Environmental and Social Management Framework for Natural Gas Efficiency Project

Reduction of Unaccounted-for Natural Gas (UFG) in SSGC’s Gas Distribution Network

Main Text

December 2010
## List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>BAP</td>
<td>Biodiversity Action Plan</td>
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<tr>
<td>BHU</td>
<td>Basic Health Unit</td>
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<tr>
<td>BOD</td>
<td>Biological Oxygen Demand</td>
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<tr>
<td>CITES</td>
<td>Convention on International Trade in Endangered Species of Wild Fauna and Flora</td>
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<tr>
<td>CP</td>
<td>Cathodic Protection</td>
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<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
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<tr>
<td>EMP</td>
<td>Environmental Management Plan</td>
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<tr>
<td>EPA</td>
<td>Environmental Protection Agency</td>
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<tr>
<td>EVC</td>
<td>Electro Volume Corrector</td>
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<tr>
<td>ESMF</td>
<td>Environmental and Social Management Framework</td>
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<tr>
<td>4 WD</td>
<td>Four Wheel Drive</td>
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<tr>
<td>GoP</td>
<td>Government of Pakistan</td>
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<tr>
<td>GHG</td>
<td>Green House Gas</td>
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<tr>
<td>GSM</td>
<td>Global System for Mobile Communications</td>
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<tr>
<td>HSE</td>
<td>Health, Safety and Environment</td>
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<tr>
<td>IPI</td>
<td>Iran Pakistan India Gas Pipeline project</td>
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<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
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<tr>
<td>MPNR</td>
<td>Ministry of Petroleum &amp; Natural Resources</td>
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<tr>
<td>NEQS</td>
<td>National Environment Quality Standards</td>
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<tr>
<td>OGRA</td>
<td>Oil &amp; Gas Regulatory Authority</td>
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<tr>
<td>PE</td>
<td>Polyethylene</td>
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<tr>
<td>PSQCA</td>
<td>Pakistan Standards &amp; Quality Control Authority</td>
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<tr>
<td>PEPA 97</td>
<td>Pakistan Environmental Protection Act, 1997</td>
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<td>ROW</td>
<td>Right of Way</td>
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<tr>
<td>SNGPL</td>
<td>Sui Northern Gas Pipelines Ltd</td>
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<tr>
<td>SSGC</td>
<td>Sui Southern Gas Company Limited</td>
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<tr>
<td>TAPI</td>
<td>Turkmenistan-Afghanistan-Pakistan-India Gas Pipeline Project</td>
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<tr>
<td>TDS</td>
<td>Total Dissolved Solids</td>
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<tr>
<td>UC</td>
<td>Union Council</td>
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<tr>
<td>UFG</td>
<td>Unaccounted-for Gas</td>
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# List of Units

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>°C</td>
<td>Degree Celsius</td>
</tr>
<tr>
<td>bbl/d</td>
<td>Barrels per day</td>
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<tr>
<td>cm</td>
<td>Centimetre</td>
</tr>
<tr>
<td>cum</td>
<td>Cubic meter</td>
</tr>
<tr>
<td>cusecs</td>
<td>Cubic feet per second</td>
</tr>
<tr>
<td>db</td>
<td>Decibels</td>
</tr>
<tr>
<td>gph</td>
<td>Gallons per hour</td>
</tr>
<tr>
<td>ha</td>
<td>Hectares</td>
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<tr>
<td>hr</td>
<td>Hour</td>
</tr>
<tr>
<td>Kg</td>
<td>Kilogram</td>
</tr>
<tr>
<td>Km</td>
<td>Kilometer</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
</tr>
<tr>
<td>mg/l</td>
<td>Milligram per litre</td>
</tr>
<tr>
<td>mg/Nm3</td>
<td>Milligram per Normal Cubic meter</td>
</tr>
<tr>
<td>mm</td>
<td>Millimetre</td>
</tr>
<tr>
<td>MMCF</td>
<td></td>
</tr>
<tr>
<td>m/s</td>
<td>meter/second</td>
</tr>
<tr>
<td>%</td>
<td>Percent</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million</td>
</tr>
<tr>
<td>psi</td>
<td>Pounds per square inch</td>
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<tr>
<td>sq</td>
<td>Square</td>
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## SSGC Natural Gas Efficiency Project

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EXECUTIVE SUMMARY

Introduction

Sui Southern Gas Company Limited (SSGC) is Pakistan's leading integrated natural gas utility company and engaged in the business of transmission, distribution and supply of natural gas in the provinces of Sindh and Baluchistan. SSGC's high pressure gas transmission system extends from Sui in Baluchistan to Karachi in Sindh comprising transmission lines of 3,320 km and distribution network of over 34,282 km (including services) covering over 1200 towns in the Sindh and Balochistan.

With the assistance of a US$200 million loan from the World Bank, SSGC intends to implement a project named Natural Gas Efficiency Project for the main purpose of reducing unaccounted-for gas (UFG). Under this project SSGC will replace approximately 5750 km distribution pipeline (excluding Supply Main) during the next five year along with overhead and underground leak survey and rectification of 1.6 million customers and about 17,700 km of network. It is projected that after the completion of this project SSGC may save UFG volume of approximately 21 billion cubic feet per year.

Environmental and social aspects of the project are discussed and presented in this Environmental and Social Management Framework (ESMF) to ensure compliance with the stipulations of Pakistan’s environmental laws and World Bank’s safeguard policies.

Need for Natural Gas Efficiency Project

Parts of SSGC’s gas distribution steel networks are as old as 40 to 50 years. Over the years these steel pipeline have corroded due to its aging as well as ineffective Cathodic Protection, resulting in continuously rising leakages, which cause unaccounted-for gas (UFG) losses. The majority of losses are caused by leakages, but UFG also consist of gas unaccounted for due to gas theft and inaccurate metering of consumed gas.

The resulting enhanced network efficiencies and capacity utilization factors will also help in reducing environmental threats through reduction in methane emissions into the atmosphere. Methane has Global Warming Potential (GWP) of 21 calculated over 100 years, indicating that it is approximately 21 times more heat absorptive than carbon dioxide, per unit of weight. However, when calculated for 20 years the GWP of methane is 56, rendering it an even more harmful greenhouse gas.

Objective of ESMF

The Environmental and Social Management Framework (ESMF) includes the environmental and social assessment and management guidelines for addressing environmental and social impacts of the project activities that are to be taken up during the project implementation.
The specific objectives of ESMF are to identify adverse environmental and social impacts associated with activities proposed under the project; develop an Environmental Management Plan (EMP) for the adverse environmental impacts; identify any possible need for a Resettlement Policy Framework or in-depth environmental assessment based on the results of a Social and Environmental Screening Checklist; and ensure appropriate level of consultation and communication between proponent, public and other stakeholders during project execution.

Project Location

The proposed rehabilitation of distribution network during the entire project duration is divided into three regions viz. Karachi, Interior Sindh, and Quetta. During the first three years of the five-year project, it is estimated that around 2,150 km network would be rehabilitated in 37 schemes/areas in Karachi; 900 km in 86 schemes/areas in 17 Districts in interior of Sindh; and 300 km in 14 schemes/areas in Quetta city.

Project Description

Bulk meters will be located many places in the gas pipeline network so that smaller parts of it – segments – can be isolated and UFG measured in it. This will help establish which parts of the pipeline network should be rehabilitated first for highest possible UFG reduction. Furthermore, the Cathodic protection system will be upgraded to improve the protection of old steel pipes that would not be replaced in the immediate future. Cathodic protection helps stop the increase in number and size of holes in the walls of the steel pipes. Automatic pressure management systems will be installed to ensure that pipeline pressures are kept at sufficient levels to meet demand through the day while not being excessive, since excessive pressure increases UFG. The existing pace of pipeline replacements (300 km/year) will be increased three to four times with focus in areas having the highest UFG, addressing the overhead as well as underground leakages. The identification of and removal of leakages will also improve the company’s ability to pursue and eliminate the remaining UFG in the form of gas theft and metering inaccuracies. Measurement systems will be upgraded and surveillance of measurement stations/gas connection points will be improved utilizing state-of-the-art technologies.

Regulatory Requirements

The Pakistan Environmental Protection Act (PEPA), 1997 is the principal law enabling the Government to enact regulations for the protection of the environment. The key features of the law that have a direct bearing on the proposed project include compliance requirement to conduct an Environmental Assessment prior to the implementation of any project.

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 (the ‘Regulations’), prepared by the Pak-EPA under the powers conferred upon it by the PEPA 1997, provide the necessary details on the preparation, submission, review and approval of the Initial Environmental Examination (IEE) and the Environmental Impact Assessment (EIA). The Regulation
classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule-I lists projects that may not have significant environmental impacts and therefore require preparation of Initial Environmental Examination (IEE). Schedule-II lists projects of potentially significant environmental impacts requiring preparation of a detailed study, the Environmental Impact Assessment (EIA). The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA. In view of the nature of the activities to be performed under Natural Gas Efficiency Project, the project do not fall under any of the categories specified in Schedule-I or Schedule-II of the Regulations and would, therefore, not require preparation of IEE or EIA report.

The Environmental and Social safeguard policies of the World Bank would, however, require preparation of an environmental and social management framework for the project activities.

The standard operating procedures, policies, and administrative requirements of SSGC applicable on the project activities are also described in the ESMF. SSGC will also obtain No Objection Certificate (NOC) from the Highway Department, Local Government and Civic Agencies for the rehabilitation works/schemes under the Natural Gas Efficiency Project. Each of these departments has its own requirements for such approvals. All of these departments would be informed and consulted for development work as per SSGC’s policy.

**Description of Natural Environment**

The **project area 1 (Karachi)**, is located in the south of Pakistan, on the coast of the Arabian Sea. Most of the land consists largely of flat or rolling plains. Mangroves and creeks of the Indus delta can be found toward the southeast side of the city. The climate of the Karachi can be characterized by dry, hot and humid conditions and in general terms it is moderate, sunny and humid. Air temperature in Karachi and along the adjoining areas is invariably moderate and have a low rainfall record.

The **project area 2 (Upper & Lower Sindh)**, is located on the western corner of South Asia, bordering the Iranian plateau in the west. Sindh is bounded by the Thar Desert to the east, the Kirthar Mountains to the west, and the Arabian Sea in the south. In the centre is a fertile plain around the Indus river. The province of Sindh is situated in a subtropical region; it is hot in the summer and cold in winter. Temperatures frequently rise above 46 °C (115 °F) between May and August, and the minimum average temperature of 2 °C (36 °F) occurs during December and January. Sindh lies between the two monsoons — the southwest monsoon from the Indian Ocean and the northeast or retreating monsoon, deflected towards it by the Himalayan mountains — and escapes the influence of both. The average rainfall in Sindh is only 6–7 in (15–18 cm) per year. The region’s scarcity of rainfall is compensated by the inundation of the Indus twice a year, caused by the spring and summer melting of Himalayan snow and by rainfall in the monsoon season.
The **project area 3 (Quetta)**, the provincial capital of Baluchistan, is situated at an elevation of 1700 meters (5,500 ft). The city of Quetta comprises approximately 2,653 km² (1,036 square miles) and consists of series of valleys which act as a natural fort surrounded on all sides by a number of imposing hills. Climate of Quetta is cold and dry, minimum temperature in winter reaches below freezing point while in summer it can reach as high as 40 C. As compared to the rest of Balochistan, Quetta district was also affected by drought. However, in recent years the rains have increased.

The project activities would be carried out mostly in the urban or semi-urban areas. Such environment does not hold any flora or fauna of significant importance. Neither are there any endangered or extinct species or biodiversity expected to be encountered in these areas. Due to the high level of human interference and the absence of suitable habitats, the area has very little native wildlife present. However, agricultural and livestock-related activities are expected in some of the towns in the interior of Sindh. Natural water courses, canals, parks, and trees would be typical element of natural environment in the project areas.

**Socioeconomic Environment**

The **project area 1 (Karachi)**, consist of 18 towns, a Cantonment & Defense Society having a total population of 9.96 million according to 1998 census. Currently Karachi population is believed to between 14 and 15 millions. The linguistic distribution of the city in 1998 census is: Urdu speaking 48.52%; Punjabi 13.94%; Sindhi 7.22%; Pashto 11.42%; Balochi4.34%; Seraiki2.11%; others 12.4%. The culture of Karachi is a manifestation of the lifestyle, festivals, literature, music, language, politics, cuisine and socio-economic conditions of the people of Karachi. Karachi is a microcosm of people from many diverse cultures and ethnicities from all over Pakistan as well as other parts of the world.

The **project area 2 (Upper & Lower Sindh)**, had a population of 51,337,129 during 2009. Sindh's population is mainly Muslim (91.32%) and Sindh is also home to nearly all (93%) of Pakistan's Hindus forming 7.5% of the province's population.

The **project area 3 (Quetta)**, had a population of 850,000 during 2005. It is the highly populated and most urbanized district in the Baluchistan. Over 90% of the people of the area are Muslims. The Pashtun make up more than 52% and Hazaras covering 37% of the population of the capital district. Quetta is a tourist attraction for foreigners to whom it is advertised as a "thrilling location, full of adventure and enjoyment". Among the attractions are the bazaars with colorful handicrafts, particularly Balochi mirror work and Pashtun embroidery both of which are admired world-wide. The Pashtun workers are expert in making fine Afghan rugs, with their pleasing and intricate designs, fur coats, embroidered jackets, waist-coats, sandals and other traditional Pashtun items.
Community Consultation Process

During preparation of this ESMF a process of Community Consultation was undertaken to obtain feedback and suggestions of the local community about recently completed activities of SSGC – of the same type as planned for this project – in their locality. A questionnaire-based survey was carried out in two areas, viz. Frontier Colony (FC) and Ittehad Town (IT), where SSGC recently carried out rehabilitation activity of gas distribution network and gas-meter change. The survey was conducted by senior field personnel and representative of HSE Head Office Team.

The survey results indicated that communication of activity schedule is important for the local community and need to be communicated well ahead in time through handouts, announcement from local Mosque and/or placement of banners; in-time completion of activity with quality work is the prime requirement of the community; and, system of complaint registration with SSGC needs to be communicated to the local community prior to commencement of any activity in their areas.

It was concluded that for assessment of social and environmental impacts it would be necessary to obtain specific baseline information of the activity area through Social & Environmental Screening Checklist. Where significant social or environmental impacts are expected, a Rapid Assessment would be carried out to identify appropriate mitigation measures for project implementation phase. Such instances are expected to be rare.

Potential Project Impacts and Mitigation

The potential environmental and social aspects of the proposed activities are assessed using the standard impact assessment methodology. It starts with scoping, through which potential environmental issues associated with the proposed project are identified. This is followed by definition of the criteria for determining significance of the impact, prediction of the magnitude of the impact, assessment of significance, identification of mitigation measures to reduce the adverse impacts to acceptable levels, evaluation of residual impacts, and identification of monitoring requirements.

The purpose of the ESMF is to minimize the potential environmental and social impacts due to the proposed project. It reflects the commitment of the proponent to safeguard the physical, ecological and socio-economic environment at the area of influence of the project activities. The mitigation plan is a key component of the ESMF. It lists all the potential effects of each of the project activities and their associated mitigation measures identified during the environmental and social assessment stage of the project. A mitigation plan for Planning, Pre-construction, construction, commissioning, and operational stages of the proposed distribution network rehabilitation project has been prepared and included in the ESMF. It also describes the roles and responsibilities of the project proponent and the contractors.
Environmental Monitoring would be undertaken during the construction, commissioning and operational phases to ensure the effectiveness of the proposed mitigation measures. In order to respond to unanticipated environmental concerns at an early stage and to determine the accuracy of impact, predictions are also required. Specific monitoring programs have been outlined along with the responsibilities for the collection and analysis of data and the reporting requirements. The plan will be used as a management and monitoring tool for the implementation of the mitigation measures.

**Conclusion**

After assessing the significance of the potential impacts, it may be concluded that if the project activities are conducted as proposed and described in this report and the recommended mitigation and environmental management measures are implemented, the project will not result in any long-term or significant adverse impacts on the local community or the environment. The project will also comply with all relevant statutory requirements and standards.
1. Introduction

1.1 SSGC Brief Description

Sui Southern Gas Company Limited (SSGC) is Pakistan's leading integrated natural gas utility Company, engaged in the business of transmission, distribution and supply of natural gas in the provinces of Sindh and Balochistan.

SSGC’s high pressure gas transmission system extends from Sui in Balochistan to Karachi in Sindh comprising over 3,200 km of pipeline ranging from 12 – 24 inch in diameter. The transmission lines of 3,320 km and distribution network of over 34,282 km (including services) covers over 1200 towns in the Sindh and Balochistan and are organized through its regional offices. More than 80% of the network consists of Steel Pipeline. An average of about 384,522 million cubic feet (MMCF) gas was sold in 2008-2009 to over 2.15 million industrial, commercial and domestic consumers in these regions. The average day load sale is 1,100 MMCFD. Out of the total sales Karachi alone consumes more than 70% of the gas. The company also owns and operates the only gas meter manufacturing plant in the country, having an annual production capacity of over 550,000 meters.

The Company has an authorized capital of Rs. 10 billion of which Rs 6.7 billion is issued and fully paid up. The Government owns the majority of the shares. The Company is managed by an autonomous Board of Directors for policy guidelines and overall control. Presently, SSGC's Board comprises of 14 members. The Managing Director/Chief Executive has been delegated with such powers by the Board of Directors as are necessary to effective conduct the business of the company, and is supported by two the Deputy Managing Directors (DMD), along with a management team. The General Manager heads the HSE department in SSGC.

1.2 Need for the Project

Pakistan is facing serious energy shortages, as its energy supply and demand gap is rapidly widening causing supply curtailments. The problem is aggravated by declining production from indigenous gas reservoirs. The contribution of natural gas in the national energy mix is nearly 50 percent, which is significant and is projected to remain so with Government of Pakistan (GOP) is trying to materialize gas import options through LNG and trans-national pipelines.

The declining supply of gas from local reserves and introduction of imported gas will result in increase in gas prices. Under a business-as-usual scenario, gas will become so expensive, that it would not be affordable by a large segment of customers, especially domestic users. This has necessitated in a need to improve the quality of gas transmission, distribution infrastructure design, construction, operation and maintenance to applicable international standards and OGRA’s licensing conditions.
The resulting enhanced network efficiencies and capacity utilization factors will also help in reducing environmental threats through reduction in methane emissions into the atmosphere. Methane has Global Warming Potential (GWP) of 21 calculated our 100 years, indicating that it is approximately 21 times more heat absorptive than carbon dioxide, per unit of weight. However, when calculated for 20 years the GWP of methane is 56, rendering it more harmful green house gas.

Parts of the Company’s gas distribution steel networks are as old as 40 to 50 years. Over the years these steel pipeline have corroded due to its aging as well as ineffective Cathodic Protection resulting in continuously rising leakages, which cause unaccounted-for gas (UFG) losses. In fiscal year 2009-2010, almost 8 percent of the gas was lost as UFG, most of it as leakages but the number also includes gas theft and metering inaccuracies. The effective means of arresting this problem is to undertake active Rehabilitation of at least 10% of the system annually to complete the rehabilitation cycle in ten years. However, if the analysis of franchise zones is made on volume basis, then situation of Karachi is worst followed by that of Sindh and Balochistan. To tackle this problem SSGC formed a new section of Rehabilitation five years back and started pipeline rehabilitation works on a small scale of 200 km to 300 km per year with limited resources. SSGC has up till now rehabilitated about 1200 km of network. However, with the passage of time, the quantum of problems has become so immense that with the existing resources and capabilities it is becoming extremely challenging to bring the losses down to an acceptable level.

With the assistance of a 200 million USD loan from the World Bank, SSGC intends to implement a project for reduction of unaccounted-for natural gas losses in SSGC’s gas distribution network (Natural Gas Efficiency Project). Under this project SSGC will replace about 5,750 km Distribution Pipeline (excluding Supply Main) during the next five years along with overhead and underground leak survey and rectification of 1.6 million customers and about 18,700 km network. It is projected that after the completion of this project SSGC would save UFG volume of approximately 21 billion cubic feet per year. The project will take the Company out of the endless degeneration loop, where new corrosion of the steel pipes nullifies all the improvement measures taken in the past. Steel pipes will for the most part be replaced by polyethylene pipes that do not corrode.

