STATEMENT
ON ENVIRONMENTAL IMPACT (SEI) FOR Development of the Shady Block of Dengizkul Field

DESIGNED:
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General director
___________________ I.A. Tsoi
"01" March 2011

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**Terms and Definitions**

**Deflation** means destruction of loose rocks and soils under the influence of wind. It is most vivid in desert terrains.

**Pollution** means entry into or emergence in the environment of new physical, chemical, information or biological agents that are normally not inherent in it or excess over natural long-term average annual levels.

**Source of Harmful Emissions** means equipment (i.e. funnel, ventilation skylight, vent shaft, etc.) used to emit pollutants into the air.

**Waste** means types of raw stock that are unfit for production of specific products, its unusable remains or substances (solid, liquid and gaseous) resulting from technological processes and energy that is not disposed of in the course of the production activities being reviewed (including agricultural and construction activities). Production waste may be used as raw stock for other types of production.

**Dispersion of Harmful Emissions** means reduction of atmospheric concentrations of pollutants caused by physical factors (air stream, gas diffusion), which occurs as one moves farther away from the source of emission.

**Reclamation** means artificial restoration of soil’s fertility and re-vegetation following man-caused disruption of a natural site.

**Flare** means a cone-shaped stream of gas or fluid.
Abbreviations

APCS CP - Automatic process control system of the control point
ABC - Amu-Bukhara canal
FOCL - Fiber optic communication link
MWDC - Main Water Discharge Channel
SEI - Statement of Environmental Impact
SOCV - Shut-off and control valves
GTE - Geotechnical element
IMS - Integrated Management System
I&C - Instrumentation and control
KMK (SNiP) - Construction Standards and Codes
CS - Cluster Site
BVS - Block valve station
OGO - Oil and gas operations
EIA - Environmental Impact Assessment
TPL - Tentative permissible levels
MPC - Maximum permissible concentration
GD - Guiding document
SPZ - Sanitary protection zone
SDW - Solid domestic waste
GWL - Groundwater level
UAPCP - Uniform Air Pollution Calculation Program
DWD - Drilling waste disposal
PL - Pig launcher
USW - Ultra-short waves
PR - Pig receiver
PGTP - Preliminary gas treatment plant
GPW - Gas production workshop
CP - Cathodic protection
Introduction

OOO “LUKOIL Uzbekistan Operating Company” is engaged in production of gas and condensate on the Khauzak and Shady Blocks of Dengizkul Field under the Production Sharing Agreement (PSA) of June 16, 2004 made by and between the Republic of Uzbekistan and the Consortium of Investors made up of Open Joint Stock Company “Oil Company LUKOIL” and National Holding Company “Uzbekneftegaz” and license G1 No. BH 0001 of 08/07/2007 authorizing extraction of minerals and the Mining Allotment Certificate for Khauzak and Shady Blocks.

Gas and condensate production activities are currently being conducted on the Khauzak Block. The project “Development of the Shady Block of Dengizkul Field” provides for commissioning of 14 wells, from where via individual flow lines gas will be delivered to cluster sites and then via a gas collecting main to the existing preliminary gas treatment plant “Khauzak”. The project provides for construction of:

- cluster sites K1 and K2;
- flow lines connecting 14 wells and cluster sites K1 and K2;
- gas collecting mains connecting cluster sites K1 and K2 and PGTP “Khauzak”;
- fuel gas trunk pipeline connecting KP-9 and cluster sites K1 and K2;
- motor roads from cluster sites KP-9 to K1 and K2 and to the wells;
- fiber optic communication link connecting KP-9 and cluster sites K1 and K2;
- external power supply lines from KP-9 to cluster sites K1 and K2;
- pipeline corrosion protection system.

The expected production of natural gas and associated condensate amounts to 1.57 bln cu.m/year.

For the assessment of and conclusions on the feasibility of the planned activities given potential environmental effects please refer to the previously developed draft Statement of Environmental Impact (SEI) "Development of the Shady Block of Dengizkul Field", that has been subject to public environmental examination. Given the review of the Draft SEI the Main Public Environmental Examination Authority (Glavgosekoekspertiza) gave a generally positive opinion of the Shady Development Project. Glavgosekoekspertiza gave its approval of the Draft SEI stipulating that the second stage i.e. environmental impact assessment procedure be developed.

This report has been developed in accordance with opinion No. 18/719z of September 20, 2010 of Glavgosekoekspertiza of Uzbekistan. According to the Opinion in preparing SEI it is required to:

- provide more information on how and where the gas pipeline crosses the lake’s neck, designating risk areas with uneven bottom, deep holes or loose soils that form the bottom’s substrata, and develop measures to prevent pollution of surface water in the course of gas pipeline construction and operation;

SEI for Project “Development of the Shady Block of Dengizkul Field”
- provide details of Dengizkul lake crossing;
- include more information on construction of flow lines and gas collecting mains given the lake’s neck crossing specifics;
- perform environmental analysis of road construction activities;
- develop efficient measures to minimize environmental impact, including those to prevent pollution of surface water in the course of gas pipeline construction and operation.

Generally, SEI is equivalent to the Draft SEI, however individual issues are made more specific, amplified and extended given the data of surveys, research and design solutions modified in accordance with the environmental requirements.

This report uses the data of the report “Research Combined with Feasibility Study of Options of Protection of Khauzak and Shady Blocks of Dengizkul Field against Flooding by the Waters of Dengizkul” prepared by OOO “UZGIP” [1] and design materials of OAO “O'ZLITINEFTGAZ”.

The report has been prepared in accordance with the “Regulations on Public Environmental Examination of the Republic of Uzbekistan” approved by Resolution No. 491 of 12/31/2001 of the Cabinet of Ministers and other environmental regulations of the Republic of Uzbekistan that are currently in effect.
1 Assessment of Environmental Issues of the Construction Site

1.1 General Overview of the Work Site’s Location

The Shady Block of Dengizkul Field is located in Alat District, Bukhara Region of the Republic of Uzbekistan (Figure 1.1).

One of the distinctive features of the area under review is lack of indigenous population living at the field or next to it. The closest temporary living locations include the camp of GPW “Khauzak” located 20 km off the Shady Block, and Dengizkul camp located 10 km northwards of the field. The district center of Mubarek with the Kagan-Karshi railway and the town of Alat are located 60 km away from the site. The camp of Urtabulak field is located 20 km south-east of the field.

The area has vast reserves of gas. The area under review has been a part of oil and gas production for several decades. Such oil, gas and condensate fields as Urtabulak, Khauzak and North Dengizkul are located within 20-35 km reach of the Shady Block.

The area’s seismisity measures 7 degrees.

The climatic description is based on the outcomes of observations conducted at Bukhara and Karakul weather stations [3].

The area’s climate is severely continental with short winters and long dry hot summers.

Table 1.1 shows the outdoor temperatures measured at the Bukhara and Karakul weather stations.

<table>
<thead>
<tr>
<th>Point</th>
<th>Monthly average</th>
<th>Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Bukhara</td>
<td>0,4</td>
<td>2,7</td>
</tr>
<tr>
<td>Karakul</td>
<td>0,6</td>
<td>3,4</td>
</tr>
</tbody>
</table>

The average maximum temperature during the hottest month, i.e. July, varies from 36.7°C to 36.9°C and the average minimum temperature during the coldest month, i.e. January, reaches minus 4.2°C. The absolute maximum temperature of 46.0°C to 46.4°C occurs in July, and the absolute minimum temperature of minus 24.9°C is registered in January.
Figure 1.1 Planimentric Map of the Shady Block of Dengizkul Field
The atmospheric pollution of the area is distinct for high contents of natural dust which is caused by strong winds and abundance of desert terrains. The most frequent wind directions include northern and eastern ones.

Also, given the concentration of oil and gas production enterprises in the Bukhara-Khivin oil and gas bearing province, which accommodates the Shady Block, and the immediate proximity of Dengizkul lake, being a water body receiving collector and drainage waters of the Bukhara Region, the air is distinct for high background contents of such substances as hydrogen sulfide and ammonia, which are of both natural (surface water evaporation during the hot season) and man-caused origin (exposure to field development activities).

The average wind speed in January is 3.0 m/sec, in July it reaches 4.1 m/sec. The number of days with dust storms varies from 13 to 38 days per annum. Table 1.2 shows the wind directions and speeds in January and July.

precipitation is scarce, and mostly occurs in the fall and winter in the form of rain and snow and does not go beyond 144 mm per annum. The maximum daily precipitation is 35 mm; the annual number of days with precipitation is 13935; the annual number of days with snow cover is 10; the annual number of days with storms is 10.2.

The average minimum relative humidity in the wintertime varies from 59 % to 62 %, and during the summertime from 21 % to 24 %. The humidity is always higher in the morning.

The adverse weather conditions that contribute into occurrence of deflation processes include high wind speeds, low humidity and scarce precipitation.

Analysis of the area’s climatic, physical and geographic characteristics suggests that the quality of air in the area under review may worsen for a short space of time when strong winds blow and dust storms set in, however, for other longer periods the state of the air is quite stable.

The Shady Block is located in the region with moderate levels of potential atmospheric pollution.

The Karshin Steppe has very variegated and complex geological, morphological, lithological and hydrogeological conditions, and abounds in soils with various water and physical properties and reclamation and soil conditions.

Table 1.2 – Wind Directions and Speeds in January and July

<table>
<thead>
<tr>
<th>Month</th>
<th>Repeatability of Wind Directions (numerator), %</th>
<th>Average speed by directions (denominator), m/sec</th>
<th>Repeatability of calms, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>17/3,1</td>
<td>17/2,5</td>
<td>17/2,5</td>
</tr>
<tr>
<td></td>
<td>16/2,4</td>
<td>15/2,7</td>
<td>10/2,9</td>
</tr>
<tr>
<td></td>
<td>15/2,7</td>
<td>10/2,9</td>
<td>6/3,2</td>
</tr>
<tr>
<td></td>
<td>10/2,9</td>
<td>6/3,2</td>
<td>6/3,2</td>
</tr>
<tr>
<td></td>
<td>6/3,2</td>
<td>6/3,2</td>
<td>13/3,3</td>
</tr>
<tr>
<td></td>
<td>6/3,2</td>
<td>13/3,3</td>
<td>8</td>
</tr>
<tr>
<td>VI</td>
<td>46/3,7</td>
<td>27/3,8</td>
<td>1/1,8</td>
</tr>
<tr>
<td></td>
<td>1/1,8</td>
<td>0/1,0</td>
<td>0/1,0</td>
</tr>
<tr>
<td></td>
<td>0/1,0</td>
<td>2/1,9</td>
<td>6/2,3</td>
</tr>
<tr>
<td></td>
<td>2/1,9</td>
<td>6/2,3</td>
<td>18/3,0</td>
</tr>
<tr>
<td></td>
<td>6/2,3</td>
<td>18/3,0</td>
<td>9</td>
</tr>
</tbody>
</table>

Precipitation is scarce, and mostly occurs in the fall and winter in the form of rain and snow and does not go beyond 144 mm per annum. The maximum daily precipitation is 35 mm; the annual number of days with precipitation is 13935; the annual number of days with snow cover is 10; the annual number of days with storms is 10.2.

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The Karshin Steppe has very variegated and complex geological, morphological, lithological and hydrogeological conditions, and abounds in soils with various water and physical properties and reclamation and soil conditions.

SEI for Project “Development of the Shady Block of Dengizkul Field”
Near-surface occurrence of heavily salinized water results in intensified saline formation. Eolian sands are accumulated and blown around in lowlands.

The groundwater salinity exceeds 3 g/l. The type of water varies from the hydrocarbonate calcium to sulfate-chloride. The water is salt water and may only be used for process purposes, feeding of groundwater takes place through seepage of collector and drainage water and to a far lesser extent through infiltration of atmospheric precipitation.

At the time of engineering and geological surveys the ground water, depending upon the terrain’s relief, was penetrated to the depths from five to ten meters.

The soil-reclamation measures to develop the Karshin Steppe included construction of collector-drainage networks. Collector waters of the Bukhara Region (from the most salinized areas on the left bank of the Bukhara and in the east part of the Karakul oases) are fed to the Dengizkul depression. Discharges into Dengizkul Lake have been taking place since 1966.

One of the distinct features of Shady’s physical and geographic location is the proximity of the production sites being designed to Dengizkul Lake (Figure 1.1).

1.2 Dengizkul Lake

Being located in the south-east of the Bukhara oasis' periphery, Dengizkul Lake is one of the largest lakes in the Aral Sea basin used for irrigation and discharge purposes. The lake used to be the end water body of the Zeravshan River.

According to the 1914 map the lake's area had been 120 sq. km, but by the mid 50s it fully dried up due to withdrawal of water for irrigation, thus becoming the biggest salt-marsh in southern Bukhara Region.

The water body’s new development commenced upon feeding of the Amudarya water into the Zeravshan’s basin and construction of the Dengizkul main drain.

Dengizkul lake is a part of the infrastructure of the Amudarya Right Bank Drain Main (Main Water Discharge Route).

Dengizkul Lake is used for collection, re-balancing and transportation of drainage wastewater to the Dengizkul branch of MWDR and then to MWDR itself.

For the time being, Dengizkul Lake is used for discharges of drainage water from the section of the Dengizkul Main Drain located in the Bukhara Region, and wastewater from the Amu-Bukhara Channel (ABC).

Drainage wastewater is diverted from Dengizkul through the shortest distance into the Dengizkul branch of MWDR.
The area of Dengizkul’s water surface is 235-320 sq.km, and it is the largest water body in Bukhara and Kashkadarya Regions. E.g., Kuyumazar water body has the area of its surface water of 15 km, and Chimkurgan – 50 km.

The lake’s depth is continuously changing, from 25 to 35 m. It has very salty water and the lake’s bottom is overlain by a 4-6 cm. thick layer of salt.

Dengizkul Lake has the following dimensions:

- lake’s length – 43 km;
- maximum width – 10 km;
- area of the water surface at the elevation of water of 182.2 m - 295 sq.km;
- area of the water surface at the elevation of water of 184.4 m - 319.9 sq. km;
- evaporation and seepage loss at the elevation of water of 182.2 m – 488 mln. cu.m
- evaporation and seepage loss at the elevation of water of 184.4 m – 560.3 mln. cu.m.

After the lake’s water balance is reached, salts start to gradually accumulate which causes the salinity to increase. In 1987 the water salinity reached 13.8 g/l. The salinity average during 1980-1987 made up 13.2 g/l. The water body has sulphate-sodium salinity.

Apart from long-standing salinity changes there occur changes during the same year caused by redistribution of water balance components throughout the year. Increased salinity in the summertime is accounted for by intense evaporation. The annual evaporation loss makes up 14-15% of the overall volume of water in the lake, which has a material impact on hydrochemical regime, and specifically, upon distribution of salinity at various depths.

Intense evaporation which in the summertime reaches 10 mm/day, contributes into continuous increase of salt concentrations in the surface layers. Heating of the surface layers causes their density to become less than that of bottom water which is cold and less salinized. Water salinity decreases as the depth increases in the deep-water part of Dengizkul which has a stable thermal stratification. The salinity distribution is uniform in the shallow part of the lake.

In the winter and spring the incoming components of the lake's water balance outweigh the outgoing ones, which results in a slight reduction of salinity. However, in the long-term perspective, the positive trend remains stable.

