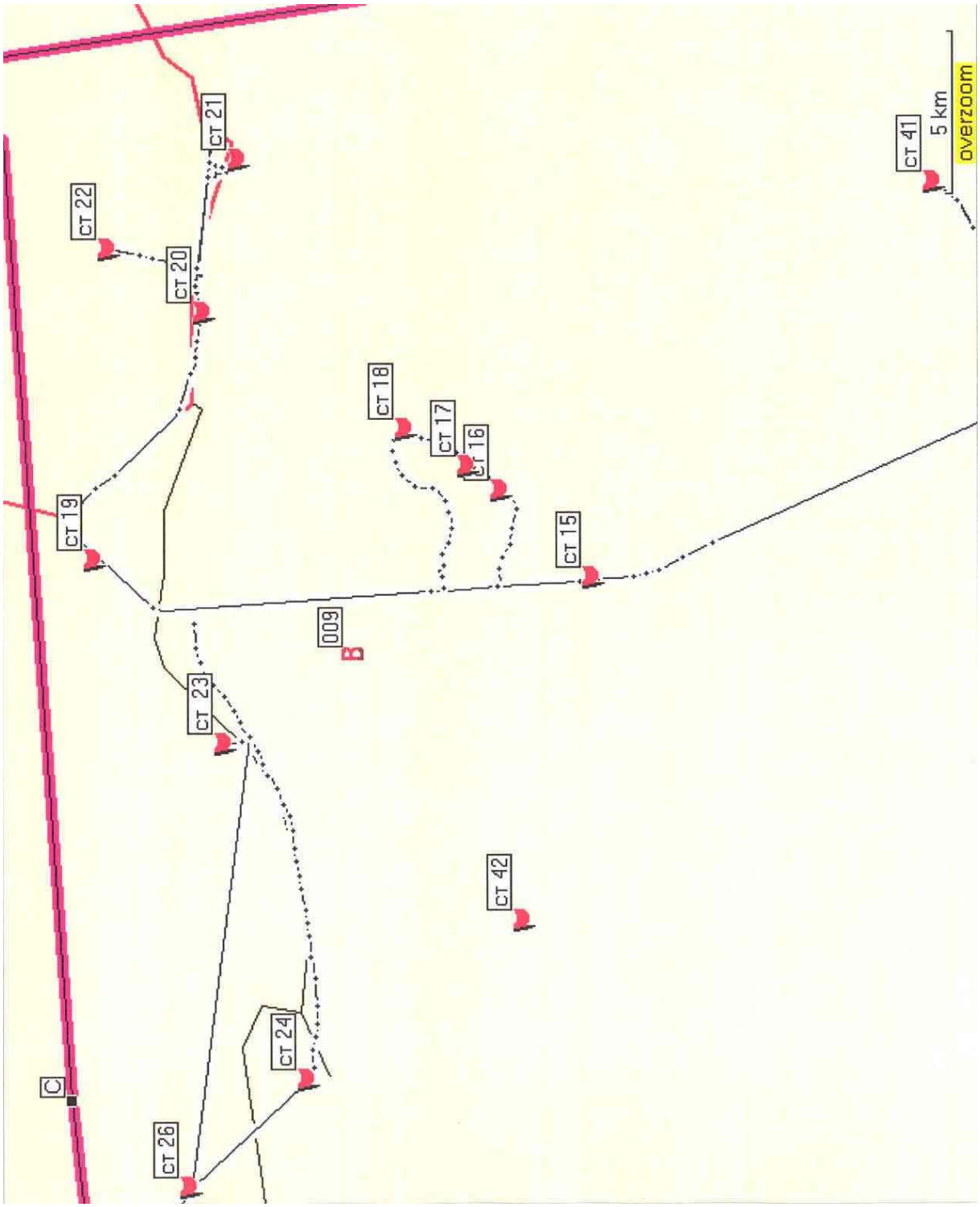


Figure 6.3 "B" – **Location of sampling stations in the Kungrad plot (north-eastern part of the Contracted Area)**

Figure 6.3 "C" – **Location of sampling stations in the Kungrad plot (south -eastern part of the Contracted Area)**

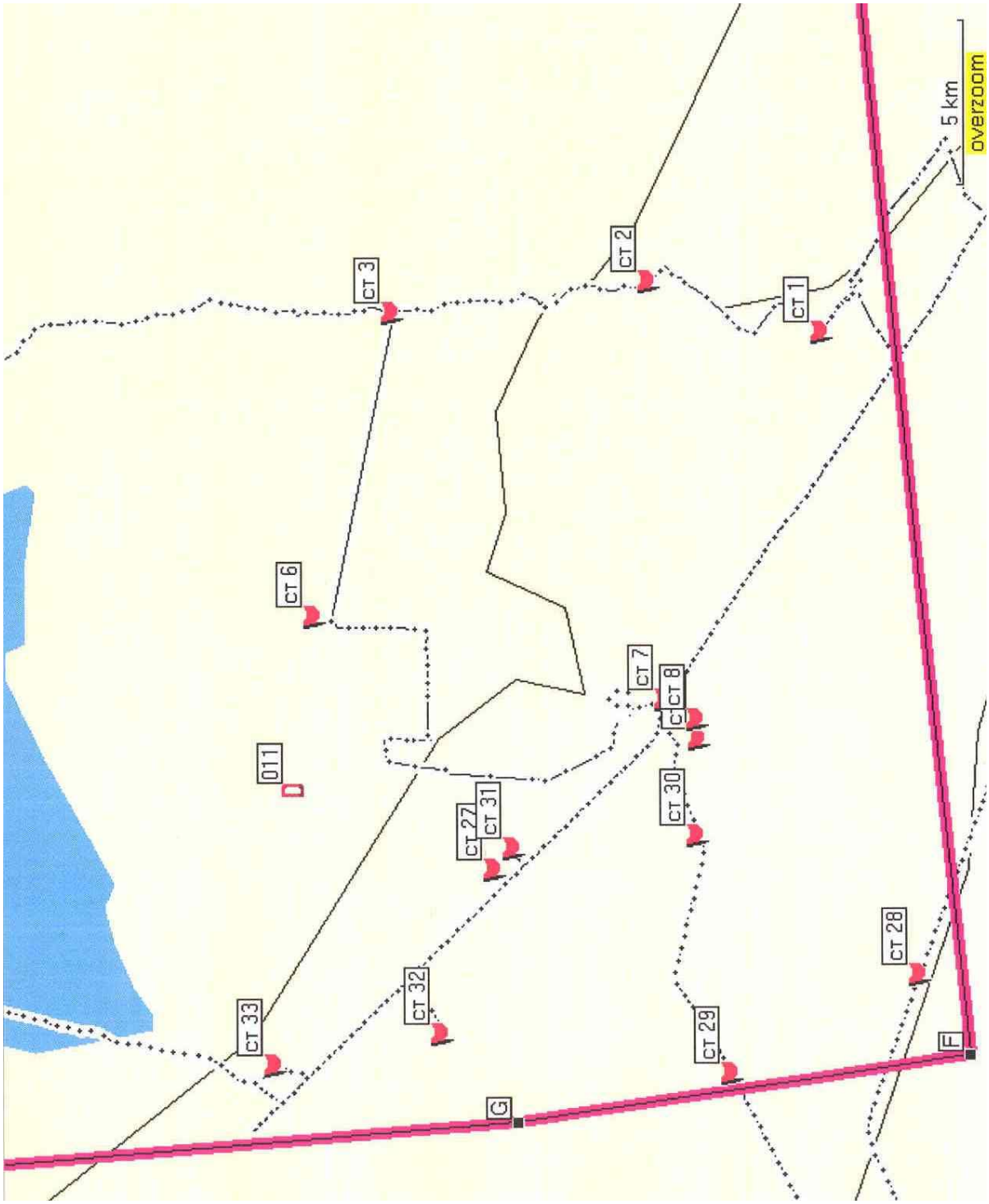


Figure 6.3 "D" – **Location of sampling stations in the Kungrad plot (south -western part of the Contracted Area)**

LEGEND TO FIGURES 6.1-6.3

– borders of the Contracted Areas

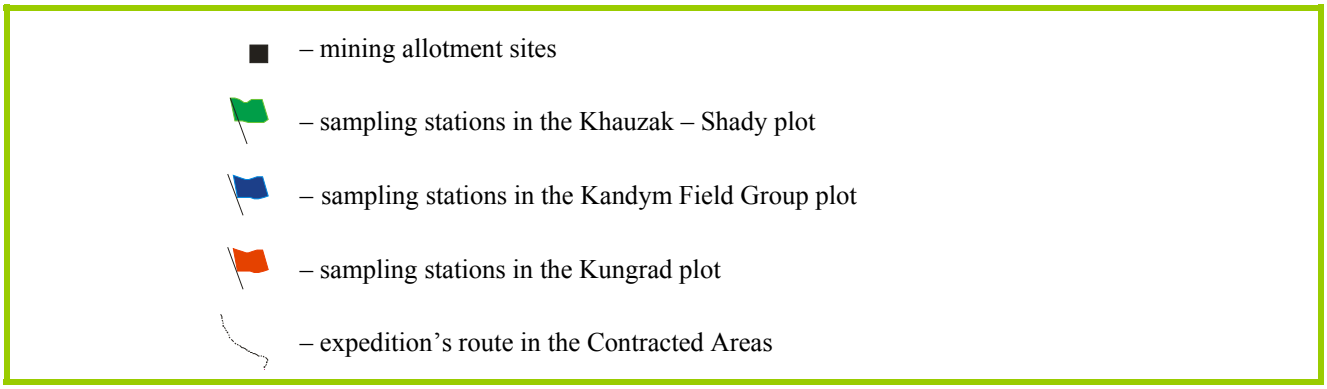


Table 6.4 – **Coordinates of Drilled and Suspended Gas Wells (Kandym and Khauzak Group Fields)**

№№	Well No.	Field	Coordinates	
			northern latitude	east longitude
1	2	3	4	5
1	**1**	Akkum	**39°47'783**	**63°02'242**
2	**2**	Akkum	39°47'297	62°59'159
3	**14**	Akkum	39°44'853	63°05'950
4	**3**	Western Hodgi	39°44'521	63°16'799
5	**9**	Western Hodgi	39°45'605	63°15'193
6	**3**	Parsankul	39°51'766	63°08'594
7	**1**	Hodgi	39°48'981	63°26'916
8	**7**	Kandym	39°33'498	63°16'336
9	**312**	Kandym	39°37'028	63°24'962
10	**217**	Kandym	39°37'464	63°24'658
11	**216**	Kandym	39°37'526	63°23'595
12	**215**	Kandym	39°37'582	63°22'801
13	**237**	Kandym	39°35'254	63°24'606
14	**321**	Kandym	39°34'623	63°24'862
15	**408**	Kandym	39°34'706	63°24'090
16	**320**	Kandym	39°34'727	63°23'355
17	**30**	Kandym	39°34'023	63°26'145
18	**243**	Kandym	39°34'091	63°23'691
19	**242**	Kandym	39°34'179	63°22'958
20	**160**	Kandym	39°34'115	63°27'203
21	**324**	Kandym	39°33'649	63°23'930
22	**246**	Kandym	39°33'537	63°23'176
23	**251**	Kandym	39°33'021	63°25'009
24	**250**	Kandym	39°33'101	63°24'236
25	**327**	Kandym	39°32'972	63°23'477
26	**253**	Kandym	39°32'673	63°22'657
27	**25**	Kandym	39°32'285	63°23'316

Продолжение табл.6.4

1	2	3	4	5

28	**256**	Kandym	39°32’280	63°22’967
29	**329**	Kandym	39°31’589	63°22’337
30	**8**	Khauzak	39°02’570	64°10’910
31	**4**	Khauzak	39°03’431	64°10’213
32	**3**	Khauzak	39°05’665	64°08’326
33	**242**	Khauzak	39°05’113	64°08’831
34	**301**	Khauzak	39°05’035	64°05’590
35	**302**	Khauzak	39°04’944	64°04’053
36	**14**	Khauzak	39°06’000	64°07’688
37	**16**	Khauzak	39°07’837	64°05’079
38	**7**	Shady	39°08’794	64°09’980
39	**4**	Shady	39°09’700	64°08’551
40	**2**	Shady	39°11’955	64°07’233
41	**1**	Shady	39°11’417	64°07’017
42	**6**	Shady	39°11’983	64°05’428
43	**8**	Shady	39°12’751	64°03’092

In the course of field surveys air samples were taken at 71 stations, including those located in the Khauzak – Shady plot – 22 stations, Kandym Field Group – 19 stations, Kungradsky plot – 30 points. Measurements of dust content and that of carbon monoxide in the air were conducted using Palladiy-MP-1-CO-100, a portable gas analyzer.

