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SHEBERGHAN GAS FIELD DEVELOPMENT PROJECT (SGFDP)

INITIAL ENVIRONMENTAL EXAMINATION FOR GAS WELL DRILLING AND REHABILITATION ACTIVITIES IN THE JUMA/BASHIKURD FIELDS

March 30, 2011

**Sheberghan Gas Field Development Project (SGFDP)
USAID Contractor**



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ABBREVIATIONS

EA - Environmental Assessment
H₂S - Hydrogen Sulfide
IEE - Initial Environmental Examination
MOM - Ministry of Mines
MOI - Ministry of Interior
MEW - Ministry of Energy and Water
MSDS – Material Safety Data Sheet
NEPA - National Environmental Protection Agency
NGO – Non-Governmental Organization
PPTA - Project Preparatory Technical Assistance
REA - Rapid Environmental Assessment
ROW - Right-of-Way
SO₂ - Sulfur Dioxide
TOR - Terms of Reference
USAID - United States Agency for International Development

UNITS

cm - Centimeter
oC - Degree Celsius
dB - Decibel
GWh - Gega watt hour
Kg - Kilogram
km - Kilometer
KV - Kilo volt
KW - Kilo watt
m - Meter
mg/L - Milligram per liter
mm - Milli meter
m³/s - Cubic meters per second
MW : Mega watt

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EXECUTIVE SUMMARY

Advanced Engineering Associates International (AEAI) is working on a project to develop a roadmap for the construction of a 200 MW gas-fired thermal power plant near Sheberghan, Jowzjan Province, by an independent power producer (IPP). Gustavson Associates, LLC (Gustavson) has been retained by AEAI to prepare an Initial Environmental Examination (IEE) report for the natural gas well reentry and rehabilitation, as well as drilling, completion, and well testing activities. The IEE supports the wells that have been identified to serve as a supply for the gas-fired thermal power plant. The reentry candidates include the Bashikurd #9 and #3 wells, along with one or two additional wells drilled as “twinning” previously drilled wells in the Bashikurd and Juma fields.

Development of the gas fields is expected to have four distinct phases:

- Well Design and Procurement
- Site Preparation and Rig Mobilization
- Rehabilitation, Drilling and Completion Operations
- Drilling Operations
- Drilling Mud System
- Casing and Cementing
- Well Logging
- Completion
- Well Testing

Environmental impacts from the development activities have been assessed using available baseline information. The IEE recommends approval based on the following assessment.

Well Design and Procurement - qualify for Categorical Exclusion as the action does not have any effect on the natural or physical environment or is technical assistance and education, workshops and meetings, information transfer and development planning.

Site Preparation and Rig Mobilization - are recommended for Negative Determination with Conditions as the proposed action will not have a significant (adverse) effect on the environment. Conditions to be imposed during site preparation and rig mobilization include site selection criteria, transportation criteria, and control of air emissions.

Rehabilitation, Drilling and Completion Operations - are recommended for Negative Determination with Conditions as the proposed action will not have a significant (adverse) effect on the environment. Conditions to be imposed during rehabilitation, drilling and completion operations include air quality controls, storm water controls, design criteria, and preparation of environmental protection plans.

Well Testing - are recommended for Negative Determination with Conditions as the proposed action will not have a significant (adverse) effect on the environment. Conditions to be imposed during well testing are flare design criteria, air quality monitoring, and limitations on the timing and volume of gas flared.

Environmental mitigation measures will be implemented conditionally on project approval. These are necessary to ensure that the potential impacts identified in this IEE do not have a significant adverse effect on the environment.

1 BACKGROUND AND PROJECT DESCRIPTION

1.1 BACKGROUND

Gustavson had been requested to analyze possible gas supply options to support the development of a 200 MW gas-fired power plant. This analysis was performed at the request of Advanced Engineering Associates International (AEAI) as part of their work on the Sheberghan gas field development in Northern Afghanistan. The objective of the study was to identify well candidates that could be possibly twinned via new drilling and tested in order to prove up gas reserves for the proposed power plant. Gustavson also reviewed wells as potential re-entry and rehabilitation candidates.

In a previous feasibility study prepared in 2005 for a 100 MW plant, the gas supply requirement was estimated to be about 600,000 m³ per day.¹ The capacity of the newly proposed plant may be twice as large. AEA I has informed us to consider that the required gas amounts vary linearly with the increased plant size. Therefore, we assumed that 1.2 million m³ per day of sweetened gas (excluding CO₂ and H₂S) must be provided for the proposed gas-fired power plant. Over a 30 year period, this rate would equate to a total demand for approximately 13.1 BCM of sweetened gas.

In order to supply the gas to the IPP, Gustavson identified two wells for reentry and two new wells to be drilled in the Juma/Bashikurd fields. This IEE is prepared in support of these activities.

¹ This assumed a heat rate of 8273 kJ/kWh, i.e., an efficiency of about 43.5%, based on a reciprocating gas engine design. This is similar to the heat rate for a combined cycle plant. The actual heat rate will depend on the final power plant design.

1.2 DESCRIPTION OF ACTIVITIES

1.2.1 PROJECT OVERVIEW AND JUSTIFICATION

The goal of the Project is to rehabilitate two wells and drill one or two wells to develop gas reserves from the Sheberghan gas fields in order to construct and operate a 200 megawatt (MW) gas-fired power plant in the vicinity of the city of Sheberghan, Jowzjan Province, Islamic Republic of Afghanistan.

Gustavson recommended that the Bashikurd and Juma fields be developed as the gas supply for the power plant. These two fields are adjacent to each other and are separated by a fault whose location is not known precisely. The Juma field alone appears to have sufficient reserves for the plant. However, the cost of drilling wells to supply gas can almost surely be reduced by selecting the best twinning candidates from the two fields rather than from Juma alone.

Having determined that the Bashikurd/Juma fields were the best supply source for the power plant, Gustavson prepared a ranking of twinning candidates at those fields. In addition, Gustavson has identified two well locations that are candidates for reentry in the existing wellbore. The reentry candidates include Bashikurd #9 and #3 well. One or two additional wells will be drilled as new to twin previously drilled wells. Table 1 below shows the order of well ranking.

Table 1: Well Ranking Summary

Well Rank	Field	Well No.	Total Depth, (m)	Choke Diameter (mm)	Gas Flow Rate ¹ (thousand CM/day)	Total Estimated Sweetened Gas Supply ² (thousand CM/day)	H ₂ S (%)	CO ₂ (%)
1	Bashikurd	9 (Reentry)	3300	N/A	120	113	1.3	
2	Bashikurd	3 (Reentry)	3340	N/A	62	N/A		
3	Bashikurd	2	3460	22	520	469	0.55	9.15
4	Juma	2	3409	18	768	700	0.72	8.22
5	Juma	7	3409	15	435	403	0.11 ³	7.35 ³
6	Bashikurd	10	3397	20	446	400	0.70	9.49
7	Juma	9	3503	16	291	270	0.77	6.48
8	Juma	6	3450	13.1	268	247	0.53 (e) ⁴	7.35 (e) ⁴
Alt	Bashikurd	15	3235	15	558	502	0.63 (e) ⁵	9.32 (e) ⁵

Notes:

1. Gas flow rates were taken from production test data.

2. Estimates exclude H₂S, CO₂, and N₂.

3. Conflicting information exists regarding the gas composition of Juma 7, two tests suggest methane content in the 59-77% range, whereas other gas composition data suggests a methane content similar to the other wells in the field of nearly 90%. We have assumed the latter for the estimated sweet gas supply.