1.3 Need for ESMF

The Environmental and Social Management Framework (ESMF) includes the environmental and social assessment and management guidelines for addressing environmental and social impacts of the project activities that are to be taken up during the project implementation.

Guidelines, procedures, and standards relevant and applicable to the activities envisaged under the project mentioned in the EMS manuals, Corporate Guidelines, World Bank Environment and Social Safeguard Policies and other documents need to be responded during the project development and implementation. These have been identified and mentioned in the ESMF.
Environmental and Social Management Framework
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The specific objective of ESMF is to:

- Identify adverse environmental and social impacts associated with activities proposed by SSGC.
- Develop an Environmental Management Plan (EMP) for the adverse environmental impacts.
- Identify any need for a Resettlement Policy Framework and detail Environmental Assessment based on the evaluation of results of Social and Environmental Screening Checklist.
- Ensure appropriate level of consultation and communication between proponent, public and other stakeholders during project execution.

1.4 Scope of ESMF

This Environmental and Social Management Framework investigates the impacts likely to arise from the replacement of old distribution network of SSGC.

The scope of this document is to:

- Identify and investigate all possible impacts of the proposed operation on the physical, biological, and socio-economic environment of the project area.
- Propose mitigation measures that would help SSGC in conducting the rehabilitation operation in an environmentally sustainable manner.
- Develop an Environmental Management Plan that would assist SSGC in effective implementation of the recommendations and to carry out monitoring activities.
2. Policy, Legal and Regulatory Framework

The ESMF has been developed after reviewing the following promulgated environmental legislation of Pakistan and the relevant World Bank’s Safeguard Policies. Areas of focus and applicability of this legislation and these policies are briefly described below. The environmental aspects of the Energy Efficiency Project (UFG reduction) are identified.

2.1 HSE Policy of SSGC

SSGC undertakes that Health, Safety and Environment management is a responsibility and is committed to give priority to health and safety of all its employees and of other personnel effected by and involved in its activities. The company’s HSE policy is built on a proactive culture. More emphasis is on the recognition and elimination of risk rather than looking for someone to blame. SSGC also confers its overriding commitment towards minimizing impact of its activities on the natural environment. SSGC’s Health, Safety and Environmental Policy is attached below. SSGC is ISO 14001:2004 and OHSAS 18001:2007 certified organization. Copies of these certificated are attached at under Annexure-A.
2.2 Environmental Legislation

2.2.1 Pakistan Environmental Protection Act 1997

The Pakistan Environmental Protection Act, 1997 (PEPA) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. It is an Act that provides for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development. PEPA 1997 is broadly applicable to air, water, land and noise pollution, as well as the handling of hazardous waste. Penalties have been prescribed for those contravening the provisions of the Act. The powers of the federal and provincial Environmental Protection Agencies (EPAs) were also considerably enhanced under this legislation and they have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon the registration of a complaint. Section 12 of the Act requires preparation of EIA/IEE before commencement of projects likely to cause adverse environmental effects.

Environmental assessment of the Natural Gas Efficiency Project has been carried out in compliance with the requirements of this Act.

2.2.2 Pakistan EPA Review of IEE and EIA Regulations, 2000

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000 (the ‘Regulations’), prepared by the Pak-EPA under the powers conferred upon it by the PEPA, provide the necessary details on the preparation, submission, review and approval of the initial environmental examination (IEE) and the environmental impact assessment (EIA). The Regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. Schedule-I lists projects that may not have significant environmental impacts and therefore require preparation of Initial Environmental Examination (IEE). Oil and gas exploration and production activities are included in Schedule-I. Schedule-II lists projects of potentially significant environmental impacts requiring preparation of a detailed study, the Environmental Impact Assessment (EIA). The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA.

In view of the nature of the activities to be performed under Natural Gas Efficiency Project, the project does not fall under any of the categories specified in Schedule-I or Schedule-II of the Regulations and would, therefore, not require preparation of IEE or EIA report.

2.2.3 Guidelines for Public Consultation under Pakistan Environmental Assessment Procedure, 1998

The Federal EPA, in collaboration with other key stakeholders, including Provincial EPA’s and Planning and Development Division from both the Federal Government and the provinces, other Agencies, representatives of Chambers of Commerce and Industry, NGOs, and academia, and consultants prepared a package of comprehensive procedures and guidelines for environmental assessment in Pakistan. These guidelines are part of that package and provide directions for
consultation, involvement and participation of stakeholders; techniques for public consultation; and effective public consultation and consensus building.

The implementation of ESMF would be carried out with involvement of relevant stakeholders to lead to a better and more acceptable decision-making and implementation of EMP.

2.2.4 National Environmental Quality Standards (NEQS)

The NEQS promulgated under the PEPA 1997 specify standards for industrial and municipal effluents, gaseous emissions, vehicular emissions and noise levels. PEPA 1997 empowers the provincial EPAs to impose pollution charges in case of non-compliance to the NEQS.

During the project implementation NEQS will be applicable to all the sources of effluents and emissions including effluents being released from field activities; emissions generated from power generating equipment, powered equipment and vehicles; and noise levels from machinery and vehicles.

2.3 Other Legal Requirements

2.3.1 Conditions of Oil and Gas Regulatory Authority (OGRA)

Oil and Gas Regulatory Authority’s Conditions for Transmission, Distribution and Sale of Natural Gas covers the design, construction and maintenance of natural gas pipeline distribution system. The scope of this standard is limited to portions of pipeline system starting from the outlet of sales meter station to the outlet of customers but not including piping downstream of customers meters. These conditions under 'Environmental Standards' require that the Licensee shall conform to the requirement of Pakistan Environmental Protection Act, 1997 (XXXIV of 1997), as amended from time to time for effluents, air emissions and vehicular emissions. The Licensee shall design, construct, maintain and operate a safe, efficient and economical distribution system in accordance with the standards prescribed by the Authority and comply with all applicable laws, rules and regulations on environment, health and safety (EHS). The licensee shall take all possible steps to keep the UFG within acceptable limits. The authority for this purpose in consultation with licensee and experts shall fix target of UFG for each financial year. The authority may fix UFG target separately for each regulated activity. The licensee shall submit a report to authority not later than 180 days which depicts breakdown of complaints in the region and average time taken to resolve the complaint.

2.3.2 Mineral Gas Safety Rules, 1960

The Mineral Gas Safety Rule, 1960 requires that any accident happening on pipelines involving loss of life or serious injury to any person or severe damage to property shall be immediately reported to the Chief Inspector Explosive and to the nearest Police Station by the quickest mean of communication by a responsible officer of the company whose name address and telephone number shall be furnished with the report. The Rules further requires grant of free access to
licensed premises to the Chief Inspector or any other authorized in this behalf to ascertain if the rules and the conditions of the license are being duly observed.

2.3.3 Distribution and sale of Natural Gas Rules

When SSGC interrupts, restrict or modifies the provision of a regulated service to a customer which is likely to continue for more than 48 hours on account of unforeseeable circumstances, as per Clause 37.1 SSGC shall inform the affected consumers by publication in one locally distributed newspaper or by a communication means of greater dissemination in the pertinent locality of the scope, duration and where possible the date and time when the said interruption, restriction or modification will end.

2.3.4 Explosive Rules

Every distribution or service line main shall be designed, constructed, installed and operated to meet the requirements of these rules and in case any specific aspect can not be met by the provisions of these rules and in case any specific aspect cannot be met by the provisions of these rules, it shall be done within the limits of the code subject to approval by Chief Inspector Explosive. All gas distributed to consumers shall have an odorant to make it detectable by the public or the employees of the company in case of any leakage.

SSGC follows the explosive safety rules for distribution network and operate distribution network as per regulation during the operation period.

2.3.5 Civil Defence Rules

For the purpose of this rule “key Point” means any public utility undertaking or other establishment of such importance which if damaged or destroyed would impair the vital national war effort. As per Civil defence rules every factory or key point organization must provide control post, First Aid posts, Fire Fighting parties etc to counter any emergency or accident situation. SSGC provides full fills civil defence requirements at all its installations and take appropriate measures to safeguard vital installations.

2.3.6 Workmen Compensation Act 1923

If a personal injury is caused to a workman by accident arising out of and in the course of employment, his employer shall be liable to pay compensation in accordance to the provision of this act. Where more injuries are caused by the same accident, the amount of compensation payable under the head shall be aggregated. SSGC has covered its employees through group insurance.

2.3.7 Employees Social Security Ordinance

As per Employees Social Security Ordinance (X of 1965), a secured person who sustains total or partial disablement shall subject to regulations, be entitled to receive upon the expiry of of his
entitlement to injury benefit, to receive disablement pension according to degrees of disablement may be fixed by the Government notification, in consultation with the institution.

SSGC covers its employees through this ordinance and contribute towards Government depository on account of employee.

2.3.8 Local Government Ordinance

This may be noted that the City district Government has imposed ban on illegal and without permission cutting of roads and footpaths in Karachi. The user has been directed to take permission from the concerned towns for road cutting and deposit any fee payable for this purpose. SSGC will comply with this regulation during the rehabilitation work.

2.3.9 The Factory Act, 1935

The Factory Act requires that in every work premises pit or opening in the ground or in a floor which by reason of its depth, situation, construction or contents is or may be a source of damage shall be securely fenced and no person shall be employed to lift, carry or move load so heavy as to likely to cause him injury. The provision of the Factory Act would be applicable to gas meter manufacturing premises and would not be applicable to the pipeline rehabilitation work along the streets/roads in urban, sub-urban areas.

2.3.10 The Land Acquisition Act, 1894

Where land is to be acquired for a public purpose and where land is to be acquired for a Company, the Provincial Government, is satisfied, after considering the result of the survey, if any, made under sub-section (2) of section 4, or if no survey is necessary, at any time, that any particular land included in a locality notified under sub-section (1) of section 4 is needed for a public purpose or a Company, as the case may be, a notification to that effect shall be published in the official Gazette, stating the district or other territorial division in which the land is situate, the purpose for which it is needed, its approximate area and situation, and where a plan has been made of the land, the place where such plan may be inspected, and the Collector shall cause public notice to be given of the substance of the notification at convenient places on or near the land to be acquired.

2.3.11 The Antiquities Act, 1975

The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments etc. The act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area, which may contain articles of archaeological significance. The law also prohibits development planning or scheme or new construction on, or within a distance of two hundred feet of, a protected immovable antiquity.
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The project area does not contain any sites notified as protected under this act. Moreover, no surface archaeological sites were identified in the project area during audit survey. Apparently, provisions of this Act shall not be applicable to the Natural Gas Efficiency Project; however, during initial environmental screening of any rehabilitation work/activity it will be ensured that the provisions of this Act are duly complied.

2.4 World Bank Policies

The Bank requires environmental assessment of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. The nature, scale, and potential environmental impact of a proposed project determine the extent and level of environmental assessment process. The basic objective is to evaluate the project's potential environmental risks and impacts in its area of influence; identify ways of improving project selection, site selection, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and develop an EMP as a process of mitigating and managing adverse environmental impacts throughout project implementation.

The Bank requires that the environmental assessment is initiated as early as possible in project processing and is integrated closely with the economic, financial, institutional, social, and technical analyses of a proposed project. The borrower is responsible for carrying out the environmental assessment.

2.4.1 World Bank Safeguard Policies

The project was also analyzed against the World Bank safeguard policies: OP 4.01 (environmental assessment), OP 4.04 (natural habitat), OP 4.36 (forestry), OP 4.09 (pest management), OP 4.11 (cultural property), OP 4.10 (indigenous people), OP 4.12 (involuntary resettlement), OP 4.37 (safety of dams), OP 7.50 (projects in international waters), and OP 7.60 (projects in disputed areas).

All the above mentioned OPs and their applicability to the present project are discussed below.

a. **OP 4.01 - Environmental Assessment:** This operation policy requires EA of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable with an objective to improve decision making process. It also helps in categorization of the project in one of the four categories on the basis of the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts. This policy is triggered due to the project interventions.

   While carrying out environmental screening of the Natural Gas Efficiency Project it may be placed under Category B due to the potential adverse impacts of the project's sub-activities on human populations and environment. These impacts are site-specific and
can be eliminated/controlled/reduced by implementation of properly designed mitigation measures.

This OP requires inclusion of components to strengthen the capacity of the project implementing Institution for carrying out environmental monitoring, inspections, and management of mitigation measures. This OP also requires identification of the 'Project area of influence'. Under Natural Gas Efficiency Project the excavation work for replacement of leaking pipes, dust emissions from rehabilitation work, emissions from the vehicles and equipment, construction waste disposal would be some of the major areas of influence.

b. **OP 4.04 - Natural Habitats**: This policy requires conservation of natural habitats for long-term sustainable development. It supports the protection, maintenance, and rehabilitation of natural habitats and requires a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development.

The waste generated from the Natural Gas Efficiency Project activities must not be disposed of in a manner that may contaminate the natural resources/habitats in contradiction with the provisions of this OP.

c. **OP 4.09: Pest Management**: Requires management of pests that affect either agriculture or public health. The policy supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.

The activities to be undertaken during implementation of Natural Gas Efficiency Project do not appear to contradict or infringe with the requirements of this OP.

d. **OP 4.11 - Physical Cultural Resources**: This policy addresses physical cultural resources defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources are important as sources of valuable scientific and historical information, as assets for economic and social development, and as integral parts of people’s cultural identity and practices.

Though the activities to be undertaken during implementation of Natural Gas Efficiency Project apparently do not appear to contradict or infringe with the requirements of this OP, however, it would be further ensured while conducting the initial environmental screening process of each scheme before conducting rehabilitation activities through screening process.

e. **OP 4.36 – Forests**: This policy requires management, conservation, and sustainable development of forest ecosystems and their associated resources essential for lasting poverty reduction and sustainable development.
The activities to be undertaken during implementation of Natural Gas Efficiency Project do not appear to contradict or infringe with the requirements of this OP.

f. **OP 7.50 - Projects on International Waterways:** This policy applies to international waterways, such as river or canal that forms a boundary between two or more states and on projects that involve the use or potential pollution of these waterways.

   The activities to be undertaken during implementation of Natural Gas Efficiency Project do not appear to contradict or infringe with the requirements of this OP.

g. **OP 7.60 - Projects in Disputed Areas:** This policy is concerned with the projects planned in disputed areas between different countries and project implementation may raise a number of delicate problems affecting relations not only between the Bank and its member countries, but also between the countries. This policy is triggered due to the project interventions.

   The activities to be undertaken during implementation of Natural Gas Efficiency Project do not appear to contradict or infringe with the requirements of this OP.

### 2.4.2 World Bank Guideline on Environment

Environmental assessment of the proposed project is carried out as per the laid down procedures under the World Bank environmental assessment guidelines. For this purpose this Environmental Assessment report is prepared and Environmental Assessment pro-forma has been developed. The EA attempts to weigh environmental effects on a common basis with economic costs and benefits. The EA is a procedure used to examine the environmental consequences, both beneficial and adverse, of a proposed development project and to ensure that these effects are taken into account in project design and construction.

#### 2.5 International Agreements

##### 2.5.1 Global Compact Agreement

The Government and the UN system in Pakistan recognize that the business sector has much to contribute to development challenges and progress of the country. It also recognizes that the government, the private sector and development agencies share many common development goals, such as a sound economy, a trained workforce, peace and political stability, a healthy environment, an active civil society, an accountable government, rule of law, fair and effective regulatory institutions and of course a vibrant and free media.

In bringing the Global Compact to Pakistan, the UN system shall act both as a facilitator and as a partner for all concerned stakeholders. It is committed to engage in and promote partnerships between the public and private sector that advance sustainable human development; consult with the business sector in the formulation and implementation of development activities that relate to, or could benefit from inputs from the business sector; and advocate for the business
sector to take responsible action, on its own or in partnership with other development actors, in light of the Global Compact principles.

2.5.2 Prevention of Global Warming

On January 11, 2005, Pakistan ratified the Kyoto Protocol. Pakistan is signatory to UNFCCC as a Non Annex I Party (June 13, 1992 at the Rio Earth Summit). UNFCCC (United Nations Frame work Convention on Climate Change) was ratified by Pakistan on June 1, 1994. The targets cover emissions of the six main greenhouse gases, namely

- Carbon dioxide (CO2),
- Methane (CH4),
- Nitrous oxide (N2O),
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs), and
- Sulphur hexafluoride (SF6)

2.5.3 The Convention on Biological Diversity

The convention on Biological Diversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The convention requires parties to develop natural plans for the conservation and sustainable use of biodiversity and to integrate these plans into national development programs and policies. Parties are also required to identify components of biodiversity that are important for conservation and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

2.6 SSGC Requirements and Policies

The standard operating procedures, policies, and administrative requirements of SSGC are briefly discussed below and are attached at Annexure-B.

2.6.1 Occupational Health, Safety and Environment Risk Assessment (HSE –P-01)

This procedure is applicable to the identification of Occupational Health and Safety hazards and associated risks, environmental aspects and impacts associated with activities, products and services of Sui Southern Gas Company (SSGC).

It is applicable for:

- Initial risk / impact assessment.
- Annual Review for updating the information.
- Conducting risk/impact assessment at the time of change in existing activities, products or services.
- Routine, non routine and emergency situations.
While conducting environmental assessment, following aspects will be considered:

- Emissions to air
- Water Discharges
- Solid non-hazardous waste
- Solid Hazardous Waste
- Consumption of natural resources/ Energy
- Noise
- Heat
- Odor
- Dust
- Vibration
- Effect on visual/ aesthetics
- Use of Ozone depleting substances
- Use of radioactive/ nuclear material

For identification of environmental aspects and impact, each process/ activity, product and service is assessed for its inputs and outputs. The inputs can be raw materials, utilities, energy etc. The output can be atmospheric emissions, liquid effluents, noise, waste, products etc.

The inputs, out puts, environmental aspects, their associated impact and controls are recorded on ‘Environmental Aspect & Impact Assessment’ HSE-F-02.

2.6.2 Identification of HSE Legal and Other Requirements (HSE-P02)

The purpose of this procedure is to define mechanism and responsibilities to identify and acquire and disseminate legal and other requirements that are applicable to Occupational Health, Safety and Environment. This procedure covers identification and having an access to all legislation and other requirements related to Occupational Health, Safety and Environment at SSGC.

2.6.3 Consultation and Communication (Internal/external) (HSE-P03)

The purpose of this procedure is to define mechanism and responsibilities for:

- Internal HSE communication within SSGC;
- Consultation and involvement of employees on HSE matters;
- Receiving and responding to HSE related communication from external interested parties.
This procedure is applicable to all internal communication, consultation and external communication with employees, contractors and external interested parties.

2.6.4 Management of Change (HSE P-04)

The purpose of this procedure is to define mechanism and responsibilities for the management of change (MOC) so that Occupational Health, Safety and Environmental concerns are formally addressed and their risks are managed at each stage of project / change process and ongoing developments at SSGC.

The Management of Change review and approval system is applicable for:

- New projects (Construction, Installation of new equipment / machinery, pipelines, design of work place, work organization etc.)
- Changes in the existing process, equipment, distribution / transmission system or procedure or work organization or Design of work place, Process Operating Parameters etc.
- A change in the setting, set limits or arrangement of protective devices installed for safety or environmental reasons (e.g. safety valves, alarms, trips, and interlocks etc)
- A physical change / modification or addition / alteration made to equipment; vessels, pipe work, distribution / transmission system, pumps, instrumentation, design of work place, protective devices and electrical systems
- Basic mechanical design changes ( bolt types, joint types, pump seals etc)

2.6.5 Permit to Work (HSE- P05)

The purpose of this procedure is to define mechanism and responsibilities for Permit to Work so as to recognize HSE hazards associated with the work and to implement appropriate operational controls for minimizing the HSE risks to personnel, equipment and environment.

This procedure is applicable to all works that require formal authorization through PTW at all SSGC locations namely:

- Head Office Building
- Meter Manufacturing Plant
- Karachi Terminal
- Headquarter Stations
- Regional Offices
- Distribution & Transmission Locations
- Billing Offices
2.6.6 Supplier & Contractor Management (HSE -P06)

The purpose of this procedure is to define:

- HSE considerations while purchasing goods and services.
- SSGC and supplier/contractor HSE responsibilities as a result of contracts/supply of materials, services and how these requirements will be communicated.