Air sampling for laboratory analysis was conducted in accordance with [12, 69] on the boundaries of the sanitary protection zones of settlements; along the contour of the Contracted Areas, and in the locations of operations previously conducted in the area, including hole drilling ones.

Surface water sampling points in the water bodies of the Contracted Areas were as applicable evenly dispersed given the availability of such water bodies. Sampling in surface water bodies took place in the areas of existing and abandoned wells, including flooded wells.

There is no centralized water supply system in the Contracted Areas, and the water isn’t chlorinated. Drinking water samples were taken from artesian wells, water conduits and water wells up to 8 m deep intended for drinking water consumption. Water samples were taken in accordance with the requirements set out in [93]. Sampling involved the use of Molchanov GR-18 barometer that can be run to 50 m and is capable of simultaneously measuring the temperature at the sampling point.

To make sure that the condition of individual components of water and their properties remain identical to their condition existing at the time of sampling, the samples were preserved in accordance with [45]. Measurements of pH and temperature were conducted at the sampling location. Given the fact that photosynthesis, respiration of aquatic organisms and decomposition of organic substances cause the carbon dioxide content to change, it was determined immediately after sampling of water, without any filtration and preservation.

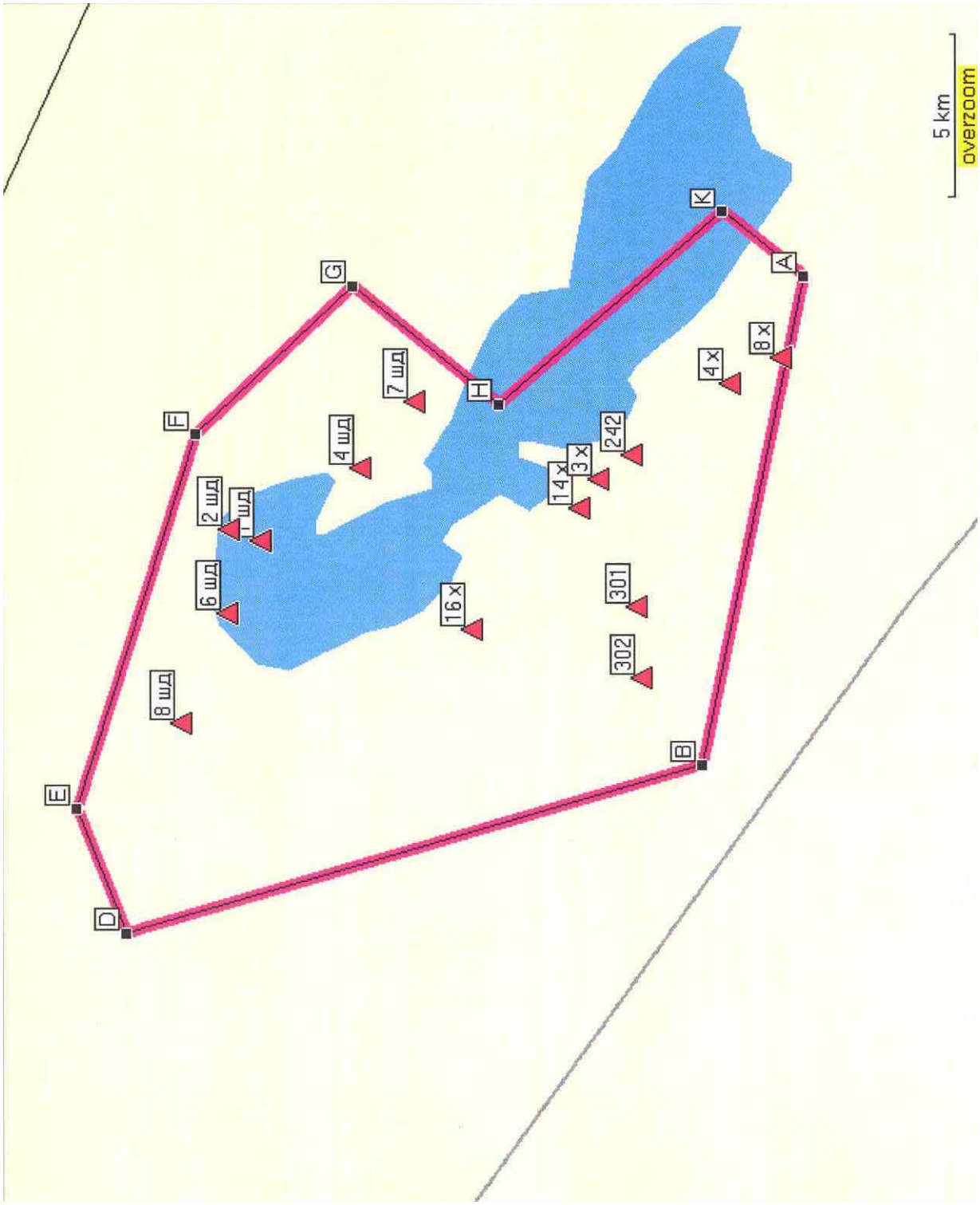


Figure 6.4 – **Location of wells in the Khauzak- Shady plot**

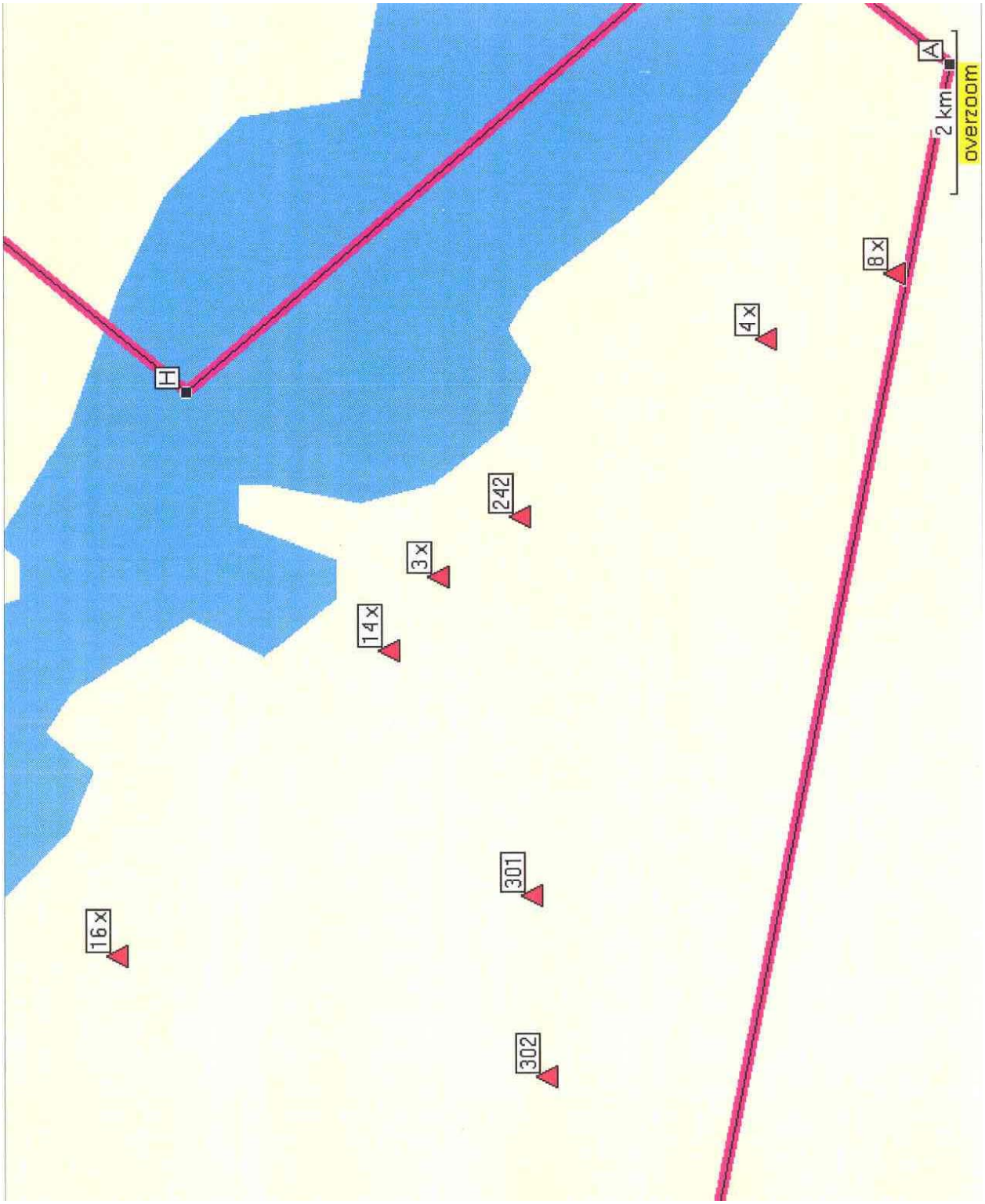


Figure 6.4 «A» – **Location of wells in Khauzak field**

Figure 6.4 «B» – **Location of wells in Shady field**

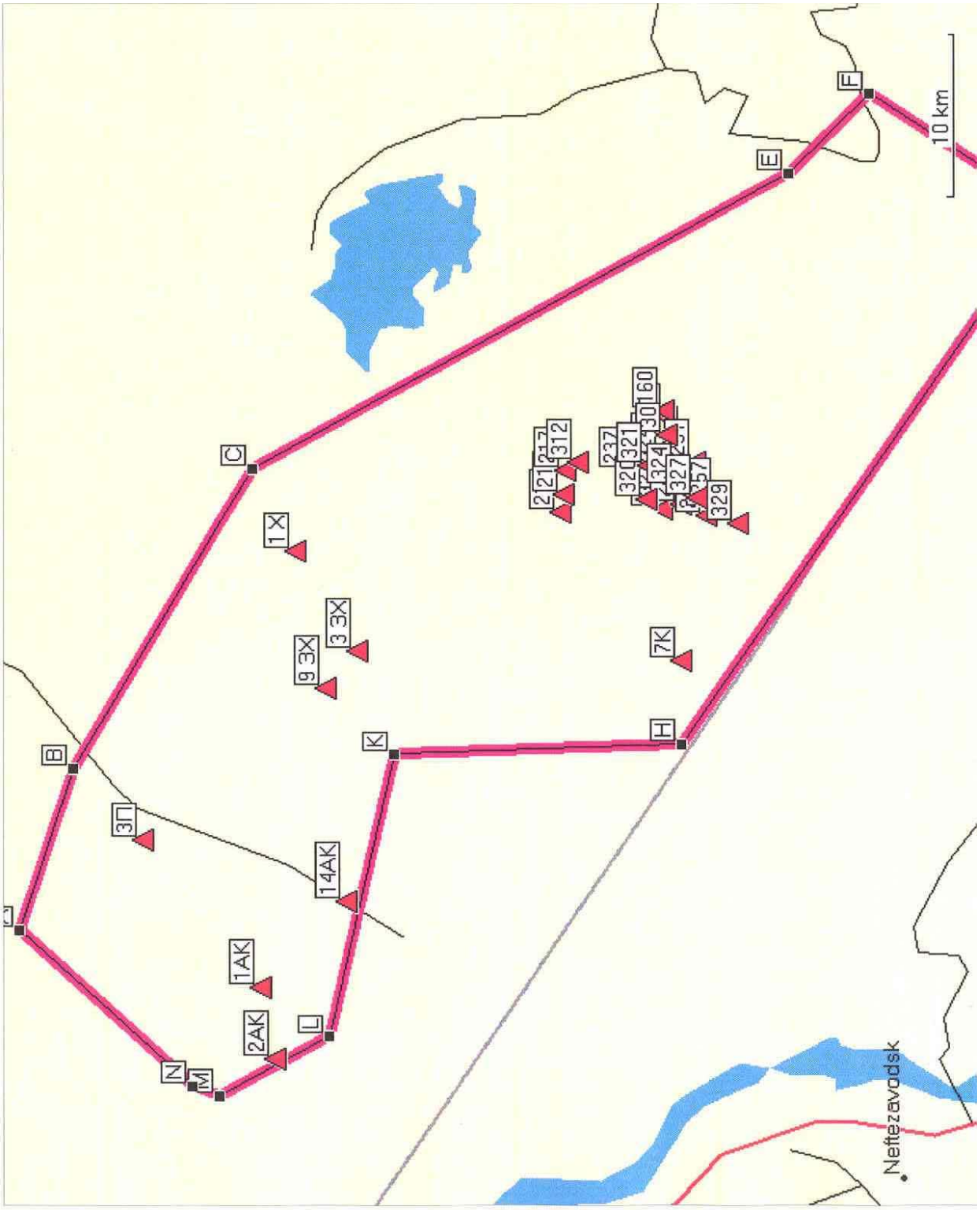


Figure 6.5 – **Location of wells in the Kandym Group plot**

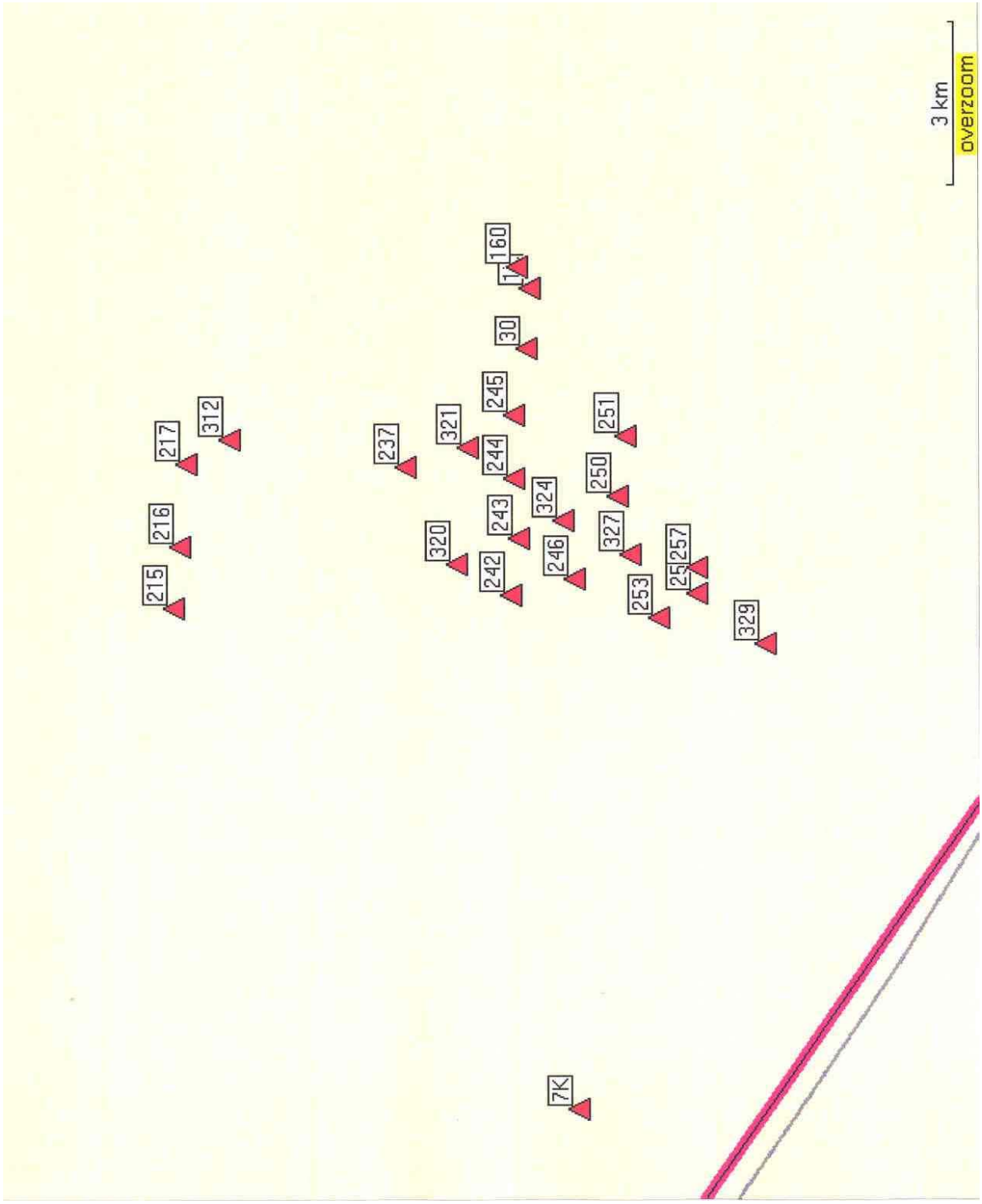


Figure 6.5 «A» – **Location of wells in Kandym field**

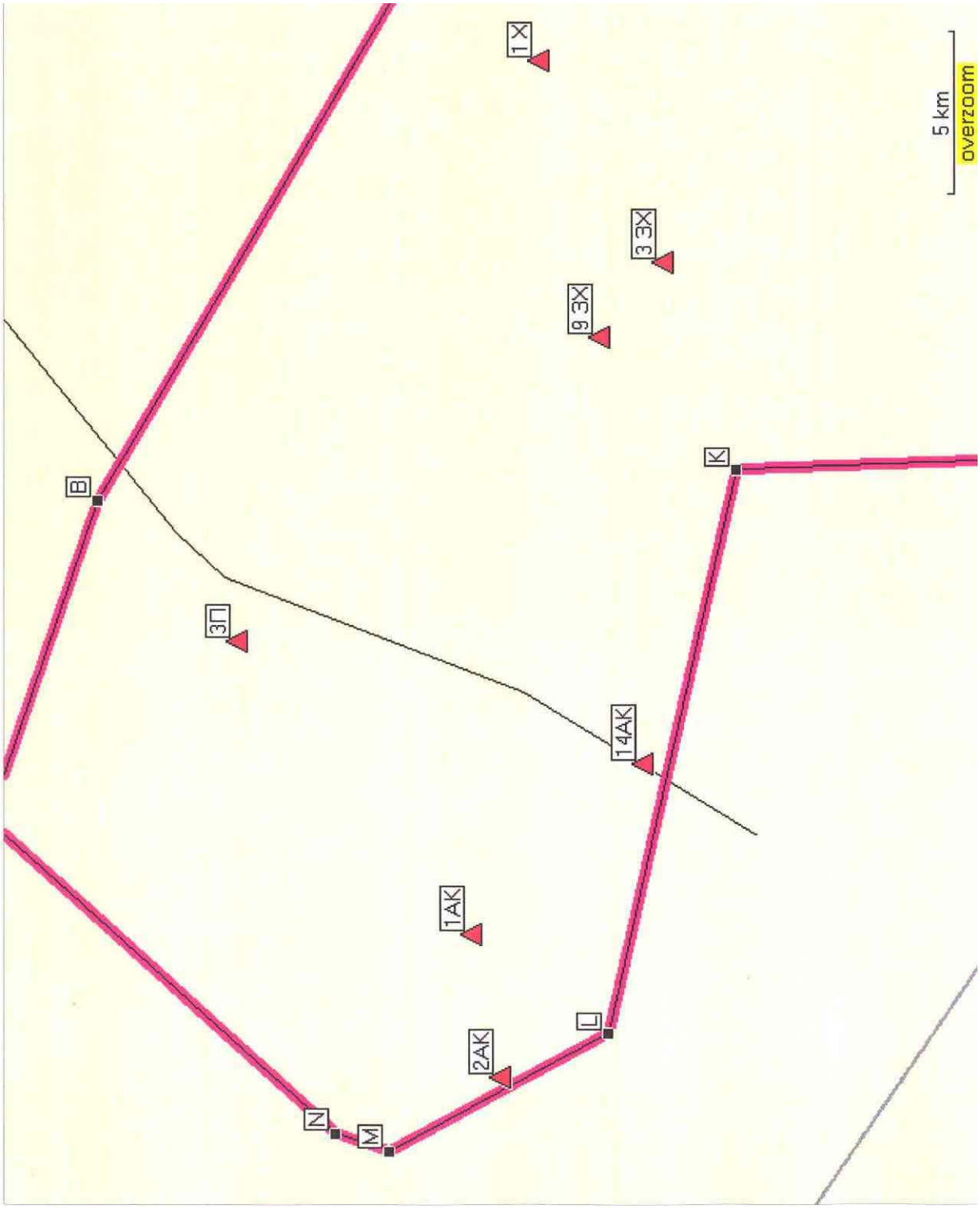


Figure 6.5 «B» – **Location of wells in Akkum, Parsankul, Hodgi and Western Hodgi**

LEGEND TO FIGURES 6.4-6.5 – gas wells previously drilled in the Contracted Areas

Given their dependency on oxidation-reduction process of water and available phytoplanktonic species, penetration of light, temperature, salinity, and water mixing, concentrations of dissolved oxygen, and nutrients (ammonium ions, nitrites and phosphates) need to be measured over short periods of time, therefore such measurements were conducted on the day of sampling at the expedition's camp.