4. Gas composition for Juma 6 is considered unreliable since there was no measurement for H₂S; therefore, the average of results from Juma wells 1, 5, and 6 were used since the gas composition is expected to be similar

5. Gas composition for Bashikurd 15 was unavailable; therefore, the average gas composition for Bashikurd 2 and 10 was used for the sweetened gas supply estimates

(e) = estimated

The Bashikurd and Juma fields are located approximately 15 - 20 km west-northwest of Sheberghan City (Figure 1). These fields were discovered by the Soviets, but most wells have been plugged and abandoned and are no longer capable of producing. The scope of work consists of (1) perforating and testing one well which has been drilled and cased (Bashikurd #9), (2) deepening, completing, and testing one well which has been drilled and cased to the intermediate casing point (Bashikurd #3), and (3) drilling one or more wells which “twin” previously drilled and abandoned wells. The well work has been prioritized based on available geologic and testing information from the Soviet-era reports.

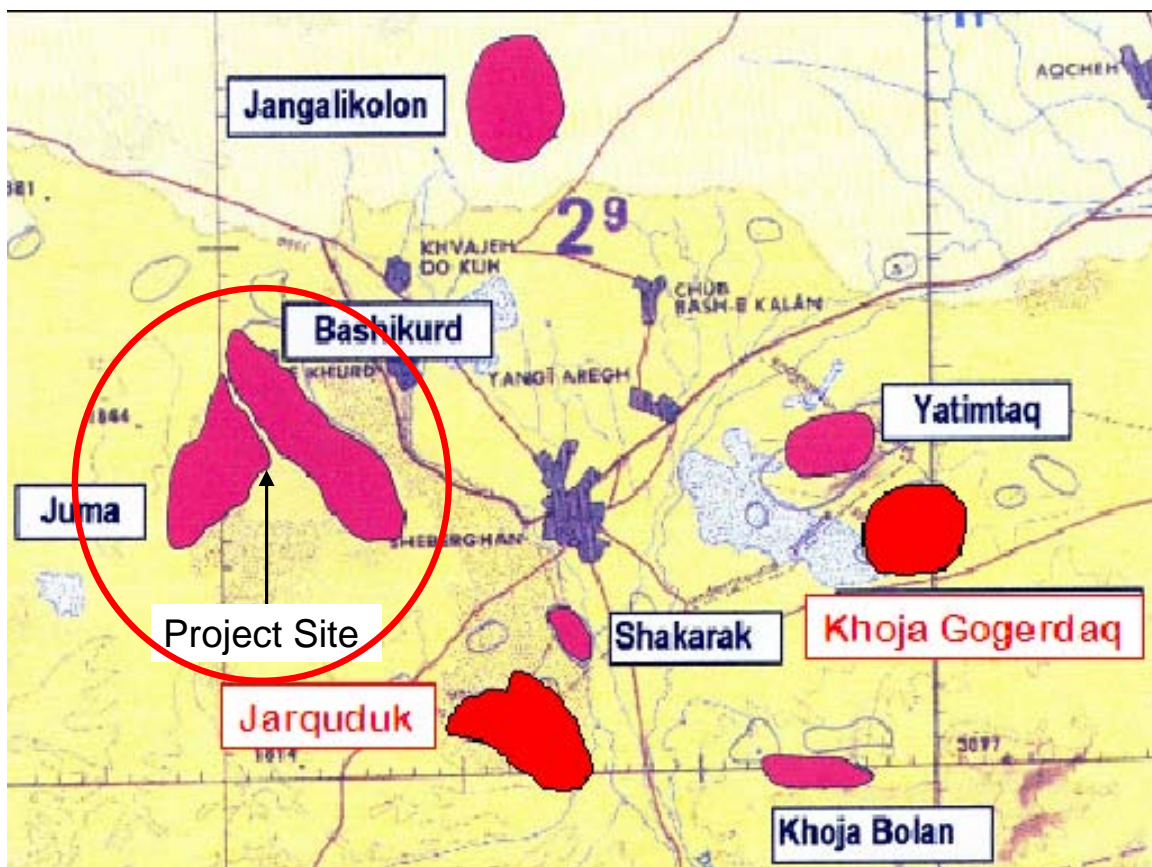


Figure 1 - Bashikurd Field and Juma Field Location Map

1.2.2 PROJECT ACTIVITIES

The estimated reserves necessary to supply a 200 MW power plant for 30 years are estimated at 13.1 billion cubic meters (BCM). The Bashikurd and Juma fields were selected for development because they are more than capable of providing the required reserves at a rate of 1.2 MCM/day. The Project will comprise the reentry and rehabilitation of two wells and the drilling, completion and testing of one or two wells in the Bashikurd and Juma Fields to determine their suitability for providing a source of natural gas to the proposed 200 MW power plant, yet to be constructed.

Historically, there have been seven significant gas finds around Sheberghan, of which three fields have been developed and produced. Khoja Gogerdag was put into production in 1967, Gerquduq in 1980, and Yatimtaq in 2001. The natural gas reserves around Sheberghan are contained primarily in two reservoirs: (i) the Hauterivian (Lower Cretaceous) and (ii) Kogitan (Upper Jurassic). The Jurassic reserves contain H₂S ranging between 0.2 and 6.75 percent and are not currently produced due to the lack of a working gas sweetening plant. An old gas sweetening plant was shut down when the Soviets departed in 1988. The Hauterivian reserves contain H₂S, but in lower concentrations, and are currently used to supply the customers of Afghan Gas.

The drilling of new wells in the Bashikurd and Juma fields will produce natural gas from the Upper Jurassic Kogitan formation. Based on testing performed during the Soviet era, the Jurassic reserves in the Bashikurd and Juma fields contain a volume weighted average of 8.89% H₂S and CO₂ (acid gases). Potential locations for exploitation wells are shown in Table 1.

Development of the gas fields is expected to have four distinct phases: (i) well design and procurement of services; (ii) site preparation and rig mobilization; (iii) drilling and completion operations; and (iv) well testing. These phases are described as follows:

Well Design and Procurement – Well design consists of engineering studies of wells drilled within the targeted field and regionally. Well construction details will be determined at this phase and generally includes civil work, rig specifications, casing and cementing program, mud program, logging program, and well completion and testing. Detailed cost estimates are also prepared at this stage.

During design of the rehabilitation of Bashikurd wells #9 and #3, the existing wells will be carefully assessed and the data will be updated, if necessary, to account for the presence of H₂S

during well testing. The Bashikurd well #9 was drilled and cased with corrosion resistant production casing through the target reservoir, but was not perforated. The work remaining on this well in order to prepare for production is to re-enter the well, confirm that there are no obstructions in the well bore, and then perforate and test the Jurassic interval.

In addition to Bashikurd well #9, Bashikurd well #3 appears to be another candidate for rehabilitation. This well was drilled to a total depth of 3,345 meters, but the second technical casing string ends beneath the Jurassic Anhydrite at approximately 3,000 meters. Remaining work, in order to prepare Bashikurd well #3 for production, involves drilling and casing of the well to approximately 3,500 meters to be followed by perforation and production tests.

After reentry of the Bashikurd #9 and #3 wells, one or two new wells will be drilled as twin wells contingent on the budget remaining. The well ranking reported in Table 1 indicates the preferred order of new twin well candidates.

Site Preparation and Rig Mobilization – In order to transport the drilling rig and associated equipment to the drilling location, construction of an access road or improvements to existing access roads will have to be completed. Construction activities are likely to be minor, given the topography and probable existence of roadways used to access the drilling of exploration wells in the Bashikurd and Juma fields by the Soviets in the 1970 – 1988 time period. The truck loads transporting the rig will be large, and infrastructure along the paved thoroughfares leading to the access road will require inspection for adequacy and possible upgrading.

At each location proposed for drilling, an engineered surface will be constructed to support the drilling rig and equipment. Drilling locations will be approximately 3.5 acres (1.5 hectares) in size consisting of a compacted surface and placement of a gravel top layer around the rig floor for safety. Three or four pits will be excavated to a depth of 3 – 4 meters. In general, pits containing drilling muds or cuttings will be plastic-lined and pits containing water will be unlined. Road and location construction is estimated to take several weeks to complete. Equipment necessary to complete the work will be the following, or similar: 1 bulldozer, 2 front-end loaders, 1 grader, and 6 dump trucks. The well proposed for re-entry and completion (Bashikurd 9) will likely require a smaller location (on the order of 2 acres).