This procedure is applicable to all purchased materials and services. It is also applicable to all SSGC contracts and resulting activities whether performed at SSGC premises or outside premises.

2.6.7 Emergency Response Plan (HSE P-07)

SSGC has developed an Emergency Response Plan encompassing all of its activities including transmission and distribution of gas. It is a comprehensive document and has been included in HSE Management System Procedures as Volume-III.

2.6.8 Availability & Maintenance of Emergency Detection & Response Equipment (HSE P-08)

The purpose of this procedure is to define mechanism and responsibilities for the availability and maintenance of emergency detection and response equipment which is appropriate to the potential emergencies associated with the activities, equipments and locations.

This procedure is applicable to emergency detection and response equipment available at all SSGC Locations.

2.6.9 Procedure for Monitoring and Measurement (HSE-P09)

The purpose of this procedure is to define mechanism and responsibilities for monitoring and measurement of occupational health, safety and environmental performance so as to determine compliance with policies, procedures, legislation and requirements of HSE Management System.

This procedure is applicable to all activities and processes related to HSE Management System.

2.6.10 HSE Incident/Accident Reporting (HSE-P11)

The purpose of this document is to define a system of reporting, investigation & taking corrective action on Occupational Health, Safety and Environmental incidents and accidents. This procedure is applicable to all incidents and accidents related to Occupational Health, Safety and Environment at SSGC.

2.6.11 Complaint Resolution Procedure (SOP-08)

The distribution network comprises of high-pressure and low pressure pipelines spread all over the Karachi, Hyderabad and Quetta region. This network is deteriorated due to aging, 3rd party damage and other unseen reasons. The purpose of this activity is system maintenance/rectification vide complaints received from Customer Relation Department to
timely attend and rectify complaints registered in CRD and passed to DSM for handling as a major emergency, which could not be handled by CRD team.

**2.6.12 Replacement of Old corroded and Leaky Distribution Gas Pipeline (SOP-22)**

This procedure requires that the 'Leak Survey' of Distribution Mains should be arranged by DSM Section. Planning Section will plan the Distribution Main and will submitted to GM (D) for necessary approval of the Rehabilitation Job. Road Cutting Permission from civil agencies should be arranged by Rehabilitation Section. All trenches and pits should be properly backfilled and new laid P.E gas pipe line should be connected with existing gas network.

**2.6.13 Permit to Work**

Prior to commencement of any work it is mandatory to acquire ‘Permit to Work (PTW)’ from the authorized personnel. The PTW describes the area of work, nature of work, time of commencement and completion, nature of work, equipment to be used, procedure of work, etc. The safety measures to be taken, including the usage of Personnel Protective Equipment (PPE) and safety equipment/signs are also mentioned in PTW. Through the implementation of PTW system it is ensured that the work is not only done in compliance with the recommended procedures but is also closed (terminated/completed) in safe manner.

**2.7 Clearances and Approvals**

SSGC will obtain No Objection Certificate (NOC) from the Highway Department, Local Government and Civic Agencies for the rehabilitation works/schemes under the Natural Gas Efficiency Project. Each of these departments has their own requirements for such approvals. All of these departments would be informed and consulted for development work as per SSGC’s policy. Responsibility of getting necessary approvals from these agencies/organizations rests with the rehabilitation department of SSGC.

- Local Authorities of City Government
- National Highways Authorities.
- Karachi Water and Sewerage Board
- Pakistan Telecommunication Corporation (PTCL)
- Karachi Electric Supply Corporation (KESC)/DICSCO
3. Project Description

3.1 The Issue – UFG Problem of SSGC

Unaccounted for gas (UFG) loss is the difference between the gas purchased and gas sold by a utility, during a period of time. It is normally expressed as a percentage of gas purchased. Every leakage in the distribution is UFG, but not all of the UFG is leakage. Leakage is only one of a number of factors causing UFG. The problem of UFG is a complex problem and there are many factors which contribute to it. Generally, the causes for UFG may be broadly categorized as follows:

- **LEAKAGE – Above Ground & Under Ground**
- **MEASUREMENT INACCURACIES AND BILLING ERRORS**
- **GAS THEFT AND OTHERS** (gas consumed but not recorded, gas blown off during pipeline repair/maintenance, pipeline ruptures due to third party damages, etc.)

Since all UFG is lost revenue, there are economic reasons for looking into it within the parameters of the cost versus savings. The savings are dependent on identifying the problem areas and taking corrective action.

Out of the above factors, only leakages contribute to physical losses; meaning that plugging a leakage will make more gas available in the gas distribution system. The elimination of measurement and billing errors will improve the accuracy of gas accounting which may result in increased sales. Gas theft is the gas utilized by a customer but not being paid for; preventing theft will mean that the revenue stream of the Company is improved, and gas can also be saved if the consumer uses less gas when paying for it.

The UFG losses of the company were 7.8% or 33,040 MMCF during the year 2008-09, as tabulated in Table 3.1. The norms about UFG are mentioned in Table 3.2.

![Table 3.1: UFG Status FY 2008-09](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAIQAAAADwCAYAAAAAdz9QAAAABGdBTUEAALGPC/xhBQAAAABJRU5ErkJggg==)

Table 3.2: Table 3.2: Gas Industry Standards about UFG, IGT Chicago

<table>
<thead>
<tr>
<th>INDUSTRY NORMS ABOUT UFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3%</td>
</tr>
<tr>
<td>3-6%</td>
</tr>
<tr>
<td>ABOVE 6%</td>
</tr>
</tbody>
</table>
3.2 Impact of Sales Volumes

Gas companies sell gas to a variety of consumers comprising: bulk, general industries, commercial and domestic. For simplicity we may divide sales into bulk and retail (general industries, businesses and households) sales. Bulk sale is almost UFG free, whereas retail sale is always associated with UFG.

The UFG problem at SSGC is mainly due to the ageing and associated deterioration of network, which tends to leak more as the time passes by. The company is also pursuing the Government of Pakistan policies for providing gas to households, CNG stations and other retail consumers which is shifting the sales mix to the retail side. The increase of gas consumption in households from 14.8% in 2003-04 to 16.9% in 2008-09, commercial gas consumption from 2.3% in 2003-04 to 2.8% in 2008-09 and CNG (Compressed Natural Gas) in transport from 1.5% in 2003-04 to 7.0% in 2008-09 are some of the indicators in the shift. This indicates that the UFG problem would increase in coming years unless the Natural Gas Efficiency Project was undertaken.

3.3 SSGC UFG during the Last Decade

The franchise area of SSGC’s business operations comprises business units of Karachi, Interior Sindh and Balochistan. The gas consumption in Karachi is almost 80% of the gas sales of the Company, whereas the rest of the business units contribute 20% of the gas sales. The UFG trends for these regions shown in Figure 3.1 to Figure 3.4 indicate an increasing trend from FY 2002-03 onwards. The average annual increase from 1999-00 to 2008-09 (ignoring 2007-08) was 1,993 MMCF/year. The average annual increase in UFG volumes during the period 2002-03 to 2008-09 was 2,308 MMCF. In the last three years the increase in UFG has gone up to 3,439 MMCF/year.

Figure 3.1: Historic UFG Volume in SSGC
Figure 3.2: Historic UFG Volume in Karachi city

Figure 3.3: Historic UFG Volume in Interior of Sindh Province
3.4 Factors Affecting UFG

3.4.1 Underground Leakages

Underground leakages are leakages on the distribution pipelines comprising: supply mains, distribution mains, feeder lines and service lines (service tee to riser). All of these pipes are buried in the ground with differing geological/soil characteristics. Pipeline material is normally steel, however, within the last decade polyethylene (PE) pipeline is also being employed in the low pressure distribution network.

The protection of steel pipeline is in two stages: 1) Coating (to isolate the pipe from the surrounding soil environment and 2) cathodic protection (CP- passing a small amount of current to decrease the rate of corrosion). PE pipeline does not require cathodic protection; however they are prone to third party damages.

SSGC maintains distribution pipeline infrastructure which is 40 – 50 years old and was designed for high pressure and smaller diameter steel pipelines. The pressure in the supply mains is 100-150 psig whereas distribution mains and feeder lines were operated at 40 – 60 psig. The higher the pressure and the larger the diameter of the hole, the larger will be the leakage. From the analysis of the leakage survey reports it is becoming evident that the leakages cause 50% - 70% of UFG in SSGC network.
3.4.2 Overhead Leakages

Overhead leakages normally occur at pipe joints of customer connections (riser to inlet of meter). The problem of overhead leakages is found only in domestic and commercial customer connection where threaded joints are used to connect riser to service shut-off valve; service shut-off valve to regulator; regulator to lock-cock valve, lock-cock valve to the inlet of meter. The UFG losses from the overhead leakages normally contribute to 3% - 7% of the UFG losses.

3.4.3 Measurement and Billing Errors

SSGC uses various categories of meters for measurement of gas sold to different customers. Diaphragm type meters are used for recording domestic and commercial gas sales. Industrial and bulk measurement is carried out by turbine meters. The measurement accuracy of diaphragm meters is within ± 2%, whereas turbine meters are fairly accurate i.e. within ± 0.1% tolerance limit. The measurement and billing errors are estimated to contribute around 3% to 5% of the UFG loss.

3.4.4 Gas Theft and Other Losses

In the gas industry, "theft of service" means tampering with or bypassing a meter in order to receive utility service free of charge. Energy theft is a financial, moral, and public safety issue. Bypassing or tampering/reversing with a gas meter is very hazardous and can result in serious injury or even death from fire or explosion. Tampering with natural gas meters and equipment can cause leaks and potential carbon monoxide problems. The extent of gas theft cannot be ascertained accurately, however, it is estimated that the figure is between 18-42%. As SSGC isolates parts of the network into smaller “segments” (enabling measurement of gas going into the segment and comparing it with metered gas consumed in the segment), the company will also improve its ability to locate and eliminate gas theft.

Other than gas theft, a very small amount of gas losses occurs due to internal consumption and gas blown off during maintenance activities and/or pipeline ruptures, which is being recorded.

3.4.5 UFG Contribution Factors

The estimated figures for the UFG from various sources are expected as under:

a. Underground leakages: 50% - 70%
b. Overhead leakages: 5% - 7%
c. Measurement and Billing (MNB) errors: 3% - 5%
d. Gas Theft: 18% - 42%

Overhead leakages and MNB errors are the only factors which can be rectified easily, but their impact in terms of UFG reduction would be limited. However, the underground leakages and gas theft have a significant potential for UFG reduction.
3.5 Reporting of UFG

OGRA after its formulation in 2002 set certain benchmarks for UFG to be allowable. OGRA while issuing the determination of Total Revenue Requirement for FY 2001-02, issued directives "to reduce UFG below 6% within three years commencing from FY 2002-03".

In the determination dated 19 October 2005 for FY 2005-06 OGRA specified UFG targets for seven years from FY 2005-06 to FY 2011-12 specifying 5.0% and 4.25% for upper and lower limit targets for FY 2010-11 as shown in Table 3.3.

<table>
<thead>
<tr>
<th>Year</th>
<th>OGRA UFG Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2002-03</td>
<td>No Target</td>
</tr>
<tr>
<td>FY 2003-04</td>
<td>6.50%</td>
</tr>
<tr>
<td>FY 2004-05</td>
<td>6.00%</td>
</tr>
</tbody>
</table>

Table 3.3: OGRA UFG target determination dated 19 October 2005

<table>
<thead>
<tr>
<th>FINANCIAL YEAR</th>
<th>UPPER TARGET</th>
<th>LOWER TARGET</th>
<th>EFFECTIVE TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005-06</td>
<td>6.00%</td>
<td>5.70%</td>
<td>5.85%</td>
</tr>
<tr>
<td>2006-07</td>
<td>6.00%</td>
<td>5.40%</td>
<td>5.70%</td>
</tr>
<tr>
<td>2007-08</td>
<td>6.00%</td>
<td>5.10%</td>
<td>5.55%</td>
</tr>
<tr>
<td>2008-09</td>
<td>5.50%</td>
<td>4.80%</td>
<td>5.15%</td>
</tr>
<tr>
<td>2009-10</td>
<td>5.50%</td>
<td>4.50%</td>
<td>5.00%</td>
</tr>
<tr>
<td>2010-11</td>
<td>5.00%</td>
<td>4.25%</td>
<td>4.63%</td>
</tr>
<tr>
<td>2011-12</td>
<td>5.00%</td>
<td>4.00%</td>
<td>4.50%</td>
</tr>
</tbody>
</table>

3.6 Strategy to Control UFG

The Company has prepared short-term, medium-term and long-term strategies for controlling UFG.

The short term strategy being implemented is “pulling up the sales and pushing down the purchases”. It comprises:

a. Manual reduction of supply pressures during off-peak hours and thus operating the entire system at optimal pressures
b. Checking/replacement of minimum bill/nil bill meters
c. Pressure surveys of commercial customers to determine the actual supply pressures against contracted pressure.

d. Load survey of industrial consumers.

The medium term strategy comprises:

a. Implementation of UFG reduction program. It has the following seven components:
   1. Replacement of aged/deteriorated pipelines
   2. Underground leakage rectification
   3. Overhead leakage rectification
4. Cathodic protection upgrade  
5. Installation of pressure management systems  
6. Advanced metering infrastructure leading to smart meters  
7. Improvement of surveillance at industrial customer meter station/gas connection point.  

b. Segmentation of network into smaller, where gas purchase (entering in the segment) is measured and sale/purchase reconciliation is carried out on monthly/weekly basis  
c. Strengthening of Maintenance and Quality Assurance functions  
d. Splitting up franchise area into smaller business units/distribution zones  

The long-term strategy comprises:  

- Planned rehabilitation starting from supply mains  
- Develop a ring of supply main around Karachi to act as an alternate supply main  
- Insertion of HDPE pipeline in existing supply mains and in distribution network  
- Capacity building for Energy Auditing (to relate rate of production/ power generation of industries/captive power with gas consumed  

3.7 Actions Taken to Reduce UFG  

The following activities have been initiated for UFG reduction:  

- Segmentation of network and development of small segments with measured gas inputs, so that UFG loss figures can be established.  
- Manual reduction of supply pressures during off-peak hours to optimize the operating pressures.  
- Rehabilitation of network with existing resources  
- Introduction of automatic pressure management systems  

3.8 Project Rationale  

Sui Southern Gas Company Limited (SSGC) is playing an important role in fulfilling the Country’s energy needs. The present energy crisis situation demands reduction of lost and unaccounted for gas (UFG) losses and enhancement of gas utilization efficiency at the end users (industries, businesses and households) so that the natural gas so saved could be made available for power generation.  

During the past ten years, the gas distribution losses have been following an increasing trend, since FY 2003-04. The company faces a cluster of problems like: ageing gas supply infrastructure, increasing overhead/underground leakage rates, measurement losses due to high tolerance.
limits (upto +/- 2%) in gas measurement, gas theft and dwindling human resource potential. In addition, the penalties from the regulator Oil and Gas Regulatory Authority has been affecting the financial health of the Company, impairing its ability to undertake major expenditure required for rehabilitation. With the passage of time, the quantum of problems has become so immense that with the existing resources and capabilities it is becoming extremely challenging to bring the losses down to an acceptable level.

The only effective means of arresting the UFG problem is to undertake active rehabilitation of at least 10% of the system annually to complete the rehabilitation cycle in ten years, together with other measures to reduce gas theft.

To tackle this problem SSGC formed a new section of Rehabilitation five years back and started pipeline Rehabilitation works on a small scale of 200 Km to 300 Km per year with limited resources. SSGC has up till now rehabilitated about 1200 Km of its network. With the assistance of World Bank, SSGC intends to replace 5,750 Km of Distribution Pipeline (Excluding Supply Main) during the next five years along with overhead and underground leak survey and rectification of 1.6 million customers and 18,700 Km network. It is projected that after the completion of this plan it is estimated that SSGC would save UFG volume of approximately 12,410 MMCF.

The implementation of the program needs to be accelerated up to the extent that rate of system improvement exceeds the rate of system deterioration. This is necessary to take the Company out of the endless degeneration loop, which nullifies all the improvement measures taken in the past. For that matter, the Company wants to borrow finances from the Bank to invest them in accelerated implementation of UFG reduction program. This will enable the Company to enhance its contribution in fulfilling national energy requirements, decrease GHG methane emissions to the environment and improve its profitability.

3.9 Scope and Nature of the project

The proposal is for soliciting financial assistance from the World Bank for implementing its UFG reduction program on a fast-track basis, so that the gas lost during the distribution to end-users is curtailed. The gas saved will be made available for fulfilling unmet energy needs, notably of power plants, which will benefit the country’s economy.

The distribution system will be divided into smaller portions with measured (metered) gas input so that gas losses can be assessed in each segment before and after rehabilitation. The existing pace of pipeline replacements (300 km/year) will be increased three to four times. Overhead and underground leakage rectification activities will be carried out intensively. Furthermore, the Cathodic protection system will be upgraded to improve the corrosion protection of steel pipelines that would not be immediately replaced. Automatic pressure management systems will be introduced to help reducing UFG by ensuring that pipeline pressures are not excessively high compared to the needed pressures for meeting service standards. On top of it, measurement systems will be upgraded and surveillance of measurement stations/gas connection points will be improved, utilizing state-of-the-art technologies.
SSGC will utilize World Bank funds in procurement of equipment and material, and expectedly some outsourcing of construction and installation activities. The QA aspect of the works will be monitored by SSGC engineers, and conformity assessment will be ensured. The proposal describes the methodology, management approach, schedule and expected benefits of the program.

### 3.10 Targets

Besides saving considerable UFG volume by rehabilitating old leaking steel network, it also provides an opportunity to remodel the network keeping in view to meet the present load demand as well as provision for next 30 years so that to operate the system at optimum pressure without upgrading the network in future. The planning/designing of new rehabilitation network contains the following features.

The old undersized steel network of 3/4” and 1” diameter are being replaced with minimum of 2” diameter and larger pipes, mostly made from polyethylene although steel will be used in some cases. This enhances the network capacity substantially compared to the old network, with minimum of cost difference due to change of pipeline size compared to volume gain.

- The pipeline identified which are badly corroded (with metal loss) but not leaking due to coating damage and disbonding which tend to cause pipeline leak in future, are also being rehabilitated.

- The old network which has gone into depth in certain areas due to land-filled and construction of multiple layers of tar road, cause much difficulties in handling emergencies as such this problem is also resolved when it is rehabilitated.

- Usually in 90% of cases the scheme/project cost is almost recoverable within 12 to 24 months. Thus besides saving gas loss it also mitigates occurrence of hazardous situation causing fire and damages to human life and public properties.

### 3.11 Basic Objectives

The basic objectives of the project are:

a. Isolation of distribution segments in large cities/towns (especially Karachi, Hyderabad, Sukkur and Quetta) and installation of bulk meters.

b. Upgrading of Cathodic Protection (CP) system to slow down the rate of pipeline deterioration.

c. Optimization of supply pressures in distribution network through integrated pressure management system.

d. Rehabilitation of most aged and highly dilapidated pipeline segments and monitor the effectiveness of rehabilitation effort.

e. Overhead leakage rectification
f. Measurement system improvement, especially at all bulk purchase and sale points

3.12 High Level Objectives

The high level objectives to which the project would contribute would include the following:

a. Conservation of Energy/Natural Gas through:
   1. Reduction of network losses (underground and overhead leakages)
   2. Increasing Measurement accuracy
   3. Enhancement of gas utilization efficiency in domestic, commercial and industrial consumption

b. The conserved gas will be made available for meeting the growing gas demand for power sector and industries leading to economic development.

c. Reduction of methane (a potent green house gas) emissions to the atmosphere.

d. Re-strengthening of core-business activities to improve organizational performance.

e. Capacity building for energy efficiency, quality assurance and R&D.