Distribution of salinity across the lake is typical of closed lakes used for irrigation and discharge purposes. The lowest salinity i.e. 7-10 g/l is observed in the north-western part of the lake that receives drainage water and wastewater. The salinity levels increase across the south-eastern edge of the water body and reach 15.99 g/l. The average water mass in the central part is 15 6815 76 g/l. The maximum salinity levels i.e. 16.22 g/l are typical of shallow-water north-western stretches whose water circulation...
with the main lake is somewhat inhibited. Such distribution of salinity levels across the water body is the same for all seasons. The salinity levels are based on the data of hydrochemical surveys, performed in August 1990, and 2005-2010 data of environmental monitoring performed by OOO “LUKOIL Uzbekistan Operating Company” (Table 1.3).

<table>
<thead>
<tr>
<th>Observation station</th>
<th>Average by years, mg/l</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Next to where the drain main enters the lake</td>
<td></td>
<td>1 616</td>
<td>6 496</td>
<td>2 431</td>
<td>2 578</td>
<td>3 809</td>
<td>2 225</td>
<td>1 466</td>
</tr>
<tr>
<td>Next to the northern boundary of Khauzak GPW (cluster 9)</td>
<td></td>
<td>20 418</td>
<td>-</td>
<td>26 457</td>
<td>27 442</td>
<td>28 712</td>
<td>29 495</td>
<td></td>
</tr>
<tr>
<td>Next to the southern boundary of Khauzak GPW (cluster 16)</td>
<td></td>
<td>26 553</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19 981</td>
<td>22 734</td>
<td>28 401</td>
<td>31 882</td>
<td>29 670</td>
<td>30 988</td>
<td></td>
</tr>
</tbody>
</table>

It goes without saying that the lake plays a significant role in preservation of wintering and migratory wading birds, however, due to the fact that its conservation status was not revised and increased in due course, this water body is under the threat of drainage as a result of irrigation and drainage activities. Nonetheless, in the event of construction of a canal connecting Sichankul Lake and Dengizkul Lake the elevation of water in the lake is expected to increase.

1.3 Environmental Restrictions and Conservation Status of Dengizkul Lake

Dengizkul is on the list of wetlands of international importance. This is the first area in Uzbekistan designated as one meeting the selection criteria of the Ramsar Convention, i.e. wetlands that are of international importance in terms of preservation of wading birds and other semi-aquatic plants and animals. The lake undoubtedly plays an important role in preservation of wintering and migratory wading birds.

The Convention on Wetlands which are of international importance primarily as waterfowl habitats was signed on February 2, 1971 in Ramsar (Iran) and has been called the Ramsar Convention ever since.
The Republic of Uzbekistan became a party to the Ramsar Convention in pursuance of Resolution No. 278P of August 30, 2001 of the Oliy Majlis of the Republic of Uzbekistan, which became binding upon the Republic of Uzbekistan on February 8, 2002.

Each year Dengizkul becomes a wintering destination for almost 300 thousand birds of 30 species.

Please note that Dengizkul Lake is a public ornithological reserve (Dengizkul Reserve) which makes it one of Uzbekistan’s areas of preferential protection.

According to the law of the Republic of Uzbekistan “On Areas of Preferential Protection” No. 711-II of December 3, 2001 specific goals and peculiarities of public ornithological reserves are set out in the regulations subject to approval by the agencies of the State Nature Protection Committee of the Republic of Uzbekistan, land owners and the authority that decided on establishment of a public reserve. An area of preferential protection should be encircled with a water protection zone that is subject to a special regime intended to prevent contamination, pollution, depletion and sedimentation of water bodies with soil erosion products and sustain a favorable water regime.

Water protection zones must be created in accordance with the procedure approved by the Cabinet of Ministers of the Republic of Uzbekistan as advised by environmental and water management authorities.

On April 7, 1992 the Cabinet of Ministers of the Republic of Uzbekistan adopted its Resolution “On Approval of the Regulations on Water Protection Zones of Man-Made and other Water Bodies; Rivers, Main and Connecting Channels, as Well as Sources of Potable and Household Water Supply, and Water Bodies Used for Health and Recreational Purposes in the Republic of Uzbekistan” No.174. The procedure for establishment of water protection zones as well as the regime of business activities in such zones to prevent pollution, contamination and depletion of water resources is governed by the Water Protection Zone Regulations [4].

For major water bodies the water protection zone must encircle the entire water body within 300-500 m (off the water edge). The water protection zone includes a coastal strip in which more stringent business activities restrictions are applicable, and therefore, construction activities within this strip must take place only in exceptional cases and upon approval by the State Nature Protection Committee of the Republic of Uzbekistan.

Dengizkul’s water protection zone is located 500 m off the water edge with the water reaching the level of 182.2 m.

1.4 Measures to Protect Future and Existing Sites Against Flooding

The 182.2 m elevation of water in Dengizkul was assumed in preparing the program of Khauzak development. Based on the same assumptions and following approval by the State Nature Protection Committee of the Republic of Uzbekistan (letter No. 02-621 of 03/29/2010) the Shady Block Development Program was also prepared in 2010 and approved by the Ministry of Agriculture and Water Management of the Republic of Uzbekistan.
The actual elevation of water as of the beginning of 2010 was 180.05 m. Table 1.4 shows variations of absolute elevations of water in Dengizkul in recent years according to the Ministry of Agriculture and Water Management of the Republic of Uzbekistan (Letter No. 05-1/32-21 of 01/29/2010).

Table 1.4 - Multi-Year Filling Volumes and Absolute Elevations of Dengizkul Lake

<table>
<thead>
<tr>
<th>Indicator/year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum volume of water, cu. km</td>
<td>3.5</td>
<td>3.2</td>
<td>3.15</td>
<td>3.1</td>
<td>2.8</td>
<td>2.55</td>
<td></td>
</tr>
<tr>
<td>Area of water surface, sq.m</td>
<td>315</td>
<td>292</td>
<td>287.5</td>
<td>281</td>
<td>278</td>
<td>258</td>
<td>250</td>
</tr>
<tr>
<td>Absolute elevation of water, m</td>
<td>184.4</td>
<td>183.45</td>
<td>182.51</td>
<td>182.04</td>
<td>181.8</td>
<td>181.47</td>
<td>180.32</td>
</tr>
</tbody>
</table>

Given Turkmenistan's continuous requests for Uzbekistan to cease discharges into Sultandag Lake, implementation of measures outlined in the program “Construction of Main Channels for Offtake of Drainable Wastewater in the Amudarya Basin in Uzbekistan and Turkmenistan” is once again a burning issue, as, by the way, is the need to construct in the near future a section of MWDR connecting Sichankul and Dengizkul Lakes.

The Right-Bank Main Channel includes a consecutive network of existing channels or those being constructed or designed, as well as Sichankul, Dengizkul and Medami Lakes that serve as regulating reservoirs.

The Cabinet of Ministers of the Republic of Uzbekistan issued order No. 281-f of August 12, 1993 approving the proposal by the Ministry of Water Management, Uzbekneftegaz, Uzvodstroy, Cabinet of Ministers of the Republic of Qoraqalpogiston, Khokimiyats of the Bukhara, Karshin and Khorezm Regions regarding accelerated construction of the head of the Right-Bank Main Channel on the route channel “Yuzhniy” – Sichankul Lake – Dengizkul Lake - Solenoye Lake and Medami Lowland, which is entirely located in Uzbekistan.

If the Sichankul – Dengizkul section is constructed, the elevation of water in Dengizkul will raise to 184.4 m which will result in the flooding of individual sites (wells, sites, utility corridors) located on the Khauzak and Shady Blocks of Dengizkul gas condensate field, including those being operated by OOO “LUKOIL Uzbekistan Operating Company” and those being designed or under construction.

Upon request of OOO “LUKOIL Uzbekistan Operating Company” OOO “UZGIP” (UZGEPROMELIOVODKHOZ) performed research combined with feasibility study of options of protection of the Khauzak and Shady blocks of Dengizkul field against flooding by the waters of Dengizkul and prepared a relevant Report [1] that lists measures which make it possible to prevent
flooding of the existing and planned facilities in Khauzak and Shady Blocks of Dengizkul field following construction of the Sichankul-Dengizkul section of MWDR.

The current sources of water entering Dengizkul Lake include waters from the Dengizkul Connecting Channel, and cross-flows from Sultandag Lake in Turkmenistan. The cumulative inflow during an average high-water year fails to make up for evaporation loss of the lake, which results in sustainable year-to-year reduction of the elevation of water in Dengizkul Lake.

Construction of the Sichankul – Dengizkul connecting channel will result in additional inflow of water into the lake which substantially exceeds the lake's evaporation loss and the elevation of water will start experiencing a sustainable growth. To make the elevation of water in Dengizkul Lake stable at 181.0 – 182.2 m one will have to enable offtake of water from the lake into the Main Water Discharge Channel (MWDC).

OOO “UZGIP” considered the options of prospective water balance of the Sichankul-Dengizkul system with the excess water being diverted to MWDC following construction of the Right-Bank Drainage Amudarya Channel (RBDAC) ranging from Sichankul Lake to Dengizkul Lake and then further on to MWDC, and also upon completion of construction of the Sichankul connecting channel.

Construction of the Sichankul – Dengizkul section will have a positive impact on hydrobiological and hydrochemical conditions existing in Dengizkul lake. The thing is, that construction of the Sichankul-Dengizkul section will cause the inflow of water into the lake to grow drastically, contribute into water circulation and reduce the size of stagnant water zones, which will be favorable in terms of biotic diversity.

Inflow of water with lower salinity (about 6-7 g/l) will cause the salinity growth in Dengizkul to stop, and bring about partial desalination of water in the south-eastern part of the lake. Gradual restoration of fish fauna may be expected in this area.

The project “Research Combined with Feasibility Study of Options of Protection of the Khauzak and Shady Blocks of Dengizkul Field against Flooding by the Waters of Dengizkul" considered several options of measures to be implemented. The performed activities included design of proposed facilities, determination of preliminary scope of work and development of construction estimates using the resource method or using the data available from peer projects.

In implementing the selected option of protection of the Khauzak and Shady against flooding, OOO “UZGIP” recommends to implement the following environmental measures:

1. Technical and biological (where appropriate) reclamation of lands disturbed in the course of construction.
2. Disposal of all solid and liquid construction waste in accordance with the successful centralized waste handling procedures introduced at the Operator's sites and approved by the State Nature Protection Committee of Uzbekistan.

3. Compulsory environmental production monitoring of the Khauzak and Shady Blocks of Dengizkul Field in strict compliance with the Programs that are subject to approval by the State Nature Protection Committee of Uzbekistan and Competent Authority on an annual basis.

4. Performance earthwork and dredging operations in strict compliance with the land resources protection and safety requirements.

The research done by OOO “UZGIP” reveals that the most preferable is the option that provides for reconstruction of the offtake channel and assumes that the maximum elevation of water in Dengizkul is 182.2 m. If chosen for implementation, this option requires reconstruction (deepening) of the existing channel from PK 1147+00 to PK 11+40 and to the Parsankul Discharge Facility with a view to retaining MWDC's reservoir and transportation capacity.

The reconstruction activities include deepening of the channels by 2.0 m vs. the target depth, and preservation of the channels' hydraulic parameters. Though requiring most investment, this option has zero OPEX, for upon completion of their construction, the offtake channel and MWDC will be re-registered in the books of the Operations Department of RBDC (Right-Bank Drainage Amudarya Channel) and operating expenses will be borne by the Ministry of Water Management of the Republic of Uzbekistan.

This option is the most environmentally friendly, for it rules out any direct impact on Dengizkul's ecosystem (both in the course of construction, and operation of the channels). What’s more, stable elevation of water and Dengizkul’s area at 181-182.2 m will enable preservation of Dengizkul's biocenosis that formed in the recent years.

OOO “UZGIP” recommends that the offtake channel reconstruction option be accepted by OOO “LUKOIL Uzbekistan Operating Company” while commencing the construction of MWDR from Sichankul to Dengizkul until 2022. Should one fail to decide upon commencement of the construction activities before 2023, it is advisable to update calculations and feasibility studies of the options of protection of the Khauzak and Shady Blocks of Dengizkul field against flooding, using the then existing prices.

The Operator must use its own resources to conduct designing and construction activities under the recommended option, commence such activities prior to designing and construction of MWDC from Sichankul to Dengizkul and the offtake channel from Dengizkul to MWDC carried out by the Republic of Uzbekistan.
OOO “UZGIP”, in its turn, undertakes to timely notify the Operator of commencement of construction of Sichankul – Dengizkul section of MWDC and Dengizkul-MWDC offtake channel. Construction of Sichankul – Dengizkul section of MWDC and Dengizkul-MWDC offtake channel shall be implemented by the Republic of Uzbekistan under an individual project and does not constitute the Operator’s responsibilities.

Thus, implementation of the recommended measures to prevent flooding of the existing and planned facilities on the Khauzak and Shady Blocks of Dengizkul gas condensate field will help considerably mitigate the risk of occurrence of possible accidents caused by flooding with Dengizkul's water, and, consequently, eliminate possible adverse impact upon the environmental media.

1.5 Geological and Engineering Conditions

The geological and engineering surveys performed within the area being reviewed revealed the following.

Geologically, the area is made up of deposits of the Mezo-Cainozoic cover and Quaternary system.

The Quaternary deposits are made up of alluvial-dealluvial deposits of the Pra-Seravshan and Pra-Amudarya Rivers that date back to the Lower and Mid Quaternary Age and are made up of sand, sandy loam, loamy soils and brown and grey-brown clays. They are overlain by Eolian sands of various thicknesses. The thickness of such deposits is different and varies from several meters to 20 cm.

The newest Quaternary deposits are Eolian sands which occur throughout the area and are represented by grey and grayish-brown pulverescent and fine sands of various thicknesses which is due to erosion of sands and Upper Neogenic aleurolites. Their thickness is different and may reach 3-5 m.

The slopes of outlier upland and hill-ridge elevations have occurrences of proluvial Low and Mid Quaternary rocks that come in the form of fine sand with inclusions of gruss and fine gravel, and rarely sandy loam and loamy soils.

The area is morphologically divided into parts, which is exhibitive of the conditions whereunder formation of geological and genetic rock complexes was taking place. The area is made up of the following geomorphological parts:

- structural and erosive outlier elevations;
- alluvial – delta plane with wind-born deposits;
- alluvial – lacustrine – depositional plain.

The Sichankul – Dengizkul section and the South Channel - Sichankul section mostly lie within the alluvial-proluvial wind-exposed upland plain.

From Dengizkul to the Dengizkul section of MWDC the channel runs through the alluvial-delta plain of the Pra-Zeravshan River. The latter represents an engineering and geological area which is an SEI for Project “Development of the Shady Block of Dengizkul Field”
erosive-depositional plain located in the delta of the Pra-Zeravshan, which is made up of Lower and Middle Quaternary deposits, i.e. sand, gravel, pebbles, loamy soil and clay. Gravel and pebbles are made up of sedimentary Miocene-Pliocene rocks, which are rarely cemented with argillaceous cement. The Upper Pliocene sediments underlying them are made up of sandstones, sand, siltstones and clays. The thickness of the deposits is insignificant and reaches 10 m. The plain is evenly sloped from north to south, south-west. Its elevations within the Dengizkul section vary from 188.1-188.45 m in the north to 184.45-186.30 m in the south.

The area is an elevated plain-type plateau with individual outliner elevations made up of Miocene rocks and Upper Pliocene deposits. The Upper Pliocene deposits constituting the clayey-sandy stratum come in the form of an interbedding of sands, sandstones, aleurolites and grey and grey-brown clays with varying strengths and confluences.

They are underlain by Miocene and Palaeogene deposits. The deposits are 40-80 m thick. From the surface they are overlain by a cover of Aeolian sands of various thicknesses that come in the form of individual hillocks and less frequently sand dunes. What's more, the plateau's surface has differently sized deflationary pits and saline terrains.