Following completion of the access road and drilling location, the rig will be mobilized to the well site and assembled. The principal equipment on a drilling rig and their functions are shown in Table 2 and a photograph of a typical rig operation is shown in Figure 2. A rig capable of

drilling to the objective depths will be mobilized in 40-60 truckloads, with an initial transport and rig assembly timeline of approximately 1-2 months. Rig moves to wells in the same field can be completed in approximately 3-4 weeks.

Table 2: Drilling Rig Equipment

Item	Description
Draw Works	Rotating drum for lifting travelling block. Powered by diesel engine or electric motors.
Engines	Provide power or electricity for draw works.
Mast	Steel structure for lifting and supporting weight of drill string.
Substructure	Steel structure supporting mast and drill floor.
Rotary System	Rotary drive to turn drilling tubulars.
Mud Pumps	Used for pumping drilling mud down drill pipe, through the drill bit and up the annular space to cool and lubricate drill bit, and transport drill cuttings.
Mud System	Tanks or pits for storing drilling mud and cuttings. Includes drilling mud conditioning equipment such as shale shakers, desander, and centrifugal separator.
Blowout Preventers	A series of stacked, remotely or manually operated valves for controlling subsurface pressure in the event of a loss of well control.
Electrical System	Diesel engines for generating electricity and related equipment to deliver power.
Fuel Tank	Tanks for diesel fuel storage.
Other Equipment	Various offices for technical specialists and crew such as: doghouse, mud engineer's trailer, geologist's trailer, mud logger's trailer. Structures will include storage areas for parts, drilling materials, pipe, drilling recording equipment, etc.

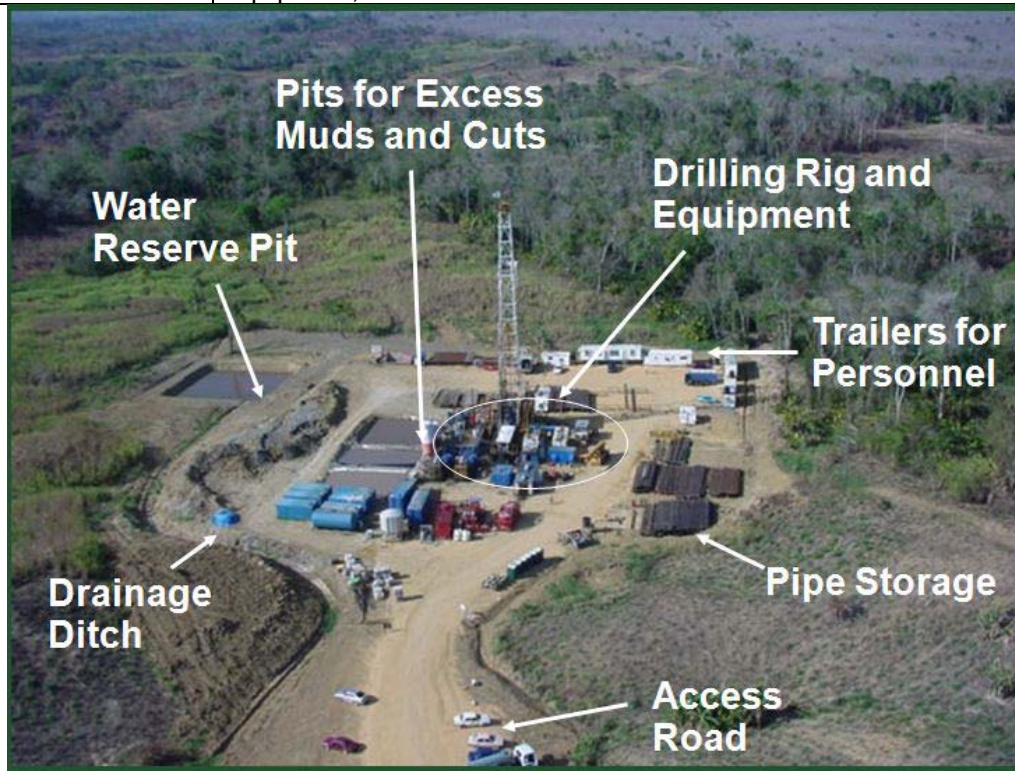


Figure 2 Typical Drilling Rig Layout

Rehabilitation, Drilling and Completion Operations – Drilling and completion of each well will be a multi-stage process, consisting of the following principal elements. The proposed re-entry well, Bashikurd 9, will not require drilling but will only be logged, completed and tested.

Drilling Operations – Drilling is accomplished by rotating a drilling bit at the bottom of the hole. Weight is applied to the bit by drill collars and drill pipe. Rock cuttings are circulated to the top of the hole using drilling mud. Cuttings are removed from the mud and placed in a lined pit at the surface. Various bit sizes and types of bits are used depending upon the depth and rock formations penetrated. Cuttings will be mixed with native soil, tested for environmental contaminants and buried at the site.

Drilling Mud – While drilling, mud is pumped down the drill pipe, this mud then exits through the bit, and circulates up the annular space between drill pipe and the hole to the surface. The mud serves several purposes including transport of cuttings to the surface, lubricating and cooling the bit, stabilizing the hole, and providing hydrostatic control over subsurface pressure. The mud is reconditioned and then reused by removing solids and adjusting the chemical and physical properties as necessary.

Water-based muds (WBM) are most likely to be used during drilling. WBM consists of a mixture of solids, liquids, and chemicals, with water being the principal component. A typical listing of WBM additives are shown in Table 3. With few exceptions, WBM is prepared with naturally-occurring materials. In some situations where borehole stability is a problem, a synthetic oil-based mud (SOBM) may be used. The supplier of the SOBM will recycle and reuse the synthetic oil at the conclusion of each well.

Mud additives are delivered to the drilling site in bags or bulk containers for use as the drilling progresses. Specialized chemical and solid additives may be used for specific well conditions. Mud additives will be stored at the rig location with protection from the elements.

The rig is powered by diesel engines. A total of approximately 2,500 horsepower of engines will be used on the rig. These engines will provide electricity to the rig and the mud pumps.

Table 3: Water-Based Mud Components

Item	Description
Barium Sulfate	Mineral weighting agent
Caustic soda (NaOH)	pH adjustment
Calcium oxide	Improve shale control
Bentonite	Increase mud viscosity
Lignite	Deflocculant
Sodium bicarbonate	Mud chemistry control
Polymers	Mud rheological properties
Cellulose	Fluid loss control
Surface active agents	Improve penetration rate
Soda ash	Mud chemistry control
Biocide	Biological control
Calcium chloride	Salt

Casing and Cementing – At certain depths during drilling, casing will be lowered into the hole and cemented in place. The casing maintains the integrity of the hole and isolates any formations requiring protection from the wellbore. A typical casing program would be:

- Surface casing to protect shallow fresh water horizons
- Intermediate casing set above the productive interval for pressure control
- Production casing set through the productive zone

A contractor will supply the cement slurry and pumping equipment and will conduct cementing operations. The cement slurry will contain Portland cement and various additives. Common cement additives are shown in Table 4.

Table 4: Cement Additives

Item	Description
Bentonite	Clay added to reduce cement slurry density
Barium Sulfate	Mineral added to increase cement slurry density
Diatomaceous earth	Used to reduce cement slurry density
Perlite	Volcanic glass used to reduce cement slurry density
Pozzolan	Mineral used to reduce cement slurry density
Sand	Used to increase slurry density
Calcium chloride	Salt used to decrease cement-hardening time
Sodium chloride	Salt used to improve cement bond to specific formations
Calcium lignosulfonate	Chemical used to increase cement-hardening time
Lost circulation materials	Wood chips, paper and other inert materials used to plug high permeability formations
Organic Polymers	Used to reduce cement water loss to permeable formations and control cement viscosity

Well Logging – Prior to cementing the casing in place at intermediate depths, and through the potentially productive gas-producing formations or to the objective depth, each well will be logged using various tools run on an electric wireline to determine if oil or natural gas is present

and to determine the properties of the reservoir such as hydrocarbon saturation, porosity, and thickness. All logging tools are handled by a contractor using some equipment on the drilling rig. Radioactive sources are permitted, transported and managed by the contractor.