The total number of soil (ground) samples taken at different depth levels i.e. 0.3, 1 and 6 m, at 21 stations in the Khauzak-Shady plot, 22 stations of the Kandym Field Group plot and 34 stations in the Kyngard plot (the overall number of stations is 77) following drilling of wells to the groundwater level using drilling equipment was 160. Samples were taken in accordance with the requirements set out in [41]. Samples of bottom sediments were taken from the bottom of surface water bodies and collecting channels using a specialized sampler unit.

Table 6.5 shows generalized data for all the field surveys performed during the expedition.

Table 6.5 – **Final List of Surveys Performed in the Course of Field Expeditions in the Contracted Areas**

No.	Operations	Total during field operations	including those in the Contracted Areas		
			Khauzak and Shady	Kandym Group	Kungard
1	2	3	4	5	6
1.	Air sampling	71	22	19	30
2.	Sampling of water from surface water bodies for physicochemical analysis	21	10	2	9
3.	Sampling of groundwater for physicochemical analysis	20	6	2	12
4.	Sampling of drinking water	24	6	7	11
5.	Sampling of soil (ground) at the depth of 0.3, 1 and 6 m for physicochemical analysis	160	43	44	73
6.	Sampling of soil in the immediate proximity to wellheads for physicochemical analysis	27	6	21	-

Table 6.5 continued

1	2	3	4	5	6
7.	Sampling of bottom sediments for physicochemical analysis	21	10	2	9
8.	Sampling of water, soil and bottom sediments for	91	32	25	34

	microbiological analysis				
9.	Sampling of soil (ground) to determine the content of radionuclides in it	65	20	20	25
10.	Total number of samples taken for various analyses	500	155	142	203
11.	Background radiation measurements (number of points)	64	22	20	22

As it was indicated above, field surveys involved the use of GPSMAP 76CS, a navigator used to measure the height of a specific point above the sea level while moving along the route and setting up sampling stations. Figures 6.6-6.8 show three-dimentional charts of the Contracted Areas drawn up as a result of computer processing of such measurements.

6.2. Meteorological Conditions Existing in the Contracted Areas at the Time of Field Surveys

Meteorological conditions in the Khauzak-Shady plot at the time of the field surveys. 4-hour (at each 3:00, 7:00, 11:00, 15:00, 19:00 and 23:00) daily field measurements of the atmospheric temperature and atmospheric pressure, as well as wind speed and direction were carried out during the field surveys in the Khauzak-Shady Plot. Figure 6.9 shows charts of the medium, maximum and minimum daily temperature differences observed in the areas of the field surveys in early November.

Figure 6.9 shows that the average daily temperature difference in the Khauzak - Shady Contracted Plot at the time of the field surveys was 11,1^{0}C which corresponds to the continental subtropic climate in which big amplitudes are inherent both in terms of annual and daily atmospheric temperatures. Its maximum was 14.8 ^{0}C (November 6, 2004) and the registered minimum was 7.0^{0}C (November 5, 2004).

