SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

FOR THE

PROPOSED FAUJI KABIRWALA POWER PROJECT

IN

PAKISTAN

April 1995

A. INTRODUCTION

1. The demand for power in Pakistan has increased rapidly over the past two decades, leading to severe peak period shortages. The Government of Pakistan has accordingly encouraged private sector participation in power generation, and has received a positive response from local and foreign entrepreneurs. Power generation plants in the private sector would supply electricity through the transmission and distribution network of the Water and Power Development Authority (WAPDA) and Karachi Electric Supply Corporation. The present Project proposal is by Fauji Kabirwala Power Company (the Company), a Pakistan public limited company, which has sponsors based in Pakistan and the United States. The proposed combined cycle power Plant will have a net capacity of 144 megawatts (MW). The Company has requested the Bank to provide loan and equity investment, as well as to arrange commercial cofinancing.

2. The environmental impact assessment (EIA) of the Project was prepared by the National Engineering Services Pakistan (Pvt.) Ltd. This summary EIA presents the important data, findings, and recommendations of the EIA. The main report is available from the Bank. The EIA involved an analysis of the emissions, effluent, and noise caused by the plant, and evaluated impacts on flora and fauna, land use, and socioeconomic aspects around the Project site. The Bank's environment specialist visited the Project site on 4 April 1995 to verify the EIA report and discuss with the Project proponents the necessary mitigation/monitoring measures. The EIA has been submitted to the Punjab Province Environmental Protection Agency (EPA), and their clearance is expected shortly. The Provincial EPA clearance is given after ascertaining public reaction to the Project.

B. Project Description

3. In August 1984, gas with low British thermal unit (BTU) values was discovered at Nandpur, District Khanewal, by the Oil and Gas Development Corporation. This gas has low methane and high nitrogen content, and the only economic use of the gas is for power generation. Based on this resource, a feasibility report for a 100-MW combined cycle power plant was prepared in June 1987. In mid-1994, the net output rating of the proposed plant was increased to 144 MW, based on a blend of low BTU gas from the Oil and Gas Development Corporation and pipeline quality gas from Sui Northern Gas Pipelines Limited (SNGPL). The site is near the village of Chuprata along the Multan-Sargodha highway, 15 kilometers (km) from the town of Kabirwala. The plant will consist of (i) two gas turbine generators of 50.5 MW each, (ii) two heat recovery steam generators and ancillary equipment, and (iii) one steam turbine generator of 59.4-MW rating. The proposed site was selected based on (i) its proximity to the low BTU gas source, (ii) the availability of canal and ground water, (iii) its proximity to the Multan-Sargodha highway, (iv) its proximity to the WAPDA 132-kilovolt (kV) transmission line, (v) its proximity to the SNGPL transmission system, and (vi) the compatibility of the terrain, meteorological conditions, and land use for the location of a power plant.

4. The water source for cooling the plant (by a closed cycle system) is ground water, the water table ranging from four to eight meters below ground level. The water abstraction rate is estimated at three cubic feet per second (ft^3/sec), which will not significantly affect the static level of ground water. If necessary in the future, the Sidhnai Canal may be used as a source of water for a once-through open cycle cooling system, using 135 ft^3/sec at maximum plant capacity. Because this level of water flow through the open cycle cooling system will be high,

there will only be a nominal rise in the water temperature. Thus, subsequent irrigation use of the water will not be affected, especially given the significant waterflow in the Sidhnai Canal, which averages 2000 ft^3/sec.

5. The power plant will be connected to the WAPDA transmission and distribution network by a 132-KV connecting line to be constructed by WAPDA, to the existing 132-KV transmission line, which is 2 km from the site.