Completion – The proposed wells will be completed and tested to confirm gas deliverability. Completion operations involve installing production equipment in the well consisting of tubing and a packer, then perforating the casing and cement at depths corresponding to the productive zones to be tested.

During drilling operations, a camp will be set up at the drilling location or in Sheberghan to house the drilling crew. The total crew will number approximately 50 persons. The primary resource inputs during drilling are water and fuel. Water is used for drilling mud and for various rig activities. Approximately 1,500 m³ of water will be required for drilling. Diesel fuel will be stored in a steel tank at the rig site and will be delivered by tank truck. The drilling rig engines and generators will use about 15,000 liters of diesel daily. All electricity needs will be generated by the drilling rig.

Well Testing - Testing will generally consist of flowing the well at various rates and measuring the well's performance characteristics. Gas will be produced into surface production equipment for measurement and separation, and the excess gas will be flared. Testing will be conducted over a 2-3 week period following the completion of the well.

1.2.3 PURPOSE AND SCOPE OF IEE

This IEE presents the environmental assessment of the rehabilitation of two wells and one or two new wells to be drilled and tested. The IEE has been prepared through review of existing reports, on-site data gathering and analysis, and reviewing the impacts of similar projects. The environmental impacts were evaluated for the physical, environmental, ecological, social and cultural resources within the project area during the construction and operational phases. Overall, the development of the Bashikurd and Juma gas reserves will require a gas sweetening plant for removal of H₂S and CO₂. The gas sweetening plant, pipelines, and other ancillary field equipment are not included in this IEE.

2 COUNTRY AND ENVIRONMENTAL INFORMATION

2.1 BASELINE INFORMATION

2.1.1 LOCATION

The current gas producing basin of Afghanistan, the Amu Darya basin, is located in the north of the country. The gas fields to be developed, Bashikurd and Juma, are located approximately 15 to 20 km from the city of Sheberghan. A map showing the location of Sheberghan and the surrounding gas fields is shown in Figure 3.

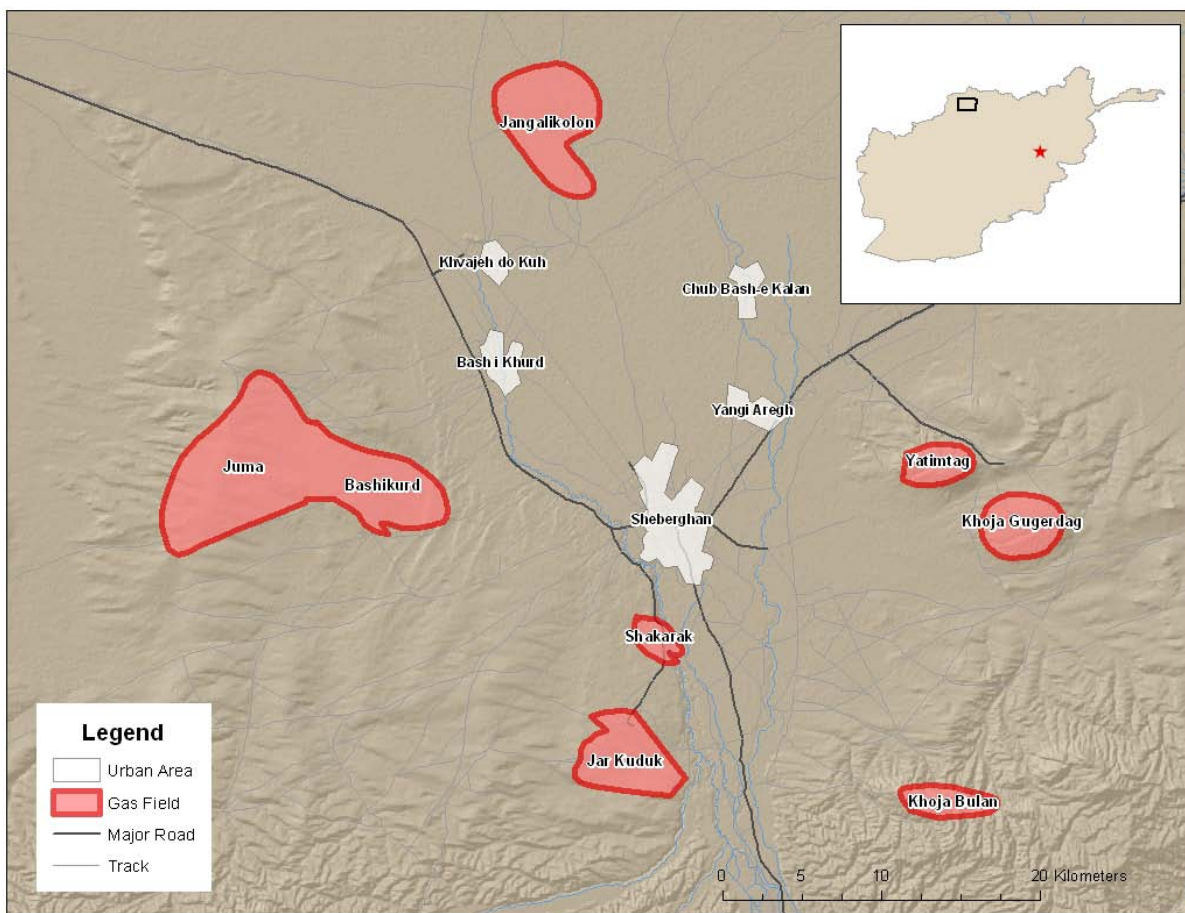


Figure 3 Location of Natural Gas Fields - Sheberghan, Afghanistan

2.1.2 TOPOGRAPHY AND SOILS

The project is located in the Northern Plain of Afghanistan in Jowzjan Province. Approximately one quarter of the province is mountainous or semi-mountainous and three quarters is flat land. A physical map of the general area is shown in Figure 4.



Figure 4 Physical Map of Project Location

The topography around the project site is part of an extensive loess covered plain which abuts the foothills of the Hindu Kush to the south and extends across the border into Turkmenistan and Uzbekistan to the north. Loess comprises fine soil particles that are transported by the prevailing northwest wind from the central Asian plains and deposited at the foot of the mountains where wind speed is decreased. The plain is gently rolling or flat with elevations ranging between 350 and 550 m. The Sar-e-Pul River valley dissects the plain approximately 15 km from Sheberghan.

The main soil type at the project site is loessy loam. Loess soils generally have excellent permeability and can absorb large quantities of water. Soils in the Northern Plain are prime agricultural soils and the Mazar-e-Sharif region is one of the major food-producing areas in Afghanistan.

2.1.3 LAND USE

The targeted gas fields are located within approximately 20 km of Sheberghan. Land utilization within and near the project site consists of residences along the A76 highway 3 km to the east, and small agricultural plots at the western edge of the gas fields. Since the targeted gas fields have never been produced, there are no existing producing wells, pipelines, or processing facilities. No existing or proposed cultural or environmental protected areas are found in or near the gas fields.

2.1.4 GEOLOGY AND SEISMICITY

The geology of the area comprises Neogene and Quaternary (Pleistocene) sediments consisting of loess beds tens of meters thick, overlying alternating layers of pebbles/gravels, sands, silts and clays. The sediments represent the products of erosion of the mountains. Modern alluvial deposits occur along the river valleys. The Quaternary sediments overlie Mesozoic limestones, conglomerates, sandstones, siltstones, and shales extending to several kilometers depth. The Mesozoic rocks are gently folded and faulted forming the reservoir strata and structures for the region's natural gas resources. The Mesozoic rocks are exposed to the south in the foothills of the Hindu Kush.