In terms of the content of easily and moderately soluble salts, they are both to salinized and non-salinized. The dry residue of the aqueous extract varies from 0.08% to 1.332%, with the average being 0.438%.

The area's geological structure includes Neocene-Quaternary deposits. The soils occurring across the designed routes of flow lines leading from the wells and the channel are salinized. The dissolved solids vary from 3840 to 11480 mg/kg. The content of chloride ion vary from 340 to 1960 mg/kg, and that of sulfate - from 920 to 4260 mg/kg, and that of carbonate alkali – from 1470 to 2810 mg/kg.

Given its lithological structure, physical and mechanical properties of the soils, the 5 m deep stratum being explored, was identified to include two geotechnical elements (GTE):

GTE-1: Aeolian sands – from dry to water-saturated state;
GTE-2 - Sandy-loam – loamy soils in the form of lenses.

GTE-1 includes undifferentiated Aeolian and alluvial sands ranging from dry to slightly wet (GTE-1) and water-saturated (GTE-1a) in the areas where the ground waters were penetrated. The sand is fine, pulverescent, underlies the groundwater and has quick sand properties (apparent quicksand).

GTE-1 occurs in the upper part of the cross-section along the entire route. The penetrated thickness of the stratum is from 4.0 to 12.0 m and more. The stratum’s roof adjoins the surface. Description of TGE-1 soil: the soil’s specific weight is 1.48 g/cm; porosity - 46.2%; humidity - 0.1; filtration rate – up to 5.0 m/day.
The GTE-1 soils were penetrated in the mine workings below the groundwater level at the depths of 5.0 to 9.5 m and at the crossing of the neck of land in the lake of Dengizkul at depths from 2.8 m and greater. GTE-1a water-saturated sands occur both in the middle part of the cross-section, and in the lower part beyond GTE-2. Description of the GTE-1a soil: the soil’s specific weight is 1.91 g/cm; porosity - 46.2%; humidity - 0.1; filtration rate – up to 5.0 m/day.

GTE-2 is made up of sandy-loam and loamy soils, and loam with inclusions of sand. The soil is from grey to brown. This element occurs in the form of lenses in the middle part of the cross-section at the crossing of Dengizkul Lake’s neck. The penetrated thickness of the stratum varies from 0.7 to 2.4 m. Description of GTE-2 soils: the soil’s specific weight is 1.78 g/cm; porosity - 42.0 %; humidity - 0.5; filtration rate – under 1.0 m/day.

Hydrogeologically the area being reviewed is dominated by a common water-bearing system made up of Middle and Upper Miocene, Pliocene, and Quaternary water-bearing complexes. The system has common conditions of recharge, transition and consumption of groundwater, and it is isolated from the underlying water-bearing complexes by a layer of Eocene water-resistant clays which are quite uniform in terms of their course and thickness. Formation and recharge of the system’s water-bearing horizons takes place due to groundwater flows from higher terrains, infiltration of precipitation and surface water from irrigation canals, condensation of vapor in thick sand strata. Water is used for household purposes and groundwater flows.

Their occurrence depth varies from 0.8 to 1.5 m (next to lakes, connecting channels and canals) up to 30 meters and more.

The groundwater has different degrees of salinity, the dry residue varies from 3-3.5 to 30-50 g/l, with the most frequent level being 5-10 g/l. The type of salinity of groundwater is also different and varies from to sulphated-calcic to sodium chloride. They reveal sulphate and chloride aggression toward concretes made of common cement grades.

There are ongoing geological processes, and specifically deflation, in the area that are typical of arid climate zones. The soils are exposed to wind erosion.
2 REVIEW OF THE ACTIVITIES TO BE CONDUCTED

2.1 Location and Completion of Wells

The activities to be conducted include: surface completion of 14 wells (No. 305, 1035, 1036, 1039, 306, 1038, 1030, 1040, 1037, 1031, 1034, 1043, 1042, and 1041), construction of two cluster sites (K1 and K2), construction of flow lines from the wells to the cluster sites and construction of channels from the cluster sites to PGTP Khauzak. The existing PGTP Khauzak will be used for processing raw gas supplied from the Shady and fed to the gas pipeline system of UDP “Mubarekneftegaz”.

The designed volume of gas production at the Shady totals 1.57 bln cu.m/year.

The gas produced at Shady contains hydrogen sulphide, with the mass fraction of hydrogen sulphide being 5.83%. The expected content of condensate in the feed gas is 15.08 g/cu.m. The gas density under standard conditions is 0.777 kg/cu.m, and the specific gravity of gas is 0.6448. The moisture content of formation gas varies from 4.5 to 9.5 g/cu.m in accordance with the level of pressure existing in the well’s specific zone. The molecular weight of the gas is 18.67.

The well sites have identical dimensions of 18 m by 7.5 m, and the area of each site is 135 sq. m.

Each well includes: X-mass tree (to be determined and provided by the customer) with piping, isolation, control and relief valves, installation of the required instrumentation and control equipment, connection of the kill unit and mobile inhibition unit and an individual enclosure.

The wellhead equipment is identical. Each well site will be enclosed with a metal panel framework enclosure. The project provides for outdoor lighting of the well sites.

As required by the "Project of Development of the Shady Block of Dengizkul Field” producers were located so as to maximize the degree of recovery of valuable hydrocarbons from the formations being developed. Please note that some of the wells being designed are to be located beyond the 500 meter water protection zone of Dengizkul Lake which is accounted for by the peculiarities of the geological structure (Figure 2.1). Following the detailed revision done by OAO “UzLITIneftegaz” using maps and repeated engineering surveys data, the distances from each well to the water edge of Dengizkul at 182.2 m were subject to adjustments.

Table 1.5 shows a list of designed wells and their adjusted locations.

<table>
<thead>
<tr>
<th>Well</th>
<th>Designed land elevation, m</th>
<th>Designed distance from the well to the water edge at 182.2 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1034</td>
<td>184.03</td>
<td>463</td>
</tr>
<tr>
<td>1040</td>
<td>183.37</td>
<td>over 500 m</td>
</tr>
<tr>
<td>1041</td>
<td>184.42</td>
<td>over 500 m</td>
</tr>
<tr>
<td>1042</td>
<td>183.32</td>
<td>over 500 m</td>
</tr>
</tbody>
</table>
Construction of producers on the Shady Block as required by the "Project of Development of the Shady Block of Dengizkul Field" will result in only four wells i.e. No. 1034 (463 m), No. 1031 (386 m), No. 1037 (369 m), No. 1043 (410 m) being located within the water-protection zone of Dengizkul with the elevation of water being 182.2 m.
Figure 2.1 – Location of Wells and Water Edge with the Elevation of Water being 182.2 m
Decree No. 174 of 04/07/1992 [4] and the requirements outlined in opinion No. 18/719z of 09/20/2010 stipulate a range of measures for such wells, which, when implemented, will help preserve the most efficient scheme of development of the Shady Block, reduce capital expenditures associated with construction, transition of wells outside of the water protection zone and minimize any adverse impact on the environment and Dengizkul’s ecosystem:

- construct water-proof dyked sites for tank reservoirs outside of the water-protection zone of Dengizkul;
- construct additional water-proof pits for receipt and disposal of drilling waste outside of the water-protection zone of Dengizkul;
- remove drilling waste from temporary water-proof pits located in the proximity of the wells into additional water-proof pits outside of such zone;
- eliminate temporary water-proof pits and perform reclamation of the drilling sites;
- dispose of drilling waste and liquidate additional sludge pits in accordance with the “Regulations for Disposal of Drilling Waste During Construction of Producers on the Shady Block” approved by the State Nature Protection Committee of the Republic of Uzbekistan.

In consideration of the foregoing the project provides for the following technical solutions for wells (No. 1034, 1031, 1037, 1043), whose wellheads are located within the water protection zone of Dengizkul with the maximum elevation of water being 182.2 m:

- preparation works being performed at such wells must make locations of the wellheads and drilling sites more specific and ensure that the sludge pit is located at the biggest distance possible off the water edge;
- temporary near-well sludge pits must have enhanced water-proof protection of their bottom and walls made up of a film material, be fully dyked and enclosed;
- it is during this stage that given the actual location of the wellhead, a site for construction of the additional water-proof sludge pit outside of the water-protection zone of Dengizkul should be selected (with it capacity exceeding the designed one by 20%);
- following commencement of well development and upon completion of its construction, construction of an additional water-proof sludge pit outside of the water-protection zone of Dengizkul should take place (with it capacity exceeding the designed one by 20%);
- at the final stage, following construction and completion of the well, drilling wastewater should be subject to treatment in the near-well sludge pit as required by the Regulations and fed for re-use at the next wells;
- upon treatment and pumping of drilling wastewater out of the near-well pit, the drilling cuttings and used drilling muds should be completely transported in specialized vehicles into an additional sludge pit located outside of the water protection zone of Dengizkul;

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drilling cuttings and used drilling muds should be recycled in the additional sludge pit as required by the Regulations;
- following its recycling, drilling waste should be buried in an additional sludge pit located outside of the water protection zone of Dengizkul;
- the final stage of work at the drilling sites includes elimination of near-well and additional sludge pits, complete technical reclamation of land and purification of the drilling site and the area adjacent to the additional sludge pit.

Implementation of the foregoing scheme at wells whose wellheads lie within the water-protection zone will help minimize the adverse impact on the lakeside area of Dengizkul, and is in conformance with the applicable legal framework of the Republic of Uzbekistan and has been given a positive opinion by the State Environmental Examination Committee under the Statement of Environmental Impact of construction of producers on the Shady Block (No. 18/860z of 11/30/2010).

Over the last decade the volume of water in Dengizkul has tended to decrease, which, therefore, results in lower absolute elevations of water.

Nonetheless, vertically the wells are designed with a tolerance of 1 m of the maximum amount of water in Dengizkul, with the absolute elevation of water assumed at 182.2 m, i.e. to the elevation of 183.2 m. In consideration of the foregoing, the wells that are below such level must be dyked so as to reach the level of 183.2 m, and there is only one such well i.e. No. 1036. Well No. 305 is located at the maximum level of 183.2 m. Two drilled wells No. 305 and 306 are completed at the relevant elevation levels, and well No. 305 uses a dam for protection against surface water and a water-proof well site surface of the well and internal slopes of the dam against groundwater.

Please note that the forecasted level of flooding corresponds to the absolute elevations of wellheads determined in the course of surveying, however the actual level of flooding is likely to be substantially lower due to the presence of land above the 182.2 m level between the wells and the current water edge of Dengizkul, i.e. presence of natural barriers (dams) which prevent flooding due to the hilly terrain. The aforementioned factors were taken into consideration by OOO “UZGIP” while performing the Research Combined with Feasibility Study of Options of Protection of the Khauzak and Shady Blocks of Dengizkul Field against Flooding by the Waters of Dengizkul.

2.2 Gas Main’s Crossing of the Neck
Gas will be transmitted from cluster site K-1 of Shady to PGTP “Khauzak” via a 21.5 km long 426 mm gas collecting main, with 16 mm thick walls and the operating pressure of 7.5 MPa. The daily transmitted volume of gas is 4.76 mln. cu.m. Onshore the gas lines will be buried in the ground with the difference between the surface and the top of the pipe being at least 1.0 m.

Routes of the pipelines have been selected on the basis of multiple feasibility studies. The "fitness" criteria include costs to be incurred in the course of construction, maintenance and repairs, including expenses associated with environmental protection, as well as steel intensity, safety, set construction time, availability of roads, etc.
Land lots for construction of pipelines have been selected in accordance with the requirements of the applicable Uzbek law.

The principle of underground corridor-type laying of linear utility lines was fully used in selecting the routes of pipelines to reduce the area of land withheld for construction and operations of the field pipeline system.

Selection of the channel route is underlain by the same principles as that of the field pipeline routes: i.e. cost-effectiveness and safety.

Construction of the collecting main includes crossing of a water barrier i.e. the lake’s neck that connects Dengizkul Lake with the bay. The crossing will be located in the narrowest place where the lake adjoins the bay. The proposed water crossing is an underwater one, and takes account of the relief of the bottom of the lake’s neck.

The crossing location was selected using the optimum design technique that takes account of hydrological and morphological properties of the lake’s neck and variations thereof throughout the entire time of operation of such underwater line.

Determination of the optimal position of the line and profile of crossing included calculations based on the incurred cost criterion in accordance with the requirements for the strength and stability of the pipeline and environmental protection.

The underwater line is to be buried into the bottom of the channel. The depth to which the line is buried must take account of potential deformations of the channel’s bed.

According to the customer’s letter No. 3249 of 05/10/2010 the water crossing takes the form of a one-line pipeline.

The proposed gas main crossing is underground, buried at 2 to 2.5 m below the lake’s bottom depending upon the bottom’s relief at the place of such crossing. For the longitudinal profile of the place where the pipeline crosses the lake’s neck please refer to Figure 2.2.

Construction of the gas main and fuel gas pipeline will be simultaneous. Fuel gas is transmitted via a 57 mm pipeline with 4 mm thick walls and at the operating pressure of 5.4 MPa.

The place where the neck is crossed represents two separate channel beds which are from 2.7 to 4.1 m deep and 260 m wide.

Crossing of Dengizkul is the “soft spot” of the gas pipeline. As the engineering and geological description has it, in the proximity of the neck the soils are made up of Aeolian fine, pulverescent dry to slightly wet sands. The soils located between the neck’s beds are similar to the aforementioned. The bottom of a wider stream is made up of sandy-loam – loamy soils with inclusions of sand. The bottom of another, narrower but deeper stream is made up of water-saturated fine to pulverescent sands.
Underwater crossings are sections of pipelines which are operated and maintained under exposure to substantial natural and man-caused factors. Natural factors, such as movements and erosion of the bottom, channel erosion accompanied by its vertical and schedule deformation, etc. are capable of substantially affecting the bottom’s morphology. Such natural processes create actual conditions facilitating erosion of the underwater pipeline. Appearance of loose sections of the underwater pipeline that have no soil beneath them is also due to interaction of gas being transferred with the pipeline’s body. The specific design of underwater pipeline crossings calls for implementation of such interaction mechanisms as “gas being transferred – pipeline” which result in pipeline buckling.
Such local loose intervals may occur alongside the pipeline. The degree of hazard depends upon the length of such loose interval and the level of its stress-strain state, which is also the length function. Given a small width of the crossing and a minimum speed of the stream, it is almost unlikely that new loose intervals will appear.

The underwater pipeline is intended to be buried into the bottom. To avoid reduction of the pipe’s flow section accompanied by alternating transversal protuberances and concavities of the wall, and resulting from loss of stability due to lateral bending combined with axis bending, the assumed burying depth takes account of potential bed deformations.

Burying of pipelines is dependent upon preservation conditions, transportation modes and properties of the media being transported.

The thickness of pipeline walls is determined by strength calculations in accordance with the pipeline section’s category, parameters of the media being transported and its design.

To make the buoyancy of the gas pipeline negative, the thickness of the gas main at the crossing is assumed to equal 20 mm.

Gabions filled with rubbles are used to level the bottom. Rubbles are highly dense, reliable and frost-resistant. Over time, free space between the stones is replaced with soil particles. Filling up empty space in the design (between the stones) soil also contributes into consolidation of the facility, i.e. its structure becomes stronger, and also promotes restoration of vegetation, and with time gabion facilities become a part of the natural landscape. It promotes formation of the tiniest organisms which are critical elements in the natural functioning of biosciences enabling maintenance of the aquatic fauna’s nutritious base. The period of complete consolidation of the structure is dependent upon the climatic conditions and type of such structure and varies from 1 to 5 years. Upon completion of their consolidation, gabion structures gain maximum stability and after that their service life is almost indefinite.