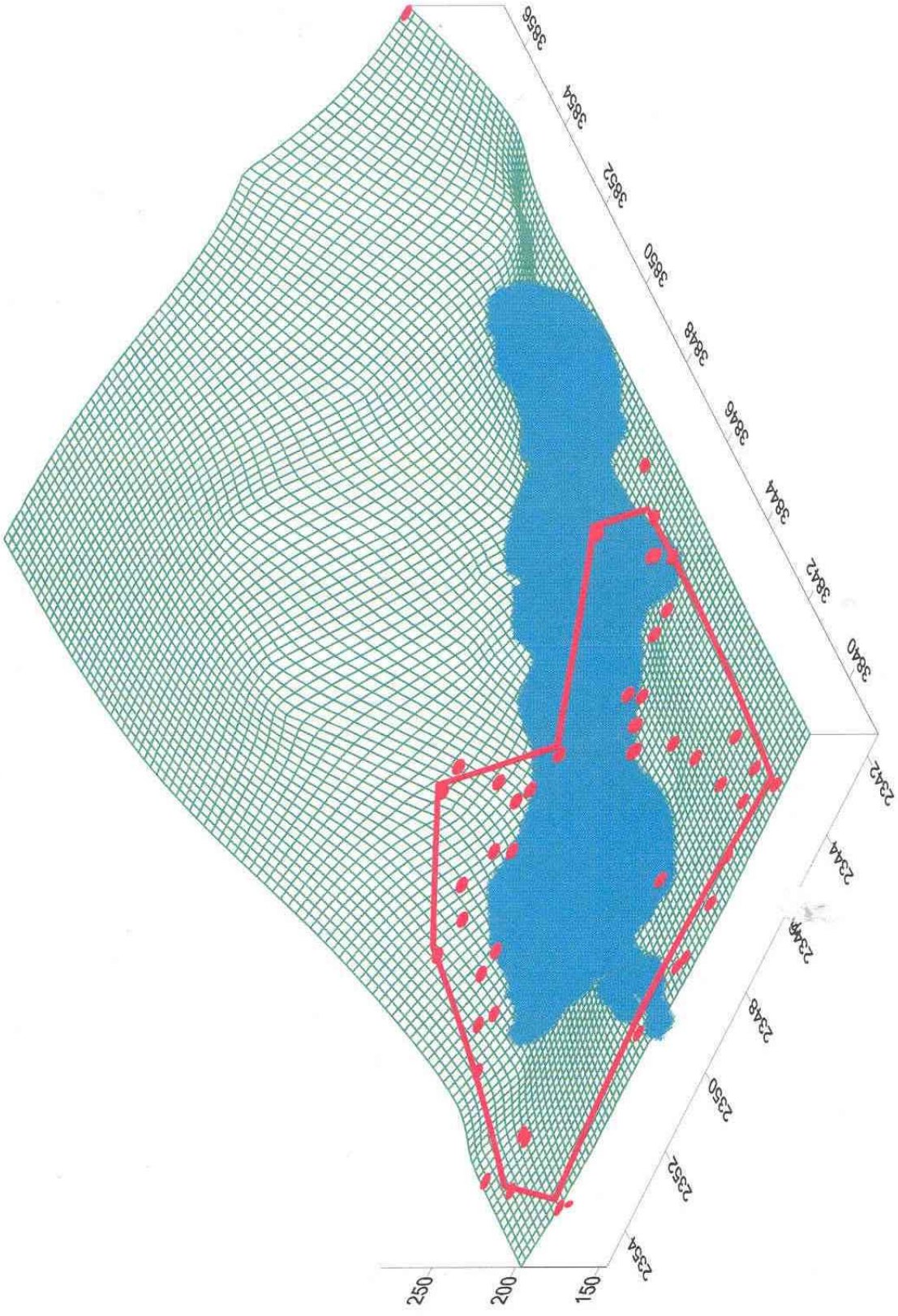


Figure 6.6 – **Three-dimensional chart of the Khauzak – Shady Contracted Area**

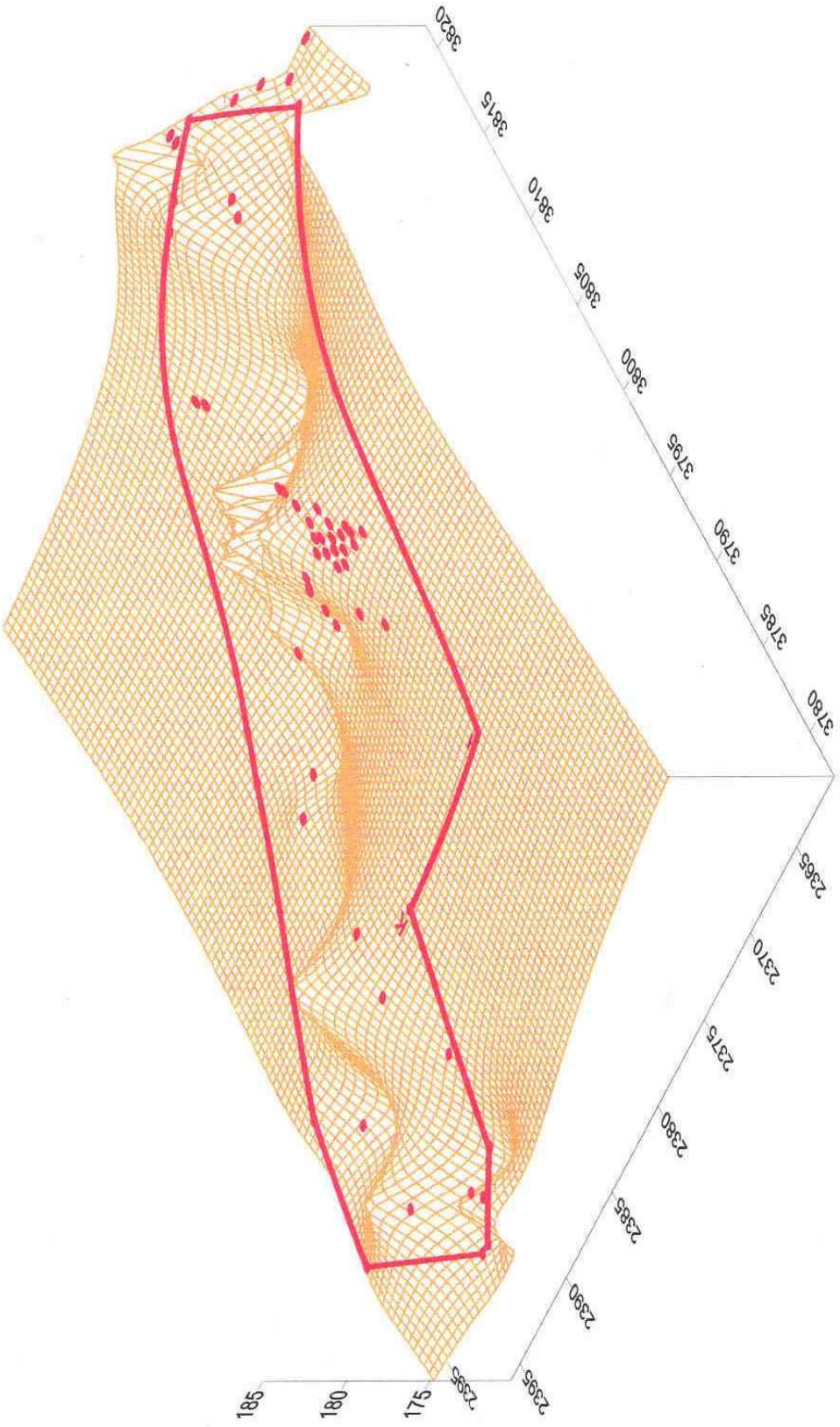


Figure 6.7 – **Three-dimensional chart of the Kandym Group Contracted Area**

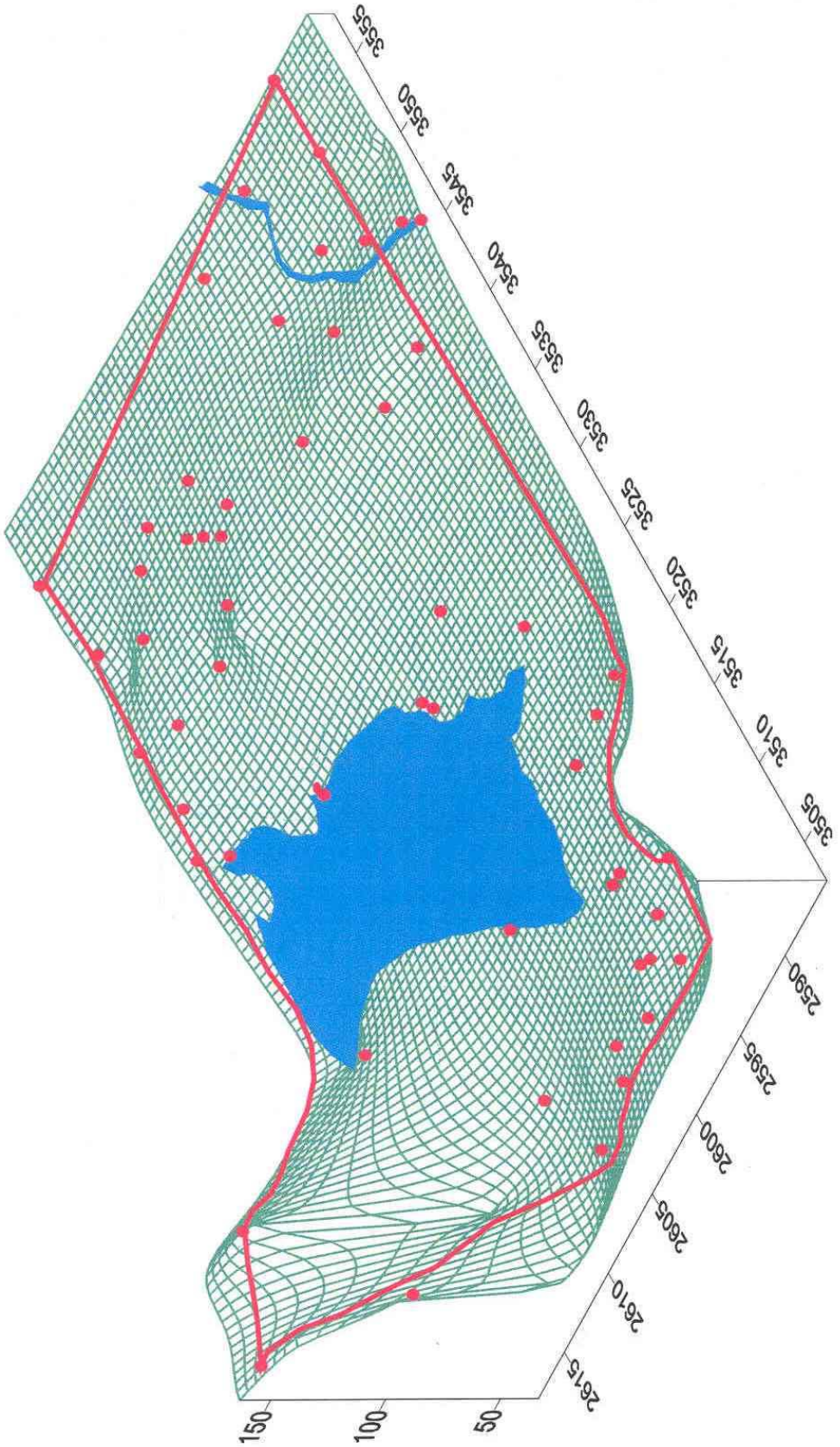


Figure 6.8 – **Three-dimensional chart of the Kungard Contracted Area**

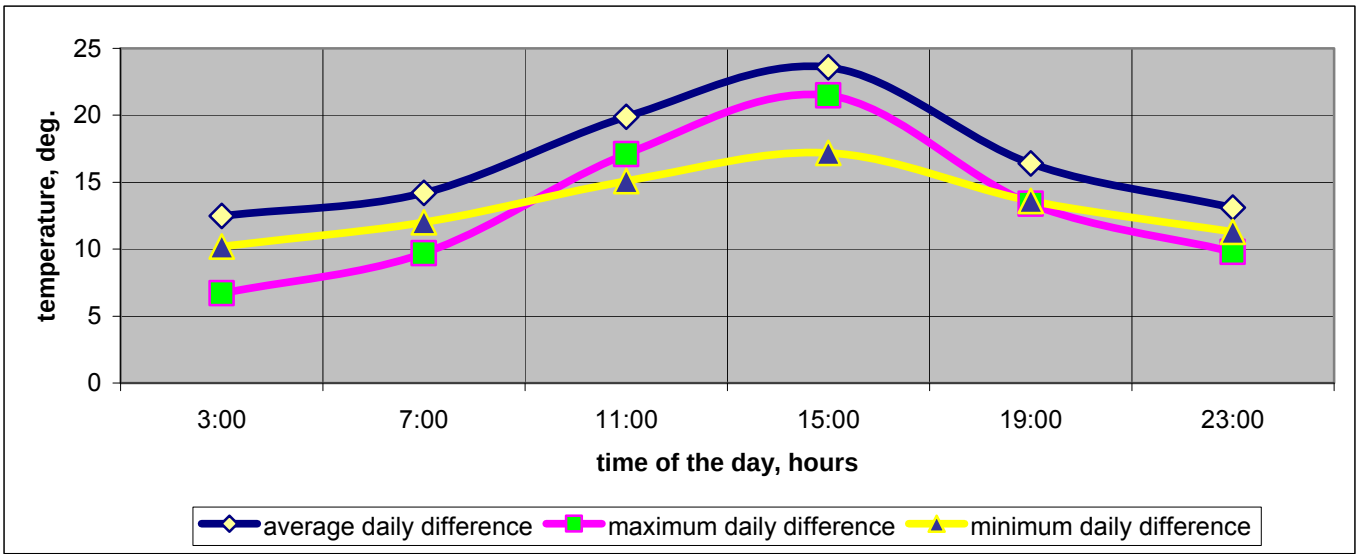


Figure 6.9 – **Daily atmospheric temperature differences in the Khauzak – Shady plot (field surveys data)**

The average atmospheric temperature over the period was +16.6^{0}C which corresponds to the average maximum temperatures for the same period registered at the Karakul weather station (see Fig. 3.4). The atmospheric pressure varied from 735 to 752 mm Hg. As a rule it was lower in the evening and reached its peak level during the day.

No strong winds were observed in the plot at the time of the field surveys. The wind speed stayed primarily within 2.5 – 3.7 m/sec. Figures 6.10 and 6.11 show the wind roses developed on the basis of measurements conducted during the period of the field surveys and average long-term weather observations at the Karakul weather station for November.

Despite the apparent dissimilarity of the foregoing figures, accounted for by a relatively short period of measurements, both cases reveal dominance of northern winds.

Meteorological conditions in the Kandym Field Group Plot at the time of the field surveys. 4-hour (at each 3:00, 7:00, 11:00, 15:00, 19:00 and 23:00) daily field measurements of the atmospheric temperature and atmospheric pressure, as well as wind speed and direction were carried out during the field surveys in the Kandym Field Group plot. Figure 6.35 shows charts of the medium, maximum and minimum daily temperature differences observed in the areas of the field surveys in early November.

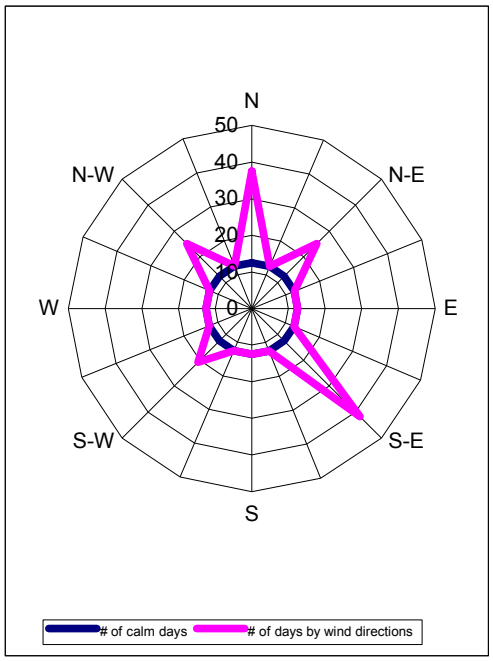


Figure 6.10 – **Wind rose of the Khauzak-Shady plot developed on the basis of field measurements**

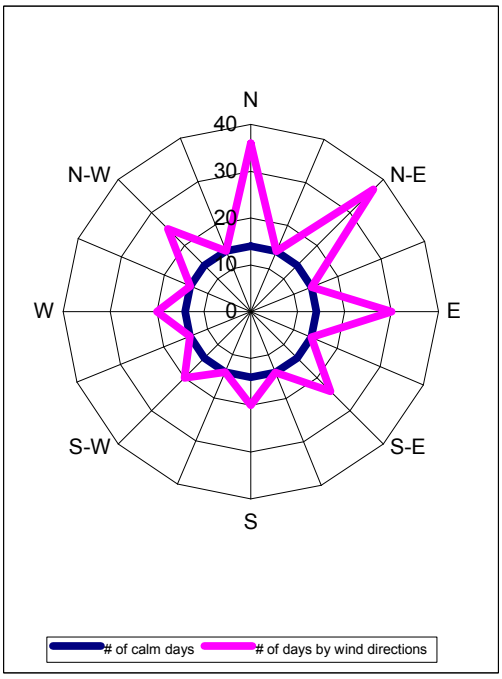


Figure 6.11 – **Wind rose developed on the basis of observations at the Karakul weather station for November**