The area is seismically active being adjacent to the northern edge of the Hindu Kush where orogenic processes are active. The region has a history of strong earthquakes, over 5.8 on the Richter scale.

2.1.5 CLIMATE AND AIR QUALITY

The climate of the Sheberghan region is dry subtropical with wide annual daily temperature variations. Winter (December to February) is mild, mostly cloudy, and has mean monthly minimum and maximum temperatures of -1.5 to 1.5 °C and 7 to 10 °C, respectively. Cold winter winds and clear weather can cause temperatures to fall to as low as -22 °C for short periods. Precipitation falls 4 to 6 days per month as rain and occasionally snow; however, fallen snow melts quickly. Spring (March and April) is characterized by rapid daytime warming and precipitation is brief afternoon downpours. Rainfall is highest during March averaging 56.4 mm per month. Average annual rainfall is 231 mm. Summer (May to September) is hot and dry with mean monthly maximum and minimum temperatures of 30 to 39 °C and 14 to 22 °C,

respectively. Daytime temperatures of 45 °C can occur. Daytime relative humidity during summer does not exceed 25 to 30% and rain is very rare. Fall (October and November) begins clear and dry then turns cloudy and rainy. Days in fall are warm and nights are cool.

Winds are primarily northwesterly and southeasterly. East winds are also common in winter and fall. Prevailing wind speeds are 2 to 3 m/s. Rare strong winds (up to 20 m/s) occur in late spring or early summer and usually result in dust storms, reducing visibility to several meters.

Ambient air quality at the project sites is likely to be good based on the following characteristics: (1) sites are in a semi-desert area approximately 15 – 20 km from Sheberghan City, where industries are the nearest potential sources of air pollution; and (2) the sites are relatively exposed topographically and not prone to atmospheric inversion. However, particulate material concentrations are likely to be high throughout the region given the prevailing winds and soil transport characteristics.

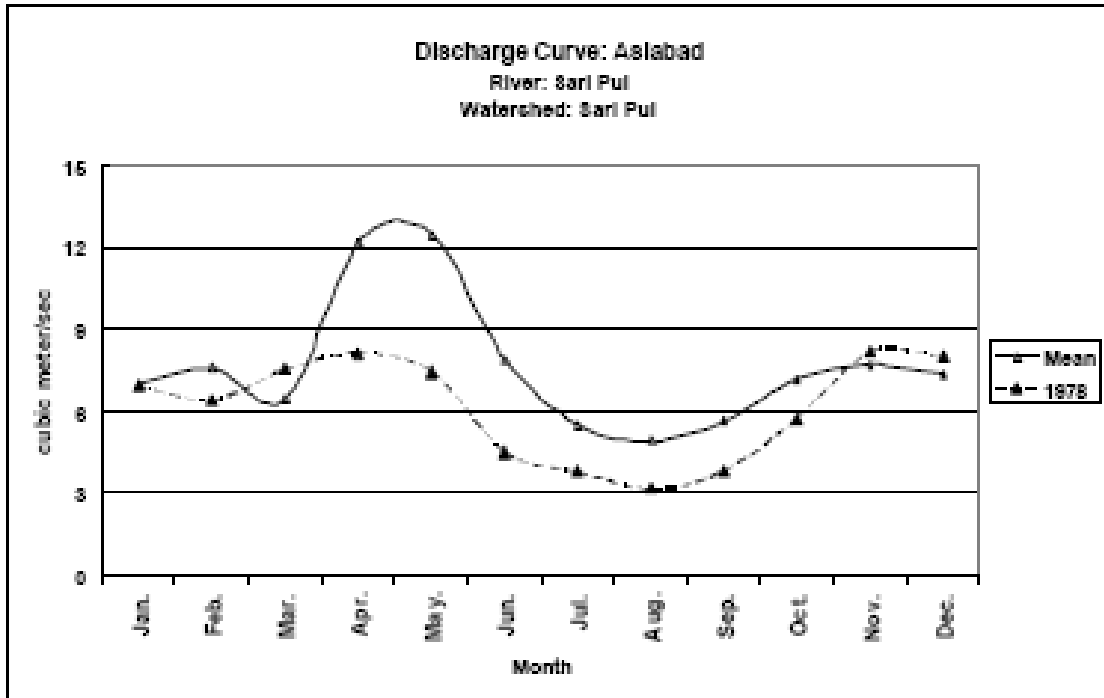
Air quality in Sheberghan City is likely negatively impacted by vehicular emissions and the burning of oil refinery residues. Vehicular density is increasing throughout Afghanistan where most vehicles run on low-grade diesel fuel. In testing performed by UNEP, dust and polyaromatic hydrocarbons were detected in Mazar-e-Sharif and other cities in Afghanistan². UNEP also found that a coal-like residue from small private oil refineries was being used for domestic heating and brick factories, which produces a thick black smoke when burned. The refinery residue results in the emissions of sulfur dioxide and hydrocarbons which are noted by UNEP to pose a threat to human health.

2.1.6 WATER RESOURCES

The project sites are situated within the Sar-e-Pul watershed of the Northern River Basin, one of five river basins in Afghanistan. The Northern River Basin has the smallest annual flow contribution of all the basins, contributing a mean volume of 1,880 m³, which is 2% of the total annual river discharge in Afghanistan. The Sar-e-Pul source is the high mountains of the central highlands and the watershed has an area of 16,743 km², comprising 2.6% of Afghanistan's total area. The watershed is drained by two main rivers: the Ab-I Sya River and the Sar-e-Pul River which join 10 km south of the town of Sar-e-Pul. Further downstream, a diversion structure splits the river into the Darya-I Sya (east side channel) and Darya-I Safid (west side channel).

² UNEP. *Afghanistan Post-Conflict Environmental Assessment*. Geneva 2003.

The channels dry up in the irrigation canals or desert sands north of Sheberghan City well before reaching the Amu Darya River. Peak discharge from the Sar-e-Pul is in April and May, illustrating the strong influence of snowmelt on river flow. Minimum discharge is in August. Annual average flow rate is approximately 6 m³/s. A hydrograph of the Sar-e-Pul River is shown in Figure 5.



Source: Watershed Atlas of Afghanistan, Kabul, 2004.

Figure 5 Hydrograph of Sar-e-Pul River

The Qarakent groundwater pumping station, located in the lower Sar-e-Pul River valley about 10 km south of Sheberghan, provided water for the Gerquduq and Khoja Gogerdaq gas treatment plants, as well as for domestic supply, from 12 wells. The gas treatment plants have not been operational for many years and currently only 2 water wells at Qarakent are operational. This data suggests that groundwater resources in the Sar-e-Pul valley are present.

Groundwater is ultimately recharged by precipitation and direct recharge of precipitation to the project areas is likely to be small. Groundwater resources, where present, are likely Quaternary aquifers recharged in the foothills by rivers and streams descending from the high mountains and infiltrating into coarse grained alluvial fans. In addition, there may be infiltration of water into the aquifers through the bed of the Sar-e-Pul River and from irrigation channels along the Sar-e-

Pul valley. Based on this interpretation, groundwater resources are likely limited to areas immediately surrounding the Sar-e-Pul River.

2.1.7 ECOLOGICAL RESOURCES

The natural vegetation around the project site is semi-desert. Ground cover is sparse, consisting of drought resistant grasses including needle grass, sheep fescue, blue grass, and sedge. Grasses usually die back by mid-summer and the landscape takes on a desert appearance. Arable land in the Sar-e-Pul valley located at the western edge of the productive gas fields is planted with grain including wheat, barley, and corn.

The region is known to provide habitat for various vertebrate species including a species of ground squirrel (*Spermophilopsis leptodactylus*), falcons (*Falco spp.*), Jerboas (*Allactaga spp.*), Caracal Cats (*Caracal caracal*), and Striped Hyenas (*Hyaena hyaena*). There are no known rare or endangered species within the project area.

2.1.8 ECONOMIC DEVELOPMENT

Economic development in the project area, like most of Afghanistan, has suffered major setbacks during the last three decades of war and civil strife. During this time, key infrastructure and economic resources were either actively destroyed or fell into disrepair through lack of maintenance.