3.13 Inputs and outputs

INPUTS

Refurbishment of SSGC distribution network and ancillary steps to reduce losses would include:

a. Upgrading the distribution pipeline cathodic protection (CP) system
b. Introduction of automatic pressure management systems at sale metering statins (SMS) and town border stations (TBS)
c. Pipeline rehabilitation
d. Underground Leakage survey
e. Measurement system improvement – (replacement of rotary meters with auto-adjust twin turbine meters along with turbo-correctors)
f. Introduction of Advanced Metering Infrastructure (AMI) leading to SMART meters
g. Overhead leakage surveys and rectification
h. Procurement of services for enhancing surveillance of commercial/industrial gas meters/connections

OUTPUTS

The successful completion of the program will yield the following major benefits to SSGC:

a. Overall UFG losses in the distribution network will be reduced.
b. Methane (a potent greenhouse gas) emissions will be significantly reduced.

c. The rehabilitated network will be capitalized as Company’s asset which will yield 17% return on investment as per Government of Pakistan’s policy.

d. The core business functions of Distribution, Planning, Quality Assurance and Research & Development will be strengthened.

e. Transformation to energy efficiency will be initiated.

3.14 Evaluation Strategy

It has to be considered that leakage in the ageing network increases with time. The impact of network rehabilitation/reinforcement measures at macro level is blanketed by the UFG losses of unattended segments. The project will change this situation. However, its impact will not only be measured on the overall network, but also segment by segment with evaluations being done before and after rehabilitation.

3.15 Project Components and Work Methodology

SSGC will primarily focus on the following components to meet the objectives and targets mentioned above:

3.15.1 Upgrading Cathodic Protection System

The underground pipeline is subjected to soil moisture which deteriorates the outer surface of the pipe. It is protected in two ways one is coating to isolate it from the soil environment and the other is cathodic protection. Cathodic protection involves passing a small amount of direct current through pipe to convert into a cathode. This results in deferring the corrosion process.

Owing to the unavailability of power, the reliability of the existing CP system has been compromised. This has necessitated installing alternate power sources like: battery backup, solar photovoltaic, wind etc. This will ensure that the supply of power is uninterrupted.

Besides, there may be segments where CP current is not reaching due to isolation of steel network segment by surrounding PE network, insufficient capacity of TEG/TR, short circuiting, electromagnetic interferences and other reasons.

In addition to the above there is a strong possibility of finding segments where coating damage and deterioration has taken place. A re-coating may be necessary in these areas. On top of it there is also a need to have an online monitoring/telemetry system for entire CP setup of distribution network.
3.15.2 Installation of Automatic Pressure Profiling Systems at Town Border Stations/Sales Metering Stations

Automatic pressure profiling systems operate a designated section of gas distribution network within specified limits of pressure. The application is essential since UFG is largely proportional with pressure.

The system shall be installed on town border stations (TBS) to automatically increase and decrease the pressure set point based on the flow consumption or according to the fluctuation in the daily consumer demand (both functions must be available and anyone can be chosen by the user).

The system shall be able to create a profile according to the requirement and it shall be possible to change the profile with respect to the change in load conditions of the network. The pressure variation created by the system, shall be smooth to prevent pressure surge in the downstream pipeline.

3.15.3 Introduction of Smart Meters

The measurement infrastructure also needs to be upgraded vis-à-vis measurement inaccuracies and remote meter reading. SMART meters would help minimize meter reading anomalies and tampering/theft practices. These meters would be installed at industrial/commercial consumers.

3.15.4 Underground Leak Survey

The leak survey techniques adopted by SSGC are in the process of upgrade with the introduction of laser methane detection technology. The Company needs to invest a great deal of its resources in Maintenance department. To begin with there are avenues for increasing underground leak detection capacity by incorporating laser, infrared and other emerging technologies for on-ground and aerial surveys. An additional 5,000 km network, comprising critical segments where deterioration is high, will be surveyed.

The Methodology for identification of leaking area and underground leak survey/rectification work is described below.

- The leaking area is identified through:
  - Excessive complaints from CRD & other sources.
  - Regular underground leak survey of each network after every five years.
- After identifying the area, the job is handed over to an Officer who arranges the respective area drawing to carry out the survey through his field staff. The survey team first identifies the location of the network and then starts survey using equipment such as Gas Leak Detector and Plunger Bar.
• The Plunger is inserted in the soil at 2-3 ft depth above the existing pipeline at a maximum interval of 10 ft distance on or near the network. Apart from the network, all service tee connections are also checked.

• After removing the Plunger bar air sample at ground hole is taken by using Gas Leak Detector and readings are noted down.

• Where readings above 50% LEL are shown the survey span is narrowed down progressively to locate the exact location of leakage. However, the LEL reading less than 50% is also attended for identification of leakage.

• After detecting the actual leak location, excavation is carried out to expose the line for inspection and necessary remedial actions.

• Leak clamp is then fixed on the leaking pipe portion to stop the leakage.

• If the pipeline condition is found more corrosive / badly leaking, than the section of pipe is replaced by welding team.

• Further, the network is handed over to rehabilitation section for complete replacement, if the network is found more corrosive and deteriorated condition.

• Fire Extinguisher charged and operative remains at site of work.

• A daily report of such leak survey is maintained by the respective officer on prescribed format, showing the nature of leak i.e. Service Tee, Elbow & Plug etc., and also marked on respective drawings for record.

3.15.5 Distribution Network Rehabilitation

The leakages in the ageing network increases with time. The impact of network rehabilitation/reinforcement measures at macro level is blanketed by the UFG losses of unattended segments. Hence, it is imperative that the overall decline in UFG figures would be visible only when most of the segments are rehabilitated. Hence, in the beginning, each rehabilitated segment may be evaluated “before & after” rehabilitation.

The distribution network comprising pipelines, metering stations like: Sales Metering Stations (SMS), Customer Metering Stations (CMS), cathodic protection setups, valve assemblies, regulators and pressure relief valves, etc. where required, will be rejuvenated. In addition to it, ample security measures will also be added to the network for prevention of gas theft.

Figure 3.5: Site information sheet

The length of distribution network excluding service is of 27,000 km. A large portion is of new installation and does not warrant rehabilitation. Initially, 5,750 km of most dilapidated network is
proposed to be replaced, which comprises 3,150 km in Karachi with the remaining between Interior Sindh and in Quetta.

The criteria for network rehabilitation have been established based on the following factors:

- Historical leak record
- Leak survey reports
- Condition of pipeline through bell hole
- Coating condition
- CP status

On the basis of above data / information, Distribution System Maintenance Department arranges leak survey and rectification of all repairable leaks such as Service Tee, Plugs, Service Tee Joints, fixing of all leak clamps etc. In case of excessive underground leaks due to damage to pipe coating and corrosion, detailed investigation is carried out in coordination with C.P department. Figure 3.5 shows a site information sheet being filled up by SSGC staff.

Previous records of PSP and present PSP level of the areas are obtained and accordingly steel pipelines are exposed at different location to verify the pipe coating, bonding strength and physical condition of pipe. In case of corrosion due to damages to coating and neutral grounding of pipes by local resident and ineffective CP system due to low resistivity soil and interferences of multiple underground steel structure. DSM suggests the rehabilitation of old network preferably with P.E, keeping in view a few exceptions. DSM then segregates the area and install check meters to observe the loss of Gas (UFG) on leaking network and recommends to Planning Department for replacement of pipeline observing substantial revenue loss to SSGC.

Usually in 90% cases the scheme/project cost is recoverable within 12 to 24 months. Thus besides saving gas loss it also mitigates occurrence of hazardous situation causing fire and damages to human life and public properties.

Photographs of on-going rehabilitation work are shown in Figure 3.6. Some rehabilitation sites are shown in Figure 3.7. Procedure for laying of PE Gas Pipeline is shown in Figure 3.8 whereas the methodology for pipeline rehabilitation is mentioned below:

- Isolation and segmentation of smaller segments/zones in the Company’s franchise area.
- Installation of bulk0020meters at all supply point(s) to monitor and record daily/weekly/monthly gas supplied.
- Readings on customer meters in the segment will be recorded and compared with bulk meter readings to establish the UFG of the segment.
- Based on the established UFG figures, the priority of rehabilitation of infrastructure the segments will be established.
- Re-laying of feeder lines followed by overhead leakage rectification and replacement of defective/old meters will be carried out under the supervision of Quality Assessors.
- The UFG figure of the segment will be closely monitored.

Figure 3.6: View of ongoing rehabilitation work in some areas of Karachi
Figure 3.7: Top four photos - A view of some planned rehabilitation project sites; Bottom two photos – completed rehabilitation sites
An estimated amount of 6% (1,982 MMCF) of overall UFG losses can be reduced if the overhead leakage survey and rectification works are carried out. This amount translates to approximately 260 cubic feet per customer. The entire project can be outsourced and executed under the supervision of SSGC Engineers. Photographs of gas leak survey carried out by SSGC staff are shown in Figure 3.9.

The Methodology of the overhead leak survey / rectification work is described as follows:

- The leaking area is identified through:
  - Excessive complaints from CRD (Customer Relations Department) & other sources.
  - Regular overhead leak survey of each network after every five years.
  - Areas where underground leak survey is in progress.
  - Age of the area and record of the last rectification carried out.
- After identifying, the job is handed over to officer who arranges the respective area drawing to carry out the survey through his field staff.
• The survey team first identifies the location of the network and then started the survey by using Soap Solution.

• The team will inform the customer and obtain verbal permission for shutdown & to dismantle and re-assemble the service connection for inspection of leak. The team will also ensure that all appliances are completely turned off by customer to avoid occurrence of any hazard.

• Leaking joints shall be dismantle / reassemble by using Teflon Tape and Clamped.

• After the completion of work, the fitter team must re-apply soap solution to ensure that the service connection is completely leak free.

• The job team will inform the customer for re-commissioning of gas and to ensure 100% gas in their burners.

• Fire Extinguisher charged and operative remains on sites of work.

• The attended / rectified service connections are marked with paint.

• Rising up / rectification of buried service valve is also carried out if required.

• Fitter team also provides detailed information (Address / Meter No. etc.) of all PUG, DPG / Defective meters, found in the assigned area.

• List of PUG / DPG / Defective meters & Theft Cases is provided to CRD / Rehabilitation cell by concerned officer for replacement

Figure 3.9: SSGC staff doing Gas Leak Survey;
Right: Meters that will be replaced
3.15.7 Advanced Metering and Improved Surveillance of Commercial/Industrial Gas Meters/Connections

The measurement system improvement component comprises:

- Installation of auto adjust turbine meters for industrial customers and ultrasonic meters for commercial customers.
- Introduction of Advanced Metering Infrastructure

This will start with installation of GSM/GPRS based Remote Monitoring System. The advantage of Remote Monitoring System is that the drop in supply pressure can be verified just by real-time monitoring the pressure in our control room. The actual reason for drop in customer’s supply pressure after monitoring the Distribution System Pressure can be assessed. If there is low distribution pressure in our system, then there will be no need to send maintenance team to customer site and complaint is simply passed to Distribution, which will save cost.

The system has the following advantages:

- **Remote Data Down loading Facility**: System has the facility to dial Customer Meter Station automatically at pre-determined time and download Electronic Volume Corrector data.
- **Monitoring Low Pressure Complaints**: System provides Inlet, Outlet pressure, hence low pressure complaints can be scrutinized and genuine complaints can be passed to Measurement maintenance team.
- **Live Temperature & Pressure of Customer**: Real-time temperature & pressure of the Customer can be monitored by this system at any time.
- **Monitoring of Auto Adjust Turbine Meters Performance**: The Performance of Auto Adjust Turbine Meters with respect to load can be monitored. Any abnormality in meter can be tackled timely.
- **Monitoring of Suspected Customer**: Suspected Customer can be continuously monitored without moving from our control room.

3.16 Equipment Used During Rehabilitation Work

Land survey for demarcating the pipeline route is undertaken by a team equipped with pipe locator, metal detectors, leveling instruments, steel measuring tapes. The equipment and machinery during the construction and rehabilitation activities will comprise of Air Compressors, Power Generators, De-Watering Pump, Pressure Recorder (100 BTR), Pressure Gauges (0-50), 0-100 psi, Grinders, Oxygen and Acetylene Cylinder with Regulator and cutting torch set, Power Brush & Grinding Disc, hot weld fusion machine, Fire Extinguisher (06 Kg Dry), Leak Detectors, Pipeline Locater and other equipment.
3.17 Area of Influence of Work

The laying of the pipeline during the rehabilitation work would include excavation up to 3 ft wide and 4-5 ft deep channel. The excavation work would be limited within the right of way. Almost hundred percent (100%) of the network route is traversing through existing right of way. Therefore, no land acquisition is anticipated in the entire project. Generally, the area of influence of the rehabilitation work would be restricted to the existing right of way of the pipeline and would be localized. The project further does not foresee any specific requirement of area for storage of construction material or excavated waste.

3.18 Location of the Project Sites

The length of distribution network excluding service is 27,000 km. However, a large portion of this network is new installation and does not warrant rehabilitation. About 5,750 km of most dilapidated network is proposed to be rehabilitated under the project.

The distribution network expected to be rehabilitated during the entire project duration is divided into three regions viz. Karachi, Interior Sindh, and Quetta. The length of rehabilitation network to be rehabilitated during the three consecutive fiscal years in each of the region is mentioned in Table 3.4. During the first three years (of the five-year project) it is estimated that around 2,150 km network would be rehabilitated in 37 schemes/areas in Karachi; 900 km in 86 schemes/areas in 17 other Districts in interior of Sindh; and 300 km in 14 schemes/areas in Quetta city. Location of rehabilitation schemes in Karachi, Hyderabad, Larkana, and Quetta are shown in Figure 3.11, Figure 3.12, Figure 3.13 and Figure 3.14. Other cities/towns in interior of Sindh where rehabilitation activities would be carried out are identified in Figure 3.15. Table 3.5 shows number of schemes/areas to be rehabilitated during the three fiscal years in each of the region. Details about the location of the schemes/areas and required length of rehabilitation work in each of the three regions are mentioned under Annexure-C. Further investigation of UFG in the various segments may cause some adjustments to the original plan presented in this document.

Table 3.4: Summary of networks to be rehabilitated in 3 Regions in 2010-2013

<table>
<thead>
<tr>
<th>Region</th>
<th>F.Y 2010-2011</th>
<th>F.Y 2011-2012</th>
<th>F.Y 2012-2013</th>
<th>Total Length (Km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Karachi</td>
<td>550</td>
<td>800</td>
<td>800</td>
<td>2,150</td>
</tr>
<tr>
<td>2 Interior Sindh</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>900</td>
</tr>
<tr>
<td>3 Quetta</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>950</td>
<td>1,200</td>
<td>1,200</td>
<td>3,350</td>
</tr>
</tbody>
</table>
### Table 3.5: Summary of rehabilitation areas planned in each region during 2010–2013

<table>
<thead>
<tr>
<th>Region</th>
<th>F.Y 2010-2011</th>
<th>F.Y 2011-2012</th>
<th>F.Y 2012-2013</th>
<th>Total Schemes/Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karachi</td>
<td>11</td>
<td>12</td>
<td>14</td>
<td>37</td>
</tr>
<tr>
<td>Interior Sindh</td>
<td>27</td>
<td>26</td>
<td>33</td>
<td>86</td>
</tr>
<tr>
<td>Quetta</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>43</strong></td>
<td><strong>42</strong></td>
<td><strong>52</strong></td>
<td><strong>137</strong></td>
</tr>
</tbody>
</table>

### 3.19 UFG Decline Monitoring

Areas/Schemes selected for rehabilitation of distribution network is on the basis of DSM reports of leaks and complaints. It has to be considered that leakage in the ageing network increases with time. The impact of network rehabilitation/reinforcement measures at macro level is blanketed by the UFG losses of unattended segments. Hence, it is imperative that the overall decline in UFG figures would be visible only when most of the segments are rehabilitated. Zones would be created with view to monitor the gas purchase figures before and after the Rehabilitation project and each rehabilitated segment will then be evaluated before and after rehabilitation.
Figure 3.10: Locations of 37 Schemes for Rehabilitation of Distribution Network in Karachi
Figure 3.11: Locations of Schemes for Rehabilitation of Distribution Network in Hyderabad
Figure 3.12: Locations of Schemes for Rehabilitation of Distribution Network in Larkana
Figure 3.13: Locations of Schemes for Rehabilitation of Distribution Network in Quetta
Figure 3.14: Cities/Towns in 17 Districts of interior Sindh identified for rehabilitation work
4. **Baseline Environmental Conditions**

4.1 **General**

In order to identify all possible impacts of the proposed rehabilitation operation on physical, ecological and socio-economic environment of area, it is imperative to describe the Baseline Environmental Conditions of complete project area. This will help the authorities to propose proper mitigation measures in conducting the rehabilitation operation in an environmentally sustainable manner. The project area can be divided into following three major regions.

- a. Karachi
- b. Lower & Upper Sindh
- c. Quetta

![Figure 4.1: Map showing Karachi, Sindh (upper & lower) and Quetta](image-url)
4.2 Physical Environment: Air, Water and Land

a. Karachi
Karachi is located in the south of Pakistan, on the coast of the Arabian Sea. Its geographic coordinates are 24°51′ N 67°02′ E. Most of the land consisted largely of flat or rolling plains, with hills on the western and Manora Island and the Oyster Rocks. The Arabian Sea beach lines the southern coastline of Karachi. Mangroves and creeks of the Indus delta can be found toward the southeast side of the city. Toward the west and the north is Cape Monze, locally known as Raas Muari, an area marked by projecting sea cliffs and rocky sandstone. The Karachi Harbor is a protected bay to the south west of the city. The harbor is protected from storms by Kiamari Island, Manora Island and Oyster Rocks, which together block the greater part of the harbor entrance in the west. The southern limit of the city is the Arabian Sea and forms a chain of warm water beaches that are rich in natural beauty.

![Map of Karachi Region](image)

Figure 4.2: Map of Karachi Region

b. Lower & Upper Sindh
Sindh is located on the western corner of South Asia, bordering the Iranian plateau in the west. Geographically it is the third largest province of Pakistan, stretching about 579 km from north to south and 442 km (extreme) or 281 km (average) from east to west, with an area of 140,915 square kilometers (54,408 sq mi) of Pakistani territory. Sindh is bounded by the Thar Desert to the east, the Kirthar Mountains to the west, and the Arabian Sea in the south. In the centre is a fertile plain around the Indus river. Details of Lower and Upper Sindh Regions are shown in Figure 4.3 and Figure 4.4 respectively.
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Figure 4.3: Detail Map of Lower Sindh Region

Figure 4.4: Detail Map of Upper Sindh Region
c. Quetta

Quetta, the provincial capital of Baluchistan, is situated at an elevation of 1700 meters (5,500 ft) and is one of the best known hill resorts in Pakistan with delightful summer weather and severe winters. It is located at North West of Baluchistan. Its bordering districts are Pishin, Sibi, Mastung and Chaghai.

The city of Quetta comprises approximately 2,653 km² (1,036 square miles) and consists of series of valleys which act as a natural fort surrounded on all sides by a number of imposing hills named Chiltan, Takatoo, Murdar and Zarghun. There are no natural boundaries between Quetta and its adjoining districts of Dera Ismail Khan to the northeast, Dera Ghazi Khan and Sibi to the east, Sukkur and Jacobabad to the southeast, Karachi and Gawadar to the south and Ziarat to the southwest. The closest major city is Kandahar in Afghanistan which is located to the west of the Quetta.

Figure 4.5: Map of Quetta

4.2.1 Climate (Temperature, Humidity, Rainfall)

a. Karachi

The climate of the Karachi can be characterized by dry, hot and humid conditions and in general terms it is moderate, sunny and humid. There is a minor seasonal variation due to a mild winter from mid December to mid February and a long hot and humid summer extending from April to September with monsoon rains from July to mid- September. The record of the three
The climate of the project area is typically tropical, dry, hot, without clear division of seasons and having a low rainfall record. Air temperature in Karachi and along the adjoining areas is invariably moderate. The yearly average temperature varies between 16.4°C and 35.8 °C. The mean maximum temperature in summer is 30°C while the mean minimum winter temperature is 22°C. The mean monthly maximum and minimum temperatures in the project area are shown in Table 4-1.