Figure 6.12 reveals that the average daily temperature difference in the Kandym Field Group Contracted Plot at the time of the field surveys was 11,7^{0}C which corresponds to the continental subtropic climate in which big amplitudes are inherent both in terms of annual and daily ambient temperatures. Its maximum was 16.3 ^{0}C (November 9, 2004) and the registered minimum was 6.4^{0}C (November 7, 2004).

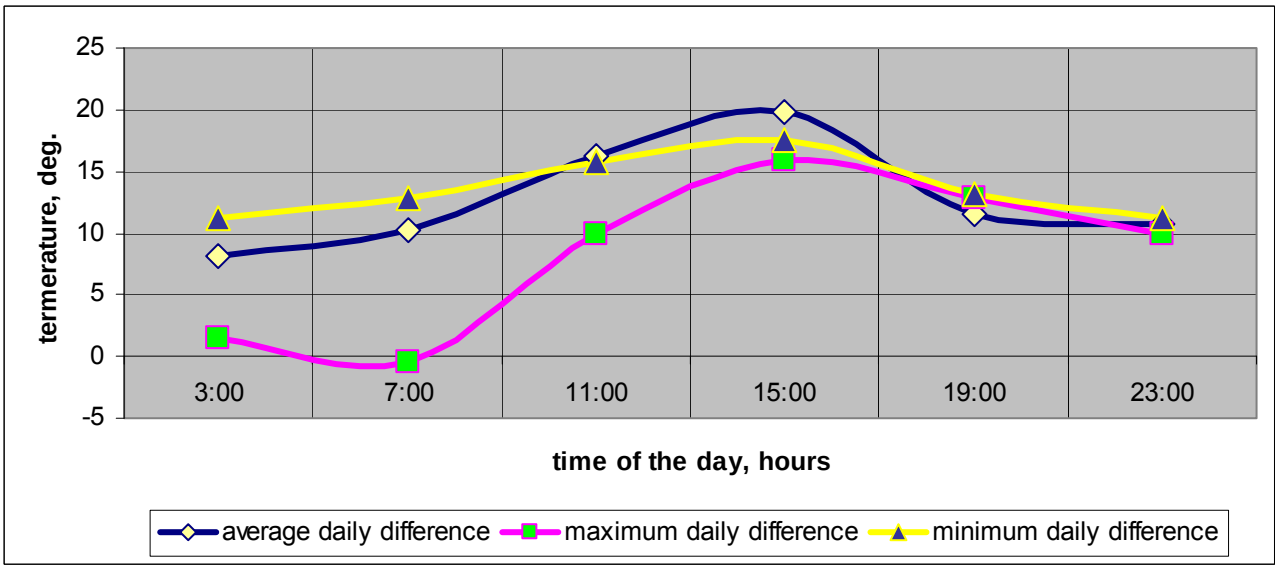


Figure 6.12 – **Daily ambient temperature differences in the Kandym Field Group plot (field surveys data)**

The average atmospheric temperature over the period was +12.8^{0}C which corresponds to the average temperatures for such period registered at the Karakul weather station (see Fig. 3.4). The atmospheric pressure varied from 736 to 752 mm Hg. As a rule it was lower in the evening and reached its peak level during the day.

No strong winds were observed in the plot at the time of the field surveys. The wind speed varied from 0.7 to 1.6 m/sec (less windy weather as compared to the Khauzak-Shady plot). Figures 6.13 and 6.14 show wind roses developed on the basis of measurements conducted during the field surveys period and average long-term weather observations at the Karakul weather station for November.

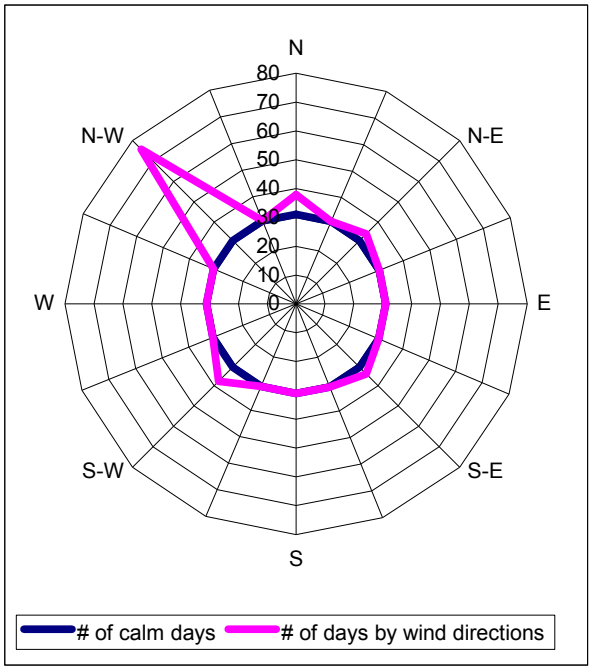


Figure 6.13 – **Wind rose of the Kandym Field Group plot developed on the basis of field measurements**

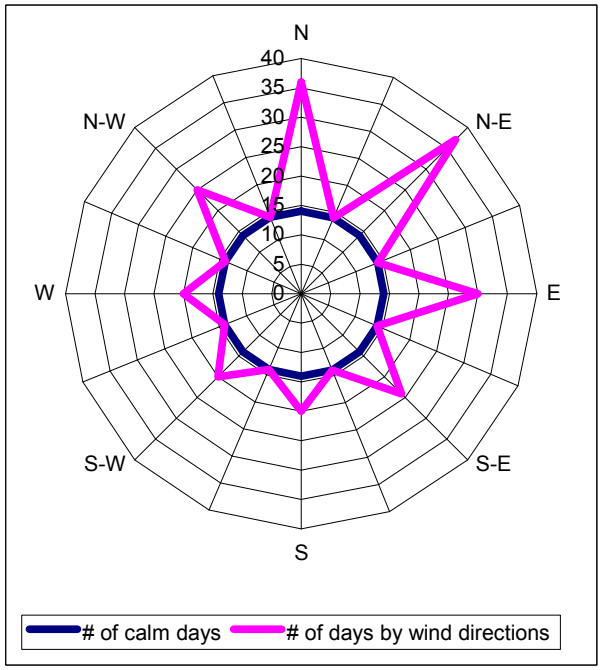


Figure 6.14 – **Wind rose developed on the basis of observations at the Karakul weather station for November**

Despite the apparent dissimilarity of the foregoing figures, accounted for by a relatively short period of measurements, both cases reveal dominance of northern winds (during the field survey period almost 1/3 of calm days alternated with days with weak north-western winds).

Meteorological Conditions in the Kungrad Plot at the Time of Field Surveys 4-hour (at each 3:00, 7:00, 11:00, 15:00, 19:00 and 23:00) daily field measurements of the atmospheric temperature and atmospheric pressure, as well as wind speed and direction were carried out during the field surveys in the Kandym Field Group plot. Figure 6.15 shows charts of the medium, maximum and minimum daily temperature differences observed in the areas of the field surveys in early November.