The area also suffered a heavy loss of human resources either through military casualties, or internal and external displacement of workers (fleeing a combination of military threats, ethnic/tribal tensions or forced to move due to drought). The result for the Sheberghan area is a collection of badly damaged or run-down factories and workshops with insufficient support infrastructure and an insufficiently skilled workforce to operate them.

Slowly, however, economic recovery is taking place, driven in large part by a construction boom (which is even being felt in regional cities such as Sheberghan), service industries responding to international reconstruction assistance projects, and recovery in the agricultural sector.

In addition to small traders and grocery shops, visible industries include welding, fitting and turning, sale of fuel and construction lumber, car and bicycle repair shops, bakeries, clothes shops and pharmacies. The local administration in Sheberghan has plans for development of a steel plant, a stone cutting plant, and a salt plant. While the economic viability of these

industries is not known, the fact that such plans exist is indicative of planned future economic growth.

Sheberghan is an important regional center for the surrounding hinterland, providing a regional market for goods (including agricultural products and crafts), a service center providing health and education facilities, and a transportation hub between the traffic moving on the ring road (which sees international traffic to and from Iran, Turkmenistan, Kazakhstan and Pakistan) to the central province of Sar-e-Pul. Sheberghan also has a small but serviceable regional airport 10 km to the east of the city.

Water supply for most of the city population consists of in-house supply from protected tube-well for the better-off residents, and street-side hand-pumped wells shared by a number of neighbors for poorer communities.

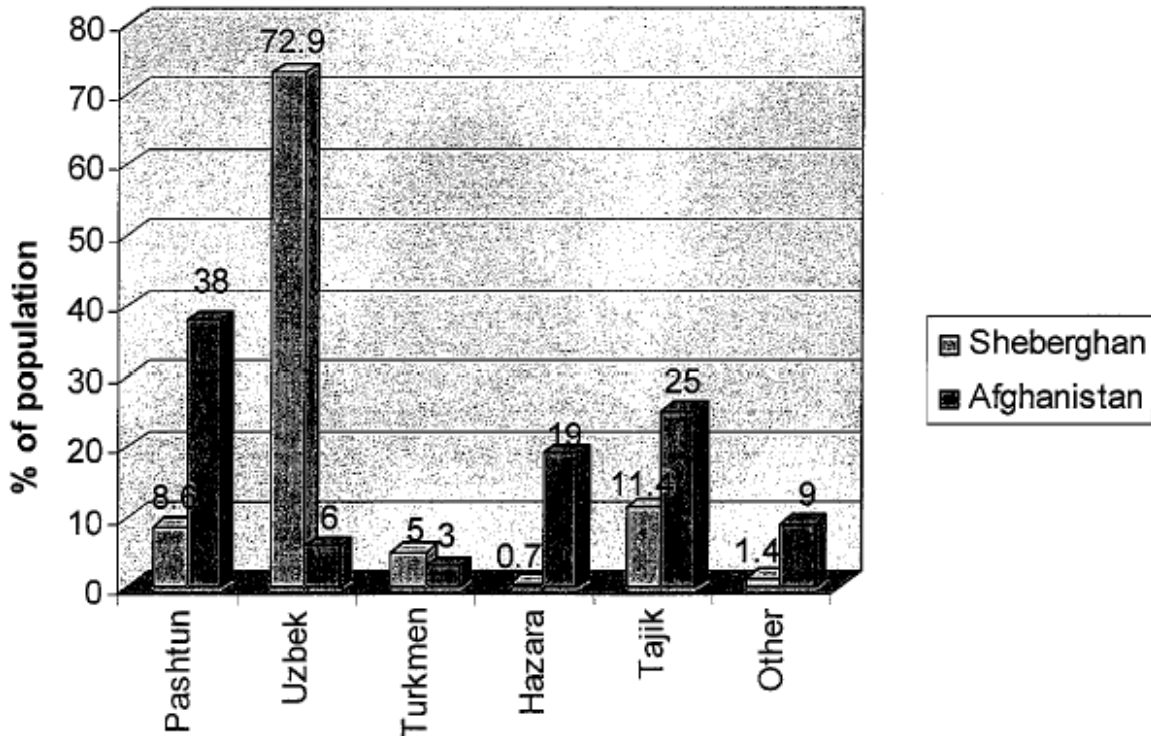
Sheberghan does not have a city-wide sewer system. Larger residences and guest houses have septic tanks. Most residences have a rudimentary system whereby waste is channeled to an alcove street-side, where it is collected by a dirt-cart operator for use as fertilizer. Many government facilities simply have a lidded bucket. Most people urinate and defecate in the lee of the buildings and at the roadside, with negative environmental and health consequences.

The prominent industry in the Sheberghan area is natural gas production. Operations in the field are on-going at a rudimentary level due to lack of funding for equipment and supplies as well as skilled labor force.

Sheberghan is also home to a sizeable cadre of public servants from district administrations concerned with power, water, mines, education, health, security, roads, and city and district governance. Sheberghan's hinterland is deceptively small, with horticultural land use in the river basins (mainly wheat and other cereals), and extensive grazing of sheep on the plains. There is some grazing of camels and goats on the more marginal pastures before they turn to desert, which dominates the landscape between Sheberghan and neighboring towns. In addition to natural gas, the Sheberghan area also has deposits of salt, coal, and coke. Importantly, Sheberghan has a reliable communications network. Several cellular phone providers have coverage in the city, and the local television station run by broadcasts in the Dari, Pashto, Uzbek, and Turkmen languages via a communication's tower on the hill at Yatimtaq.

2.1.9 SOCIAL AND CULTURAL PROFILE

To get an accurate picture of the socioeconomic dynamics of the Sheberghan region, a simple household survey was undertaken in 140 randomly selected households by USAID as part of the preparation of their EIA for a natural gas-fired power plant. Since this is less than a 1% sample, the results are not statistically significant. Rather, they provide a 'snapshot' of the general socioeconomic picture in the region. Ethnic composition is shown in Figure 6.



Source: USAID. Feasibility of Development of a Gas-Fired Thermal Power Facility in Sheberghan, Afghanistan

Figure 6 Ethnic Composition of Sheberghan and Afghanistan

Of the respondents, 21% were female and the balance male. Only one household in the sample was headed by a woman. Of those who answered the survey, only 35% were able to read or write a simple message in any language. Graduates of high school (or higher) comprised 17% of all respondents.

The most common occupation of the household head was that of the government official or employee, comprising 23% of respondents. Also prominent were private sector employees (22%) and farmers (21%). Fourteen percent of household heads responded that they had no job. Seventeen percent were small traders, laborers, retired or some other occupation.

On the whole, the population of the Sheberghan area is poor. Over 80% earn less than US \$1 a day per capita. The population of Sheberghan is around 200,000, majority of them in the Uzbek ethnic group. This is reflected in the domed earthen building styles of local residences rather than the flat roofed style common in other parts of the country. The survey showed that 96% percent of the respondents lived in houses constructed of mud-brick, and 92% of respondents owned their own house.

The Sheberghan region population has been reasonably geographically mobile, with 27% of respondents having lived there for five years or less and 43% ten years or less. Conversely, 57% had lived there more than 10 years. The average household (number of occupants living in same dwelling) size is 9.5, with the range extending from two persons to 24. The large size of most households is in part due to a high fertility rate of 6.8, but also to a non-nuclear family structure, with one household often comprising three generations, more than one wife per married male, and married brothers and their families living together.

The population distribution shows 53% children (0-14 years); 44% economically productive adults (14-60); and an elderly population of 3%.

The dependency ratio is defined as the ratio of the percentage of persons 0-14 and 61 years and over to people in the working age groups 15-60 years old. This gives an indication of the economic burden falling on the population of working age. The survey sample has a dependency ratio of 1.27, which is very high. This is to be expected, given a high population growth rate (1.9%) and a high fertility rate (6.8%). Also there is a socioeconomic propensity for large families in the absence of social welfare and reproductive health choices and due to years of social insecurity. The survey may be underestimating the dependency ratio, since it is still not common in Afghanistan for women to undertake paid employment outside the home.