**Table 4.1: Month wise Temperature & Precipitation Data (Karachi)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Temperature</th>
<th>Years on Record: 17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Highest Recorded Temperature</th>
<th>Years on Record: 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>33</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lowest Recorded Temperature</th>
<th>Years on Record: 17</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Average Precipitation</th>
<th>Years on Record: 44</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>---</td>
</tr>
</tbody>
</table>
Rainfall:
Highest rainfall events have occurred in July 1994: 256.3mm, July 2003: 270.4mm and August 2006: 77mm in 3 hours

Table 4.2: Precipitation Record of Karachi

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Rainfall/Year(m)</th>
<th>Highest Rainfall Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1944(August)</td>
<td>-</td>
<td>162.4mm (Duration not known)</td>
</tr>
<tr>
<td>1953 (August)</td>
<td>-</td>
<td>278.1 mm/24 hour</td>
</tr>
<tr>
<td>1977 (July)</td>
<td>-</td>
<td>207.0mm (Duration not known)</td>
</tr>
<tr>
<td>1991</td>
<td>24.5</td>
<td>-</td>
</tr>
<tr>
<td>1992</td>
<td>268.0</td>
<td>-</td>
</tr>
<tr>
<td>1993</td>
<td>35.5</td>
<td>-</td>
</tr>
<tr>
<td>1994</td>
<td>481.5</td>
<td>256.3 July, 147.8 August (24 Hours)</td>
</tr>
<tr>
<td>1995</td>
<td>94.7</td>
<td>-</td>
</tr>
<tr>
<td>1996</td>
<td>99.0</td>
<td>-</td>
</tr>
<tr>
<td>1997</td>
<td>150.1</td>
<td>-</td>
</tr>
<tr>
<td>1998</td>
<td>82.4</td>
<td>-</td>
</tr>
<tr>
<td>1999</td>
<td>14.5</td>
<td>-</td>
</tr>
<tr>
<td>2000</td>
<td>46.9</td>
<td>24.9 August</td>
</tr>
<tr>
<td>2001</td>
<td>100.4</td>
<td>73.6 July</td>
</tr>
<tr>
<td>2002</td>
<td>55.8</td>
<td>52.2 August</td>
</tr>
<tr>
<td>2003</td>
<td>324.9</td>
<td>270.4 July</td>
</tr>
<tr>
<td>2004</td>
<td>65.9</td>
<td>39.3 October</td>
</tr>
<tr>
<td>2005</td>
<td>97.8</td>
<td>54.9 September</td>
</tr>
<tr>
<td>2006 (August</td>
<td>-</td>
<td>77mm in 3 hours (Critical)</td>
</tr>
<tr>
<td>Masroor)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.3: Month wise Temperature & Precipitation Data (Hyderabad)

Hyderabad(Climate)
Elevation: 41 meters  Latitude: 25 22N  Longitude: 068 25E

Average Temperature  
Years on Record: 113

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>27</td>
<td></td>
<td>17</td>
<td>20</td>
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<td>33</td>
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<td>31</td>
<td>30</td>
<td>29</td>
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Average High Temperature  
Years on Record: 43

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</table>

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### Average Low Temperature

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<td>20</td>
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<td>27</td>
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<td>25</td>
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<td>16</td>
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### Average Precipitation

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<td>18.1</td>
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<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
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</tbody>
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**Table 4.4: Month wise Temperature & Precipitation Data (Sukkur)**

**Sukkur (Climate)**

Elevation: 67 meters  
Latitude: 27 42N  
Longitude: 068 52E

### Average Temperature

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<td>18</td>
<td>29</td>
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<td>35</td>
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<td>28</td>
<td>22</td>
<td>17</td>
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### Average High Temperature

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<td>22</td>
<td>26</td>
<td>37</td>
<td>41</td>
<td>42</td>
<td>39</td>
<td>38</td>
<td>35</td>
<td>30</td>
<td>24</td>
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### Average Low Temperature

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<tbody>
<tr>
<td>19</td>
<td>7</td>
<td>10</td>
<td>21</td>
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<td>21</td>
<td>14</td>
<td>9</td>
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</tbody>
</table>

### Average Precipitation

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<tbody>
<tr>
<td>7.8</td>
<td>0.5</td>
<td>0.5</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>2.9</td>
<td>1.6</td>
<td>0.4</td>
<td>---</td>
<td>0.2</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Table 4.5: Month wise Temperature & Precipitation Data (Nawabshah)**

**Nawabshah (Climate)**

Elevation: 38 meters  
Latitude: 26 15N  
Longitude: 068 22E

### Average Temperature

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>26</td>
<td>14</td>
<td>17</td>
<td>24</td>
<td>29</td>
<td>33</td>
<td>35</td>
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<td>32</td>
<td>31</td>
<td>27</td>
<td>21</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

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Average High Temperature

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>34</td>
<td>23</td>
<td>27</td>
<td>33</td>
<td>38</td>
<td>43</td>
<td>40</td>
<td>38</td>
<td>38</td>
<td>36</td>
<td>31</td>
<td>24</td>
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</tbody>
</table>

Average Low Temperature

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
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<tr>
<td>°C</td>
<td>17</td>
<td>5</td>
<td>8</td>
<td>14</td>
<td>19</td>
<td>24</td>
<td>27</td>
<td>27</td>
<td>26</td>
<td>24</td>
<td>18</td>
<td>11</td>
</tr>
</tbody>
</table>

Average Precipitation

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>cm</td>
<td>14.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>1</td>
<td>5.1</td>
<td>4.7</td>
<td>1.7</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 4.6: Mean Monthly metrological data

<table>
<thead>
<tr>
<th>Months</th>
<th>Rainfall (mm)</th>
<th>Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.7</td>
<td>47.90</td>
</tr>
<tr>
<td>February</td>
<td>3.87</td>
<td>45.38</td>
</tr>
<tr>
<td>March</td>
<td>5.05</td>
<td>42.40</td>
</tr>
<tr>
<td>April</td>
<td>5.74</td>
<td>41.88</td>
</tr>
<tr>
<td>May</td>
<td>3.47</td>
<td>46.96</td>
</tr>
<tr>
<td>June</td>
<td>13.84</td>
<td>56.35</td>
</tr>
<tr>
<td>July</td>
<td>56.66</td>
<td>63.42</td>
</tr>
<tr>
<td>August</td>
<td>60.75</td>
<td>65.26</td>
</tr>
<tr>
<td>Sept</td>
<td>21.41</td>
<td>61.37</td>
</tr>
<tr>
<td>Oct</td>
<td>1.50</td>
<td>47.65</td>
</tr>
<tr>
<td>Nov</td>
<td>2.10</td>
<td>46.40</td>
</tr>
<tr>
<td>Dec</td>
<td>1.99</td>
<td>49.26</td>
</tr>
<tr>
<td>Annual /Mean</td>
<td>177.75</td>
<td>51.19</td>
</tr>
</tbody>
</table>

c. Quetta
Climate of Quetta is cold and dry, minimum temperature in winter reaches below freezing point while in summer it can reach as high as 40 C. As compared to the rest of Baluchistan, Quetta district was also affected by drought. However, in recent years the rains have increased. In 2004, the total rainfall was 105.9 mm which was much better in 2005 with 310.5 mm of rain. The minimum, maximum temp and rainfall data is shown in table 4-7.
Table 4.7: Month wise Temperature & Precipitation Data (Quetta)

Quetta (Climate)
Elevation: 1600 meters  Latitude: 30 15N  Longitude: 066 56E

<table>
<thead>
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<tr>
<td>°C</td>
<td>14</td>
<td>4</td>
<td>6</td>
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<td>24</td>
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<td>20</td>
<td>13</td>
<td>9</td>
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<tr>
<td>Average High Temperature</td>
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<td>17</td>
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<td>33</td>
<td>34</td>
<td>33</td>
<td>30</td>
<td>24</td>
<td>18</td>
<td>13</td>
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<tr>
<td>Average Low Temperature</td>
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<tr>
<td>°C</td>
<td>6</td>
<td>-2</td>
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<td>3</td>
<td>7</td>
<td>11</td>
<td>15</td>
<td>18</td>
<td>16</td>
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<td>3</td>
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<tr>
<td>Highest Recorded Temperature</td>
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<tr>
<td>°C</td>
<td>41</td>
<td>25</td>
<td>28</td>
<td>28</td>
<td>35</td>
<td>38</td>
<td>39</td>
<td>41</td>
<td>41</td>
<td>39</td>
<td>33</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>°C</td>
<td>-19</td>
<td>-16</td>
<td>-13</td>
<td>-9</td>
<td>-2</td>
<td>-1</td>
<td>-1</td>
<td>8</td>
<td>7</td>
<td>---</td>
<td>-5</td>
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<td>cm</td>
<td>23</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>2</td>
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<td>1</td>
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<td>4</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<td>2</td>
</tr>
</tbody>
</table>
### Table 4.8: Quetta- Highest, lowest Temperatures & Monthly Heaviest Rainfall

<table>
<thead>
<tr>
<th>Month</th>
<th>Highest Maximum Temperature (°C) (dd/mm/yyyy)</th>
<th>Lowest Minimum Temperature (°C) (dd/mm/yyyy)</th>
<th>Monthly Heaviest Rainfall (mm) (mm/yyyy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>23.6 (28/01/1987)</td>
<td>-18.3 (08/01/1970)</td>
<td>178.0 (01/1982)</td>
</tr>
<tr>
<td>February</td>
<td>26.7 (26/02/1953)</td>
<td>-16.7 (01/02/1970)</td>
<td>189.2 (02/1982)</td>
</tr>
<tr>
<td>March</td>
<td>31.0 (08/03/2004)</td>
<td>-8.3 (12/03/1973)</td>
<td>232.4 (03/1982)</td>
</tr>
<tr>
<td>April</td>
<td>35.0 (27/04/1979)</td>
<td>-3.9 (02/04/1965)</td>
<td>158.7 (04/1992)</td>
</tr>
<tr>
<td>May</td>
<td>39.4 (11/05/2000)</td>
<td>-0.3 (03/05/1989)</td>
<td>39.9 (05/1963)</td>
</tr>
<tr>
<td>June</td>
<td>41.5 (**/06/2005)*</td>
<td>5.0 (01/06/1958)</td>
<td>61.0 (06/2007)</td>
</tr>
<tr>
<td>July</td>
<td>42.0 (10/07/1998)</td>
<td>8.9 (07/07/1955)</td>
<td>163.6 (07/1956)</td>
</tr>
<tr>
<td>August</td>
<td>40.6 (09/08/1970)</td>
<td>3.3 (23/08/1949)</td>
<td>173.0 (08/1983)</td>
</tr>
<tr>
<td>September</td>
<td>38.3 (01/09/1970)</td>
<td>-0.6 (30/09/1962)</td>
<td>62.0 (09/1994)</td>
</tr>
<tr>
<td>October</td>
<td>34.0 (01/10/1998)</td>
<td>-8.3 29/10/1949)</td>
<td>68.8 (10/1982)</td>
</tr>
<tr>
<td>December</td>
<td>25.0 (14/12/1970)</td>
<td>-18.3 (21/12/1950)</td>
<td>162.0 (12/1982)</td>
</tr>
<tr>
<td>Annual</td>
<td>42.0 (10/07/1998)</td>
<td>-18.3 (08/01/1970)</td>
<td>949.8 (1982)</td>
</tr>
</tbody>
</table>


#### 4.2.2 Seismic / Tectonic Data

**a. Karachi & Sindh**

Four major faults exist in and around Karachi and other parts of deltaic Indus, and the southern coast of Makran. The first of these is the Allah Bund Fault. It traverses Shahbundar, Jah, Pakistan Steel Mills and continues to the eastern parts of Karachi- ending near Cape Monz. Earthquakes along this particular fault have been responsible for considerable destruction in the past. A major earthquake in the 13th century destroyed Bhanbhor. Another major earthquake in 1896, was responsible for extensive damage in Shahbundar.

The second major fault near Karachi is an extension of the one that begins near Rann of Kutch region. The third is the Pubb fault which ends into Arabian Sea near the Makran coast. Finally, the fourth major fault near Karachi is located in the lower Dadu district, near Surajani. Many earthquakes have occurred on these faults.
Another major fault along the offshore Makran coast (Baluchistan and Sindh provinces), is the result of active subduction zone where major earthquakes have occurred in the past. This zone forms the boundary of Arabian plate subducting under the Iranian micro-plate. However, the seismicity of the Makran region is relatively low compared to the neighbouring regions, which have been devastated regularly by large earthquakes.
4.3 Ecological Environment

Almost all of the rehabilitation project sites are located in urban or semi-urban areas and would not pose any danger to the biodiversity of the overall district.

4.4 Socio-Economic & Cultural Environment

4.4.1 Population

a. Karachi

Karachi consist of 18 towns, a Cantonment & Defense Society having a total population of 9.96 million according to 1998 census. The breakup of population is given below in table no. 4-17.

Table 4.9: Population of Karachi

<table>
<thead>
<tr>
<th>S.No</th>
<th>Towns</th>
<th>Population in 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Keemari</td>
<td>384,378</td>
</tr>
<tr>
<td>2</td>
<td>SITE</td>
<td>467,560</td>
</tr>
<tr>
<td>3</td>
<td>Baldia</td>
<td>406,165</td>
</tr>
<tr>
<td>4</td>
<td>Orangi</td>
<td>723,694</td>
</tr>
<tr>
<td>5</td>
<td>Lyri</td>
<td>607,992</td>
</tr>
<tr>
<td>6</td>
<td>Saddar</td>
<td>607,992</td>
</tr>
<tr>
<td>7</td>
<td>Jamshed</td>
<td>733,821</td>
</tr>
<tr>
<td>8</td>
<td>Gulshan- e-Iqbal</td>
<td>625,230</td>
</tr>
<tr>
<td>9</td>
<td>Shah Faisal</td>
<td>355,823</td>
</tr>
<tr>
<td>10</td>
<td>Landhi</td>
<td>666,748</td>
</tr>
<tr>
<td>11</td>
<td>Korangi</td>
<td>546,504</td>
</tr>
<tr>
<td>12</td>
<td>North Nazimabad</td>
<td>496,194</td>
</tr>
<tr>
<td>13</td>
<td>North Karachi</td>
<td>684,183</td>
</tr>
<tr>
<td>14</td>
<td>Gulberg</td>
<td>453,490</td>
</tr>
<tr>
<td>15</td>
<td>Liaquatabad</td>
<td>649,091</td>
</tr>
<tr>
<td>16</td>
<td>Malir</td>
<td>398,289</td>
</tr>
<tr>
<td>17</td>
<td>Bin Qasim</td>
<td>316,684</td>
</tr>
<tr>
<td>18</td>
<td>Gadap</td>
<td>289,584</td>
</tr>
<tr>
<td>19</td>
<td>Cantonment</td>
<td>306,165</td>
</tr>
<tr>
<td>20</td>
<td>Defense</td>
<td>250,000</td>
</tr>
<tr>
<td></td>
<td>Total in Million</td>
<td>9.96</td>
</tr>
</tbody>
</table>

The earliest inhabitants of the area that became Karachi included Baloch in the west, and Sindhi tribes such as the Jokhio, Mallaah and Jath in the east. The partition of India saw the settlement of what is now the largest ethnic community in the city, the Muhajirs. The Pashtuns, originally from Khyber Pakhtunkhwa and northern Baluchistan are now the city's second-largest ethnic group. With an estimated 7 million Pashtuns, including approximately 50,000 registered Afghan refugees, Karachi hosts the largest Pashtuns population in the world. Currently Karachi population is believed to between 14 and 15 millions. The linguistic distribution of the city in 1998 census is: Urdu speaking 48.52%; Punjabi 13.94%; Sindhi 7.22%; Pashto 11.42%; Balochi 4.34%; Seraiki 2.11%; others 12.4%. The others include Gujarati, Dawoodi Bohra, Memon, Brahui, Makrani, Khowar, Burushaski, Arabic, Persian and Bengali. The religious breakup of the
city is as follows: Muslim 96.49%; Christian 2.35%; Hindu 0.83%; Qadiani 0.17%; others 0.13%. The others include Parsi, Jews and Buddhist.

b. Lower & Upper Sindh

The 1998 Census of Pakistan indicated the population of Sindh to be 35 million and the current population in 2009 is 51,337,129 using a compound growth in the range of 2% to 2.8% since then. Sindh’s population is mainly Muslim (91.32%), and Sindh is also home to nearly all (93%) of Pakistan’s Hindus forming 7.5% of the province’s population. A large number of Hindus migrated to India during Partition. Muhajirs who settled in the province migrated from India.

Table 4.10: Population of middle region of the Sindh province

<table>
<thead>
<tr>
<th>S.No</th>
<th>District</th>
<th>Area (km²)</th>
<th>Population (1998 Census)</th>
<th>Density (Peoples/Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Jamshoro</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>02</td>
<td>Hyderabad</td>
<td>5,519</td>
<td>2,891,488</td>
<td>524</td>
</tr>
<tr>
<td>03</td>
<td>Matiari</td>
<td>1,417</td>
<td>515,331</td>
<td>364</td>
</tr>
<tr>
<td>04</td>
<td>Dadu</td>
<td>19,070</td>
<td>1,688,811</td>
<td>89</td>
</tr>
<tr>
<td>05</td>
<td>Khairpur</td>
<td>15,910</td>
<td>1,546,587</td>
<td>97</td>
</tr>
<tr>
<td>06</td>
<td>Tando Muhammad Khan</td>
<td>1,733</td>
<td>447,215</td>
<td>257</td>
</tr>
<tr>
<td>07</td>
<td>Tando Allahyar</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>08</td>
<td>Naushahro Feroze</td>
<td>2,945</td>
<td>1,087,571</td>
<td>369</td>
</tr>
<tr>
<td>09</td>
<td>Mirpurkhas</td>
<td>2925</td>
<td>1,569,030</td>
<td>536</td>
</tr>
<tr>
<td>10</td>
<td>Umerkot</td>
<td>N/A</td>
<td>663,100</td>
<td>N/A</td>
</tr>
<tr>
<td>11</td>
<td>Tharparkar</td>
<td>19,638</td>
<td>914,291</td>
<td>47</td>
</tr>
<tr>
<td>12</td>
<td>Badin</td>
<td>6,726</td>
<td>1,136,044</td>
<td>169</td>
</tr>
<tr>
<td>13</td>
<td>Thatta</td>
<td>17,355</td>
<td>1,113,194</td>
<td>64</td>
</tr>
</tbody>
</table>

Table 4.11: Population of Upper Region of Sindh

<table>
<thead>
<tr>
<th>S.No</th>
<th>District</th>
<th>Area (km²)</th>
<th>Population (1998 Census)</th>
<th>Density (Peoples/Km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Jacobabad</td>
<td>5278</td>
<td>1,425,572</td>
<td>270</td>
</tr>
<tr>
<td>02</td>
<td>Shikarpur</td>
<td>2512</td>
<td>880,438</td>
<td>350</td>
</tr>
<tr>
<td>03</td>
<td>Qambar Shahdad Kot</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>04</td>
<td>Kashmore</td>
<td>2592</td>
<td>662,462</td>
<td>255</td>
</tr>
<tr>
<td>05</td>
<td>Sukkur</td>
<td>5,165</td>
<td>908,373</td>
<td>176</td>
</tr>
<tr>
<td>06</td>
<td>Ghotki</td>
<td>6,083</td>
<td>970,549</td>
<td>160</td>
</tr>
<tr>
<td>07</td>
<td>Larkana</td>
<td>7,423</td>
<td>1,927,066</td>
<td>260</td>
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<tr>
<td>08</td>
<td>Nawabshah</td>
<td>4,502</td>
<td>1,071,533</td>
<td>238</td>
</tr>
</tbody>
</table>

c. Quetta

The population of Quetta district was estimated to be over 850,000 in 2005. It is the highly populated and most urbanized district in the Baluchistan. Over 90% of the people of the area are Muslims. The Pashtun make up more than 52% and Hazaras covering 37% of the population of the capital district. Out of a large number of Baloch tribes, Shahwani is the ancient one, which owns the rest of district lands, beside Shahwanis other Baloch tribes include the Bangulzai, Lehri and M. Shai. The Muhajir Urdu (settlers and their descendants from India) and Punjabi settlers...
also dwell in Quetta. The Population of Quetta saw two surges ie in 1970-71, when Quetta was made capital of newly formed province Baluchistan. During this period large number of Balochs came to Quetta in search of jobs and settled due to the comparatively better infra structure and job situation. The second surge in population occurred in the 80s when a large number of Afghan refugees entered Quetta when the Soviet Union invaded Afghanistan.