Use of gabion structures helps to resolve various engineering and environmental issues that may arise in the course of construction and operation of waterside structures.

To mitigate adverse impact upon the surface water it is recommended that construction of the gas pipeline take place while the elevation of water is the lowest.

A temporary dam shall be constructed for the period of construction of the gas pipeline crossing across the lake’s neck. Construction of such temporary dam shall include layer-by-layer bulldozer
compaction and relocation of the soil for 100 m. Upon completion of the gas pipeline construction activities, the temporary dam shall be liquidated.

To protect the pipelines against internal corrosion, inhibitors must be injected into the stream of gas being transported.

Cathodic protection shall be installed at the time of pipeline construction.

One of the major threats to accident-free operation of the pipeline sections that cross water barriers is lateral corrosion. Its intensity, is, inter alia, dependent upon the hydrological regime.

In case of an accident, the gas pipeline’s negative impact will, first of all, manifest itself in contamination of water and air with methane (CH₄) and hydrogen sulfide (H₂S). The maximum loss of gas in case of an accident taking place at the underwater crossing were calculated to equal 1 tn. And only a small part of it will dissolve in water. The negative impact of underwater gas pipeline accidents upon the lake’s biota results from partial dissolution of methane and hydrogen sulfide, their surfacing, local near-bottom turbidity of sediments and their subsequent sedimentation to the bottom. In concentrations equaling or exceeding 2 mg/l natural gas adversely impacts planktonic crustaceans. There have been practically no studies of the impact that methane and its homologues have on fish during the early stages of its development. Methane and other hydrocarbons are suspected to have a narcotic, convulsant and generally toxic action upon aquatic organisms which becomes more intense as the water temperature increases. The main thing that it causes is hypoxia which becomes a whole lot more intense in the presence of ethane, propane, butane and other homologues of this series. Initial sublethal effects are deemed to begin to appear at methane concentrations being close to 10-11 mg/l. Methane is not subject to biotransformation in tissues and is released from the body in its unchanged form. It is an endogenous product of life.

In the event of an accident on the gas pipeline being designed, the adverse environmental impact will be substantially more intense due to hydrogen sulfide contained in the gas. Hydrogen sulfide is the most toxic out of the gaseous components of the natural gas. Under standard conditions 3500 – 4000 mg of hydrogen sulfide can dissolve in 1 cu.dm of water, with such hydrogen sulfide reacting with water and forming a weak acid and dissociating into ions (sulphides and hydrosulfides). The ratio of dissociated and non-dissociated forms of hydrogen sulfide depends on the concentration of hydrogen ions in aqueous solutions.

Oxygen that is present in the aquatic medium alongside with hydrogen sulfide oxidizes it to elemental Sulfur and its intermediary forms (SO₃²⁻, SO₄²⁻, S₂O₃²⁻). In neutral and weak-acid media the reaction lasts several hours.

Hydrogen sulfide present in the water is a powerful catalyst for anodic and cathodic metal corrosion, and promotes entry of hydrogen atoms into the metal and emergence of the so-called
hydrogen brittleness. In their turn corrosion products (iron sulfides) form a galvanic couple with the metal and substantially accelerate its destruction, which is particularly dangerous for steel works located next to road crossings.

Demise of organisms, mostly planktonic ones, due to the toxicity of methane and hydrogen sulfide may occur only in the immediate proximity to where the gas comes up to the water surface. No population reactions and disruptions are forecasted in case of an accident. In case of gas pipeline breaking in shallow water, the negative impact of natural gas upon fish in the early stages of its development will be intensified by a powerful hydrodynamic shock, which will accompany a major blowout of pressurized gas. However, the adverse impact of such shock will be local and its impact upon ichthyoplankton is insignificant. Research reveals that in case of the most powerful effects of elastic waves produced by explosions of multi-kilogram explosive charges, the deadly area of exposure for fish does not exceed several dozens meters. Emergency blowout of gas in case of the underwater pipeline breaking will result in formation of a hole and a local high turbidity zone which pose a threat to biota within the area adjacent to the accident site. Generally, turbidity of sediments in case of an emergency gas pipeline breaking will be local and short-lived and will not have any powerful adverse impact on the aquatic organisms.

Following commissioning of the facility in accordance with the schedules approved by the Director General of OOO “LUKOIL Uzbekistan Operating Company”, the condition of the pipelines and equipment of the underwater crossing must be continuously monitored.

2.3 Road Construction Options

A inter-site network of hard-surfaced roads has been designed to ensure vehicle accessibility of all of the facilities and sites.

The access motor road belongs to the 5th technical category. The motor road adjoins the existing network of motor roads next to cluster site K-9 of Khauzak. The primary traffic speed is 60 km/hr. The assumed parameters of the road include:

- roadbed width – 8.0 m;
- carriageway width – 4.5 m;
- roadside width – 1.75 m.

Given the sand accumulation conditions, the guiding mark of the elevation of the roadbed’s edge is designed at 0.7 m. To enable discharge of potential rainwater the roadbed’s excavations are designed to include 0.3 m deep side ditches. Construction of the roadbed is done by moving ground from the excavations onto the embankment.

Missing ground is to be moved from horizontal reserves. The roadbed’s slopes and those of side ditches must be reinforced with gravelly earth.

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The motor road is designed to include round metal 720 mm pipes for discharge of potential rainwater and facilitate migration of smaller animals.

The motor road crosses the neck of Dengizkul Lake in its shortest part.

There were two proposed possible routes of the access road from the existing cluster K-9 of Shady to well No.305 of Shady (Figure 2.3).
Figure 2.3 – Possible Motor Road Routes
Both proposed routes are located within Kyzyl-Kumy sands area. The terrain across which both routes go is made up of fixed sands which are from 2 to 5-6 meters high. The vegetation growing on sand dunes includes shrubs of saxaul and zhingil which must be uprooted during construction.

Both of the routes cross water barriers.

The first route of the road from K-9 to well No.305 crosses a water barrier in the form of 0.5 m – 4.5 m deep channels. This necessitated development of another route of the access road leading to well No.305 and bypassing the aforementioned water barrier.

The second route of the access road leading to well No. 305 crosses 3 water barriers, i.e. a 0.3-0.35 m deep channel between the lakes and 2 connecting channels which are 0.3-0.5 m deep. The route goes across saline land areas which require additional expenses to be incurred in the course of road construction.

The water surface part of route 1 is 260 m long with the maximum depth in this area of 4.5 m, and the distance to the water edge of Dengizkul is 500 m. The route is 15.805 km long.

The water surface part of route 2 is 150 m long, and the maximum depth reaches 2.1 m, and the distance to the water edge of Dengizkul is 2 km. The route is 24.071 km long.

In deciding upon the route of the road across the neck of Dengizkul, one of the primary challenges was to mitigate the impact of the facility on the level of water and free circulation of the lake’s water mass considering its conservation status.

From the engineering perspective, it is easier to enable circulation of water while crossing deeper areas, rather than shallow ones.

As it was mentioned above, the area’s soils are represented by saline soils, which are occasionally marshy and subject to wind erosion. Construction of a longer road will not only be more expensive, but will also be detrimental to soils, flora and fauna.

The first route was the best in terms of its cost-effectiveness and environmental friendliness, and was chosen as the basic one.

Calculations of the crossing’s strength and stability were done in accordance with the construction standards.

The most acceptable route was selected i.e. in the narrowest part of the neck connecting the bay and the lake. The gas pipeline route was selected considering the following factors: construction, maintenance and repairs costs, security and possible application of reliable construction techniques. While selecting the route of the crossing, the focus was on long-term, sustainable, safe and reliable operation of the motor road.

To ensure stable operation of the culvert, the following conditions must be met:
- the water transmitting capability must be at least 50 cu.m/sec;
- units must be installed on previously made foundations;
- make sure that joints are tightly sealed.

SEI for Project “Development of the Shady Block of Dengizkul Field”
The design provides for construction of a dam with 4360x3060 mm square culvert units. The pipe is 34.0 m long with the inside dimension of the unit being 10.14 sq.m. The total area is 162.24 sq.m.

Pursuant to Letter No. 077-139 of 06/07/2010 of the Ministry of Agriculture and Water Management the maximum water consumption in the crossing area must be 50 cu.m/sec.

For calculation purposes the crossing was divided into 16 sections, and the water velocity was assumed at 0.34 m/sec. The water flow rate for a single pipe is 3.41 cu.m/sec, and the total flow of 16 sections enables passing of 54.56 cu.m of water per second. The water transmission tolerance is 9.12%.

Leveling of the bottom for placement of culverts shall be done by filling hollow parts with stones or stone square gabions. Gabions represent mesh grids filled up with differently sized stones. In their upper parts gabions have a gravel-sand edging, 70.0 m in length and 1.0 m in height, which is covered with geotextiles from four sides. 16x34=544 concrete blocks are installed onto the edging. The blocks are joined together in accordance with 3501-104 series.

Figure 2.4 shows the longitudinal section of the dam.
A reinforced trapezoid edging (according to the dam’s cross-section) made of geotextiles and filled up with ground serves as the foundation for culvert units. Geotextiles are covered with cobble fill to reinforce the dam’s slopes and protect them against erosion or washing out. The dam’s top elevation is 0.5 m above the maximum elevation of water i.e. 182.2 m. A motor road is planned to be constructed on top of the dam. The road will be made up of 810 reinforced concrete slabs. The slabs will be underlain by one layer of geoweb. The roadside is reinforced by putting a 100 mm layer of gravel onto the geotextiles. The roadbed made of road slabs is 830 m long, and 4.44 m wide.

Figure 2.5 shows the dam’s cross-section.

The selected design solution which provides for construction of the road along the neck crossing and construction of culvert is not going to affect the neck’s hydrological regime, even in case of a drastic increase of the water level, for the head of water in this case will not be substantial.

According to the water level there are two modes of operation of water-discharge facilities which are different in terms of their hydraulic parameters:

a) free flow mode;

b) head-flow mode.
Figure 2.5. Longitudinal Section of the Dam

SEI for Project “Development of the Shady Block of Dengizkul Field”
Free-flow mode means the watermarks of the lake and the bay are identical. The forced-flow mode means that watermarks in the lake and the bay differ by a certain value (H) which is the head.

The assumed layout of the units ensures unimpeded circulation of water masses, both vertically, from surface to bottom, and across the bay, which eliminates the possibility of formation of stagnant zones in the areas of the lake adjacent to the facility. This is the most acceptable solution both from the environmental and hydrological perspective.

2.4 Other Sites and Facilities

The Shady Development Project includes key solutions in the field of heating, ventilation, power supply, communications, HVAC systems for the control rooms at the cluster sites.

Given inconsiderable heat loads required for heating of the control room (container-type unit) and switchboard room and remoteness of heat sources, the control rooms have electrical heating systems in place which in the wintertime maintain the indoor temperature of 5°C (without continuous presence of the maintenance staff).

Operation of the heating system and heating equipment included into the project ensures explosion and fire safety.

The project includes a feasibility study of external power supply systems to be used at the facilities and structures of cluster sites K-1 and K-2:

- option 1 – use the existing 10 kV overhead lines as the power source;
- options 2 and 3 – stand-alone systems using alternative (unconventional) sources of power (wind, solar).

The feasibility calculations of the foregoing options were submitted to the Customer, and OOO “LUKOIL” replied in its letter No. 7881 of 12/25/2009 setting forth its approval of the existing 10 kV electric grid option (option 1).

Measurements of power supply shall be performed using power supply meters.

10 kV overhead line runs across the state fund’s land that is not used for agricultural purposes. Its route has received approval from land owners and other corporate stakeholders.

The crossing of the neck of land across Dengizkul is based on poles. Use of reinforced concrete poles with SV105 posts is the most cost-effective vs. other types of poles and enables standard durable and reliable power supply of users. This is proven by a long period of operation of 10kV overhead lines at Uzbek oil and gas sites located in the steppe zone.

The project provides for use of poles, foundations, equipment and materials that are manufactured in accordance with the applicable national standards (GOSTs), industry specific standards (OSTs) and terms and reference (TUs) and meet the existing standard quality, reliability and operation requirements.

SEI for Project “Development of the Shady Block of Dengizkul Field”
The 10 kV lines are equipped with ShF20 insulator because the area is exposed to saline dust and flying dust from the salt lake of Dengizkul.

The project provides for use of Raychem cases to prevent birds from getting dangerously close to the top live part of the insulators installed on reinforced concrete poles of 10 kV overhead lines and provide corrosion protection of the steel works of the overhead lines against bird droppings.

The scope of work includes fixation of sands around the poles with macadam pavement. The underground surface of reinforced concrete poles of the 10 kV overhead lines and the surface 0.5 m above the ground, as well as reinforced concrete slabs must be coated twice with water-proof compounds.

The selected route and design of the overhead lines are consistent with the environmental requirements and fundamental land management principles of the Uzbek law.

While being constructed and operated, 10 kV overhead lines do not produce any waste that may be detrimental to the environment. 10 kV overhead lines do not cause any pollution of air, soil and sources of water.

The project provides for outdoor lighting of the cluster site and well site. The site is lighted with two searchlights installed 8 m above the ground on the reinforced concrete lightning rod.

There are two 15 m high lightning rods in place that are used for lightning protection.

According to the engineering solutions the items being controlled include:
- wells (20)
- cluster sites K1 and K2;
- flare unit and rack;
- safety valve.

APCS CP is intended for control and management of a range of process equipment used for production and transportation of gas from the Shady Block of Dengizkul field, and specifically:
- stabilize pre-set process modes by monitoring engineering parameters, visualizing, and generating control output to control actuation mechanisms of producers and cluster sites both in the automated and non-automated modes;
- identify accidents and near misses taking place at process units by automatic scanning of sensors connected to the System, analyzing their measurements and switching the process units into the safe mode by automatically generating control output to control actuation mechanisms or at the operating personnel’s sole discretion.

APCS CP enables:
- automatic shut-off of the well cluster site’s process line in case of emergency deviations of the parameters;

SEI for Project “Development of the Shady Block of Dengizkul Field”
- remote emergency shutdown of the well cluster site’s process line from the duty operator’s control board and transfer of process media to the flare line.
- remote control of process parameters and capturing of the basic process parameters;
- automatic regulation of the level of media in the process equipment in case of process parameters deviations;
- automatic alarm that signals if the process parameters (pressure, temperature, etc.) go beyond the permissible levels;
- monitoring of air at the sites (H₂S) and display of information on the control boards;
- current use of the gas contamination warning system.

The engineering communications system being designed enables:
- telephone communications between the control room of PGTP “Khauzak” and control rooms of cluster sites No.1 (K-1) and No.2 (K-2);
- communication channels for the dispatcher control and data collection system (APCS) from the control rooms at cluster sites K-1 and K-2;
- extension of the dispatcher radio telephone network and creation of a radio telephone communications systems which enables communications between PGTP “Khauzak” and repair-and-renewal and operations services working at the newly designed cluster sites and wells.

The preliminary gas treatment plant is where processing, analysis and storage of data takes place, and the time required for accessing such data is minimized.

The equipment included into the project provides a flexible and reliable network structure, enables creation of a common transportation network for all traffic types, telephone communication channels, channels for cross-site connections for USV radio communications, data transmission channels which enable further expansion of the scope of telecommunication services.

FOCL connects the existing operator room of cluster site K-9 with the operator rooms designed for cluster sites K-2 and K-1 and runs along the gas-collecting main to the left of it in the direction of gas transport. The total length of FOCL designed constitutes 16 km. The fiber optic cable is lain manually into 1.2 m deep ditches which are dug using excavators.