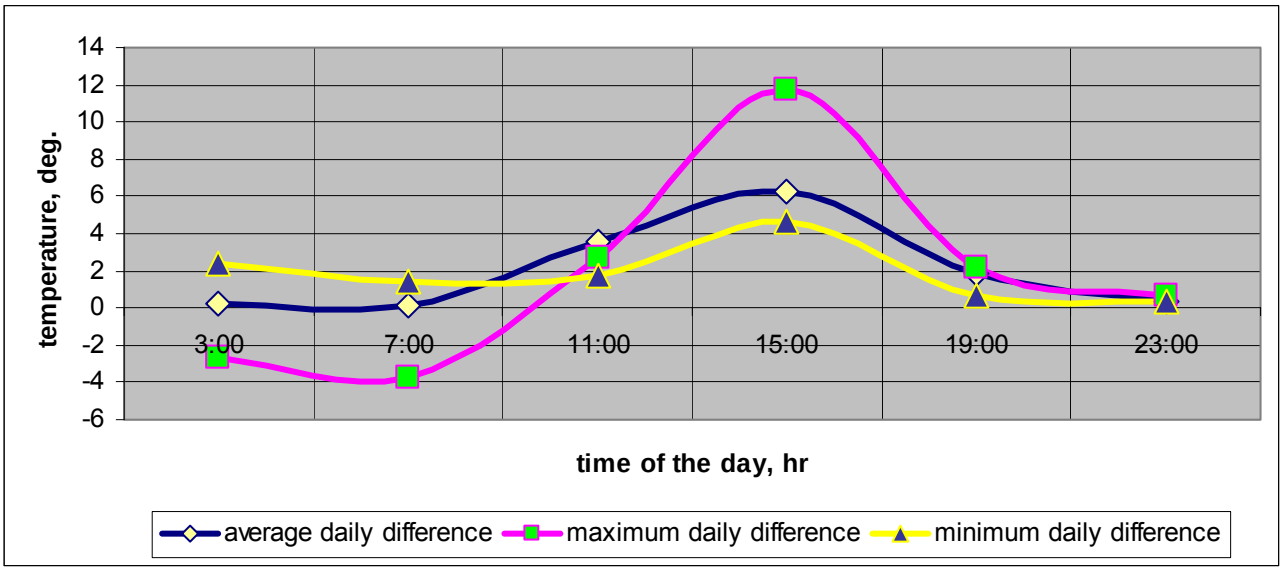


Figure 6.15 – **Daily ambient temperature differences in the Kungrad Plot (field surveys data)**

Figure 6.15 shows that the average daily temperature difference in the Kungrad Contracted Plot at the time of the field surveys was $6{,}2^0$C which corresponds to the continental climate of continental type in which big amplitudes are inherent both in terms of annual and daily ambient temperatures. Its maximum was 15.4 ^{0}C (December 5, 2004) and the registered minimum was 4.3^0C (December 6, 2004).

The average atmospheric temperature over the period was $+2.1^0$C which corresponds to the average temperatures for such period registered at the Kungard weather station (see Fig. 3.4). The atmospheric pressure varied from 739 to 752 mm Hg. No patterns of atmospheric pressure variations were recorded over the period.

No strong winds were observed in the plot at the time of the field surveys. The average wind speed varied from 1.5 to 2.8 m/sec. The surveys period saw less windy weather setting in the Kungard plot as compared to that of the Khauzak - Shady plot, however it was windier than that existing in the Kandym Field Group plot, though it is the Kungard plot as the long-term observation data reveal, that out of the terrains under review is the most exposed to wind loads. Figures 6.16 and 6.17 show wind roses developed on the basis of measurements conducted during the field surveys period and average long-term weather observations at the Kungard weather station for the winter months.

As one can clearly see from Figures 6.16 and 6.17 the “wind roses” developed on the basis of the field survey data and on the basis of long-term observations are considerably different: the first case was dominated by south-south-eastern and north-western winds, and the second one by eastern and north-eastern winds. It may be accounted for by the short-term nature of field observations.

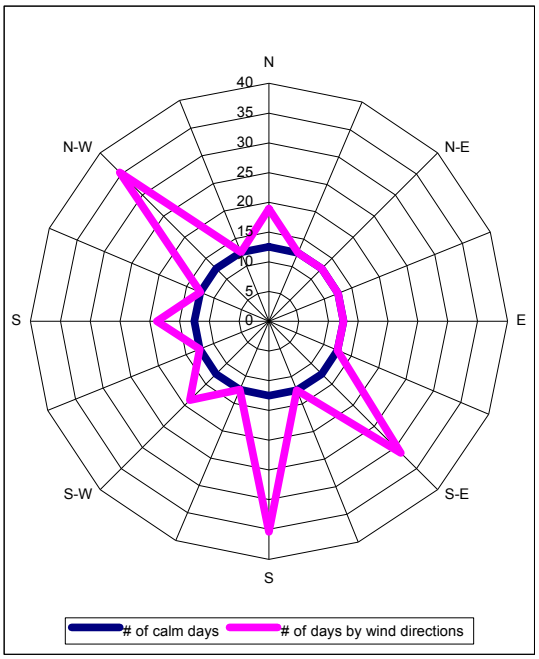


Figure 6.16 – **Wind rose of the Kungard plot developed on the basis of field measurements**

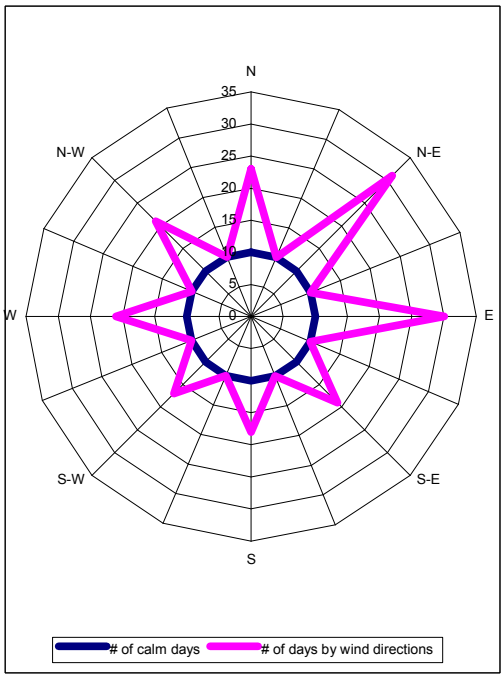


Figure 6.17 – **Wind rose developed on the basis of observations at the Kungard weather station for the winter months**

6.3. Laboratory Analysis of Samples

The following are the locations where samples taken during the field expeditions were analyzed:

- ✧ Laboratory of the State Specialized Inspectorate for Analytical Control of the State Environmental Committee of the Republic of Uzbekistan to determine the physicochemical properties of: air, water, including without limitation water from surface water bodies, groundwater, drinking water from artesian wells and collecting channels, as well as soil;
- ✧ Pilot plant of the Nuclear Physics Institute of the Uzbek Academy of Sciences to determine their radionuclide content;
- ✧ Environmental research expedition of the Division for Comprehensive Geological Exploration and Topographical Surveys of Azneft Production Association to identify microbiological elements contained water and soil samples.

6.3.1. Laboratory Analyses to Determine Physicochemical Properties of Air and Water, Including Without Limitation Drinking Water, Groundwater and Drainage Water, and Soil (Grond)

Table 6.6 and Figures 6.18-6.21 show photos of laboratory equipment and describe the methods used to determine individual parameters of air.

Table 6.6 – **Description of Methods Used to Determine the Presence of Pollutants in Air**

Ingredient being determined	Method's general description	Experimental inaccuracy, %
Dust	Dust level is determined by the weight increment occurring after aspiration of air through an aerosol filter. The determination sensitivity is 0.05 mg of dust per sample.	5*
Carbon monoxide - CO	Portable gas analyzer Palladiy MP-1-CO-100. The basis of the the gas analyzer's operation is the controlled potential amperometry method, which is about measuring the electrochemical oxidation current of the gas being analyzed on the electrochemical cell's main electrode. The range of measured carbon monoxide concentrations is 0-100 mg/cu.m.	10*
Sulphur dioxide - SO_2	The basis of the method is oxidation of sulfurous gas in the course of its recovery from air with the help of the hydrogen peroxide solution followed by turbidimetrical determination of the sulphate-ion with barium chloride. The determination sensitivity is 0.05 mg per sample being analyzed.	7*
Nitrogen dioxide - NO_2	The basis of the method is recovery of nitrogen dioxide from air using the potassium iodide solution. The resulting nitrite-ion is determined on a photometric basis by the azo dye resulting from the nitrite-ion's interaction with sulfanilic acid and I-naphthylamine. The determination sensitivity is 0.1 mg per sample being analyzed.	7*
Nitric oxide - NO	Following its oxidation by chrome oxide (YI) and conversion into a dioxide, the nitric oxide is recovered from air using the potassium iodide solution. The resulting nitrite-ion is determined on a photometric basis by its reaction with sulfanilic acid and I-naphthylamine resulting in emergence of red-colored dye. The determination sensitivity is 0.065 mg per sample being analyzed.	6,5*
Hydrogen sulfide – H_2S	The basis of the method is the interaction of silver nitrite with sulfosalt that is produced in the course of the consumption of hydrogen sulfide by the sodium arsenate solution. The silver sulfide produced in the course of the above reaction dyes the solution yellow-brownish, and its intensity is used to determine the content of hydrogen sulfide. The determination sensitivity is 1 mg per sample being analyzed.	1,5*

Table 6.6 continued

1	2	3
Hydrocarbons: ***-methane - CH_4;*** ***-ethane - C_2H_6;*** ***-ethylene - C_2H_4;*** ***-propane - C_3H_8;*** ***-propylene - C_3H_6;*** ***-isobutane - iC_4H_{10};*** ***-butane - C_4H_{10};*** ***-butylene - CH_4;*** ***- isopentane - iC_5H_{12};*** ***-pentane - C_5H_{12};*** ***-hexane - C_6H_{14}.*** ***Gases:*** ***-nitrogen -N_2;*** ***-oxygen - O_2;*** ***-carbon dioxide - CO_2***	These compounds are determined using the gas-chromatographic method and a flame ionization detector. The chromatograph columns must be made of steel and need to be 1.5-3 m long; stationary phases: alumogel, silica gel, coal.	10*
Phenol - C_6H_5OH	Where phenol interacts with diazotized paranitroaniline the sodium carbonate solution produces a red-colored compound. The phenol concentration is determined based on the intensity of the solution's color. The determination sensitivity is 0.2 mg per sample being analyzed.	1,5*
Benzene - C_6H_6 ***Toluol - $C_6H_5(CH_3)$*** ***Xylol - $C_6H_4(CH_3)_2$***	1. These compounds are determined using the gas-chromatographic method and a flame ionization detector. Concentrations of benzene, toluol and xylol being measured range from 0.02 to 15 mg/cu.m. 2. The photometric determination of benzene, toluol and xylol is based on release of nitric compounds which when placed into an alkaline medium produce colored solutions. The determination sensitivity is 0.5 mg per sample being analyzed.	1,5*
Ammonia - NH_3	The determination is based on release of yellow-brown compound (dimercur-ammonium iodide) when ammonia interacts with Nessler's reagent. The detection limit is 1 mkg per solution volume being analyzed.	1,5*

* Inaccuracy values were calculated based on the outcomes of the state inspection of the inaccuracy of the State Specialized Inspectorate for Analytical Control laboratory's equipment.

All of the above methods are on the "List of Certified and Approved Methods to Measure Concentrations of Pollutants Contained in Emissions of Industrial Enterprises and Air", approved by the State Environmental Committee of the Republic of Uzbekistan.

Figure 6.18 – **Gas analyzers to detect and determine the content of carbon monoxide and hydrocarbons**

Figure 6.19 – **Analytical balance, photoelectric colorimeter KFK-3 and KFK-2**

Figure 6.20 – **Heat chamber KS-5, spectrophotometer SF-46**

Figure 6.21 – **Polarograph PU-1**

Tables 6.7 and 6.8 and Figures 6.22-6.27 show techniques used to detect pollutants in air and soils, as well as photos of some of the equipment used by *the laboratory of the* State Specialized Inspectorate for Analytical Control to analyze water and soil samples.