4.4.2 Demography

a. Karachi
Out of a total population of 14 to 15 million, the linguistic distribution of the city in 1998 census is: Urdu speaking 48.52%; Punjabi 13.94%; Sindhi 7.22%; Pashto 11.42%; Balochi 4.34%; Seraiki 2.11%; others 12.4%. The others include Gujarati, Dawoodi Bohra, Memon, Brahui, Makrani, Khowar, Burushaski, Arabic, Persian and Bengali. The religious breakup of the city is as follows: Muslim 96.49%; Christian 2.35%; Hindu 0.83%; Qadiani 0.17%; others 0.13%. The others include Parsi, Jews and Buddhist.

b. Lower & Upper Sindh
Sindhi-speaking households make up 59.7% of Sindh's population; Urdu-speaking households make up 21.1%; Punjabi 7.0%; Pashto 4.2%; Balochi 2.1%; Seraiki 1.0% and other languages 4.9%. Other languages include Gujarati, Memoni, Kutchi (both dialects of Sindhi), Khowar, Thari, Persian/Dari, Luri and Brahui (may also identify themselves as Sindhi). Sindh's population is mainly Muslim (91.32%), and Sindh is also home to nearly all (93%) of Pakistan's Hindus forming 7.5% of the province's population. A large number of Hindus migrated to India during Partition. Muhajirs who settled in the province migrated from India.

The Sindh is as a whole are composed of original descendants of an ancient population known as Sammaat, various sub-groups related to the Seraiki or Baloch origin are found in interior Sindh and to a lesser extent Sindhis of Pashtun or Punjabi origins. Sindhis of Balochi and Seraiki origins make up about 60% of the total Sindhi population (they however speak Sindhi as their native-tongue), while Urdu-speaking Muhajirs make little over 20% of the total population of the province. Also found in the province are groups of Sindhi tribes claiming descent from early Muslim settlers including Arabs and Persian.

c. Quetta
Over 90% of the people of the area are Muslims. The Pashtun make up more than 52% and Hazaras covering 37% of the population of the capital district. Out of a large number of Baloch tribes, Shahwani is the ancient one, which owns the rest of district lands, beside Shahwani other Baloch tribes include the Bangulzai, Lehri and M.Shai. The Muhajir Urdu (settlers and their descendants from India) and Punjabi settlers also dwell in Quetta. The Population of Quetta saw two surges ie in 1970-71, when Quetta was made capital of newly formed province Balochistan. During this period large number of Balochs came to Quetta in search of jobs and settled due to the comparatively better infra structure and job situation.

4.4.3 Cultural Heritage

The cultural heritage of the areas subject to rehabilitation under the project will not be impacted.
5. Community Consultation Process

During preparation of this ESMF a process of Community Consultation was planned and executed to obtain feedback and suggestions of the local community about recently completed activities of SSCG in their locality. It was planned to carryout community consultation survey in areas where SSCG carried out rehabilitation activity of gas distribution network and gas-meter change. Details of the community consultation process and analysis of results are provided in this section.

5.1 Survey Questionnaire

For the purpose of the community consultation a ‘Questionnaire’ was developed with the objective of seeking pertinent information from the local community (copy of Questionnaire attached as Appendix-1 of Annexure-D). The questionnaire had four parts. In part one, information about the survey area, schedule of survey, details of surveyors and description of SSCG activity carried out in the area were recorded. In part two, details of respondent including name, age, gender, employment status, and qualification were recorded. In part three, feedback on quality of service/work carried by SSCG was recorded. In part four, feedback on SSCG emergency response and complaint center besides suggestions for improvement were acquired.

5.2 Areas of Survey

Following two areas were selected for community consultation:

a. Frontier Colony (FC), Orangi Town, Karachi
b. Ittehad Town (IT), Baldia Town, Karachi

5.3 Survey Team

The survey team included 8 persons and was headed by Mr. Imtiaz Sheikh, Engineer Rehabilitation. The team comprises mostly of senior field personnel, however, representative of HSE Head Office Team were also included. Overall, the survey was organized and supervised by Chief Engineer HSE, Head Office.

5.4 Pre-Survey Activity

Before commencement of the actual survey in field, a brief training session of the survey team was carried out. The areas covered in training included purpose of the survey, selection of respondent, procedure of seeking information from the respondents, procedure for recording information in the questionnaire, and conflict management. Importance of the quality of data was also emphasized. Before going into actual surveys, a mock activity was also conducted at the field using a local resident.
5.5 Analysis of Survey Results

The data and information obtained during the community consultation process through the questionnaire has been analyzed and discussed below:

5.5.1 Number of Respondents

A sample of 54 persons from the local community who had either received services from SSGC or were current SSGC customers were interviewed from both the localities. From Frontier Colony (FC) 25 persons were interviewed and 29 persons from Ittehad Town (IT) were interviewed.

5.5.2 Analysis of Respondents’ Profile

The aspects of respondents’ profile examined include Age, Gender, Employment Status, Work Status, and Qualification. The information received in these five categories has been represented graphically in Figure 5.1, 5.2, 5.3, 5.4, 5.5 below.

Around 80% of the respondents were in the age group of 20 to 60 years in both survey localities. The areas under survey may be categorized as lower-middle class, therefore, people in this age group are bread earners of their family and are socially responsible class of the society.

Out of 54 people interviewed only 3 were females, which comes out to be 6% of the total respondents. The majority of the population in both of the region belong to Phakhtoon cast/tribes.
Though 72% of people interviewed reported their employment status as ‘Un-Employed’, however, in next question, 65% respondent (Combined) identified their work status as ‘Self-Employed’. This is because majority of people identifying themselves as un-employed had categorized themselves ‘Self-Employed’ in Work Status profile. Only those people reported themselves ‘Employed’ who described their work status as ‘Service’ in the next question. Therefore, in data analysis, ignoring the response of earlier question and inferring Employment Status of respondent from Work Status response reveals about 92% employment. This incongruity may be resolved either by re-phrasing the Employment Status question or by combining it with the Work Status question.

About 88% and 66% people interviewed in Frontier Colony (FC) and Ittehad Town (IT) respectively were educated, whereas 12% and 28% respectively had no education (Illiterate). Overall, 28%, of people interviewed had education up to High School. None of the respondents had education level of Graduation or above.

Overall it may be deduced that the majority of people interviewed in IT and FC are less education and self-employed, having some sort of local business/trade. SSGC distribution network rehabilitation activities may have adverse impacts on their livelihood, if planned unappropriately.
5.5.3 Analysis of Respondents’ Feedback on Quality of Service

For acquiring feedback of people on quality of services provided by SSGC questions pertaining to time, duration, disturbance to routine activities, incident information, improvement measures, etc. were asked from the respondents during community consultation in FC and IT areas. The information received has been represented graphically in Figure 5.6 to Figure 5.12 below.

Responding to first question, around 44% of respondents showed unawareness about the gas distribution network rehabilitation and meter change activity being carried out in their locality. However, when asked whether the rehabilitation work would improve the quality of life in their respect areas, 91% responded affirmatively. For remaining 9% respondents low gas pressure was prime apprehension.

In both the survey areas (FC and IT) 89% of respondent showed satisfaction with the SSGC activity and reported no disturbance to their routine life during the work. The disturbance to routine life identified by 11% respondents include problem to women and children from excavation trenches and no prior information about gas supply stoppage. However, it was also admitted that disturbances were temporary and for a few days only.

The survey results also reveal that local community received information about the activity mostly from the SSGC team and the Contractor. Receiving information from neighbors and neighborhood shops was also reported. Mobilization of contractor’s equipment and placement of
material was also recognized as source of information by a few respondents.

Responding to the preferred source of information for SSGC activity in future, 37% of respondents (combined) reported making announcement from local Mosque, 35% reported distribution of Handouts, while few identified TV and local newspaper as their preferred source of information. Placement of banners in the locality was also identified by a respondent. About 38% respondents suggested that activity commencement information should be communicated at least one week in advance, 35% suggested more than one week (10 to 15 days), while for 27% respondents less than a week was also acceptable.

People showed complete satisfaction about the timings of the SSGC activities. 98% responding positively, while conflict with business hours was concern of one respondent. Morning hours were preferred by 93% of respondents while only 6% suggested afternoon hours for the activity. One person suggested conducting rehabilitation activity in evening hours.

98% of the respondents neither experienced nor were aware of any incident being occurred during the SSGC activity carried out in their areas. The only incident reported by a respondent was an argument between the contractor and local resident based on some misunderstanding.
while responding to the identification of some priority measures that need to be followed by SSGC or its Contractors during the rehabilitation of distribution network activities in future most of the respondents stressed on quality of work and compliance of activity schedule. Other measures identified are as under:

- undertaking safety measures during work;
- trenches and excavations to be barricaded;
- backfilling excavations in same day after laying of pipes;
- use of machinery for quick progress;
- progress of contractor to be monitored on daily basis;
- presence of SSGC officials on site during work;
- working on day light only;
- removal of all debris after work; and
- site cleaning after completion of activity.

5.5.4 Analysis of Respondents’ Feedback on Complaints

For acquiring feedback of people on procedures of complaints and response of SSGC for their remedy questions pertaining response of SSGC in emergency situation, procedure of registering complains, time taken to respond, etc. were asked from the respondents during community consultation in FC and IT areas. The information received has been represented graphically in Figure 5.13 to Figure 5.18

About 74% of overall respondents (combined) showed their satisfaction with the response of SSGC during emergency situations. The unsatisfied respondents expressed apprehension on the delayed response of SSGC team based on their experience.

Nearly 60% of respondents were aware about the system of registering any complaints with

**Figure 5.12: Occurring of incident during SSGC activity**

**Figure 5.13: Response of SSGC during emergency situation**
SSGC. Number of people lacking knowledge about complaint registration system were more in FC than IT.

About half of the respondents had registered complaints with SSGC. Percentage of people filing complaints were comparatively more in FC that IT area. While commenting on the time taken by SSGC to respond 33% reported ‘Very Quikly’, 33% reported within 2 to 4 hours and 33% reported over 8 hours to 24 hours.

Though majority of respondents, 72%, did not suggest anything for improvement of the complaint filing system, however, the few suggestion received included; registration of complaints through SMS services; printing of telephone numbers of senior management on gas bills; complaint center to be made at nearest location; and a center for re-conformation of complaints may be established.

5.6 Suggestions

Based on the response of community consultation process following is concluded:

- Survey team should include female interviewers as well to keep gender balance in respondents.
• Communication of activity schedule is important for the local community. It need to be communicated well in time and appropriately based on the suggestions received. Distribution of handouts, announcement from local Mosque and placement of banners may be better strategies of communication to the local community.

• In time completion of activity with quality work is prime requirement of the community.

• Necessary safety and precautionary measures must be taken by the SSGC team or the Contractor while executing work.

• The system of complaint registration with SSGC needs to be communicated to the local community prior to commencement of any activity in their areas.

5.7 Conclusions

Majority of the SSGC rehabilitation activities would be carried out in the urban or semi-urban areas of cities and towns. For assessment of social impacts it would, therefore, be necessary to obtain specific baseline information of the activity area, such as the economic situation of the people living in those areas; the housing conditions; the kind of roads/alleys where activities are to be conducted; water courses, trees; and other natural resources that the activities will be disrupting.

Prior to commencement of any field work a Social & Environmental Screening Checklist would be prepared for each rehabilitation activity area. Format of the checklist is attached as Appendix-2 of Annexure-D.

In case areas having signification social or environmental impacts were identified by the checklist a Rapid Assessment would be carried out to identify appropriate mitigation measures for project implementation phase.

The Social Screening Checklist would be prepared immediately after the actual work areas in various cities/towns are identified.
Figure 5.17: Community consultation photographs
6. Environmental and Social Impacts and Mitigation Measures

SSGC has 3,320 km of transmission lines and 34,282 km of distribution network (including services) in over 1200 towns in Sindh and Balochistan. The distribution pipeline infrastructure is up to 40 – 50 years old and it accounts for 50% - 70% of UFG in SSGC network. Besides underground, overhead leakages, leakages measurement inaccuracies and billing errors are other sources of UFG. Overhead leakages normally occur at pipe joints of customer connections (riser to inlet of meter). The UFG losses of SSGC were 7.8% or 33,040 MMCF during the year 2008-09, whereas normal UFG is 1-3%. SSGC plans to reduce and control UFG through rehabilitation of old distribution network, installation of new gas-meters and better metering system.

The possible environmental impacts of the proposed project of rehabilitation of the gas distribution network, replacement of old gas-meters, and metering system in Karachi, interior Sindh and Quetta, Baluchistan are discussed in this section along with identification of suitable mitigation measures to redress them appropriately. For the purpose of impact assessment the project activities are divided in three phases: construction phase, commissioning phase and operation phase of the pipeline.

6.1 Impact Assessment Guidelines

The impact assessment has been carried out in the light of the guidance and standard procedures mentioned in the following documents:

- Pakistan Environmental Protection Act, 1997
- Oil and Gas Regulatory Authority Ordinance, 2002
- Natural Gas (Licensing) Rules, 2002
- The World Bank's Policies for Environmental Assessment OP 4.01
- The World Bank's Environmental Assessment Sourcebook, Volume III: Guidelines for Environmental Assessment of Energy and Industrial Projects; section on Oil and Gas Development—Onshore

6.2 Impact Assessment Methodology

Environmental impact assessment and mitigation measures are identified in the following steps:

- Identification of potential impact
- Evaluation and quantification (where possible) of potential impact
- Interpretation of significance of potential impact.
- Interpretation of suitable mitigation measures
- Making Environmental Management Plan
For the impact deemed detrimental to the environment, appropriate mitigation measures are identified to eliminate or reduce them to the level possible. Finally, the management and monitoring measures are identified for quantification and evaluation of the residual impacts and effectiveness of the mitigation measures.

**Identification of Significant Potential Impact**

To determine the significance of the potential impact, both the consequence and the likelihood of occurrence of the impact is considered. The consequence of the proposed activity is evaluated on the basis of institutional recognition, public recognition, and technical recognition of the issue or the environmental resource that is affected.

Institutional recognition means that the importance of the impact is recognized in the laws, development plans, and policy statements of the government. Public recognition means that a segment of the public, especially the community directly affected by the project, expresses concern about the impact. Technical recognition means that the importance is based on scientific or technical knowledge, or on the judgment of critical resource characteristics.

The overall assessment of significance is made using a standard risk assessment approach that considers the potential consequences of the impact in conjunction with the likelihood of occurrence.

**Identification of Mitigation Measures**

If it is determined that the predicted impact does not comply with one or more of the above criteria, suitable mitigation measures are identified. There is a range of mitigation measures that can be applied to reduce impact. Broadly, these measures can be classified into five categories:

- Avoiding the impact altogether by not taking a certain action or parts of an action
- Minimizing impact by limiting the degree or magnitude of the action and its implementation
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the actions
- Compensating for the impact by replacing or providing substitute resources or environments

**Management Actions / Environment Management Plan**

The key to the successful implementation of the proposed mitigation measures is the development of an Environmental Management Plan (EMP). The EMP for this project has been mentioned in Section 7 of this ESMF.
6.3 Phases of Rehabilitation Work

The activities to be carried out during the implementation of the schemes to rehabilitate dilapidated pipelines during the project may be divided into four phases for the purpose of impact assessment. These phases are described below:

**Phase-I: Planning Phase**

This phase includes following selection of:

- Sites for rehabilitation work.
- Type of pipeline material.
- Processes of laying and welding.
- Process of construction.

**Phase-II: Pre-Construction and Construction Phase**

This phase includes following activities:

- Pipeline route survey
- Right-of Way (ROW) trenching
- Jointing and Pipeline laying
- Backfilling and Compaction
- Restoration

Restoration will be undertaken after the pipeline has been laid. It will include compacting the backfilled material; placing the topsoil stockpiled during the trenching phase as the topmost soil layer; re-contouring the ROW to its original conditions to the extent possible; repairing any natural drainage paths if required; removing any surplus soil, leftover materials, and debris from the site for appropriate disposal.

**Phase-III: Commissioning Phase**

This phase includes following operations

- Pneumatic & purging
- Testing and commissioning which involve leakage tests, detailed pipeline inspection

**Phase-VI: Operation Phase**

This phase includes supply of gas, monitoring, and maintenance of distribution network.
6.4 Potential Impact and Mitigation Measures – Physical and Biological Environment

The possible environmental impacts of the proposed project of rehabilitation of Gas distribution network in Karachi, interior Sindh and Quetta, Balochistan are discussed in this section along with identification of suitable mitigation measures to redress them appropriately.

The pipeline design has been carried out according to international code which provides guidelines for safety factors and selection of equipment and materials for a safe installation.

The buried natural gas pipeline does not pose a serious threat to its surroundings during normal operations. During the operational phase, the principal threat to the environment is from leaks, which may have a number of causes. Although a “zero percent loss” at the time of installation can be assumed, leaks can arise from damage caused by external factors.

6.4.1 Planning Phase

Potential Impacts

Selection of a particular network for rehabilitation would be an important aspect. Only those pipelines need to be replaced which are in dilapidated condition and are causing gas leakages resulting in loss of a potential natural resource. Selection of the type of pipeline material is another important aspect of the entire project of rehabilitation distribution network. Appropriate type of pipeline needs to be selected for the replace of the dilapidated pipes to avoid similar circumstances in future. Better processes of welding and laying of pipelines need to be selected to prevent risk of gas leakages and to maintain the integrity of the infrastructure.

Mitigation Measure

Criteria for selection of network for rehabilitation would be based on historical leak records; leak survey report; condition survey of pipeline through bell hole; coating condition; and CP status. The sites/schemes for rehabilitation would be selected after thorough investigations.

Preferably, the polyethylene (PE) pipelines would be used for rehabilitation work. However, in case of constraints and limits steel pipelines would be used. Use of cast iron pipelines would be totally avoided. The procedures selected for welding and laying of pipelines would be most appropriate and in consistent with the material of the pipeline.

6.4.2 Pre-Construction and Construction Phase

Potential Impacts

Most of the potential environmental impacts of the pipeline are related to the construction phase of the project. However, these have been appreciably mitigated by routing along the existing ROW of the pipeline. Construction activities include surveying, ROW clearing, pipe line
stringing, bending, line welding, coating and wrapping, ditching, laying, back filling, installation of Cathodic Protection for corrosion control, testing, restoration and cleanup.

Short term environmental impact can arise from excavation and backfilling operations during the pipeline construction activities. The likely impacts of these activities include increased risk of land slippage/collapsing of trench and alteration of soil quality by loss of top soil. The loss of top soil during the trenching operation can potentially affect the soil productivity.

Construction activities that use plant and machinery and those employ workers in temporary camps, in general, may cause some pollution/hazard including ground and surface water pollution. Since the pipeline will be laid at a depth of 1.5 m and the water table in the project area is generally more than 3 m below the surface, therefore, no direct impact on groundwater quality is anticipated.

Emissions during construction works will include:

- Emissions from generators/compressors.
- Dust emissions from vehicular traffic on roads.
- Dust emissions from earthworks along the ROW and other construction sites.
- Exhaust fumes from vehicles and construction machinery.
- Emission of gas in case of leakage or purging.

The emission of pollutants during construction has no serious threat to the air quality because of the emission rate is very slow.

Along the proposed rehabilitation pipeline route more than 90% of the area falls in urban category and there is no natural vegetation present in the project area. A few numbers of trees are present in the road median and they are not on the Right of Way of the designated corridor; therefore, construction activities will not affect these trees.

Under the existing environmental setting of the project area no significant impact on wildlife is expected nor is any serious wildlife issue anticipated. No animal dens or nests of breeding birds are located along the ROW. The potential impacts to wildlife may include falling of animals in the open trenches or injury by vehicular/machinery movement.

The construction phase of the project is a short-term activity, and the level of disturbance will go down during the operational phase.

**Mitigation Measures**

The following mitigation and preventive measures will be adopted to minimize the intensity of the above mentioned impacts:

- Barriers, guard rails and reflective tape would be used to prevent risk of falling/slippage into the excavated trench.
• Warning signs will be placed at appropriate locations.

• The area covered by the project activities will be kept to a minimum by daily backfill of the excavated material.

• The size of the cleared area will be minimized, consistent with health and safety considerations.

• Fuel, oils, and other hazardous substances will be handled and stored according to vendor’s specifications and Material Safety Data Sheet.

• Fuel, oils and chemicals storage area will be bonded and lined with impervious material for prevention of seepage of any spilled material into the ground. The area would be checked daily for signs of any leakage.