The radio telephone USW communications system is intended to enable USW communications between PGTP “Khauzak” and repair-and-renewal and operations services working at the newly designed cluster sites and wells.

The project provides for construction of a 30 m high antenna tower to be used for installation of USW radio communications antennae at cluster site K-1 being designed.

The video surveillance system is intended for round-the-clock video surveillance over the current situation at the cluster sites and wells.
The video surveillance system includes six network video cameras located at the cluster sites being designed, three cameras at each site. Two fixed video cameras and one rotating video camera shall be installed at each cluster site being designed.

The video cameras are installed in thermal cases which protect them against exposure to adverse environmental conditions.

Images from the video cameras are televised to the video surveillance equipment of PGTP “Khauzak”.

The uninterrupted power supply system installed in the operator rooms of the cluster sites is used to provide electric power to optical switches and video cameras.
3 Assessment of Expected Environmental Impact

To determine the quantitative and qualitative impact of the facility under review upon the environment, the draft SEI includes an analysis of the major sources of pollution, condition of the sites exposed, entry of harmful substances into the environment, and withdrawals of natural resources associated with the activities of OOO “LUKOIL Uzbekistan Operating Company”, and intensity, duration and geography of such impact.

3.1 Atmospheric Impact

The quality, quantity, volumes and properties of atmospheric emissions of pollutants, and therefore, levels of environmental impact were determined on the basis of the available inputs.

The major sources of atmospheric impact resulting from operations of the facilities in the Shady Block include:

- flare unit and cluster site K-1;
- flare unit and cluster site K-2;
- Flare unit of PL, the existing flare unit of the shutdown valve to enable discharges from PR.

Sources of pollutants within the cluster site include the flare unit and uncontrolled emissions from the site’s block-valve stations.

Flaring results in emissions of such pollutants as: carbon oxide, nitric dioxide, nitric oxide, hydrocarbons (methane), sulfur dioxide and soot. Flaring is continuous. Raw gas is fed to the flare unit in the course of well blowdown operations. The volume of gas being flared fed from one well, given its average forecasted well flow, is going to constitute around 691500 cu.m/year.

The number of wells connected to cluster K-1 is seven. There will be equipment in place to enable one backup connection and two future wells. The cumulative volume of formation gas being flared at K-1 will be 6915000 cu.m/year or 0.219273 cu.m/sec. With the raw gas density of 0.777 kg/cu.m, the weight flow will be 170.3751 g/sec.

Please note that to maintain standby burning at 10 cu.m/hr, 0.002778 cu.m/second raw gas will be fed to the flare unit equipped with two pilot lights. Its weight flow will be 2.1113 g/sec.

Pollutants at industrial site K-1 include: hydrocarbons (methane) and hydrogen sulfide. Sources of pollution are non-leak-proof spots of shut-off and control valves. The source operates on a round-the-clock basis i.e. 8760 hr/year.

The overall number of shut-off and control valves installed at site K-1 is 131. There occur leaks of the gas streams if the stream leak through one valve is 5.83 mg/sec and the calculated ratio of seals that have become leaky is 0.293. The methane volume fraction is 89.42% and that of hydrogen sulphide is 3.19%.

SEI for Project “Development of the Shady Block of Dengizkul Field”
The properties of released substances and discharges taking place at cluster site K-2 are identical to those of K-1.

The sources of pollutants on the linear part of the gas pipeline include the flare units of pig launchers and pig receivers, and the linear valve. Burning of gas may cause the following substances to be emitted to the air: carbon oxide, nitric dioxide, nitric oxide, (methane) hydrocarbons, sulfur dioxide and soot.

The amount of harmful emissions from the pig launcher’s and pig receiver’s flare unit is identical to that of Khauzak.

The project does not provide for construction of a flare unit of the pig launcher and pig receiver; from the treatment plant gas will be fed to the existing flare unit of the safety valves of PGTP “Khauzak” (500 m off the preliminary gas treatment plant). Pollutants also include carbon oxide, nitric dioxide, nitric oxide, (methane) hydrocarbons, sulfur dioxide and soot.

A linear valve with the conditional diameter of 400 m must be installed at the 10th km of the gas main from K-1 to the preliminary gas treatment plant. A 35 m high flare unit with the conditional diameter of 300 mm must be in place to bleed (burn) gas. The volume of fuel gas required to maintain standby burning at 15 m/hr (3 pilot light burners) or 131400 cu.m/year. Given the density of fuel gas of 0.76 kg/cu.m, the weight flow will be 3.192 g/sec.

The amount of harmful emissions from the linear valve’s flare unit is identical to the flare units of Khauzak’s valves.

Tables 3.1 and 3.2 list pollutants by emission sources and their components.

<table>
<thead>
<tr>
<th>Source of harmful emissions</th>
<th>Pollutant</th>
<th>Emissions g/sec.</th>
<th>Emissions tn/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster site K-1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flare unit at K-1</td>
<td>Carbon oxide</td>
<td>9,831725</td>
<td>310,053</td>
</tr>
<tr>
<td></td>
<td>Nitrogen dioxide</td>
<td>0,275978</td>
<td>8,704</td>
</tr>
<tr>
<td></td>
<td>Nitrogen oxide</td>
<td>0,068995</td>
<td>2,176</td>
</tr>
<tr>
<td></td>
<td>(Methane) hydrocarbons</td>
<td>5,174592</td>
<td>163,184</td>
</tr>
<tr>
<td></td>
<td>Sulfur dioxide</td>
<td>20,007328</td>
<td>630,951</td>
</tr>
<tr>
<td></td>
<td>Soot</td>
<td>0,00614</td>
<td>0,194</td>
</tr>
<tr>
<td>Industrial site of cluster K-1</td>
<td>(Methane) hydrocarbons</td>
<td>0,200098</td>
<td>6,310</td>
</tr>
<tr>
<td></td>
<td>Hydrogen sulfide</td>
<td>0,007138</td>
<td>0,225</td>
</tr>
<tr>
<td>Total for K-1</td>
<td></td>
<td><strong>35,57199</strong></td>
<td><strong>1121,797</strong></td>
</tr>
<tr>
<td>Cluster site K-2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flare unit at K-2</td>
<td>Carbon oxide</td>
<td>9,831725</td>
<td>310,053</td>
</tr>
<tr>
<td></td>
<td>Nitrogen dioxide</td>
<td>0,275978</td>
<td>8,704</td>
</tr>
<tr>
<td></td>
<td>Nitrogen oxide</td>
<td>0,068995</td>
<td>2,176</td>
</tr>
<tr>
<td></td>
<td>(Methane) hydrocarbons</td>
<td>5,174592</td>
<td>163,184</td>
</tr>
<tr>
<td></td>
<td>Sulfur dioxide</td>
<td>20,007328</td>
<td>630,951</td>
</tr>
<tr>
<td></td>
<td>Soot</td>
<td>0,00614</td>
<td>0,194</td>
</tr>
<tr>
<td>Industrial site of cluster K-2</td>
<td>(Methane) hydrocarbons</td>
<td>0,200098</td>
<td>6,310</td>
</tr>
</tbody>
</table>
Table 3.2 List of Pollutants on the Shady Block

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Atmospheric emissions</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>g/sec.</td>
<td>tn/year</td>
</tr>
<tr>
<td>Carbon oxide</td>
<td>21,984468</td>
<td>693,302</td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>0,617107</td>
<td>19,463</td>
</tr>
<tr>
<td>Nitrogen oxide</td>
<td>0,154278</td>
<td>4,866</td>
</tr>
<tr>
<td>Hydrocarbons (methane)</td>
<td>11,970968</td>
<td>377,512</td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td>43,568148</td>
<td>1373,964</td>
</tr>
<tr>
<td>Soot</td>
<td>0,066212</td>
<td>2,09</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>0,014276</td>
<td>0,450</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>78,375</strong></td>
<td><strong>2471,647</strong></td>
</tr>
</tbody>
</table>

Cumulative standard emissions from the Khauzak and Shady Blocks will amount to 7897.05 tn/year (see Table 3.3). Shady’s emissions will make up 31.3%.

Table 3.3 – Cumulative Emissions of Pollutants from the Khauzak and Shady Blocks

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Total amount of pollutants emitted by all sources in Khauzak and Shady, tn/year</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>7897,054544</td>
</tr>
<tr>
<td><strong>Including solid:</strong></td>
<td>15,066795</td>
</tr>
<tr>
<td>Soot</td>
<td>11,200273</td>
</tr>
<tr>
<td>Metal dust</td>
<td>0,151801</td>
</tr>
<tr>
<td>Abrasive dust</td>
<td>0,089413</td>
</tr>
<tr>
<td>Iron oxide</td>
<td>0,029800</td>
</tr>
<tr>
<td>Cement dust</td>
<td>0,004259</td>
</tr>
<tr>
<td>Inorganic dust</td>
<td>3,587069</td>
</tr>
<tr>
<td>Magnesium dioxide</td>
<td>0,002180</td>
</tr>
<tr>
<td>Silicium oxide</td>
<td>0,002000</td>
</tr>
<tr>
<td><strong>Gaseous and liquid:</strong></td>
<td><strong>7881,987749</strong></td>
</tr>
</tbody>
</table>
To determine the levels of atmospheric pollution during the facility’s operation, the analysis of bottom layer concentrations for emission sources in Shady was done at two sites and took account of the sanitary protection zone. SanPiN No. 246-08 [6] requires that sanitary protection zones of natural gas production enterprises must be 1000 m. For individual wells that fall under the 2nd hazard category, the size of the sanitary protection zone must be 500 m.

Regulation of emissions was done in accordance with the ground level concentrations that make a part of the rated operating conditions existing outside of the industrial sites/sanitary protection zones (next to PGTP “Khauzak”) and the existing quotas.

The inputs used in such calculations included the properties of atmospheric emission sources, estimated quantitative and qualitative composition of pollutants, and meteorological descriptions and coefficients that affect dispersion of chemicals in the air of the facility’s location.

K-1, K-2 and PL site.

The calculations reveal that:

- the maximum forecasted concentration of carbon oxide outside of K-1 and K-2 is about 0.26 MPC. The concentration of impurities next to PL may reach 0.25 MPC (see Figure 3.1);
- the maximum forecasted concentration of nitrogen dioxide outside of K-1 and K-2 is about 0.09 MPC. The concentration of impurities next to PL may reach 0.08 MPC (see Figure 3.2);
- the maximum forecasted concentration of sulfur dioxide outside of K-1 and K-2 is about 0.28 MPC. The concentration of impurities next to PL may reach 0.26 MPC (see Figure 3.3);
- the maximum forecasted concentration of hydrogen sulfide outside of K-1 and K-2 is about 0.22 MPC. The concentration of impurities next to PL may reach 0.13 MPC (see Figure 3.4);
- the maximum forecasted concentration of soot outside of K-1 and K-2 is about 0.03 MPC. The concentration of impurities next to PL may reach 0.02 MPC (see Figure 3.5);
- the maximum forecasted concentration of (methane) hydrocarbons outside of K-1 and K-2 is about 0.01 MPC. Concentrations next to PL may reach 0.01 MPC (see Figure 3.6).

The data of the analysis suggest that atmospheric pollution caused by operation of sites K-1, K-2 and PL will be moderate. No excess over the maximum permissible concentrations of pollutants is forecasted.

SEI for Project “Development of the Shady Block of Dengizkul Field”
Figure 3.1 – Highest Concentrations of Carbon Oxide Outside of the Cluster Sites and Pig Launcher Site
Figure 3.2 - Highest Concentrations of Nitrogen Dioxide Outside of the Cluster Sites and Pig Launcher Site
Figure 3.3 - Highest Concentrations of Sulfur Dioxide Outside of the Cluster Sites and Pig Launcher Site
Figure 3.4 - Highest Concentrations of Hydrogen Sulphide Outside of the Cluster Sites and Pig Launcher Site
Quota = 0.33 MPC

MPC = 0.15 mg/cu.m

MPC fractions

Figure 3.5 - Highest Concentrations of Soot Outside of the Cluster Sites and Pig Launcher Site
Figure 3.6 - Highest Concentrations of (Methane) Hydrocarbons Outside of the Cluster Sites and Pig Launcher Site
Calculations of emissions caused by operations of the pig receiver site with relevant sources of PGTP “Khauzak” suggest that:

- the maximum forecasted concentration of carbon oxide outside of the sanitary protection zone is 0.05 MPC (Figure 3.7);
- the maximum forecasted concentration of nitrogen dioxide outside of the sanitary protection zone is 0.25 MPC (Figure 3.8);
- the maximum forecasted concentration of sulfur dioxide outside of the sanitary protection zone is 0.19 MPC (Figure 3.9);
- the maximum forecasted concentration of soot outside of the sanitary protection zone is 0.04 MPC (Figure 3.10);
- the maximum forecasted concentration of (methane) hydrocarbons outside of the sanitary protection zone is 0.01 MPC (Figure 3.11).

In consideration of the foregoing one can state that atmospheric protection will be moderate. No excess over the maximum permissible concentrations of pollutants is forecasted.
Figure 3.7 – Highest Concentrations of Carbon Monoxide Outside of the Pig Launcher Site Given the Existing Emissions from PGTP “Khauzak”
Figure 3.8 - Figure 3.7 – Highest Concentrations of Nitrogen Dioxide Outside of the Pig Launcher Site Given the Existing Emissions from PGTP “Khauzak”
Figure 3.9 - Highest Concentrations of Sulfur Dioxide Outside of the Pig Launcher Site Given the Existing Emissions from PGTP “Khauzak”
Figure 3.10 - Highest Concentrations of Soot Outside of the Pig Launcher Site Given the Existing Emissions from PGTP “Khauzak”
Quota = 0.50 MPC
MPC = 50.0 mg/cu.m

- UAPCP “Ekolog” -

Figure 3.11 - Highest Concentrations of (Methane) Concentrations (Outside of the Pig Launcher Site Given the Existing Emissions from PGTP “Khauzak”

Republic of Uzbekistan

Republic of Turkmenistan

SEI for Project “Development of the Shady Block of Dengizkul Field”
Figure 3.12 - Highest Concentrations of Carbon Monoxide Outside of the Cluster Sites and Pig Launcher Site

SEI for Project “Development of the Shady Block of Dengizkul Field”
3.2 Withdrawal of Water Resources, and Wastewater Discharge

Operations of the cluster sites and the linear part of the gas pipeline do not include consumption of water for household and drinking purposes due to the fact that the facilities are unmanned. No water is intended to be used for production or fire-suppression purposes during the operation of the facilities under review. The facilities under review are not going to produce any wastewater.

Quite large amounts of water will be required for performance of leak-tightness tests of the gas pipeline prior to its commissioning.

Possible options which were considered for inclusion into the project included gas and water testing of the gas pipeline. Fuel gas testing of pipelines necessarily entails release of gas into the air, which is undesirable, given the environmental requirements of the Republic of Uzbekistan and the Customer’s environmental policies.

Natural gas may be used to perform void pigging and testing of the gas pipeline only in exceptional cases, whereas the use of sulfur dioxide for pipeline testing purposes is prohibited.

Therefore the water testing option was included into the project.

Removal of dirt, and soil and other items that happen to be inside the pipeline, must take place prior to pipeline testing. Void pigging must be performed at each and every stage of pipeline handling operations: transportation, loading, unloading, movement and laying of sections along the route, welding of sections into one line, and laying thereof.