C. Existing Environmental Conditions

1. Physical Environment

6. The site measuring 10.7 hectares has been acquired from private landowners, who have voluntarily sold the land. The site is on a flat plain, 183 meters above sea level. The soil substrata consists mainly of brown, firm, clayey silt/silty clay, with slight to medium plasticity, low to medium dry strength, small and occasional concretions, sometimes with alternate layers of nonplastic silt. Geomorphologically, the site is part of a flood plain, with deposits of sand, silt, and clay. These deposits are generally alluvial in nature. The alluvial deposit is more than a thousand feet thick, and the underlying rocks have no influence on soil formation. The soils lack a definite Kankar zone, and humification has taken place down to about one meter. The substructure soils are massive and in a stratified pattern. Although the site is in the flood plain of the Ravi River, which flows from the northeast and joins the Chenab River in the southwest, the site is at a high level, with no recorded incidence of flood in the last 50 years. A site location map and layout plan is provided in Appendix 1.

7. The climate at the site is semiarid, of subtropical continental type. Summers are extremely hot and long, and winters are severe but short. The closest meteorological observatory is at Multan, 60 km from the site. The maximum temperature at Multan in recent years was 48.5^{o}C in June 1991, and the minimum was -1.1 ^{o}C in February 1984. Frost occurs intermittently during December to February. The relative humidity at Multan is lowest during May and June (15-30 percent), and increases during the monsoons in July and August. It is highest in December and January (86-90 percent). The site lies in an annual rainfall zone of 62 millimeters (mm) to 205 mm. The highest recently recorded rainfall at Multan was 204.7 mm in 1983. The maximum precipitation occurs during July and August, while October to January is relatively dry. Hail storms occur occasionally during spring, the hailstones ranging from 6.35 mm to 25.4 mm in diameter. The normal wind velocity is 3.5 to 5.2 km per hour. Windstorms are frequent during March to August, and their direction is generally from west to south or from north to east. Meteorological data is presented in Appendix 2.

8. The site is in a vast agricultural plain with no significant stationary sources of air pollution within a radius of 5 km. The ambient air quality measured at the site in May 1993 furnished values which are typical of clean air, with no detectable sulfur dioxide or nitrogen dioxide (NO_2). Measurements of the ambient air quality are presented in Appendix 3.

9. The quality of water from tubewells and handpumps in the vicinity of the site, as well as from the Sidhnai Canal, was evaluated. In each case, the water was found to be of good quality, with no heavy metals, e.g., arsenic, iron, lead, or mercury, being detected. However, coliform bacteria are present in the canal water, and accordingly, the water will have to be treated before use for drinking. The results of the water quality analysis are presented in Appendix 4.

2. Biological Environment

10. The site is in an agricultural district, with crops of wheat and other cereals, and sugarcane, in addition to mango, pomegranate, and citrus fruit trees. Animal rearing includes buffaloes and other cattle, poultry, and goats. While there are several local tree, wild animal, and bird species, none are endangered.

11. No wildlife sanctuary exists in the vicinity of the Project site.

3. Sociocultural Environment

12. The surrounding areas are inhabited by agricultural communities, settled in small irrigation command areas (called "Chaks"), with 20-30 families in each. The communities are comprised mainly of three clans: Sherazis (Syeds), Jat, and Katti. However, none of these clans are considered as distinct from the mainstream population. The population density is low (less than 100 persons per square kilometer), and there are no towns or cities in the vicinity. Educational facilities are up to the primary school level, and while a small hospital and a few clinics provide medical services, they are understaffed and underequipped.

13. Two mosques exist in the vicinity of the site, and a cemetery is located at the boundary of the site. One of the mosques, as well as a gas station, will be relocated because of the planned extension of the Multan-Sargodha highway, for which a contract has already been awarded by the Punjab highway department.

14. There are no heritage or historical/archaeological sites in the area.

D. Anticipated Environmental Impacts and Mitigation Measures

1. Physical Environment

15. The physical environment could be affected by gaseous and liquid discharges from the power plant. The sulfur content of the natural gas is negligible. When natural gas is employed as fuel, particulate and carbon monoxide concentrations in the flue gas are very low because the combustion efficiency is high. The main gaseous emission of concern is NO_2, which is formed by the combination of nitrogen and oxygen at the high temperature of the combustion chamber. While NO_2 in dilute concentration is beneficial for agriculture, in the presence of unburnt hydrocarbons, particulate matter and sunlight it forms oxidants that are lung and eye irritants. For this reason, NO_2 concentrations are controlled, especially in urban areas.