• Smoking would not be allowed in the entire work site and in the vehicles. Information signs will be placed at appropriate locations.

• Fire extinguishers will be available at the rehabilitation work site.

• In case water is encountered in the trench, it would be safely disposed of using mechanically pumped into the nearby sewerage system or water channel.

• Welding and hot work will be done by only by authorized, competent person using identified personal protective equipment.

• All vehicles engaged in the rehabilitation work would be inspected and maintained regularly and proper records will be maintained. Leaking vehicles will not be operated unless repaired. Vehicles non-complying with NEQS in emissions and noise levels or found leaking oil would not be engaged in work unless fully repaired.

• All machinery including pumps, cutters, welding plant, generators, compressors, etc. would be inspected and maintained regularly and proper record would be maintained. Any machinery or equipment found either leaking oil/fuel or emitting noise higher than recommended levels would be rendered unfit for job until repaired.

• The re-fuelling of vehicles and machinery will be scheduled in a manner to minimize traveling and probability of spills during refilling. The schedule will be based on quantum of work and usage of a particular vehicle and machinery.

• Risk of spillage will be avoided during fuel and oil transfer operations by using appropriate arrangements including use of drip pans and impervious linings.

• Waste bins will be placed at the work site for collection of garbage, construction waste such as wrappers, packing materials, shopping bags, paper, cans, bottles, food stuff or any other kind of litter or debris.

• Materials suitable for recycling will be stored separately and sold to approved recycling contractors

• Heavy construction machinery will be kept off the waterfront to the extent possible
The excavation will be carried out in such a manner that the natural drainage would not be disturbed. Damage, if any, will be repaired.

Any water used in the construction work would be disposed off in water body after meeting the permissible standard limits given by Pakistan Environmental Protection Agency (PEPA 1997).

The dust emission from the vehicular and machinery movement is very less as compared to urban terrain and NEQS compliance monitoring will be done quarterly. Though none of the impacts on air quality are expected to be in excess of the safe limits, adopting the following measures will further reduce such effects:

- Only vehicles that are properly tuned and which do not emit abnormal exhausts will be used.
- Vehicular congestion will be minimized through management of peak work in off traffic hours thus creating less difficulty for the public.
- All equipment, generators and vehicles used during the project will be properly tuned and maintained in good working condition, in order to minimize the exhaust emissions and periodic checking of exhaust.
- Watchmen are hired and the patrolling is done for pipeline Leak detection or occurrence of any damage or emergency (details given in EMP)

Though no significant impacts are anticipated on the wildlife or biodiversity, however, following measures will be adopted to further minimize any potential impacts during the construction of the proposed project:

- Efforts will be made to increase the site crew’s general awareness regarding the area’s fauna through training, toolbox talks and notice board clippings.
- Falling of trees will be minimized if encountered then re-plantation of same specie will be done after compaction and restoration.
- Wildlife will not be hunted, captured, or trapped. Project personnel will be prohibited from buying wild animals or birds.
- Waste of any kind will not be discharged in the area and leftover food will be disposed of properly.
- Special care will be taken while driving, where there is wildlife, to avoid accidents
- Use of horns will be prohibited near colonies of birds or other wildlife if any.
- Night time construction and vehicular traffic will be avoided as much as possible.
6.5 Potential Impact and Mitigation Measures - Socioeconomic and Cultural Environment

The project’s socioeconomic and cultural impact was assessed based on the analytical understanding gained from the baseline socioeconomic and cultural environment of the area. Social impact assessment and analysis techniques were employed during the field survey and communities were interviewed to identify the potential socioeconomic and cultural impact of the proposed project and the impact of related project activities on the area and its people. The impacts identified were screened and their relevance determined through a review of baseline data and a study of project activities and processes. The effects were analyzed on the basis of positive or negative impacts and their intensity and permanence.

The socioeconomic impact of the project and its mitigation measures are discussed below.

6.5.1 Planning and Construction Phase

6.5.1.1 Land Acquisition & Resettlement

**Impacts**

Issues arising from land acquisition, to be considered, include:

- Agricultural, grazing or otherwise valuable land coming in the ROW.
- Local population/inhabitants living on or near the ROW.
- Temporary land acquisition during construction activity only.
- Buildings and other public infrastructure and utilities corridor coming in the ROW.

**Mitigation Measures**

The work will be limited in the ROW which is government land and designated for public utilities. No loss of private property and/or any agricultural land are foreseen to which damage may be caused. The entire rehabilitation work is authorized through NOCs from relevant agencies.

6.5.1.2 Employment (Hiring of Labour)

**Impact**

The proposed pipeline construction is not likely to create significant long-lasting job opportunities. Unskilled and semi-skilled employment opportunities that are likely to be created will be for a short period. As persons with relevant skills are not typically available locally, people from outside the project area may fill most of the semi-skilled jobs, which means that few employment opportunities will be available for the local community. Contracts for digging trenches, refilling trenches, and restoring road surfaces are expected to provide work for local contractors for a period of time.
Influx of un-skilled labour for the project from outside the project area can be a disruptive influence.

No significant mitigation measures are needed.

6.5.1.3 Cultural Resources and Religious Centers

Impact

Any cultural resource within or in immediate vicinity of the ROW may be affected by construction activities. Access of local people to any of the cultural resource or religious centre may be affected.

Mitigation Measures

Presence of any significant monuments of cultural importance is not foreseen in the project areas. However, if such monuments are found during the project construction, the following measures would be undertaken:

- The pipeline will not be laid within a distance of 100 m of such sites
- Local leaders and the communities will be communicated accordingly
- Government agencies shall be informed.

6.5.1.4 Archaeological Sites

Impact

Damage may occur to Archaeological site or any structure of historic significance due to construction activities.

Mitigation Measures

No archaeological sites are present within or close to the ROW. Around 90% of the distribution network is passing through the streets in urban and developed areas. However, following mitigation measures will be taken during construction activities to avoid any adverse impacts:

- All potential archaeological sites would be identified during the initial environmental screening of the project area.
- In case any items of archaeological importance are found during excavation or project construction activities, it would be communicated to concerned archaeological Government department.

6.5.1.5 Communities Grievances

Impact

Rehabilitation work disturbs or jeopardizes routine activities of the community since community was not informed about the rehabilitation work.
Community grievances and complaints with respect to the rehabilitation work are not addressed properly.

Community not aware of the system of complaints filing.

**Mitigation Measures**

A framework for addressing community grievances in the context of the project is already in practice at SSGC. The company will address all community grievances in order to avoid conflict between the company and the local communities.

The SSGC authorities maintain a social complaint register at its web site to document all complaints received from local communities. The complaints received are addressed accordingly by the concerned authorities of SSGC to mitigate these concerns.

### 6.6 Risk Assessment Matrix

The risk assessment for the potential aspects of the proposed project activities are mentioned in the Table 6.1.

**Table 6.1: Impact Assessment, Significance, and Mitigation Measure for the project activities**

<table>
<thead>
<tr>
<th>Actions Affecting Environment Resources &amp; Values</th>
<th>Environmental Impact</th>
<th>Recommended Mitigation Measures</th>
<th>Significance of Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Groundwater</td>
<td>Impairment of beneficial water uses</td>
<td>Monitoring of water quality in areas of high water table or deep trenching</td>
<td>X</td>
</tr>
<tr>
<td>2. Air</td>
<td>Impairment of air quality</td>
<td>Timely tuning of generators and emissions monitoring</td>
<td>X</td>
</tr>
<tr>
<td>3. Noise</td>
<td>Environmental Degradation &amp; Health hazard</td>
<td>Engine tuning, noise reduction devices installation, noise level monitoring</td>
<td>X</td>
</tr>
<tr>
<td>4. Impacts on adjacent land users including recreation/tourism</td>
<td>Impairment of land uses</td>
<td>Careful planning &amp; SOP compliance</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Occupational Health &amp; Safety Hazards</td>
<td>Hazards to workers health &amp; safety</td>
<td>Worker rotation and welfare and fatigue monitoring to offset problem</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------------------</td>
<td>----------------------------------</td>
<td>-------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>6. Hazards due to Spills/fires/explosions</td>
<td>Hazards to workers health &amp; safety</td>
<td>Management of safety control</td>
</tr>
<tr>
<td></td>
<td>7. Area sanitation</td>
<td>Sanitation/disease hazards</td>
<td>Disposal of waste materials and debris as per sop.</td>
</tr>
<tr>
<td></td>
<td>8. Hauling routes in/out areas</td>
<td>Traffic congestion and nuisances along routes</td>
<td>Managing work in off peak hours</td>
</tr>
<tr>
<td></td>
<td>9. Dust/odors/fume</td>
<td>Problems of Environmental Degradation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. Noise/vibration hazards</td>
<td>Problems of Environmental Degradation</td>
<td>Training and execution by skilled workers</td>
</tr>
<tr>
<td></td>
<td>11. Trenching hazards</td>
<td>Problems of Environmental Degradation, safety issues</td>
<td>Dewatering at designated point, debris disposal, safety signs, barricade</td>
</tr>
<tr>
<td></td>
<td>12. Machinery &amp; Equipment mobilization</td>
<td>Problems of Environmental Degradation</td>
<td>Careful Planning and Implementation, noise level and emission monitoring</td>
</tr>
<tr>
<td></td>
<td>13. Uncovered cut &amp; fill trenches/areas</td>
<td>Soil erosion &amp; consequent damage to properties &amp; environment</td>
<td>Careful Planning and Implementation, safety signs, barricade</td>
</tr>
<tr>
<td></td>
<td>14. Occupational Health &amp; Safety Programmes including accidents</td>
<td>Hazards to workers health &amp; safety</td>
<td>Careful O&amp;M including readiness for emergency, better awareness level</td>
</tr>
<tr>
<td></td>
<td>15. Uncovered cut &amp; fill trenches/areas</td>
<td>Soil erosion &amp; consequent damage to properties &amp; environment</td>
<td>Careful Planning and Implementation, safety signs, barricade</td>
</tr>
<tr>
<td></td>
<td>16. Removal or damage to vegetative growth</td>
<td>Problem at preparation of site &amp; during operation</td>
<td>Implementation of activities as per EMP, re-plantation</td>
</tr>
</tbody>
</table>
7. Environmental Management Plan (EMP)

7.1 Introduction

This section of ESMF delineates an environmental management plan (EMP) for the proposed project of rehabilitation of distribution network of gas pipeline in Karachi, Interior Sindh and Quetta, Balochistan. The potential impacts and associated risks have been identified in the Section 5 along with the responding appropriate mitigation measures for the construction, commissioning and operation phases of the project. Implementation of the proposed mitigation measures and a monitoring plan for evaluation of corrective measures and residual impacts have been mentioned in this EMP. Mechanism of enforcement of EMP has also been addressed along with the financial estimates and capacity building requirements.

7.2 Purpose and Objectives

The Environmental Management Plan (EMP) will provide a delivery mechanism to address the adverse environmental impacts of the rehabilitation work during its execution and operation, to maximize project benefits and to introduce standards of best practices to be adopted for all phases of the project. The primary objectives of the EMP are to:

- Facilitate the implementation of the earlier identified mitigation measures.
- Develop a proper monitoring mechanism and identify requisite monitoring parameters to confirm effectiveness of the proposed mitigation measures.
- Define the responsibilities of the project proponent and contractors, and provide a means of effectively communicating environmental issues among them.

7.3 Organizational Structure and Job Description

7.3.1 SSGC HSE Department

SSGC, being an environmental conscious organization, is ISO 14000 certified and has already in force an effective environmental management system. A well establish HSE department is in place to implement the EMS and ensure HSE related compliance identified in the SSGC’s Standard Operating Procedures (SOPs) during field operations/activities.

The HSE Manager leads the HSE department which comprises of following persons as per organogram and reports directly to General Manager. An organogram of the HSE department is shown in Figure 7.1.
Figure 7.1: Organogram of HSE Department in SSGC.
7.3.2 Job Description

The environmental and social aspects of the SSGC in general and of development activities and field operations in particular are managed by the HSE Department. The roles and responsibility of the HSE Department personnel are briefly describe in Table 7.1.

Table 1.1: Key Responsibilities of the HSE Department Personnel

<table>
<thead>
<tr>
<th>S.No</th>
<th>Position/Job Title</th>
<th>Responsibilities under the Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chief Engineer (Karachi)</td>
<td>Monitoring and compliance of rehabilitation project as per EMP in Karachi Region.</td>
</tr>
<tr>
<td>2</td>
<td>Deputy Chief Manager (Balochistan)</td>
<td>Monitoring and compliance of rehabilitation project as per EMP in Balochistan Region.</td>
</tr>
<tr>
<td>3</td>
<td>Deputy Chief Engineer Hyderabad</td>
<td>Monitoring and compliance of rehabilitation project as per EMP in Interior Sindh Region.</td>
</tr>
</tbody>
</table>

7.4 Management Approach

SSGC will undertake an overall responsibility for implementation of the EMP and ensuring its compliance in all activities to be undertaken during the proposed project of rehabilitation of distribution network.

SSGC may also engaged Contractor(s) in carrying out the field activities as part of the proposed rehabilitation project. In such case, the contractor besides the liabilities bestowed under the prevailing environmental legislation in the country would also be required to comply with the pertinent provisions of this EMP through exclusive clauses mentioned in the contract document.

The SSGC also obligates that it will,

- ensure that all Contracts it executes with the sub-contractors comply with positive environmental sensibilities.
- cooperate with the concerned regulatory agencies, including the Sindh Environmental Protection Agency, Balochistan Environment Protection Agency, Local Government Department and other Civic Agencies during the project implementation.
7.5 Responsibilities under the Project

7.5.1 HSE Department

The HSE Department of SSGC will be responsible for the overall environmental management and supervisory affairs during the construction, commissioning and operational phases of the proposed Project. It will ensure preparation of Social & Environmental Screening Checklist (Appendix-2 of Annexure-D). In the area where any significant environmental aspect is identified in the Checklist, a more detail assessment would be carried out to identify level of impact and corresponding mitigation measure. Such incidents are expected to be rare.

The prime responsibilities of the HSE department are mentioned below:

- To ensure implementation of all the proposed mitigation measures during and after the proposed Project as proposed in the ESMF.
- To ensure compliance with relevant operational guidelines during project execution.
- To organize routine monitoring of motor vehicle emissions, air quality, noise and vibration etc. In case any the levels are found exceeding the acceptable limits or recommended standards take measures to control the same.
- To maintain an efficient system of receiving complaints, to redress the grievance on priority, and to keep records.
- Make arrangements for the monitoring plans.
- Make arrangement for the financial resources for implementation of the EMP.
- Coordinate with the concerned government departments with respect to environmental issues.
- To ensure that the proposed Project is implemented in an environmentally friendly manner, causing least harm to the existing environment including flora and fauna, sites of religious and cultural significance and minimal disturbance to local community.

7.5.2 Contractor

The Contractor(s) or Sub-contractor(s), if engaged during the project implementation, would be equally responsible for ensuring implementation of EMP at the work site.

The prime responsibilities would be as under:

- Ensure compliance with the applicable provisions of the EMP during project activities as per the clauses mentioned in the Contract Document or Agreement.
- Carryout required monitoring as per the given frequency and submit reports to HSE Department of SSGC as per the agreed schedule.
- Comply with all other legal obligations specified under the prevailing environmental legislation or other laws/regulations being in force.
Maintain a system of receiving and addressing the public grievance and complaints with respect to the project activities.

### 7.5.3 Responsibilities of Rehabilitation Department

- Ensuring construction activities in an environmentally sound manner during the rehabilitation project will be the responsibility of the Field Manager.
- SSGC’s Construction In-charge will be responsible for the overall environmental compliance of all field operations.

### 7.6 Environmental Mitigation Plan

The purpose of the Environmental Mitigation Plan is to minimize the potential environmental impacts due to the proposed project. It reflects the commitment of the proponent to safeguard the physical, ecological and socio-economic environment at the area of influence of the project activities. The mitigation plan is a key component of the EMP. It lists all the potential effects of each of the project activities and their associated mitigation measures identified during the environmental and social assessment stage of the project. For each project activity the following information is presented:

- Associated potential impacts
- Identified mitigation measures
- The persons responsible for ensuring the full implementation of the action
- The person responsible for monitoring the action
- The timing of the implementation of the action to ensure that the objectives of mitigation are fully met.

The mitigation plan for Planning, Pre-construction, construction, commissioning, and operational stages of the proposed distribution network rehabilitation project is presented in Table 7.2.

The Social and Environmental Checklist to be prepared at the initial stage of the project, after the areas for rehabilitation are identified, would be a tool for identification of relevant and significant environmental aspects at a particular site. Preparation of the checklist is thus a pre-requisite for preparation of an effective EMP and its implementation.
### Table 1.2: Environmental Mitigation Plan

<table>
<thead>
<tr>
<th>Activities/ Aspects</th>
<th>Potential Impact</th>
<th>Mitigation Measures</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Planning Stage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Quality and characteristic of pipeline material | • Leakages due to corrosion, decay and breaking would result in release of gas into the atmosphere contributing to GHG Emissions and causing loss of natural resource (UFG) | • Use of polyethylene (PE) pipeline on priority basis.  
• Use of steel pipeline where PE may not be used technically or due to financial constraints. | Rehabilitation Department, SSGC  
Rehab/HSE Department, SSGC |
| Welding of joints | • Breaking of joints, leakages would result in release of gas into the atmosphere contributing to GHG Emissions and causing loss of natural resource (UFG) | • Use of electric fusion welding procedure/technique in PE & Arc Welding for steel pipe | Rehabilitation Department, SSGC  
Rehab/HSE Department, SSGC |
| **Pre-Construction Phase** |                  |                     |                            |
| Trees/Plantation in ROW or Construction zone | • Cutting of trees.  
• Loss of vegetation/plantation. | • Planning for relocation of large/grown up trees.  
• Re-plantation of new trees after completion of construction work. | Rehabilitation In Charge, HSE Department  
Rehab/HSE Department, SSGC & Contractor |
| Presence of utilities in the construction zone/ROW | • Damage to existing utilities from construction related activities.  
• Disturbance to public due to interruption or break down of the utilities. | • All utilities in the ROW and construction zone would be identified in pre-construction phase and relevant department/agencies contacted for their relocation or protection during construction period.  
• NOC would be obtain from other departments/agencies (custodian of utilities) prior to commencement of construction work. | Planning/Rehabilitation Department, SSGC  
Rehabilitation Department, SSGC |
<table>
<thead>
<tr>
<th>Activities/ Aspects</th>
<th>Potential Impact</th>
<th>Mitigation Measures</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degradation of ambient air quality.</td>
<td>• Emissions from generators at construction sites.</td>
<td>• The campsites will be selected at least 200 m away from any settlements.</td>
<td>Rehabilitation In Charge, HSE Department, Rehab/HSE Department, SSGC &amp; Contractor</td>
</tr>
<tr>
<td></td>
<td>• Exhaust fumes from vehicles and construction machinery</td>
<td>• All equipment, generators and vehicles used during the project will be properly tuned and maintained in good working condition, in order to minimize the exhaust emissions.</td>
<td>Do</td>
</tr>
<tr>
<td></td>
<td>• Dust emissions from earthworks along the ROW and other construction sites</td>
<td>• Dust emissions at the construction sites will be minimized by implementing good housekeeping and sound management practices. • At very critical places, construction work would be carried out rapidly.</td>
<td>Do</td>
</tr>
<tr>
<td></td>
<td>• Dust emissions from vehicular traffic on roads</td>
<td>• Dust emissions due to the vehicular traffic will be minimized by reduced speed. • Vehicular traffic will be minimized through good journey management. Water will be sprinkled where necessary.</td>
<td>Do</td>
</tr>
<tr>
<td></td>
<td>• Damage to utilities or property of local population from construction related work or any accident.</td>
<td>• Any property damaged by the rehabilitation activities will be fully compensated.</td>
<td>Do</td>
</tr>
<tr>
<td></td>
<td>• Community was not aware of the rehabilitation work, its schedule and potential adverse impacts, if any.</td>
<td>• Rehabilitation work and schedules will be announced effectively locally by means of street banners, notifications at mosques, in local newspapers, or</td>
<td>Do</td>
</tr>
<tr>
<td>Activities/ Aspects</td>
<td>Potential Impact</td>
<td>Mitigation Measures</td>
<td>Institutional Responsibility</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>otherwise to ensure the proper prior notice to the population.</td>
<td></td>
</tr>
<tr>
<td>Community cannot communicate with the SSGC for sharing their grievance and register complaints.</td>
<td></td>
<td>• Continuous liaison will be maintained with the affected community and their concerns will be addressed appropriately.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Complaint registration system already in place in SSGC.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Complaint register for the rehabilitation sites/schemes under the project will be maintained separately.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td>Safety hazards for the local population.</td>
<td></td>
<td>• The construction area will be cordoned off and no irrelevant personnel will be allowed inside.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The construction machinery will not be left un-attended.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• The trench will not be left open for extended period.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No trespassing would be allowed.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Proper signs will be placed for warning, information and awareness.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td>Right of community is hindered.</td>
<td></td>
<td>• The construction activities will not block the existing roads and tracks.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If unavoidable, alternate routes would be provided in consultation with the affected people/concerned department.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td>Adverse impact on health due to degradation in ambient air quality.</td>
<td></td>
<td>• Work would be scheduled for implementation in shortest possible</td>
<td>Rehabilitation, Rehab/HSE</td>
</tr>
</tbody>
</table>