Table 6.7 – **Description of Methods Used to Determine the Presence of Pollutants in Water**

Ingredient being determined	Method's general description	Method	Experimental inaccuracy, %
1	2	3	4
Hydrogen index (pH)	The method is based on measurements of potential differences arising on the boundary between the outer surface of the electrode's glass membrane and the solution	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M,	0,5*

	being analyzed on the one hand, and the membrane's inner surface and the standard solution on the other hand.	1990	
Hardness	The complex measurement method is based upon release of a complex compound formed by calcium and magnesium ions with sodium ethylene diamine tetraacetate (trilon B), with pH being 10. Detection involves use of the black chromogen.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	4,5*
Calcium	The complex measurement method is based upon release of a complex of the calcium ion with the anion of the ethylenetetraacetic acid (trilon B) in the presence of the murexide indicator.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	4,5*
Magnesium	Magnesium concentrations shall be determined based on a difference between the overall hardness value and total amount of calcium.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	4,5*
Alkalinity	The method is based upon titration of water with 0.1 normal solution of hydrochloric acid in the presence of 0.05% methylene orange indicator.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	5*
Chlorides	The method is based upon titration precipitation of chlorides resulting from exposure to silver nitrite in the presence of the 5% potassium chromate indicator.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	5*

Table 6.7 continued

1	2	3	4
Sulfates	The photometric method is about causing the sulfate ion to precipitate by applying barium chloride and detecting it as barium sulfate. Glycerol is used here as the suspension stabilizer.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	5*
Ammonium ions	The photometric method is based	RD	5*

	on release of yellow mercur-ammonium iodide with a mercury (I) alkaline solution.	118.3897485.16-92. Tashkent, 1992	
Nitrites	The photometric method is based upon release of intensely colored diazo compounds with sulfanilic acid and alfa-naphthylamine (Griss reagent).	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	4,5*
Nitrates	The photometric method is based upon the reaction between nitrates and phenol disulphonic acid accompanied by release of nitro derivatives phenol, which when interacting with alkalis produce yellow-colored compounds.	RD 118.3897485.12-92. Tashkent, 1992	4,5*
COD (chemical oxygen demand)	The titrimetric method is based upon oxidation of organic and inorganic substances in water, when boiled up with potassium dichromate in a sulfurous medium.	Collection of methods to measure pollutants in the environment, issue 1, Tashkent, 2001	4,5*
Dissolved oxygen	The standard iodometric Winkler method is based upon the capability of magnesium hydroxide (II) to oxidate, when placed in an alkaline medium, to magnesium hydroxide (IV). When placed into a acidic medium magnesium hydroxide (IV) returns to the 2-valent state, and the equivalent amount of iodine becomes bonded with oxygen.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	1,5*

Table 6.7 continued

1	2	3	4
BOD (biological oxygen demand)	It is determined by the amount of oxygen in mg, required for organic substances contained in 1 liter of water to oxydate.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies"	4,5*
Boron	Photometric method. It is based on the boric acid's ability to alter the carmine indicator's colour in concentrated sulfuric acid.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	4*

Aluminum	Photometric method. It is based on the aluminum ion's ability to form with aurintricarboxylic acid an orange-red sparingly soluble complex compound in the presence of ammonium sulphate and with pH being 4.5.	GOST 18165-89	4*
Cadmium	Atomic absorption spectrometry (AAS). The method is based upon absorption of ultraviolet rays by gas atoms.	RD 52.24.377-95. All Russian Research Institute for Water Protection, 1995	4*
Potassium	This calculation method is based upon the fact, that when found in natural waters, the potassium ion is subordinate, which is reflected in such calculation in the form of the potassium ion's mass concentration.	GOST 2874-82. Publishing House of Standards. 1984	4*
Nickel	AAS. The method is based upon absorption of ultraviolet rays by gas atoms.	RD 52.24.377-95. All Russian Research Institute for Water Protection, 1995	1,5*
Sodium	This calculation method is based upon differences between the sum of anions and the overall hardness.	GOST 2874-82. Publishing House of Standards. 1984	4*
Molybdenum	This photometric method is based on release of an orange-red complex compound of 5-valent molybdenum with ammonium thiocyanate.	GOST 2874-82. Publishing House of Standards. 1984	1,5*
Arsenic	AAS. The method is based upon absorption of ultraviolet rays by gas atoms.	GOST 2874-82. Publishing House of Standards. 1984	1,5*

Table 6.7 continued

1	2	3	4
Mercury	AAS. The method is based upon absorption of ultraviolet rays by gas atoms.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	1,5*
Lead	AAS. The method is based upon	RD 52.24.377-95.	1,5*

	absorption of ultraviolet rays by gas atoms.	All Russian Research Institute for Water Protection, 1995	
Fluorides	The photometric method is based upon emergence of yellow color i.e. release of a complex compound of zirconium (IV) with alizarin - sulfonate in an acidic medium.	Collection of methods to measure pollutants in the environment, issue 1, Tashkent, 2001	1,5*
Benzene	The photometric method is based upon release of a brown reaction product resulting from interaction of the formaldehyde mixture with sulfuric acid.	SEV, unified water quality analysis methods, parts I-II, M,. 1987	1,5*
Methanol	A photometric method. Double distillation is used for certain water compositions. Colorless distillate is treated with potassium permanganate in a sulfuric acid medium until formaldehyde is produced. The resulting formaldehyde is detected by applying chromotropic acid.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990	1,5*
Phenols	This photometric method is based upon formation of colored compounds with 4-aminoantipyrin in the presence of ferrocyanide (III).	RD 118.3897485.7-95. Tashkent, 1995	1,5*
Petroleum products	The fluorimetric method is based on their extraction from water using a solvent i.e. a 4-carbon chloride. The extract is run through a column filled with a sorbent agent (aluminum oxide). Concentration levels are measured.	RD 118.3897485.13-92. Tashkent, 1992	5*

Table 6.7 continued

1	2	3	4
Iron	The photometric method is based upon its reaction with sodium sulfosalicylate and release of a yellow complex compound.	Guideline 118.3897485.9-92. Tashkent, 1992	1,5*
Copper	AAS. The technique is based upon absorption of ultraviolet rays by	Guideline 52.24.377-95. All	1,5*

	gas atoms.	Russian Research Institute for Water Protection, 1995	
Magnesium	The photometric method is based upon quantitative oxidation of magnesium (II) ions to permanganate ions in a nitro-acid medium when exposed to ammonium persulphate.	Collection of methods to measure pollutants in the environment, issue 1, Tashkent, 2001	1,5*
Molybdenum	The photometric method is based upon emergence of carmine-red complex compound in sulfuric acid solutions with thiocyanate ions.	Yu.V. Novikov and others. "Methods to Determine the Quality of Water in Water Bodies", M, 1990.	**1,5***
Xylol	The gas-chromatographic method is based upon extraction by using tetrachlorethylene with subsequent gas-chromatographic detection in a column filled with colored chrome – 1 coated with polyethylene glycol PEG-20 M (10% of the weight of the carrying agent)	Yu.Yu. Lourier and others. "Hydrochemical materials", 1971	10*
Toluol	The gas-chromatographic method is based upon extraction by using tetrachlorethylene with subsequent gas-chromatographic detection in a column filled with colored chrome – 1 coated with polyethylene glycol PEG-20 M (10% of the weight of the carrying agent)	Yu.Yu. Lourier and others. "Hydrochemical materials", 1971	10*
Chrome	The photometric method is based on release of a red-violet soluble compound in the course of interaction with diphenylcarbazide.	RD 118.3897485.10-92. Tashkent, 1992	1,5*

Table 6.7 continued

1	2	3	4
Zink	The photometric method is based on formation of a complex compound in the presence of xylain orange.	RD 118.3897485.20-95. Tashkent, 1995	1,5*
Synthetic surfactants	The photometric method is based upon formation of methylene blue	Yu.V. Novikov and others. "Methods to	1,5*

	and complex associates soluble in chloroform and producing blue solutions. The methylene blue does not dissolve in chloroform.	Determine the Quality of Water in Water Bodies", M, 1990	
Pesticides	The gas-liquid chromatographic method is based upon extraction of pesticides by using a 4:1 hexane:acetone mixture. The extract is dried by using a water-free sodium sulfate and concentrated to 1 ml. The content is measured using an electron capture detector.	RD 52.24.66-88. All Russian Research Institute for Water Protection, 1988	10*
Sanitary and biological analysis		Oz DSt 950:20000 "Drinking Water", Tashkent, 2000	
Total bacterial count	The method is about identifying the overall content of mesophilic and mesotropic aerobes and facultative anaerobes capable of growing in the nutrient agar of such composition at 37 (give or take) 0.5^0C during 24 hours.	GOST 18963-73	10*
Coli index	The method is about concentrating bacteria out of a specific volume of water being analyzed onto a membrane filter at 37 (give or take) 0.5^0C on the Endo agar	GOST 18963-73	1,5*

Table 6.7 continued

1	2	3	4
Coli titer	The method is about inoculating certain volumes of water being analyzed at 37 (give or take) 0.5^0C of accumulation media with subsequent removal of the bacteria from the media and determination of the most likely bacterial count for 1 liter of water.	GOST 18963-73	1,5*

* Inaccuracy values were calculated based on the outcomes of the state inspection of the inaccuracy of the State Specialized Inspectorate for Analytical Control laboratory's equipment.

Table 6.8 – **Description of Methods Used to Determine the Presence of Pollutants in Soil (Ground)**

Ingredient being determined	Method's general description	Method	Experimental inaccuracy, %
1	2	3	4
Detection of humus	The method is based on oxidation of soil humus with potassium chromate (II) in sulfuric acid with subsequent detection of 3-valent chrome of the equivalent amount of humus in the photoelectric colorimeter.	Tyurin's method. GOST 26213-84	1,5*
Methods used to determine the cationic-anionic composition of the aqueous extract (chlorides, sulfates, potassium, magnesium, carbonates, solid residue, pH)	This standards establishes techniques used to determine the composition of aqueous extracts from saline soils with a view to determining the overall concentration of salts in conducting soil, agrochemical and soil-reclamation reviews of areas, control over the salt regime of soils and in other surveys and researches. The method is about extracting water soluble salts from the soil using distilled water, with the soil/water ratio being 1:5.	GOST 26423-85 GOST 26428-85	5*

Table 6.8 continued

1	2	3	4
Detection of nitrogen	The Kjeldahl method of detecting nitrogen is based upon decomposition of organic compounds contained in the soil by exposing it to sulfuric acid, which results in release of amine nitrogen and its retention by sulfuric acid in the form of sulfurous ammonium. The subsequent stage is burning of the organic matter. Ammonia is recovered by using distillation equipment.	E.V. Arinushkina "Guidelines on Chemical Analysis of Soils".	4,5*
Detection of gypsum	Gypsum normally occurs in the soil in the form of dihydrate Ca $SO_4 \cdot 2H_2O$. Due to its poor solubil-	E.V. Arinushkina "Guidelines on Chemical Analysis	4,5*

	ity in water, gypsum is recovered by exposing it to 0.2 hydrochloric acid solution. The content of gypsum sulfate ion is determined by determining the content of SO_4 in the solution and subtracting the amount of aqueous extract sulfate ions from it, and the resulting data is used to determine that amount of $CaSO_4 \cdot 2 H_2O$ in the soil.	of Soils".	
Determination of phosphorus content	The method is based on recovery of phosphorus by exposing it to 0.2 HCL solution. The extract absorbs all calcium phosphates and most sesquialteral oxides phosphates, and phosphorous from apatite. The phosphorus content is determined using the colorimetric method.	A.T. Kirsanov's Method. GOST 26207-84	4,5*
Determination of the content of potassium and sodium in aqueous extract.	The method is about determining the radiation intensity of the atoms of elements being detected by using a flame photometer.	GOST 26427-85	1,5*
Determination of the petroleum products content	The method is based upon extraction of petroleum products from the soil by exposing it to 4-carbon chloride with simultaneous treatment of eluates by running them through aluminum oxide in the column. Concentrations of hydrocarbons in samples are determined with the help of fluorimetric methods.	RD 118.3897485.13-92	4,5*

Table 6.8 continued

1	2	3	4
Determination of the content of chlorinated organic pesticides	Mass fractions of organic halogen pesticides are measured by using the gas-liquid chromatography method and electron capture detector with separating phases of different polarities.	RD 52.18.180-89	10*
Determination of the content of heavy metals	This atomic-absorption method is based on the property of metal atoms to extinguish, when in their ground state, the light of certain wave lengths, which they radiate in the excited state. The resonance line required for such extin-	RD 52.18.191-89	1,5*

	guishing is most frequently produced by a hollow-cathode lamp, with such cathode being made of the element being determined.		
Determination of the phenol content	The content of volatile phenols is determined with the help of the colorimetric method based on formation of dyed compounds including phenol and its compounds with 4-aminoantipyrin in the presence of potassium ferrocyanide (III) in an alkaline medium, with pH being 10.0 ± 0.2	RD 118.3897485.7-92	1,5*

* Inaccuracy values were calculated based on the outcomes of the state inspection of the inaccuracy of equipment in the laboratory of the State Specialized Inspectorate for Analytical Control.