To eliminate contamination of the hollow space of the pipeline and reduce the cost of subsequent pigging, the relevant construction and assembly organization must, in the course of construction, take measures to rule out any possibility of water, snow, soil and other foreign items getting inside the pipeline, including, withhold from unloading of pipes onto platforms that have not been previously prepared for such purpose, dragging of pipes on the ground, etc. Temporary plugs must be used to eliminate contamination of the hollow space.

Pigging and testing are the final process operations of the entire range of linear pipeline construction activities.

Strength testing must follow pigging activities.

The techniques, parameters and schemes of pipeline strength testing shall correspond to a specific procedure, developed by the construction organization, that takes account of the local working conditions.

Washing and testing water shall be pumped into the pipeline through filters which rule out the possibility of sand, clay or foreign objects getting into the pipeline.

Sources of water for hydraulic testing include natural or artificial water bodies that are crossed by the pipeline or located next to it. The amount of water in such sources must be sufficient for
performance of tests, and its level (irrespective of the presence of filters) must make sure that the water fed to the pipeline is clean (i.e. does not contain any mechanical impurities).

The proposed source of water for hydraulic testing is Dengizkul Lake. For water intake purposes temporary water intake facilities may be constructed at the water body, with their head walls being equipped with fish-protecting units.

Testing of flow lines whose total length is 17.6 km, diameter - 0.168 m, and the wall thickness – 0.014 m will require 271 cu.m of water, testing of the 0.5 km long gas collecting main that is 0.273 m in diameter with 0.014 m thick walls will require 24 cu.m; and testing of a 21.5 km long collecting main that is 0.426 m in diameter with 0.016 m thick walls will require 262023.8 cu.m. Given the loss factor of 1.012 the required volume of water is 2950 cu.m. Water intake will meet all of the conditions required to prevent any adverse impact upon Dengizkul’s fish fauna, and the area of water intake will be enclosed with special fish-protecting nets. The requisite precondition of water intake activities is the maintenance of water consumption records.

The techniques, parameters and schemes of gas pipeline void pigging and strength testing shall correspond to a specific procedure, developed by the construction organization, that takes account of the local working conditions. The techniques, parameters and schemes of tests which specify water intake and discharge locations must be subject to approval by corporate stakeholders.

There is practically no contamination of water during hydraulic testing, and the chemical composition of water remains unchanged. The amount of water removed from the pipeline following hydraulic testing will equal to that of taken water, i.e. 2950 cu.m. Such water may be categorized as conditionally clean.

VSN 011-81, clause 4.12 recommends that used water from the linear section, in case of lack of sources of water located in the immediate proximity, be discharged onto the terrain into natural lowland areas (pits, ravines, etc.) or specially prepared water bodies (oil and sludge pits made in the form of a ditch, or by dyking such water bodies). No water shall be released immediately on the slopes without making sure that they are duly protected against washing out.

It is required to install baffles (e.g. reinforced concrete cantledges, slabs etc.) to dissipate the energy of the stream coming out of the pipeline.

3.3 Generation of Solid Waste

Enterprises normally generate production and consumption waste, including solid household waste. No solid waste is expected to be generated at the well sites during the operation thereof. The expected waste at the linear section of the gas pipeline is sludge generated by gas pipeline pigging activities. There will be periodical generation of waste at the pig receiver which will be located next to PGTP “Khauzak”.

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The standards require that an underground condensate gathering tank should be in place made of the same pipe as the gas pipeline and used for removal of the gas pipeline cleaning waste. The capacity of the condensate gathering tank must be calculated in accordance with the degree of contamination of the gas, and the pre-set cleaning cycle. Cleaning of the gas pipeline shall be performed as necessary, and therefore waste is fed to the condensate gathering tank periodically.

Such waste represents a mixture of mechanical impurities, hydrocarbons and water. The amount of waste depends upon the degree of pollution and humidity of the gas being transported through this section of the gas pipeline, and should be determined by experiment. The annual weight of such waste type was determined by experiment on the basis of actual measurements. Lessons learned during the operation of Dengizkul Field suggest that the volume of fluid displaced by the piston is 70-80 cu.m and such fluid has 97% of water. Up to 320 tn of waste may accumulate over a year. The gathering tank is not intended for long-term storage, for the residue is hard to remove after it solidifies. The waste will be transported in cesspool emptiers to the existing landfill of GPW “Khauzak” used for temporary storage and disposal of drilling waste. A special mechanism is used for loading of cesspool emptiers.

Thus, if the project is implemented, the waste being generated will only include sludge generated by gas pipeline pigging activities which belongs to the 3d hazard class.

The area’s lighting system will also from time to time generate waste. It is normally arc mercury lamps falling under the 1st hazard category that are used for such purposes. The project provides for outdoor lighting of the cluster sites and well sites using two searchlights. Thus, the outdoor lighting system of the facilities being designed includes 30 lamps whose service life makes up 12 000 hours. Each lamp weighs 400 g. Given the average daily period of operation of 12 hours a day, the weight of used lamps accumulated over one year will be 0.0047 tn.

Inoperable lamps are replaced with new ones. Used lamps are temporarily stored at the storage facility of GPW “Khauzak” and then, as they accumulate, they are transported to the relevant enterprise that specializes in recycling of mercury lamps (TK “Sitora”).

Given the absence of permanent staff at the sites, there will be no generation of solid domestic waste.

### 3.4 Impact on Land

The impact upon land, soil and vegetation is accounted for by withdrawal of land lots for (long-term) and temporary (during the construction period) use, and mechanical disturbance of the soil and vegetative cover on such land lots as a result of operation of construction and digging machinery.

The area of the permanent allotment of land is insignificant and will be around 3 ha. The area of land to be allotted on a temporary basis should be at least 91 ha, which will be subsequently subject to

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reclamation and returned to its owner. Land lots located in the pipelines’ protection areas shall not be subject to withdrawal form land users and shall be used for agricultural and other activities in strict conformity with the safety requirements.

The soils of the area under review and adjacent territories constitute a naturally low fertility zone. Analysis of the condition of the soil cover in the exposed areas reveals that construction activities are being conducted in areas which are unfit for cultivation of crops due to their low fertility.

Most of the impact will be caused by disturbance of the soil structure.

Soils are the most exposed to gas pipeline laying activities (flow lines, gas collecting main, fuel gas pipeline). Construction of the facilities being designed will result in disturbance of the soil layer. The project includes technical and biological reclamation activities which allow to reduce the adverse impact on the soil cover. Reclamation activities will promote restoration of the initial state of the biogeocenosis.

Atmospheric emissions of pollutants from the facilities being designed with time will settle on the soil. It may occur both due to natural settling, and in the form of solutions during precipitation. Lessons learned from the operation of gas pipelines show that pollutants emitted to the air from sources at the facilities being designed mostly settle within the sanitary protection zone.

Provided that soil protection and accident-free operation activities are implemented, the impact on the soil will be minor.

The most environmentally vulnerable is the crossing of Dengizkul’s neck. Initially the soil cover in the allotted area is forecasted to be disturbed (due to mechanical exposure). Subsequently, the soil and vegetative cover will be impacted by pipeline maintenance activities.

To restore land lots and, to a certain degree, vegetation disturbed in the course of construction and assembly operations, it is planned to implement reclamation measures.

The entire scope of construction activities will be done only within the allotted area to eliminate any uncontrolled disturbances of soil and vegetation. No vehicles are allowed to travel off-road.

To eliminate contamination of soil and vegetation, fueling activities and storage of fuels and lubes will only be allowed in special hard-surfaced and fully dyked locations.

3.5 Impact on Biotic Environment

Any anthropogenic interference taking place under desert conditions affects living organisms to a certain extent. Even a minor disturbance of the soil and vegetative cover causes the habitats of the biocenosis to shrink. Almost all flora and fauna species inhabiting the area under review are common for the biotypes adapted to living the arid zone. Animals (predominantly smaller rodents, reptiles and
birds) may find it very stressful to find themselves in the areas allotted for construction activities, with such stress being caused by both immediate sources of stress, and through food chains.

Disturbance of the surface along onshore ditches taking place during construction will result in complete destruction of the vegetative cover within the allotted area. Physical exposure mostly reveals itself in disruption of soils, destruction or thinning of biocenoses along the ditches, at the sites around the camps of mobile construction crews.

Construction of the underground crossing will, above all, adversely impact the ecosystem’s most sensitive component i.e. aquatic biota. The following are the effects that may emerge at this stage:
- demise of bottom species in the earthwork locations;
- suppression and demise of benthos and plankton in areas with increased turbidity caused by dredging;
- detrimental effect on fish stock caused by shrinking of food reserves;
- disturbance of the fish fauna habitats;
- noises, vibrations, and lighting that may scare off the avifauna.

Construction of the underwater crossing requires a large scope of earthwork to be performed, including trenching in lakeside and floodplain areas, filling of trenches, bank consolidation, construction of drainage channels, coffer dams, and location of construction sites in the lakeside area.

Mechanized trenching causes the concentration of mineral particles suspended in water to grow dramatically. The most common effects include intense turbidity and substantial contamination while trenching in clayey soils. The foregoing effects are detrimental to aquatic organisms, and the living environments of fish, plankton and benthos. Fish’s gills get blocked, spawning grounds, foraging sites and feeding areas are either contaminated or fully destroyed. A failure to properly choose a location for underwater stacking of ground being excavated may result in disruption of the feeding and spawning migrations of fish or filling up of wintering holes. Please note that the requirements for the composition of water in the water bodies are very stringent. The content of suspended substances, including soil particles, shall not exceed the natural content plus 0.25-0.75 mg/l.

It will take a long time to restore the bed disturbed by construction of the crossing. Disruption of the structure of soils caused by lakeside and bottom trenching will bring about fundamental changes in their properties. Here belong increased porosity of the soil, reduced cohesion and shear strength of the soil. Such changes are one of the causes of scours, especially in lakeside areas.

Considerable, and often irreparable damage is done to minor water bodies by construction of crossings with excavators operating from the bank or temporary dams, drag scraper machines, pneumatic and hydraulic soil samplers. Sometimes, the activities performed included temporary channel change and performance of earthwork immediately on the water body’s bottom. It is not always
that upon construction of crossings, constructions companies restore the channel of the crossing (partial dam removal, preservation of the temporary channel, etc.) which results in changes of the channel, swamping, bushing of the banks or changes in their regime and water content. Nonetheless, cross-flows and shallow waters play an important role as spawning grounds and feeding areas of fish, and sources of replenishment of water in the lake.

Changes in biodiversity will result in disruption of ecosystems and any business activities may accelerate such adverse processes.

However, given the land reclamation and vegetation restoration activities included into the project i.e. planting of various shrubs and trees, the impact of the construction activities upon natural complexes will be insignificant.

Considering the nature, scope and times of the planned activities, harmful emissions taking place during the operation of the facilities, and provided that the sites and facilities are operated on an accident-free basis, atmospheric emissions may be forecasted to have a minor suppressive effect on biocenoses.

Performance of all of the construction-related requirements will help minimize the environmental damage, promote rapid restoration and adaptation of biota to new man-made facilities.

Accidents involving burning of gas and pollution of air may be the most detrimental to flora and fauna. Specialized process measures ensuring reliable operation of the equipment must be developed to prevent occurrence of such accidents.

The project’s man-caused loads will not exceed the self-restoration potential of the ecosystems.

Accidental blowouts of formation fluid (open flowing, breaking of the gas pipeline or flow line) may have the most detrimental effect on the flora and fauna which will manifest itself in their degradation. However such accidents are unlikely to occur and the proposed gas production, gathering and transportation technique demonstrates a sufficient degree of reliability.

### 3.6 Noise and Vibration

In addition to polluting the air with chemicals, the facilities being designed may be sources of acoustic action caused by the operation of motor vehicles and machinery, which produce noise and are used in construction activities. The resultant physical action on air is caused by various levels of sound pressure, which affects the man and animals through the atmosphere.

When exposed to the noise produced by machinery being used in construction and assembly operations, smaller animals and insects may migrate or partially die.
Man-induced noises are a type of anthropogenic impact upon the environment. Not only do they have a powerful effect on personnel working next to sources of noise, but they also adversely impact the entire biocenosis within its habitats.

The harmful effect of the noise is accounted for by several factors: intensity (in dB), frequency (the most dangerous are high-frequency noises), duration (the intensity of adverse effects of the noise is proportionate to the duration of exposure to it) and the nature of noise (the most dangerous is impulsive noise).

Noise or acoustic pollution belong to the category of purely environmental factors (direct environmental impact) for it directly and solely impacts living organisms. The major source of noise is motor vehicles, construction machinery and equipment which contribute into the noise field.

The issue of restricted noise pollution shall be addressed in combination with the influence of vibration on the environment. The term “vibration” means fluctuations with a relatively low amplitude and not too low a frequency. Vibration in solid bodies means standing or traveling acoustic waves, which, upon reaching the interface, are either reflected or enter another medium. At the same time fluctuations of air in space produce airborne noise.

Vibration may occur in various equipment due to imperfections of their design, improper operation, external conditions (e.g. relief of the roadbed used by motor vehicles). There’s also purposefully generated vibration. Resonance may cause vibration to increase.

The most complex stage will be the construction stage involving use of a lot of machinery and equipment. However exposure to the construction activities will be time-limited. The construction period is 18 months, and the preparatory period lasts 4 months. The exposure will be periodical and local. The noise and vibration exposure will be moderate both for the working staff and the environment.

Traffic noise is a non-permanent type of exposure. Heavy trucks and specialized vehicles produce more noise, whereas passenger cars are less noisy.

The level of noise during construction will reach 80-100 dB which is comparable to the noise of city streets and may cause mammals to feel anxious. The short-lived nature of construction activities makes it possible to assume that noise exposure will not have any material effect on the biocenosis.

When operated on the roadside and given the low traffic intensity, the level of noise produced by heavier trucks is 56 dB, and that of passenger cars and buses is 42-44 dB. No substantial environmental impact caused by the noise and vibration of motor vehicles is forecasted due to small average annual daily traffic intensity (under 50 motor vehicles a day).
3.7 Social and Economic Aspects

The primary business goal of the Shady development project is to produce additional quantities of natural gas and gas condensate.

From the economic perspective natural gas is of critical importance for it is used as chemical raw stock and one of the most efficient fuels, it is the most environmentally friendly, high-quality and the most cost-effective vs. coal and fuel oil.

The facilities being designed are intended to operate as unmanned ones, however the number of personnel engaged in construction activities will be 108 people. The labor force requirement is planned to be met by construction companies’ personnel and free employment of personnel, including out of the residents of settlements which are the closest to the construction site.

The facilities being designed are located in Alat District, where the level employment is low due to the district’s focus on agricultural activities. As the official statistics have it, about 44% of the labor pool are employed. The major part of the unemployed are youths and women. Creation of new jobs, even for the time of construction, is a positive social contribution into the district’s life.

Analysis of the environmental impact in the area of the construction site reveals that any adverse impact on the health of personnel resulting from operation of the wells, cluster sites, flow lines and gas mains is completely ruled out.

Being successfully addressed the issue of efficient economic development through use of internal resources and engagement of foreign investments creates an environment for self-development, self-assertion and financial prosperity of the people.

Exports of gas to the neighboring countries will generate foreign currency proceeds, required inter alia for further development of the oil and gas industry and addressing of other issues faced by the state. The planned construction activities will facilitate improvement of the social and economic situation in the country.

The possibility of direct harmful impact on the people is almost fully ruled out due to the absence of residential districts within the area being reviewed.

Please note that from the republic-wide perspective, performance of the construction activities and additional production of gas and gas condensate belong to the measures aimed at creating a sustainable rawstock base, thus providing the population and industry with fuels and petroleum products in the planned quantities.