December 2010
<table>
<thead>
<tr>
<th>Activities/ Aspects</th>
<th>Potential Impact</th>
<th>Mitigation Measures</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dust emission will be minimized by sprinkling of water, where feasible.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ambient air quality will be monitored for evaluation of emission levels.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Impacts on historical and cultural features.</td>
<td>• Construction work would not be carried out on, or within a distance of 200 ft of, a protected antiquity or a place of archaeological, historical, cultural and religious significance.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• If any artifacts are discovered during the excavation, the relevant authorities (Department of Archaeology and Museums, Government of Pakistan, Karachi, and its subordinate departments, Southern Circle of Archaeology).</td>
<td>Rehabilitation</td>
</tr>
</tbody>
</table>

**Commissioning Phase**

<table>
<thead>
<tr>
<th>Activities/ Aspects</th>
<th>Potential Impact</th>
<th>Mitigation Measures</th>
<th>Institutional Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bursting of pipeline due to over pressurizing</td>
<td>• May cause fire.</td>
<td>• Compliance of standard operating procedures during operation</td>
<td>Distribution</td>
</tr>
<tr>
<td></td>
<td>• Damage nearby utilities and infrastructure.</td>
<td></td>
<td>Distribution/ HSE</td>
</tr>
<tr>
<td></td>
<td>• Potential threat to community.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Create panic in community.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purging of pipeline</td>
<td>• Release of methane emission into the atmosphere.</td>
<td>• Purging is done with air and away from population.</td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td>• Contribution to GHG emissions.</td>
<td></td>
<td>Rehabilitation</td>
</tr>
<tr>
<td></td>
<td>• Disturbance to community.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Health hazard.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activities/ Aspects</td>
<td>Potential Impact</td>
<td>Mitigation Measures</td>
<td>Institutional Responsibility</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------</td>
<td>---------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td><strong>Operation Phase</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Gas leakages from pipeline due to corrosion or poor workmanship. | • Degradation of soil/land and/or water quality. | • Minimum soil cover depth of buried sections of pipeline shall be of one meter.  
• Provision of Cathodic protection system and coating of pipeline with three layers of polyethylene coating for protection against corrosion. | Rehabilitation/CP  
Rehabilitation/CP |
| Patrolling on ROW. | • Degradation of ambient air quality due to dust emissions caused by patrolling vehicles. | • Vehicle speed near settlements will be reduced to 25 km/hr to minimize the dust emissions. | 
| Socioeconomic issues due to release of gas from pipeline. | • A potential hazard to the community, utilities, and other infrastructure.  
• Safety of population would be at risk. | • Regular patrolling by SSGC staff in ROW.  
• A system of receiving complaints form public is available with an efficient system of redressing the same.  
• Emergency response system is place. | 
| Damage of distribution pipeline due to:  
• Explosion at distribution pipeline.  
• Corrosion  
• Third party action  
• Heavy rains and floods. | • May cause fire.  
• Damage nearby utilities and infrastructure.  
• Leakages of gas may cause damage to soil and pollute ambient air.  
• Contribution to GHG emissions.  
• Potential threat to community.  
• Create panic in community. | • Careful selection of pipeline material and welding/laying procedure during planning.  
• Regular inspection of the ROW.  
• System of receiving complaints in place. | Planning/Rehab  
Rehab/Distribution |
### 7.7 Environmental Monitoring Plan

Environmental Monitoring would be undertaken during the construction, commissioning and operational phases to ensure the effectiveness of the proposed mitigation measures. In order to respond to unanticipated environmental concerns at an early stage and to determine the accuracy of impact, predictions are also required. Specific monitoring programs are outlined below along with the responsibilities for the collection and analysis of data and the reporting requirements.

The basic purpose of the environmental monitoring plan is:

- To evaluate the effectiveness of mitigation measures.
- To respond to the unanticipated environmental impacts when the Project is under implementation.
- To make necessary modification in the EMP to improve the management and environmental controls based on the monitoring data.

An Environmental Monitoring Plan is provided below in Table 7.3. The plan will be used as a management and monitoring tool for the implementation of the mitigation measures.
Table 1.3: Environmental Monitoring Plan

<table>
<thead>
<tr>
<th>Environmental Component</th>
<th>Project Stages</th>
<th>Parameters</th>
<th>Duration and Number of Samples</th>
<th>Number of Monitoring Sites</th>
<th>Standards</th>
<th>Implementation / Supervision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Air Quality</td>
<td>Construction</td>
<td>PM$<em>{10}$, PM$</em>{2.5}$</td>
<td>3 samples / each for 8 hours continuous</td>
<td>As a minimum of 3 schemes in Karachi Region, 5 in Interior of Sindh, and 2 in Quetta Region (Quarterly basis)</td>
<td>WHO/USEPA Guidelines,</td>
<td>HSE Department-SSGC / Contractor</td>
</tr>
<tr>
<td>Air Emissions - Equipment</td>
<td>Construction &amp; Commissioning</td>
<td>SO$_2$, NO$_x$, CO/CO$<em>2$, Hydrocarbon (HC), Ozone, PM$</em>{10}$</td>
<td>5 samples for each source</td>
<td>As a minimum of 5 schemes per month in each of the 3 regions. (Quarterly basis)</td>
<td>WHO/USEPA guidelines, NEQS</td>
<td>HSE Department-SSGC</td>
</tr>
<tr>
<td>Air Emissions – Vehicular Exhaust</td>
<td>Construction &amp; Commissioning</td>
<td>CO/CO$<em>2$, Smoke, Hydrocarbon (HC), Ozone, PM$</em>{10}$</td>
<td>3 samples for each source</td>
<td>As a minimum of 10 Vehicles per quarter in each of the 3 regions.</td>
<td>WHO/USEPA guidelines, NEQS</td>
<td>HSE Department-SSGC &amp; Contractor</td>
</tr>
<tr>
<td>Noise Levels - Ambient</td>
<td>Construction</td>
<td>dBA</td>
<td>Twice in 8 hours at selected sites at 1 m, 7.5 m, 15 m, and 50 m from the right-of-way</td>
<td>As a minimum of 5 schemes per month in each of the 3 regions.</td>
<td>EPA Ambient Noise Standards, OSHA 18001 : 2007 Standards</td>
<td>HSE Department-SSGC</td>
</tr>
<tr>
<td>Environmental Component</td>
<td>Project Stages</td>
<td>Parameters</td>
<td>Duration and Number of Samples</td>
<td>Number of Monitoring Sites</td>
<td>Standards</td>
<td>Implementation / Supervision</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------</td>
<td>------------</td>
<td>--------------------------------</td>
<td>---------------------------</td>
<td>-----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Noise Levels - Vehicles</td>
<td>Construction &amp; Commissioning</td>
<td>dBA</td>
<td>3 samples at 7.5 m from the source</td>
<td>As a minimum of 10 Vehicles per quarter in each of the 3 regions.</td>
<td>EPA Noise Standards</td>
<td>HSE Department-SSGC &amp; Contractor</td>
</tr>
<tr>
<td>Plantation in Construction zone</td>
<td>Pre-Construction</td>
<td>Visual inspection of plant species to be removed</td>
<td>Once</td>
<td>At each site</td>
<td></td>
<td>Rehabilitation/HSE Department-SSGC</td>
</tr>
<tr>
<td></td>
<td>Operation</td>
<td>Visual inspection of replanted species survival rate and status of maintenance</td>
<td>Once</td>
<td>At each site</td>
<td>75% survival rate</td>
<td>Rehabilitation/HSE Department-SSGC</td>
</tr>
</tbody>
</table>
7.8 Emergency Response System

SSGC has established emergency response centres (ERCs) to tackle the emergencies. For this purpose the emergency centres (1199) are established in Karachi, interior Sindh and Balochistan. These centres are equipped with Gas Leak / Fire fighting, light and heavy equipment. In case of leakage in the pipeline, the gas leakage plan is made by SSGC, which gives measures and responsibilities to detect and repair leakages.

Potential risks that may be encountered during construction and operation phases of the rehabilitation work and response measures are mentioned below.

7.8.1 Common Risks

During construction activities no major incident has been forecasted in context with the type and extent of work. The construction activities would be carried out by qualified personnel/contractors. Some common incidents that most likely may occur due to negligence or lack of safety precautions would include:

- Electric shock
- Falling objects
- Incident from moving machinery
- Minor injury cases such as minor cut, bruises, strain etc
- Collapsing of an excavated trench
- Equipment failure
- Serious medical illness / fracture, requiring medical evacuation
- Traffic accidents

7.8.2 Risk Reduction Measures

The purpose of Emergency Response Procedure (ERP) is to provide direction and guidance to worker engaged by SSGC or Contractor so as to enable them to effectively manage all emergencies resulting from internal or external sources during the construction activities being carried out.

In order to prevent and reduce the likelihood of any incident or accident following measures would be adopted:

- Use of appropriate Personal Protection Equipment during various construction related activities e.g. helmet, coverall, safety shoes, gloves, goggles, mask, body harness, etc.
- Use of properly trained drivers and operators for heavy mechanical equipment/machinery.
- Provision of necessary firefighting equipment at the construction site, including appropriate type of fire extinguisher, fire blanket, remote fire hydrant system etc.
Availability of well trained and experienced fire fighting and first-aid staff during the entire construction activity.

Availability of first aid boxes with items as listed in Table 7.4.

Table 1.4: First Aid box contents list for construction sites

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bandage 2&quot;, 3&quot;, 4&quot; &amp; 6&quot;</td>
<td>01doz Each</td>
</tr>
<tr>
<td>2</td>
<td>Triangular Bandage</td>
<td>04 Nos.</td>
</tr>
<tr>
<td>3</td>
<td>Tweezer</td>
<td>01 No.</td>
</tr>
<tr>
<td>4</td>
<td>Wooden Splint (Arm &amp; Leg)Sam</td>
<td>02 Each</td>
</tr>
<tr>
<td>5</td>
<td>Clinical Thermometer</td>
<td>01 No.</td>
</tr>
<tr>
<td>6</td>
<td>Pyodine Solution</td>
<td>50 Ml 01 Btls</td>
</tr>
<tr>
<td>7</td>
<td>Tablets Panadol</td>
<td>30 Nos.</td>
</tr>
<tr>
<td>8</td>
<td>Tab Dispirin</td>
<td>30 Nos</td>
</tr>
<tr>
<td>9</td>
<td>Tablets Gelusils</td>
<td>30 Nos.</td>
</tr>
<tr>
<td>10</td>
<td>Uzit</td>
<td>01 Btl</td>
</tr>
<tr>
<td>11</td>
<td>Sani Plast</td>
<td>50 Strips</td>
</tr>
<tr>
<td>12</td>
<td>Oral Rehydration Salts (Ors)</td>
<td>06 Pkts</td>
</tr>
<tr>
<td>13</td>
<td>Burnol</td>
<td>02 Tube</td>
</tr>
<tr>
<td>14</td>
<td>Sterile Gauze 4 X 4</td>
<td>04 Packs</td>
</tr>
<tr>
<td>15</td>
<td>Adhesive Paper Tape</td>
<td>01 Roll</td>
</tr>
<tr>
<td>16</td>
<td>Scissor Stainless Steel</td>
<td>01 No.</td>
</tr>
<tr>
<td>17</td>
<td>Eye Wash Bottle</td>
<td>01 No.</td>
</tr>
<tr>
<td>18</td>
<td>Water-Jel Burn Dressing/Blanket Kit</td>
<td>02 Nos.</td>
</tr>
<tr>
<td>19</td>
<td>Snake Bite Kit</td>
<td>01 No.</td>
</tr>
<tr>
<td>20</td>
<td>Crape Bandages 4&quot; &amp; 6&quot;</td>
<td>01 Each</td>
</tr>
<tr>
<td>21</td>
<td>Mosquito Repellent</td>
<td>02 Each</td>
</tr>
<tr>
<td>22</td>
<td>Instant Ice Pack</td>
<td>02 Nos.</td>
</tr>
<tr>
<td>23</td>
<td>Latex Gloves</td>
<td>01 Pair</td>
</tr>
</tbody>
</table>

7.8.3 Steps during Injury to Worker

In case any worker encounters any incident or accident during construction work at site of rehabilitation of distribution network following steps should be taken:

- Evaluate the health of injured personnel.
- Attempt to rescue by providing appropriate first aid.
- Accompany the patient or victim from site to nearby medical facility in case of serious incident.

7.8.4 Steps to Encounter Emergency Situation

The risk-factor or emergencies associated with the operation of distribution network would be:

- Explosion at distribution pipeline.
- Gas leakage at the distribution pipelines
• Damage to the distribution pipeline as a result of heavy rains and floods.
• Damage to the pipeline due to corrosion
• Third party damage to distribution pipeline.

The effects of accidents/incidents can be mitigated by contingency provisions to contain and deal promptly with such occurrences. The focus of these plans would be to:

• Safeguard company employees and general public within the facility or within the surrounding area.
• Protect company’s installations and property and minimize the effects of emergency at site and upon other surrounding facilities and properties.
• Provide competency based training to all employees to ensure high-level preparedness at all times

For details refer to the HSE-P-07 of SSGC on Emergency Response Plan available as HSE Management System Procedures, Volume-III.

7.9 Capacity Development

To support timely and effective implementation of environmental management plan and recommended mitigation measures it is imperative to carry out capacity development of the relevant departments of SSGC. As capacity development initiatives would focus on providing trainings, developing awareness manuals & guidelines, and ensuring availability of physical resources. In these areas following initiatives need to be undertaken for capacity development:

7.9.1 Training

The training sessions that are to be carried out to strengthen environmental management capability during project implementation and monitoring are described in Table 7.5. HSE Department of SSGC is responsible for development of training materials and implementation of trainings sessions as per the given schedule.

The trainings should be carried out preferably using internal resources of SSGC; however, where adequate resources are not available, services of professional training institutes and consultants may be acquired.

Table 7.5: Training Sessions and their Schedule

<table>
<thead>
<tr>
<th>Training Session</th>
<th>Learning Objectives</th>
<th>Target Group</th>
<th>Training Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General Environmental Awareness</td>
<td>Understanding of environmental issues, legal obligations, environmental assessment, monitoring and</td>
<td>a, b, c</td>
<td>Within first month of commencement of the project</td>
</tr>
<tr>
<td></td>
<td>Environmental and Social Management Framework</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SSGC Natural Gas Efficiency Project</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>December 2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Environmental Management Plan (EMP)

- Understanding of implementation requirements and roles and responsibilities
- Within first week of commencement of the project

3. Environmental & Occupational Health (EOH)

- Understanding occupational health and associated risks, principles of job safety, health impacts of unsafe practices.
- Within first month of commencement of the project.
- Repeated at least once a year for field team.
- As and when new contractor is engaged.

4. Environmental Monitoring and Reporting

- Understanding of legal requirements, roles and responsibilities, sampling, monitoring, analysis, reporting and record keeping.
- Within two month of the commencement of the project.
- Repeated at least once a year.

Target Group:

- a. Top Level Management
- b. HSE Department Team
- c. Rehabilitation / Construction Work Team
- d. Other Relevant Department (managers, deputy managers, persons in charge of Planning Department, Field Operations, Maintenance, Inspections & Surveys)
- e. Contractor’s Staff

7.9.2 Awareness Material

Responding to the aspect of lack of awareness, EMP requires preparation of awareness material and guidelines. It is the responsibility of the HSE Department to prepare the following:

- Material for awareness on relevant environmental and occupational health issues for field team and contractor’s staff.
- Brief guidelines on HSE aspects of the construction work including monitoring and waste handling and safe disposal. This would also include the usage of protective equipment and responding in emergency situations.
- Posters and display sign for awareness on safe practices to be posted at construction sites.

7.9.3 Physical Resources

EMP and monitoring activities, besides trainings, would require physical resources for effective implementation and execution. It is the responsibility of SSGC to make available the following resources:

- Sampling and monitoring equipment.
- Personal protection equipment.
- First aid boxes
- Firefighting equipment.

7.10 Evaluation of EMP

Evaluation of EMP implementation is necessary for effective enforcement and positive outcomes. Environmental Audits and Hazards & Risks Assessments are necessary tools for evaluation of effectiveness of the EMP and its implementation mechanism and will be utilized in accordance with relevant legislation and regulation.

- **Environmental Audit** is an instrument to determine the nature and extent of all environmental concern of an activity, process, or a facility. The audit identifies and justifies effectiveness of a mitigation measure to address an environmental aspect.

- **Hazard Assessment** is an instrument for identifying, analyzing, and controlling hazards associated with the presence of dangerous materials and conditions at a project site.

- **Risk Assessment** is an instrument for estimating the probability of harm occurring from the presence of dangerous conditions or materials at a project site. Risk represents the likelihood and significance of a potential hazard being realized; therefore, a hazard assessment often precedes a risk assessment, or the two are conducted as one exercise. Risk assessment is a flexible method of analysis, a systematic approach to organizing and analyzing scientific information about potentially hazardous activities or about substances that might pose risks under specified conditions.

7.11 EMP Implementation Budget

Since the project has minimal environmental and social impact and the project only consists of current Company activities on a larger scale, the extra costs relating to environmental and social aspects are relatively small and related to any necessary capacity expansion of the HSE department as well as training of SSGC’s management and staff, and of subcontractors. SSGC has set aside a self-financed budget relating to the EMP implementation of US$ _____ per year.
8. Conclusions

Screening of potential environmental and social impacts at the different stages viz. siting, construction, installation of machinery and equipment and operation, leads to the conclusion that environmental and social impacts of the proposed Natural Gas Efficiency Project are insignificant or of short term, or minor and of local consequence. Implementation of recommended mitigation measures through the environmental management plan will minimize any short-term impacts.

The proposed rehabilitation project would have no significant impact on the micro-and macro-environment of the corridor of impact of the pipeline routes which consist of SSGC’s existing routes. The proposed rehabilitation project when commissioned would become an integral part of the SSGC distribution network.

SSSGC has a comprehensive Health, Safety and Environmental Management System which comprises a set of different operational procedures. A strict compliance to these procedures and other applicable guidelines would surely minimize the potential of any environmental hazard during various field operations and activities from construction to operations phase.
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Annexures (separate file)

Annexure-A
Copy of ISO 14001:2004 Certificate of SSGC
Copy of OHSAS 18001:2007 Certificate of SSGC

Annexure-B
Appendix–1: OHS&E Risk Assessment (HSE–P 01)
Appendix–2: Identification of HSE Legal and other Requirements (HSE–P 02)
Appendix–3: Consultation and Communication (HSE–P 03)
Appendix–4: Management of Change (HSE–P 04) Error! Bookmark not defined.
Appendix–5: Permit to Work (HSE–P 05)
Appendix–6: Supplier & Contractor Management (HSE–P 06)
Appendix-8: Procedure for Monitoring and Measurement (HSE–P 09)
Appendix 9: HSE Incident/Accident Reporting (HSE–P 11)
Appendix-10: Complaint Resolution Procedure (SOP-08)
Appendix-11: Replacement of Old Corroded and Leaky Distribution Gas Pipeline (SOP-22)
Annexure-C – Description of Rehabilitation Schemes
Annexure-D
Appendix-1: Community Survey Questionnaire
Appendix-2: Social and Environmental Screening Checklist