The age pyramid resulting from the household survey demonstrates this high dependency ratio. It is also notable for the dominance of male children over female (which we can speculate is due to a cultural preference for males, backed up by anecdotal evidence from focus group discussions), and also the dominance of males in the 14-60 year age group. Given the many years of war in Afghanistan during which mainly men rather than women were killed, this is somewhat unexpected, but may be attributable to Afghanistan's extremely high maternal mortality rate (1.8%), and the fact that women suffer disproportionately to men from serious illnesses such as tuberculosis, where 70% of those affected are young women.

Despite the large household size, 58.6% of the households have a single income earner, with 22% having two and 18% having three, four, or five income earners. Ten percent of respondents reported some form of business was conducted from the house, most commonly manufacture of crafts. The average annual household income is US \$1,465 which equates to a household income of US \$4 a day, or a per capita average daily income of \$0.40. Fifty-two percent of households surveyed have at least one outstanding loan presently, mostly (71%) taken out to buy food, with 9% taken out to build/repair a house, and 12% to pay for a family function such as a wedding or funeral. Only 3% of loans were for productive purposes such as to start a business or buy tools/machinery. This demonstrates a high degree of social insecurity in the region.

A simple analysis of energy demand was undertaken. Of all households, 72% of respondents reported insufficient electricity supply, and 27% stated that supply was just barely enough. Only one household reported that supply was fully adequate to their household needs. Most households in the Sheberghan region use gas for cooking and kerosene for lighting. When asked to rank their preference for social infrastructure, respondents overwhelmingly gave first priority to clean potable drinking water. Second reported preference was electricity, followed by roads, health facilities, job opportunities, and schools.

2.2 NATIONAL ENVIRONMENTAL POLICIES AND PROCEDURES

The Government's regulation on environmental impact assessment is based on the Environmental Act of the Islamic Republic of Afghanistan (Gazette No. 873) dated 29 Jada, 1384 (19 January 2006). The National Environmental Protection Agency (NEPA) is responsible for coordinating and monitoring conservation and rehabilitation of the environment and for implementing the Environment Act. Articles 16 and 17 of Chapter 3 of the Environmental Act describes the process of preparing a preliminary environmental assessment, an environmental impact statement and a comprehensive mitigation plan to be completed by the proponent of each project. Article 21 states that public consultation is required for all projects. Article 18 describes the approval procedure for an Environmental Impact Assessment (EIA). Permits lapse in three years if the proponent fails to implement the project. Article 19 describes the appeal procedure. Chapter 6 of the Environmental Act of the government describes the national biodiversity strategy and protected areas management framework. As of the writing of this report a national biodiversity strategy and action plan remains in the process of being developed by NEPA. NEPA is also developing a plan for the system of national protected areas.

3 EVALUATION OF ENVIRONMENTAL IMPACT POTENTIAL

A Leopold Matrix was developed for the project and is presented in Annex 2. The main activities provided in the Leopold Matrix include the reentry and rehabilitation of existing wells and the drilling of new wells. Discussion of the main environmental impact potentials is contained in the following sections.

3.1 WELL DESIGN AND PROCUREMENT

Well design and procurement will have a minor beneficial impact on employment as local services may be required for these aspects of the work. No negative environmental impacts are expected during this phase. During the reentry and rehabilitation of existing wells, the well design will be carefully assessed and will be updated, if necessary, to account for the presence of H₂S and CO₂ in the produced gas. Design work on wells to be rehabilitated and new wells will include facilities for flaring during the testing phase.

3.2 SITE PREPARATION AND RIG MOBILIZATION

Agriculture – The access road and drilling location may impact existing agriculture. This can be avoided by proper site selection and road design.

Soil Erosion/Contamination – Soil erosion from construction areas can lead to loss of top soil from productive agricultural areas. Contamination of soils can occur from accidental leaks and spills of fuels and oils. Soil erosion can be mitigated by proper design, and the installation of erosion control measures during and following construction. The impact of soil contamination can be mitigated by the implementation of procedures for fuel handling, inspections, and spill contingency.

Air Quality – Construction and transport equipment will emit the products of combustion from internal combustion engines – i.e. nitrous oxides (NO_x), sulfur dioxide (SO₂), particulates (PM₁₀), carbon monoxide (CO), and volatile organics (VOC). Construction in the loess soils prevalent in the region will result in the creation of airborne dust particles. Air quality impacts during construction and transport can be mitigated by the use of properly inspected and maintained vehicles. Construction areas can be periodically watered to reduce fugitive dust emissions.

Noise – Construction of the access road and drilling location, and transportation of the drilling rig will result in noise. As the drilling site is at least 2 km distant from the populated areas, the impact of construction noise is expected to be minimal. Truck traffic may increase noise levels within populated areas as these are generally the best roads. Noise impacts can be mitigated by design of transport routes, and limitations on when travel occurs. The drilling contractor will be responsible for the Traffic Management Plan and its approval.

Resource/Land Use – The construction of an access road and drilling location may affect the local land use. Proper site selection and access road design can mitigate the impact of changes in land use.

Utilities and Infrastructure – Mobilization of the drilling rig to the site will require approximately 50 truckloads of equipment to be delivered. These may strain roadways, bridges, and other facilities along the transport route. These impacts can be mitigated by inspection of the route and documentation of condition prior to mobilization. Proper route selection can avoid inadequate infrastructure which may be damaged.

Employment – Construction operations create a moderate positive benefit to residents as these will likely be carried out by a local contractor.

3.3 DRILLING AND COMPLETION OPERATIONS

Drilling Operations

Air Quality – During drilling operations, the use of internal combustion engines to power the rig, generate electricity, and pump the drilling mud will consume energy (diesel fuel) and emit combustion products as air pollutants. Estimated emissions for a typical drilling rig are shown in Table 5. The impact of air emissions on air quality can be minimized by ensuring the rig engines are maintained to manufacturer’s specifications.

Table 5: Drilling Rig Air Emissions

Air Pollutant	Emission Factor¹, kg/l	Estimated Emission Rate, kg/day
Nitrous oxides (NO _x)	0.052544	788
Sulfur dioxide ² (SO ₂)	0.024876	373
Particulate material	0.000941	14
Carbon dioxide	0.013957	209
Hydrocarbons	0.001478	22

Data assumes 15,000 liters of diesel fuel used per day.
¹ From U.S. EPA AP-42 Compilation of Air Pollution Emission Factors.
² Assuming diesel sulfur content of 1.5%.

Water Quality - The rig may also generate effluent from storm water run-on and run-off. This potential impact can be eliminated by collecting rain water in a perimeter drain(s) and treating prior to release. Ground and surface water can be impacted by accidental spills and releases of fuel, oil, or chemicals. A poor cement job on the surface casing can lead to contamination of ground water aquifers. Spill Prevention and Contingency Plans are used to protect against the possibility of a spill reaching surface and ground water. Cement integrity on the surface casing should be confirmed prior to resumption of drilling. A Waste Management Plan should be prepared for dealing with the various types of waste generated.

Noise - The drilling rig and associated equipment will generate noise 24 hours per day. Since the nearest residents will be located at least 2 km from the rig location, the impact of noise is expected to be minor.

Public Health - During drilling, subsurface pressure is controlled by the hydrostatic pressure exerted by the drilling mud on the formation. Standard procedures govern the actions of the rig crew when a well control problem is encountered in order to bring the well back into control. This includes increasing mud weight and use of the blowout prevention systems. Rarely, through human error, mechanical failure, or both, a loss of well control can occur. This can result in the escape of gas to the atmosphere at the maximum rate attainable. One of two events will occur when this happens: (1) the gas will find an ignition source at the rig site and create a jet fire; or (2) the gas will expand and, if an ignition source is present, create a flash fire. A flash fire is created only where the gas has been diluted to a concentration between the upper explosive limit (UEL) and lower explosive limit (LEL). A flash fire will ultimately burn back into a jet fire. For practical purposes, 100 to 500 m is the distance at which the LEL would occur; a person closer than this distance would potentially be at risk.