Therefore the social and economic effect of the project being reviewed is obvious.
4 Environmental Monitoring

In the course of performance of the Oil and Gas Operations both on the Shady Block and in all other contract areas, OOO “LUKOIL Uzbekistan Operating Company” (hereinafter referred to as the Operator) shall be guided by the provisions of the Health, Safety and Environment Policy approved by the resolutions of the Steering Committees of 06/05/2009. (Annex No.1 to the Operator’s order No.226 of 07/24/2009).

This Policy is based on enhanced industrial and environmental safety of industrial sites, reduction of emissions and discharges of pollutants and waste through introduction of new cutting-edge technologies, improved reliability of process equipment and safe and accident-free operation thereof.

To ensure better implementation of the Health, Safety and Environment Policy the Operator has an Integrated Health, Safety and Environment Management System in place, which is subject to continuous improvement (hereinafter referred to as "IMS") and was created in accordance with ISO 14001 and OHSAS 18001.

With IMS in place the Operator assumed the obligation to operate in conformity with the requirements established by the Uzbek law, international conventions and treaties to which Uzbekistan is a party, and the requirements imposed by the International Finance Corporation for Environmental Preservation, as well as other health, safety and environment requirements.

As required by the environmental law of the Republic of Uzbekistan and Article 23.7 of PSA, the Operator shall, from the commencement of the Oil and Gas Operations and on, conduct in-house environmental monitoring of the contract areas which is one of the Operator’s top-priority obligations.

Pursuant to Article 23.4 of PSA and prior to commencement of the Oil and Gas Operations the Environmental Monitoring of the Khauzak-Shady Blocks was performed in 2004 which helped determine the initial environmental state of the Contract Area.

The basis for performance of the environmental monitoring activities shall be compliance with the following requirements:

   - Article 28 “Natural Environment Monitoring”;
   - Article 29 “Goals of Environmental Monitoring”;
   - Article 32 “In-House, Production and Public Environmental Control”.

2. Production Sharing Agreement for the Khauzak and Shady Blocks made by and between the Republic of Uzbekistan and a consortium of investors comprising OAO “Oil Company “LUKOIL” and NHC “Uzbekneftegaz” on 06/16/2004:
- Article 23 "Environmental Protection and Occupational Safety", and specifically, 23.4 “Environmental Audit”, and 23.7 “Continuous Monitoring”;

3. Health, Safety and Environment Policies;

4. Production Environmental Control Regulations approved by the Operator’s order No. 25 of 02/05/2010;

5. Programs of in-house monitoring of the state of environment in the course of the Oil and Gas Operations on the Khauzak-Shady Blocks of Dengizkul Field;

6. Terms of reference for in-house monitoring of the state of environment in the course of the Oil and Gas Operations on the Khauzak-Shady Blocks of Dengizkul Field;

In accordance with the previously developed Programs which received approval from the State Nature Protection Committee of the Republic of Uzbekistan, 2005-2010 saw performance of the in-house environmental monitoring in the course of the Oil and Gas Operations. Contractor General: State Specialized Inspection of Analytical Control.

The surface water monitoring focused on:
- Dengizkul Lake (areas located next to the cluster sites);
- outfall sewer (background water stream cross-section).

The typical factors describing hydrosphere pollution included concentrations of organic substances and petroleum products.

The facilities being operated on the Khauzak-Shady Blocks were found to have no impact on the water of Dengizkul, and variations of pollutants in the lake’s surface water are fully dependent on the composition of water in the outfall sewer and the area’s natural and climatic conditions. Please note natural accumulation of pollutants in the locations of local stations.

The air monitoring activities focused on:
- cluster sites;
- preliminary gas treatment plant and treatment facilities;
- field support base, gas stations and the camp;
- utilities corridor;
- drilling waste disposal landfill.

The typical air pollutants include hydrocarbons, nitrogen, carbon, sulfur oxides and hydrogen sulfide.

Atmospheric monitoring revealed that:
- concentrations of hydrogen sulfide throughout the entire area exceed MPC, background pollution levels are also high, over the 2007-2010 period the concentrations of hydrogen sulfide did not exceed the levels identified in the course of Environmental monitoring.
- concentrations of nitrogen and sulfur oxides are almost equal to the background levels and have the same variations; no excess over MPCs and the Environmental Audit levels were recorded in 2007-2010;

- concentrations of carbon oxides are generally higher than the background levels, and the Environmental Audit levels, with the difference between the background levels and those recorded at the local stations not going beyond the 0.5 MPC quota.

Soil and ground monitoring focused on:
- cluster sites and wells;
- preliminary gas treatment plant and treatment facilities;
- field support base and the camp;
- utilities corridor;
- drilling waste disposal landfill;
- gas stations.

The typical soil pollutants include petroleum products and salinization (dry residue).

The analysis data suggest that the concentrations of all typical components in the soil of the Khauzak-Shady Block measured at the local stations do not exceed the background values and are substantially lower than the Environmental Audit levels.

This proves the efficiency and timeliness of the reclamation of disturbed land and streamlining of the waste handling practices being applied by the Operator.

The 2011 environmental monitoring program provides for inclusion into the existing fixed observation network of additional stations on the Shady Block next to the wells under construction, construction of crossing of Dengizkul Lake’s neck and a station to monitor the actual elevation of water in Dengizkul Lake (Figure 4.1). The previously successful monitoring technique is used in this program without any changes.
Figure 4.1 – 2011 Location of Monitoring Stations
5 Measures to Reduce Environmental Impact

One of the priorities of any business activities is environmental protection and preservation. OOO “LUKOIL Uzbekistan Operating Company” has been contributing a lot of effort to maintain the balance of its business and environmental performance on the Khauzak and Shady Blocks of the Dengizkul Field and outside of such blocks.

In addition to rigorous observance of the environmental laws of the Republic of Uzbekistan, the company’s operations are based on a systemic approach to address environmental issues, the best and long-term environmental research-based strategy, application of scientific development and cutting-edge technology which contribute into better reliability of equipment and minimize the adverse impact upon ecosystems.

The analysis of environmental, social and economic effects of the planned activities reveals that the most important adverse effects of the planned activities are atmospheric emissions, and exposure of soils and Dengizkul Lake to pipeline laying and motor road construction activities, and the risk of occurrence of accidents. Generally speaking, the processes and process equipment that constitute the Shady Block development complex meet the up-to-date requirements, with the basic one being application of cutting-edge technology which ensures safety of people, property and environmental safety.

The analysis of accidents at gas production and transportation facilities reveals that the most frequent cause of accidents is corrosion, which is particularly important when gas contains hydrogen sulfide.

For this reason the project includes a range of corrosion prevention measures. Pipelines must have a reliable internal corrosion protection which is achieved through application of protection techniques, internal coatings, rust preventers, cleaning of pipelines from water and solids. The appropriateness of a specific protection technique (or a combination of such techniques) at various stages of pipeline operation will be supported by cost analysis, as well as the appropriateness of application of external corrosion prevention in the form of application of insulating materials and cathodic protection.

The field development project requires that pipelines have points equipped with sensors and secondary control instrumentation to monitor the internal corrosion rate.

Construction of the gas pipeline will be taking place at the time of the lowest water level.

The underwater crossing part of the pipeline will be buried into the bottom to prevent reduction of the pipe’s flow area, which is accompanied by alternating transversal protuberances and concavities of the wall, and resulting from loss of stability due to lateral bending combined with axis bending, and the assumed burying depth takes account of potential bed deformations at the place of such crossing.

The pipeline wall is designed reinforced with its thickness being determined by strength calculations in accordance with the pipeline section’s category, parameters of the media being transported and its design.
The isolation valves of infield pipelines are installed at calculated distances, which ensure mutual safety of the pipeline sections and meet the environmental requirements.

The isolation valves are installed in accordance with the design that takes account of the terrain at the beginning of each pipe branch which is over 500 m long on both sides of water barriers.

Onshore burying of pipelines depends on their preservation requirements, mode of transportation and properties of the media being transported. The pipes mostly have manufacturer-applied three-layer corrosion-resistant coating to protect pipelines against soil corrosion.

If pipes are supplied without manufacturer’s insulation to protect gas pipelines against soil corrosion and protect joint pieces, application of a 0.635 mm thick band is one of the possible options. Three-layer cups may be used for protection of welded joints.

If laid in soils that contain crushed stones and pebbles, pipelines must have a soft soil protection. Rust preventors should be injected into the stream of gas to prevent internal corrosion of pipelines.

The chemical (inhibitor) remaining after inhibiting of wells should be used in gas pipelines, flow lines and gas mains.

Inhibition of the 426 mm gas main will be done by placing an inhibition plug between two pistons while causing them to go through the gas pipeline.

Cathodic protection shall be installed at the time of pipeline construction.

Continuous corrosion control ensures systemic observation of such corrosive processes as uniform (general) corrosion, pitting, hydrogenation and includes the following techniques: gravimetric method of measuring the rate of corrosion on the basis of check pieces; assessment of a medium’s aggressiveness in terms of its hydrogenation; assessment on the basis of twisting of wire samples or stretching of stressed and unstressed samples.

Ultrasonic equipment shall be used to perform measurements of the equipment walls. The preferred equipment for measuring the medium’s aggressiveness is an electronic portable corrosimeter.

Control of the state of metal of equipment and pipelines, operated in an aggressive medium shall be done with ultrasonic and X-ray defect detectors in accordance with the requirements outlined in [7] and RH 39.0-04:27 [8].

The design of buildings and structures shall take account of antiseismic measures. The foundations of the operator room, flaring units, and antenna tower must be capable of sustaining a major and specific combination of loads, i.e. when subject to seismic forces. The foregoing antiseismic measures are intended to ensure reliable and safe operation of buildings, structures and process equipment.
They should be surrounded by protection zones to ensure standard conditions of their operation and rule out any damage to the pipeline equipment.

- along pipelines transporting natural gas – in the form of a strip of land confined to conditional lines that run 25 m off the pipeline axis on each side of such pipeline;
- along underwater crossings – in the form of water space from surface to bottom, confined to parallel planes that are located 100 m away from the axes of the outside lines on each side of the crossing.

There shall be protection zones in place along the gas main and flow lines, as required by the Trunk Pipeline Protection Regulations.

The following are the activities prohibited in the protection zone:

a) construct buildings and structures;

b) perform mining, blast hole drilling, construction and assembly operations, both on a permanent and temporary basis, without obtaining permission from organizations operating the pipeline;

c) construct communication lines of other ministries and agencies, overhead and cable power supply networks and various pipelines without obtaining an approval from the operator;

d) set up field camps, drylots, tethering posts or shooting ranges;

e) create land fills, store fodder, burn grass and make fires.

The design solutions used in the construction of the facilities make it possible to:
- compactly locate the facilities;
- make sure that the amount and intensity of harmful emissions to the site and adjacent areas are minimized;
- perform timely reclamation of land disturbed in the course of construction and operation of the site.

Soils, flora and fauna belong to renewables, whose natural restoration may take place with various tempos which is dependent upon numerous factors. Reclamation activities are intended to accelerate the restoration process.

It is the lands which were disturbed as a result of the facilities’ impact upon natural landscapes during construction of the linear and areal facilities, lands that as a result of such disturbance have lost their initial business value and are now a source of adverse environmental impact that are subject to reclamation and restoration.

Reclamation of land normally takes place in two subsequent stages i.e. technical and biological reclamation, and is performed by construction contractors.
The technical stage includes the following activities: remove construction waste, remove scrap metal and other materials from the site, remove all and any temporary machinery from the construction site; remove soils polluted with hydrocarbons; perform their disinfection and collection for burial in a dedicated site; fill up ditches and trenches with ground used for dyking; loosen the ground surface in locations where it is tightly compacted. Fill trenches up with ground and level the surface following compaction of the ground; disperse the remaining ground on the area of reclamation so that to form an even layer; tidy up slopes, dykes, excavations, fill up or level potholes and holes. The above measures will be implemented by the construction contractor upon completion of all of the construction and assembly operations included into the project.

As engineering surveys reveal, the area under review has abundant Aeolian processes which manifest themselves in deflation, blowing and spreading of sand. Aeolian sands are not fixed and move around at the time of strong winds. Therefore it is required to plan measures to fix them. The goal behind such measures is to ensure protection of the gas pipeline, communications cables and overhead lines poles against blowing, and to fix the sands on the areal facilities of the gas pipeline. The scope of work includes fixation of sands around the overhead line poles with macadam pavement.

One of the possible ways to prevent the blowing of sand surface is to erect mechanical protection, e.g. in the form of reed cages. Live protection made of ammocolous plants and seedlings may also be used to create unblowable surface of bare sand. Such plants include: circassian, candym and saxaul. The first stage (1-3 years) includes temporary mechanical protection in the form of cages placed on top of the gas pipeline’s and the adjacent area’s dykes and planting of psammophytes. It is cages that serve as the protection before ammocolous plants become rooted, and subsequently, it is plants that actively prevent the blowing of the sand surface.

Reed is harvested by forestry agencies in the Republic of Uzbekistan, which also provide seed grains and planting material. Seeding and planting activities take place when the soil is moistened to the depth of 25-50 cm, which is most often not the case until November. Given the possibility of destruction of protective coating and plants caused by anthropogenic processes, it is required to make provisions for costs associated with planting of additional ammocolous plants and repairs of the protection equipment.

Thus, the range of measures includes installation of reed cages, coating of the surface with binding materials, construction of ditches and dykes which ensure reliable protection of the gas pipeline against blowing and subsequent silting of the allotted area’s surface.

In case of motor road construction, the vegetative cover is used to reinforce the roadbed’s slopes and its sides, excessive ground is used for earthing of disturbed or unproductive areas.
The project requires that prior to construction of the roadbed of the motor road being designed, shrubs, and saxaul bushes be cut and 0.10 m of topsoil be removed across the entire temporarily allotted area and transported to the waste pile located outside of such temporary allotted area. Construction activities are followed by planning of the horizontal reserves, relocation of topsoil to the boundary of the permanent right-of-way and its uniform distribution. For the avoidance of wind erosion the disturbed land must be reinforced by planting desert herbs and subsequent harrowing.

Biological reclamation includes restoration of the soil’s fertility, which was lost during the construction activities, throughout the allotted area, which is exposed to operations of construction machinery and other types of mechanical action, and is about seeding grains of perennial herbs, saxaul and other ammocолос and halophytic plants and shall take place after technical reclamation activities.

All and any land reclamation activities shall be performed strictly within the allotted area as required by the project.

The motor road is designed to have 720 mm round-shaped metal pipes which serve the environmental purposes (i.e. enable migration of smaller animals). Migration of animals will not be impeded in any way due to the fact almost all of the pipelines lie underground.

After the construction is completed, flora along the road will be restored and the animals that were disturbed during the construction will return to their habitats.

The crossing over the water barrier represents the most difficult design section. A particular technique to be used for construction of the underwater line will be determined at the early design stages following the results of engineering and geological survey.

Sufficient solidity of the underwater line structure is ensured by the following:
- assigning the pipeline section category with respective pipe wall thickness increase;
- utilizing pipes with advanced metal strength properties;
- weld tests including 100% monitoring with the use of 100% visual-measuring and ultrasonic methods, and repeated 100% radiographic tests.
- utilizing pipes with special factory-made protective coating;
- checking condition of header insulation for correspondence of its resistance to design values using cathodic polarization technique;
- pipeline flow tests in three stages;
- inter-pipe diagnostics with additional runs of a four-arm caliper and ultrasonic device after completion of construction and assembly operations.