16. The concentrations of sulfur dioxide and NO_2 in the stack gases are within the relevant Pakistan National Emission Standard. The ground level concentrations of these gases were calculated by the Gaussian air dispersion model. Both the short time and yearly average ground level concentrations of these gases (baseline concentrations assumed to be nil) were well within the World Bank ambient standards. The results of the air dispersion modeling exercise are presented in Appendix 5.

17. Except for sanitary sewer discharge, wastewater from the plant will be discharged into an evaporation pond or into the Sidhnai Canal, with approval of the Irrigation Department of the Punjab Province. The wastewater will be treated before discharge into the canal to comply with the applicable Pakistan EPA industrial effluents standards. The wastewater discharge will not exceed one ft^3/sec. Process wastewater effluent streams include boiler blowdown, cooling tower

blowdown, and demineralizer waste. Demineralizer regeneration waste will be neutralized before discharge into the evaporation pond or the canal. Cooling water blowdown will account for 98 percent of the total wastewater effluent.

18. Some sanitary waste from washrooms and toilets will also be generated. Sewer drains will be led to an on-site disposal area for treatment or holding in septic tanks with leach fields. All waste from plant drains subject to oil spills will be collected into an oily water separator before being drained into the disposal system. The oil waste will be separated and collected in drums and shipped to disposal areas from where they will be hauled away by local contractors. If an evaporation pond is used, periodic cleaning of the accumulated salt residue may be necessary. Such residue, if any, will be hauled to the nearest landfill area, and it will be ensured that this procedure complies with applicable environmental regulations.

19. Noise will be generated by the plant. Noise levels within the workers' colony (inside the site) and at the site boundary will be maintained within the limits of the appropriate World Bank standards. The design noise level will be 90 decibels (A) at one meter from the equipment. Noise level for some equipment, e.g., the emergency diesel generators, turbines, and boiler feed pumps, may exceed the design levels, and protective devices will be provided to workers to minimize the effects of high noise levels.

20. Dust generated during construction is expected to have some adverse impact on air quality. This problem will be mitigated by wetting the paths of heavy vehicles with water, and controlling the speed of vehicles. Wastewater, including sanitary waste and oil contaminated water, will be handled according to proper procedures. All vehicles will be equipped with silencers, their speed will be restricted, the noise generated by machines will be controlled, and protective earmuffs will be provided to workers.

2. Biological Environment

21. Construction and operation of the plant will have an insignificant effect on the biological environment. No disturbance to endangered species or loss of wildlife habitat will be involved. About 10.7 hectares of agricultural land will be converted to industrial use.

3. Sociocultural Environment

22. The economic, social, and cultural impacts of the Project will be mostly positive. The plant will increase the supply of electricity in Pakistan, with multiple benefits. About 300 persons will be employed during construction. Some commercial activity such as restaurants, gas station, general stores, workshops, and small warehouses may develop at the site during construction. These activities will, on the whole, benefit the local population.

23. A few mud structures exist on the site. Families who occupy these structures will have to be relocated to adjacent areas. These persons may continue to work as farmers, but if they wish to be considered for employment in the plant, and are qualified, they will be given jobs on a preferential basis.

E. Alternatives

24. The conventional options for power generation include hydropower and thermal power plants based on coal, oil, or natural gas. While Pakistan has appreciable hydropower potential, this is being exploited by other power projects. Pakistan is not a major producer of coal or oil.

The low BTU natural gas available near the Project site is a significant national resource for power generation, and does not have alternative economic use. Natural gas-based power generation is also one of the most environmentally benign conventional power options. The combined cycle natural gas-fired technology has high conversion efficiency, resulting in resource conservation and low pollution emissions. For all of these reasons, the power generation option chosen for the Project is considered appropriate.

25. The requirements of proximity to (i) the Nandpur gas field, (ii) the Multan-Sargodha highway, (iii) the WAPDA transmission line, (iv) the SNGPL pipeline, and (v) availability of canal/groundwater, greatly restrict the feasible sites for the plant.

F. Cost Benefit Analysis

26. Environmental costs are based on the expenditures primarily required to alleviate the impact of pollution on the surrounding area due to installation and operation of the power plant. The environmental costs are comprised of mitigation costs, institutional costs, and monitoring costs.