Employment – Drilling and completion operations create a minor positive benefit to employment.

Completion Operations

During completion operations, the potential impacts are similar to those during drilling. A completion rig will be used, with internal combustion engines used to power the rig, thus generating air pollutants. Accidental spills of fuel, oil, or chemicals can result in contamination of surface and ground water. Completion operations will produce noise. Properly managed, completion operations are expected to result in negligible to minor environmental impacts. The

contractor's well completion plans will address all normal and contingency actions during testing and completion operations as well as managing the environmental impacts arising from the work.

3.4 WELL TESTING

Air Quality – The principal impact from well testing will be the impact on air quality from the combustion of sour gas. When burned in modern smokeless flare or incinerator, virtually 100 percent of the H₂S in sour gas converts to SO₂. The major health concerns associated with exposure to high concentrations of SO₂ are the effects on the respiratory system. The United States National Ambient Air Quality Standard for SO₂ is 140 parts per billion over a 24-hour period.

Based on an H₂S concentration in the Bashikurd and Juma gas of 0.52%, SO₂ emissions from a flare would be 14 kg/1000 m³ of gas produced. A preliminary evaluation of the impact of flaring on ambient air quality using the US EPA model SCREEN3 indicates that the US NAAQS would not be exceeded for SO₂. Mitigation measures for flaring would be proper design height of the flare and safety shut downs in the event the flare were to go out. Monitoring of downwind SO₂ during flaring would determine if air quality was being degraded. A limitation on the amount of days of flaring or volume flared could also be used to mitigate the emissions of SO₂ to the atmosphere.

Noise from flaring is also a potential impact. This impact can be mitigated by limiting the timing and duration of flaring activities.

3.5 CUMULATIVE IMPACTS

A possible associated project to the proposed well drilling and testing is the construction of a gas sweetening plant and a 200MW-gas fired power plant. Cumulative impacts, should such development take place, would be primarily emissions of air pollutants. However, the primary emissions from a gas-fired power plant, if installed, are CO₂ and nitrous oxides (NO_x), while the primary emissions from the proposed gas sweetening plant are SO₂. Therefore, it is considered unlikely that significant cumulative impacts will occur as a result of these projects being implemented. There will be no induced development as a result of these projects as they are located in a remote desert area with no other supporting infrastructure.

4.1 RECOMMENDED IEE DETERMINATIONS

4.1.1 WELL DESIGN AND PROCUREMENT

The proposed project design and procurement activities qualify for Categorical Exclusion per 22 CFR 216.2(c)(1)(i) as the action does not have an effect on the natural or physical environment and 216.2(c)(2)(i), (iii), (v) and (xiv) as technical assistance and education, workshops and meetings, information transfer and development planning.

4.1.2 SITE PREPARATION AND RIG MOBILIZATION

The site preparation and rig mobilization activities are recommended for Negative Determination with Conditions per 22 CFR 216.3(a)(2)(iii) where "the cognizant Bureau or Office will record a Negative Determination if the proposed action will not have a significant (adverse) effect on the environment." Conditions to be imposed during site preparation and rig mobilization are discussed in the following section, but include site selection criteria, transportation criteria, and control of air emissions.

4.1.3 REHABILITATION, DRILLING AND COMPLETION OPERATIONS

The rehabilitation, drilling, and completion operations are recommended for Negative Determination with Conditions per 22 CFR 216.3(a)(2)(iii) where "the cognizant Bureau or Office will record a Negative Determination if the proposed action will not have a significant (adverse) effect on the environment." Conditions to be imposed during rehabilitation, drilling, and completion operations are discussed in the following section, but include air quality controls, storm water controls, design criteria, and preparation of environmental protection plans.

4.1.4 WELL TESTING

The well testing activities are recommended for Negative Determination with Conditions per 22 CFR 216.3(a)(2)(iii) where "the cognizant Bureau or Office will record a Negative Determination if the proposed action will not have a significant (adverse) effect on the environment." Conditions to be imposed during well testing are flare design criteria, air quality monitoring, and limitations on the timing and volume of gas flared.

4.2 MITIGATION, MONITORING AND EVALUATION

Environmental mitigation measures will be implemented conditionally on project approval. These are necessary to ensure that the potential impacts identified in this IEE do not have a significant adverse effect on the environment. Environmental mitigation measures applicable to the project are presented in Table 6.

Table 6: Environmental Mitigation Measures

Category/ Activity	Potential Impacts	Mitigation Measures
Well Design and Procurement		
Site Selection	Land use changes	Sites and adjoining land are government owned; therefore, there should be no land use changes. Avoid agricultural areas in site selection
Public Consultation	Social fabric	Conduct public consultation prior to project
Well Design	Water quality	Ensure design protects fresh water aquifers
	Public health	Specify BOP and BOP testing procedures
		Site selection to avoid populated areas (100 – 500 m)
Testing Design	Air quality	Ensure flare design minimizes impact on air quality
Site Preparation and Rig Mobilization		
Rig Mobilization	Noise and traffic	Avoid populated areas to the extent possible
	Infrastructure	Document condition and repair if damaged
Road and Location Construction	Air quality	Maintain engines and water construction areas
	Land use	Avoid land use changes in design
Drilling and Completion Operations		
Drilling Operations	Air quality	Maintain engines to manufacturers specifications
	Water quality	Control run-on and run-off with perimeter drain
		Prepare and implement Oil Spill Prevention and Contingency Plan
		Prepare and implement Waste Management Plan
Completion Operations	Air quality	Maintain engines to manufacturers specifications
	Water quality	Control run-on and run-off with perimeter drain
		Prepare and implement Oil Spill Prevention and Contingency Plan
		Prepare and implement Waste Management Plan
Reentry, Perforation, and Logging		
Perforation and Logging	Radiation	Comply with recommended practice for handling and transportation of explosives and radioactive materials.
Well Testing		
Flaring	Air quality	Limit timing and duration of flaring to minimize emissions
		Monitor downwind air quality to ensure standards are not exceeded
	Noise	Limit timing and duration of flaring to minimize noise

5 SUMMARY OF FINDINGS

Recommended Action: Categorical Exclusion

All activities related to Rehabilitation, Well Design, and Procurement are categorically excluded from requirements for an environmental examination, environmental assessment and environmental impact statement under Title 22 of the Code of Federal Regulations (CFR) Section 216.2 (c)(2). Pursuant to 22CFR216.2(c)(3), 22CFR216.2(c)(1)(i) and 22CFR216.2(c)(2)(i), the originator of the proposed activities has determined that these activities are fully within the following classes of action:

Education, technical assistance, or training programs except to the extent such programs includes activities directly affecting the environment (such as construction of facilities, etc.) [22 CFR 216.2(c)(2)(i)]

Analyses, studies, or academic workshops and meetings [22 CFR 216.2(c)(2)(iii)]

Document and information transfers [22 CFR 216.2(c)(2)(v)]

Recommended Action: Negative Determination with Conditions

Pursuant to 22 CFR 216.3(a)(2)(i), the originator of the proposed project recommends a negative determination of significant environmental effect for the following activities:

- Site Preparation and Rig Mobilization
- Rehabilitation, Drilling and Completion Operations
- Well Testing

Impacts for these activities were identified using a Leopold Matrix (Annex 2) and mitigation measures are contained in Table 6.

Revisions: Pursuant to 22CFR216.3(a)(9), if new information becomes available which indicates that activities to be funded by the Project might be "major" and the Project's effect "significant," this negative determination will be reviewed and revised by the originator of the project and submitted to the E&E Bureau Environmental Officer for approval, and if appropriate, an environmental assessment will be prepared.

ANNEX 1

Environmental Impact Assessment

ANNEX 2
Leopold Matrix