To make the buoyancy of the gas pipeline negative, the thickness of the header wall at the crossing is assumed to be 20 mm.
During the construction operations the following factors will produce mechanical, thermal and physiochemical effects on the environment:

- earthwork at channel, lakeside and flood plain sections of the crossings (digging and filling up trenches using onshore and floating facilities, construction of access ways, dams, fill and hydraulic-fill earth grounds for construction, etc.);
- wheel and track machines used in transportation and mounting operations at welding-mounting areas of the crossings.

Negative changes in the environment resulting from the above factors are as follows:

- destruction of soil and vegetative cover and disturbance of natural environmental and geological conditions within the lakeside and floodplain trenches;
- occurrence and intensification of dangerous channel processes, erosion of lakeside slope areas;
- deterioration of hydrocole living environment resulting from formation of increased turbidity zones in water, destruction or reduction in the number of spawning grounds, hibernating grounds and foraging sites for fish;
- pollution of surface water and soil with fuels and lubricants, bilge water and utility waste.

The following should be done during performance of underwater earthwork:

- surface water protection requirements should be complied with concerning water quality in the water column 500 m below the point where operations are performed. This includes increase in the content of suspended matter up to 0.75 mg/l (in case of natural water turbidity of 30 mg /l at the low water, the actual turbidity may exceed the initial value by 5%);
- waste piles should be eliminated in spawning locations;
- underwater technical operations should be prohibited during the spawning season.

When organizing underwater earthwork, design organizations should provide for obligatory control and transportation by floating facilities (pontoons, floating platforms) of the soil extracted from under water into lakeside waste piles (or into underwater near-edge waste piles with dyking). Pulp and soil should not be dumped onto water surface at the operations site.

When developing a list of transportation routes for delivery of pipes, machines and freights to the area of underwater crossings, solutions should be worked out to avoid causing damage to soil and vegetation outside the assigned areas, and to construct facilities for crossing minor waterways. It is compulsory that water should pass under such crossing facilities without affecting hydrogeological regime.

Areas for:

- welding, isolation, lining up and ballasting, preliminary hydraulic testing of underwater pipeline sections;
- parking, fuelling and repair of vehicles and surface machines;
- accommodation camp for crossing builders,

should have waste containers for construction and household waste and litter, vessels to collect waste fuel and lubricants.

Sedimentation tanks (pits) to collect bilge water and water from hydraulic tests should be leak-proof to avoid pollution with ground and surface water.

The construction project should specify disposal sites for pollutants accumulated in the pits. Those should be coordinated with local sanitary authorities.

Also, a design solution was developed for construction of a road along the crossing over the lake’s neck and construction of culverts from the units at different levels. This will ensure that the neck’s hydrological regime is not affected, even in case of a drastic increase of the water level, for the head of water in this case will not be substantial.

The assumed layout of the units ensures unimpeded circulation of water masses, both vertically, from surface to bottom, and across the lake’s neck, which eliminates the possibility of formation of stagnant zones in the areas of the lake adjacent to the facility.

This is the most acceptable solution both from the environmental and hydrological perspective.

In construction of the crossing cutting-edge technologies will be used including gabion structures and geomaterials. Gabion walling consists of wire-made frames (gabions) filled with stones. Factory-made gabion netting is made of galvanized wire with the diameter ranging from 2.5 to 3.6 mm, with cells of the size corresponding to the size of stones. Both rectangular and cylindrical forms are possible. After installation to the design position a gabion is filled with natural stones, generally crushed rock aggregate (pebbles and small boulders are also acceptable). The size of stones should exceed the netting cell size. Generally, those should be crushed stone fines from 70 to 150 mm. Stone material should have high density, solidity and frost resistance, especially in gabion facilities subject to hydrodynamic effects.

After filling the cases with stone material (up to 80-90% of all the gabion construction operations are performed manually), 30-40% porosity construction element – a gabion – will be available.

Over time, the empty space in pores is filled with soil particles. In a few years the gabion work will be fully consolidated, obtain maximum stability and will then have unlimited lifetime. After the consolidation is completed, even a break in the metallic netting would not cause destruction of the structure, since the soil particles accumulated in the gabions become more dense and solidly cement the stone core of the gabions.
Note that each gabion is tightly bound to adjacent ones with galvanized wire, which make it a monolithic structure.

The key properties of a gabion structure are their flexibility, strength, water permeability, noise absorption, long lifetime and environmental friendliness.

The flexibility is due to metallic netting that helps the structure respond to soil settlement without any negative effects. Even a major soil washout at the base of a gabion structure would in most cases result only in minor deformations causing no loss of strength or destruction.

High strength and stability are due to great properties of the double-twisted metallic netting – the structure’s element of reinforcement; ability to withstand high loads (erosion, waves, ice, soil weight, etc.) without damage; combination of flexibility with strong bonds within the structure that ensures structural integration.

The water permeability is conditioned by the porosity of gabions. It secures a number of advantages for such a structure: no hydrostatic pressure on the structure, which improves its stability; no additional drainage is required; no loss of contact between surface and ground water; water filtration within the gabion structures promotes vegetation growth.

All the previous experiments and natural observations related to the functioning of gabions provide a ground to believe that, in case of a correct design solution, their lifetime is almost unlimited (except for extreme situations like disastrous earthquakes, mud torrents, rockfalls, etc.). Moreover, the consolidation process in gabion structures and the adjacent soil mass improves their strength and stability over time. Long lifetime of gabions is conditioned by the fact that the service life of the galvanized metal wire significantly exceeds the gabion consolidation period. Steel wire coated with galfan and plastic will last for more than 100 years even in a pretty aggressive environment.

Gabion structures are environmentally friendly because of their high water permeability and the ability to accumulate soil particles which promotes vegetation growth. Their construction in the lakeside area will help the development of aquatic flora and fauna. The research has shown that the use of galvanized steel, including that with plastic shell, does not affect the natural environment. The construction of gabion structures mostly involves manual labor without heavy machines, which itself does not cause any major environmental harm. Of course, of major importance for the area’s environmental balance is the unimpeded filtration of water in gabion structures. Gabion structures fit into natural environment so well, and often they simply merge into it. Not only do they preserve the aesthetic value of nature (in contrast to, say, reinforced concrete structures), but also supplement it.

Another material used is the geotextile. Geotextiles are water permeable synthetic textile materials created by mechanical and thermal fixation of synthetic fibers. They may be nonwoven,
woven or knitted. Woven geotextiles help create closed three-dimensional frame structures. Nonwoven geotextiles are utilized as separating interlayers and filters.

Geotextile is the unwoven material made of thermally fixed endless fibers of 100% polypropylene. This ensures resistance to moisture and chemical compounds, particularly to alkali and acids, absence of septicity and resistance to effects produced by various fungi and mould, rodents and insects, improves root-proofness.

High elongation at rupture: depending on the material brand, geotextile has up to 45% elongation at maximum load. Thus, local damages do not cause destruction of the material.

Universal filtering property is conditioned by peculiar structure of the material, which makes penetration of soil particles into geotextile pores and their clogging almost impracticable. This helps ensure stable filtration properties of the material under earth pressure and in heavy vibration conditions.

High resistance to break and punching, which is especially important during pipe laying operations.

Other important material properties include:
- ease in laying: the material comes in small light rolls, which reduces transportation and warehousing costs as well as payroll costs;
- ease in processing: rolls of material can be cut up right at the site using a manual or chain saw;
- geotextile does not absorb water: when using in moist environment the weight of rolls stays unchanged;
- geotextile does not allow the roots to grow through, it is resistant to natural acids and alkali, as well as to insects, bacteria and mould.

Geotextile structure ensures high filtering properties. In addition to traditional applications like road, drainage and anti-erosion facilities, optimal combination of its properties ensures wide use of geotextile in construction of roofs, basements, drainage systems, in land management, etc. Key functions of geotextiles include separation, reinforcement, filtration and draining. Their combination ensures high modulus of elasticity due to which the material can withstand significant loads and perform the reinforcement function with relatively low deformations.

The environmental friendliness of geotextile is represented by helping reduce industrial impact on the environment and utilization of natural resources in industrial and civil engineering.

The operations program includes labor safety and health measures.

Additional safety measures when working near active gas pipelines are as follows:
- crossing facilities are constructed for multiple crossing of active gas pipelines by heavy machines;
prior to start of operations actual thickness of the filling up layer is checked against the design value, and additional fill-up operations are performed, if necessary;
- the operations site is checked for contamination with gas, gas leaks are eliminated;
- tractor-based bulldozers are used to fill up trenches connected to the access to active gas pipelines.

Special attention is paid to pre-launch diagnostics and pressurization of pipelines before commissioning.

Fire safety measures for the designed sites were developed in compliance with the fire safety regulations for oil and gas industry of the Republic of Uzbekistan. The design takes into account the requirements for the number of emergency escapes. There is a fire department in the existing area of PGTP “Khauzak”. The department includes a gas rescue team and the required number of fire water vessels.

Depending on the substance transported, pipelines should be marked with identification color or with numbers.

When operating cluster sites, gas mains and flow lines the personnel closely monitors changes in wall thickness of pipes and equipment, micro-cracks in pipelines and surface equipment. Checking points and frequency should be set by the process regulation. The personnel of Khauzak Gas Production Center performs monitoring in cooperation with crack detection team and chemical lab staff.

To ensure normal operation of the pipeline and equipment, annual preventive maintenance schedules will be developed and approved.

Artificial lighting system will be in compliance with the effective standards that ensure the illumination level per labor health norms.

To ensure longer lifetime and reliable operation of the system used to supply power to overhead lines, supports made of reinforced concrete were selected that appeared to be the most economical solution compared to other types of supports. This is proven by a long period of operation of similar overhead lines at Uzbek oil and gas fields located in steppe and desert zones.

Since the area is exposed to saline dust, the design includes placement of special isolators on 10 kV power lines. The upper part of the isolators is under high voltage. To protect isolators from dirt and to prevent the birds from dying, the design provides for installation of bird safety stoppers.

The communication system of Khauzak Gas Production Center is designed for uninterrupted real-time process management, ensuring effective interaction and communication between emergency, rescue and other teams in the course of emergency response operations, natural disasters and other emergencies.
The internal in-plant communication system includes real-time communication for the managers, dispatcher, communication between divisions of the sites, communications between mobile facilities within the area of Khauzak Gas Production Center, and real-time communications for the fire department on duty.

The staff permitted to perform operations should meet special requirements. According to such requirements, operations personnel are permitted to work at the site only after a special briefing, of both introductory and on-site type.

To ensure environmental safety, according to the laws and regulations of the Republic of Uzbekistan, industrial environmental monitoring is performed within the area of possible impact by industrial facilities.

In general, processes and equipment used in the design are in line with current requirements. The key requirements include the use of breakthrough technology and ensuring safety of human life, property and environment. As mentioned in other sections of this paper, the design includes various measures reducing environmental load.

Taking the proposed environmental measures along with those aimed at protection of existing and currently designed facilities of Khauzak and Shady from flooding with Dengizkul water will ensure safe operation of surface facilities at Shady Block and help significantly improve environmental performance.
Summary

The need to accelerate commercial development of Shady Block financed by foreign investments is dictated by the economic situation and high demand for raw hydrocarbons in the Republic of Uzbekistan.

The project entitled “Construction of Shady Block of Dengizkul field” was designed according to the requirements of environmental, sanitation, fire safety and other norms, rules and standards applicable in the Republic of Uzbekistan. The design ensures safe and healthy operation of the asset subject to taking certain measures per execution plan.

At the FEL documents stage the EIA procedure stage one – Draft SEI – was performed for the asset under analysis. According to the recommendations provided in the Draft SEI Opinion, this paper now contains more detailed information on the crossing of the gas line over the neck, with risk sections specified. It was identified that the most vulnerable section is that of the underwater crossing of the 426 mm gas pipeline and the 57 mm fuel gas pipeline over the neck of Dengizkul Lake. The proposed gas line crossing is underground, buried at 2 to 2.5 m below the lake’s bottom in the crossing point depending upon the bottom’s relief. Risks are associated with uneven bottom, availability of two channels and loose soils that form the bottom’s substrata. These risks are minimized by scientific and engineering measures. Burying of pipelines is dependent upon preservation conditions, transportation modes and properties of the media being transported. Stop valves were installed according to the applicable standards at both banks of the water barrier given the terrain relief.

The planning is performed for the entire width of the belt in order to remove sands that are subject to blowing up to the level of inter-ridge depressions, as well as to ensure free access for machines and vehicles. When laying a gas pipeline in soils containing crushed stones and pebbles its isolation will be protected with soft soil. Pipelines will be protected from internal corrosion using inhibition method. Condition of pipeline metal for the pipelines operated in aggressive environment will be monitored using non-destructive control techniques (ultrasonic and X-ray flaw detectors).

Environmental analysis of road construction options demonstrated that unimpeded construction of the road is impracticable. It is possible that bypassing of Dengizkul ‘s neck will require construction of facilities to cross water barriers. Those are represented by a channel between the lakes and two connecting channels. In this case the route length difference will be around 8.3 km.

Comparison of pipe laying effects in different motor road options demonstrated that the longer option results in heavier damage to soil, flora and fauna, and promotes wind erosion processes. In this case we cannot but take into account the road operation period as well, if the kilometrage difference is doubled, which therefore results in more emissions from motor vehicles. In addition, in the first case, construction of access ways to the underwater gas pipeline crossing is a possibility. Therefore, the area
of the land withdrawn for long-term use will increase, and so will the impact on the biota living along the road.

After reviewing the road route options, the shortest route was selected with a crossing in the narrowest point of the lake’s neck. The focus was put on minimizing the impact on the level of water and free circulation of the lake’s water mass given its conservation status.

A more detailed analysis of the gas pipeline route results in a conclusion that to ensure stable environmental condition of the natural and technical systems in the area where gas transportation facilities are to be located, it is necessary to do the following:

- at design stage – all-round study of the area’s peculiarities (geological and engineering surveys) and taking design solutions that correspond to the environmental conditions;
- at construction stage – implementing design solutions with field supervision by designers and ecologists over their execution, improving culture of operations;
- at operation stage – regular diagnostics of industrial sites, production and environmental monitoring and improving real-time response mechanism to eliminate destabilizing effects.

Analysis of the crossing section identified that construction and further operation of the crossing over the water barriers is one of the most complicated engineering issues. The selection of place and configuration of the crossing over the neck was made strictly in accordance with the norms and rules applicable in Uzbekistan. When selecting the road route, not only costs of construction, maintenance, repair and operation were taken into account, but also the expenses associated with conservation of environment, safety, time period available for construction, etc.

Cutting-edge technologies will be used in construction of the crossing, including gabion structures and geomaterials.

The measures included into the design are aimed at minimizing environmental impact. In addition, the designed provides for a number of measures aimed at protection of existing and currently designed facilities of Khauzak and Shady from flooding with Dengizkul water, which will significantly reduce the risk of emergencies.

Construction of transportation facilities leads to disturbance of the land. The design pay great attention to the measures reducing such effects. Measures are planned not only for the construction period and for remedying consequences of construction operations (reclaiming), but are also available in the design solutions:

- almost all the gas pipelines will be laid under the ground (no obstacles for animal migrations);
- round metal pipes for migration of small animals will be laid across the road;
- at the upper part of isolators on overhead lines there will be special frames to protect birds from high voltage;
- many other engineering solutions will also be utilized, such as use of gabions, geotextiles, etc. for construction purposes.

The most environmentally vulnerable areas, such as flare areas and crossing over the neck, will be included into the production and environmental monitoring system.

In terms of the environmental impact, the design under analysis meets the applicable environmental standards.
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