27. Major components of the environmental costs are the costs of the measures to be adopted at the Project design and implementation stage. The equipment required for mitigation measures will be a part of the turnkey construction contract. The institutional costs include the costs of performing environmental impact assessment and monitoring.

28. Costs of monitoring environmental impacts mainly consist of the cost of equipment required for monitoring air quality, toxic effluents, and gaseous emissions.

29. The total capital cost of the mitigating measures will amount to US$1,018,000 as indicated in the tables in Appendix 6.

G. Institutional Requirement and Environmental Monitoring

30. The Project proponents will conduct an environmental monitoring program. A monitoring component for ambient concentration of NO_2 will be conducted following commercial operation of the plant. Monitoring will be performed at selected points in the vicinity of sensitive areas and near predicted points of maximum ground level impacts. To account for variations in seasonal wind conditions, monitoring will be conducted for up to three consecutive months in both summer and winter seasons, with a total of four monitoring points in each season. Laboratory tests for groundwater quality will be conducted every six months. The wastewater stream will be tested every week. The solid waste will be dumped in landfills, which will be monitored periodically for compaction and soil cover. Noise levels will be monitored annually. The quality of groundwater in the vicinity of the landfills should also be regularly monitored.

H. Public Involvement

31. The Punjab Province EPA, as part of its procedure for approval of projects on environmental grounds, ascertains public reactions to the proposal by various means. This process will be followed for the proposed Project. The Project has been well known to the public in the area for some time, and it appears unlikely that any adverse public reaction will occur.

I. Conclusion

32. Environmental factors were important considerations during site selection and accordingly, the Project will not generate any adverse environmental impacts that cannot be properly mitigated.

INPUT METEOROLOGICAL DATA

Table 1. Maximum and Minimum Temperatures at Multan (1982-1991)

Year	Maximum Temp. (Degree Celsius)	Month	Minimum Temp. (Degree Celsius)	Month
1982	46.5	June	0.0	February
1983	45.2	June	0.0	January
1984	48.9	May	1.1	February
1985	47.5	May	1.0	January
1986	48.5	June	0.9	December
1987	48.0	June	1.6	December
1988	48.0	July	3.2	January
1989	46.0	May	1.0	January
1990	46.7	May	0.8	December
1991	48.5	June	0.4	January

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995.

Table 2. Maximum and Minimum Percentage Humidity (1982-1991)

Year	Maximum at 0300 hrs	Month	Minimum at 1200 hrs.	Month
1982	90	December	2.8	January
1983	91	January	2.8	January
1984	86	January	21	May
1985	92	December	20	May
1986	87	December	22	May
1987	87	January	30	June
1988	89	December	16	May
1989	87	December	15	May
1990	87	January	23	May
1991	89	December	26	June

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995.

Table 3. Annual Rainfall at Multan (1982-1991)

Year	Rainfall (mm)
1982	150.1
1983	204.7
1984	86.4
1985	127.7
1986	124
1987	61.2
1988	89.2
1989	113.6
1990	133.3
1991	85.7

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Table 4. Wind Direction at Multan by Month (1987-1991)

Recorded at: 0000 hrs.
0300 hrs.
1200 hrs.