6.3.2. Microbiological, Pathomorphological and Ecotoxicological Laboratory Analyses of Living Organisms

Various physiological groups of microorganisms contained in soil, ground and water samples are identified and registered by inoculating 1 ml of limiting dilutions of a bacterial suspension onto culture media three consecutive times. The bacterial suspension from ground or soil forms as a result of preparing a mix (10 g of ground-soil and 90 ml of sterile tap water). Water bacterial suspension is prepared through its immediate dilution.

Oil oxidizing bacteria are identified and registered in a liquid Raymond's medium that has the following ingredients: NH_4NO_3 – 2 g; $MgSO_4$ x $7H_2O$ – 0.2 g; KH_2HPO_4 – 2 g; NaH_2PO_4 – 3 g; $CaCl_2$ x $6H_2O$ – 0.01 g; Na_2CO3 – 0.1 g; $MnSO_4$ x $5H_2O$ – 2 ml of 1% solution; $FeSO_4$ x $7H_2O$ – 1 ml of 1% solution. The amount of distilled water is 1000 ml. 1% $FeSO_4$ solution , 1% HCl and 1% $MnSO_4$ solution are prepared separately and added to the medium immediately before inoculation.

Figure 6.22 – spectrophotometer Spekol 1100 (density test)

Figure 6.23 – Infrared spectrophotometer, field pH-meter

Figure 6.24 – Atomic absorption spectrophotometer "Shimadzu" AA-650IS

Figure 6.25 – Atomic absorption spectrophotometer AAC-500

Phenol oxidizing bacteria are identified and registered in a liquid Stolbunov's mineral medium that has the following ingredients: $K_2H_2HPO_4$ – 1 g; NaCl – 0.1 g; $CaCl_2$ – 0.1 g; Na_2SO_3 – 0.15 g; $(NH_4)_2SO_4$ – 0,3 g; $FeSO_4$ traces; phenol – 0.3 g. Phenol is sterilized separately and added to the medium immediately before inoculation.

The most likely cell count (MLC) per unit of volume in liquid media is calculated using the McCready table based on the analysis of variance. For such purpose one develops a numerical characteristic made up of three numbers that show the number of tubes of the dilutions that manifested growth in all repeated dilutions.

Figure 6.26 – Chromatograph 3700

Figure 6.27 – Chromatomass spectrometer ATI UNICOM

Then one uses the table to find the most likely count of microorganisms corresponding to a specific numerical characteristic. Development of microorganisms in liquid media is determined visually: turbidity of the medium; formation of biomass sediment and film on the medium-oil boundary; occurrence of pigments with additional microscopic control in the phase contrast per 2250 power microscopic field. This mircobiological analysis method was developed on the basis of

how-to books by M.N. Pimenova, S.I. Kuznetsov and T.N. Nazina. The inaccuracy of this method is ± 500 cells per 1 g of matter or 1 ml of water.

Determination of the pesticide content of plants tissues A 1-2 g weighed sample of plant tissues is used to extract the entire weight of pesticides by exposing it to acetone. The solution is evaporated on the watch glass, and the sediment is dissolved in 0.1 ml of acetone. The content of pecticides is determined using Autosystem XL (Perkin Elmer) chromatograph, and the calculations are based upon standard solutions. Conditions of the analysis: evaporator temperature – 300°C; column HP-5, 30 m × 0,25 mm × 1.0 mm (Crosslinked 5% pH ME Siloxane).

Determination of the metal content of plants tissues A weighed sample of plant tissues is dried until its weight gets stable at 105-110°C. Tissue samples are homogenized using a manual homogenizer or a stainless-steel mixer-homogenizator. The tissues are decomposed with acid. Homogenized samples are weighed out into 250 ml boiler flasks, 10 g per flask. The weight of the damp plant tissue is registered. The sample is dried at 100°C for 12 hours. The dry weight is registered. 30 ml of concentrated nitric acid (BDH Aristar) is added to the samples, the flasks are covered with watch glasses and left to cool down for the night. After that the flasks are heated on the electric stove to 60°C until emergence of brown vapor. The temperature is then increased to 80°C and the volume of the acid is reduced to 5 ml.

20 ml of deionized distilled water is added to the sample, and the sample volume is once again reduced to 5 ml. The remaining part of the boiled sample is placed into a vial with 1% nitric acid solution, with its final volume being 25 ml. Procedural control specimens are subject to treatment alongside with each batch of samples. An atomic absorption spectrometer (AAS) is used for elemental analysis. The concentration of metals is measured using AAC Aanalyst-700 (Perkin Elmer) in the modes that are standard for each metal.

Determination of the content of polyaromatic hydrocarbons in animal tissues For analysis of animal tissues to identify and determine the content of polyaromatic hydrocarbons, animal organs are homogenized using a pestle and a mortar. Homogenized samples are weighted out to round-bottom flasks, 500 ml into each, and a solution that contains amounts of components required by the standard is then added to each sample (using a dosing unit similar to Hamilton's Microlab 1000).

It is followed by addition of quicklime granules and 100 ml of potassium hydroxide alcoholic solution (35 g of KOH, dissolved in 10 ml of water with subsequent dilution with methanol to 1 l), after which the mixture is boiled up under reflux for 1 hour. Following its cooling, the mixture is subject to vacuum filtering and the tissue residue is flushed with three 100 ml pentane portions. The filtrate and washings are placed in a one liter separating funnel, and then 100 ml of pentane-washed distilled water is added.

The pentane layer is poured into a 500 ml round-bottom flask, and the methanol-water layer is extracted by exposing it to two 50 ml pentane portions. Pentane extracts are evaporated in a rotational evaporator to approximately 2 ml. Polar components (including lipids) are removed in a silica gel column (using Kieselgel 60 silica gel, activated at 200°C).

1 ml combined lipids extract is added to the silica gel column that contains 5 g of absorbent and around 1 g of activated powder copper to secure removal of potentially present unbound cop-

per. The sample is eluated: 35 ml of dichloromethane/pentane with the ratio of 1:2. The extracts are concentrated in Kuderna-Danish unit (approximately to 2 ml). The eluated matter is evaporated in a rotational evaporator until its volume equals approximately 2 ml, after which it is divided into two subsamples.

One of the portions is reduced to the required volume by running nitrogen through it. Fractionation of the samples takes place in microcolumns with alumina that contain 2 g of adsorbent. The aliphatic fraction is eluated by adding 2.5 ml of pentane to it, and the aromatic one by adding 5 ml of dichloromethane/methanole (98:2 ratio). The aliphatic fraction is reduced to the required volume by running nitrogen through the sample and analyzed using the gas chromatography method. Autosystem XL (Perkin Elmer) chromatograph is used to analyze polycyclic hydrocarbons.

Determination of the metal content of animal tissues. A 1-2 g. weighed sample is dried until its weight gets stable at 105-110°C. Tissue samples are homogenized using a manual homogenizer or a stainless-steel mixer-homogenizator. The animal tissues are decomposed with acid. Homogenized muscle samples are weighed out into 250 ml boiler flasks, 10 g per flask. The weight of the damp plant tissue is registered. The sample is dried at 100°C during the night. The dry weight is registered. 30 ml of concentrated nitric acid (BDH Aristar) is added to the samples, the flasks are covered with watch glasses and left to cool down. After that the flasks are heated on the electric stove to 60°C until emergence of brown vapor.

The temperature is then increased to 80°C and the volume of the acid is reduced to approximately 5 ml. 20 ml of deionized distilled water is added to the sample, and the sample volume is once again reduced to 5 ml. The remaining part of the boiled sample is placed into a vial with 1% nitric acid solution, with its final volume being 25 ml. Procedural control specimens are subject to treatment alongside with each batch of samples.

Gonad and one-piece liver sample are placed into 125 or 250 ml boiler flasks. The further procedures to be followed are identical to those previously described for muscles; however the volume of nitric acid used is 20 ml. An atomic absorption spectrometer (AAS) is used for elemental analysis. The concentration of metals is measured using AAC Aanalyst-700 (Perkin Elmer) in the modes that are standard for each metal.

Pathomorphology. One uses sterile surgical instruments to obtain organ and tissue pieces that are placed into 10% formalin (spinal muscle and liver) or in Bouin's and Surret's fluids (genital glands). Pieces of gonad tissue are placed into glutaraldehyde to prepare semithin gonad sections.

Laboratory treatment of such tissue pieces takes place in accordance with the histological methods (Reumeis, 1953): dehydrated in alcohols, run through celloidin-castor oil, covered with paraffin, serial frontal and longitudinal 5-10 mkm sections are caused to change their color by using Heidenhain's iron hematoxylin (gonads) or eosin-hematoxylin (muscles and liver). To obtain semithin (2000-3000 angstrom thick) sections, gonad pieces are covered with Araldite, sections are prepared using LKB ultratome (Sweden) and caused to change their color using toluidine blue and counter-stained with uranyl acetate, lead citrate.

So-prepared histological specimens of tissue and organ sections are examined and analyzed using NIKON E-400 (Japan) light microscope in the phase contrast and fluorescence mode, and also using JEM-100CX electron microscope (Japan) (ultrathin sections of gonads that are 300-400 angstrom thick). NIKON E-400 that has an in-built digital camera DXM-1200 (Japan) is used to

photograph sections of organs per 140, 280, and 560 power microscopic field. Another equipment to photograph the sections is JEM-100CX and in this case one uses 1000, 3200 and 5400 power microscopic field.

Morphofunctional condition of the liver, genital glands and pathologies of myogenesis are assessed using common methods (A.S. Loginov, B. Reumeis, V.V. Serov, B.G. Eliseev, A.I. Abrikosov and A. Khem).

Figures 6.28-6.31 show some pictures of equipment in the laboratory of the Complex Exploration Department of the Division for Comprehensive Geological Exploration and Topographical Surveys used to conduct microbiological, ecotoxicological and pathomorphological analyses.

Figure 6.28 – NICON DXM-1200x1500, a microscope with a built-in photographic camera

Figure 6.29 – "Perkin Elmer" gas chromatograph

Figure 6.30 – Chromatomass spectrometer "Perkin Elmer"

Figure 6.31 – Atomic absorption spectrometer "Perkin Elmer"

6.3.3. Determination of the radionuclide content

The gamma-ray spectrometry method was used to determine the radionuclide content of the samples being analyzed. The basic gamma-ray spectrometry equipment includes highly efficient detectors with a good energy resolution level and equipment for multichannel detector pulse-height analysis. The method involved the use of semi-conductor germanium detectors with a relative efficiency of 15 and 20% and 1.7 kiloelectronvolt resolution. The samples weight when measured in a Marinelli-type measurement vessel was about 400-1000 g, and the exposure time totaled 6 hours.

The cutting-edge Genie-2000 software was used to determine the activity of ^{40}K nuclides and those of the thorium and uranium radioactive series ((^{212,214}Pb, ^{212,214}Bi, ^{226}Ra, ^{208}Tl, ^{228}Ac, ^{234}Th). The data of such measurements were used to determine the average activity of nuclides of the uranium and thorium radioactive series. RDs establish the maximum permissible values of the aggregate specific activity of natural radionuclides (radium-226, thorium-232, potassium-40) contained in construction materials (Sanitary Regulations and Standards No. 0029-94, clause 8.4).