MONTH	YEAR									
	1987		1988		1989		1990		1991	
January	N	S	NW	SE	SW	NE	S	N	SW	NE
	E	W	SW	NE	S	N	S	N	S	N
	W	E	SW	NE	NE	SW	S	N	SW	NE
February	S	N	SW	NE	SW	NE	SW	NE	SW	NE
	S	N	N	S	SW	NE	S	N	S	N
	NW	SE	NW	SE	NW	SE	NW	SE	S	N
March	S	N	W	E	S	N	SW	NE	SW	NE
	S	N	SW	NE	S	N	SW	NE	S	N
	NW	NE	NW	SE	W	E	SW	NE	W	E
April	W	E	NW	SE	SW	NE	SW	NE	S	N
	SW	NE	W	E	S	N	S	N	S	N
	NW	SE	NW	SE	SW	NE	SW	NE	SW	NE
May	W	E	NW	SE	NW	SE	NW	SE	S	N
	SW	NE	SE	NW	S	N	N	S	S	N
	N	S	N	S	NE	SW	N	S	SW	NE
June	N	S	N	S	N	S	N	S	NW	SE
	N	S	N	S	N	S	N	S	N	S
	NE	SW	N	S	NE	SW	NE	SW	NE	SW
July	N	S	N	S	NW	SE	N	S	N	S
	NE	SW	N	S	NE	SW	N	S	N	S
	NE	SW	N	S	NE	SW	N	S	N	S
August	NW	SE	NW	SE	N	S	NW	SE	N	S
	N	S	N	S	N	S	N	S	N	S
	N	S	N	S	NE	SW	NW	SE	N	S
September	N	S	NW	SE	N	S	NW	SE	N	S
	N	S	NW	SE	N	S	NW	SE	N	S
	N	S	NW	SE	NE	SW	N	S	N	S
October	W	E	W	E	NW	SE	NW	SE	SW	NE
	S	N	S	N	NW	SE	W	E	SW	NE
	NW	SE	N	N	N	S	NW	SE	NW	SE
November	Calm	Calm	NW	SE	W	E	Calm	Calm	N	S
	S	N	NW	SE	SE	NW	SW	NE	NW	SE
	N	S	N	S	SW	NE	W	E	NW	SE
December	S	N	S	N	NW	SE	S	N	Calm	Calm
	S	N	S	N	SW	NE	S	N	S	N
	SE	NW	SW	NE	S	N	S	N	Calm	

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995.

**Table 5. Maximum and Minimum Wind Pressure (Millibar)
At Multan During 1982 to 1991 (0300 to 1200 HRS)**

Year	Maximum	Month	Minimum	Month
1982	1004.9	December	981.6	July
1983	1004.6	January	983.9	July
1984	1003.1	January	979.0	June
1985	1004.3	January	980.9	June
1986	1005.2	December	981.8	June
1987	1005.4	January	982.3	July
1988	1004.4	December	982.0	July
1989	1005.5	December	983.6	July
1990	1000.1	December	981.2	July
1991	1004.2	January	980.9	July

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Appendix 3

AMBIENT AIR QUALITY

Ambient air quality at site tested in May 1993

Substance	Quality	Unit
O_2	21.00	% Vol.
N_2	78.96	% Vol.
CO_2	0.04	% Vol.
SO_2	Not Detected	
NO_2	Not Detected	

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Appendix 4

WATER QUALITY ANALYSIS

Sr. No.	Parameters	SL-1	SL-2	SL-3	SL-4	WHO Standards
1	Temp. Deg. C	25	25	25.3	21.8	-
2	pH	7.3	7.25	7.42	7.78	7.0-8.5
3	T.D.S. mg/L	692	696	732	184	500
4	Elect. Conductivity Us/cm	990	985	1115	292	-
5	Turbidity NTU	0.9	0.95	1.3	257	5
6	Total Hardness mg/L	450	440	316	148	-
7	Calcium mg/L	260	250	127	59	75
8	Magnesium mg/L	180	160	93	43	50
9	Total Alkalinity mg/L	400	390	200	600	
10	Sulphates mg/L	180	175	150	30	
11	Chlorides mg/L	25	22	17.5	19.5	200
12	Iron mg/L	N.D.	N.D.	N.D.	4.6	
13	Nitrates mg/L	N.D.	N.D.	N.D.	4.6	
14	Coliforms NPM	N.D.	N.D.	N.D.	3	0

Note:

Sample	SL-1 & SL-2	From Tubewells
	SL-3	From Handpumps
Sample	SL-4	From Sidhnai Canal

N.D.: Not Detectable

NPM: Number per ml

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

INPUT DATA FOR DISPERSION CALCULATION

Table 1: Stack Properties

Exit Temperature	110 ^{o}C
Stack Diameter	3.38 meters
No. of Stacks	1
Exit Velocity	22 m/sec
Stack Height	26.15 meter
Exhaust Volume	407,455 ACFM (Actual Cubic Feet per Minute)

Table 2: Stack Emission Rates

Pollutants	$\mu g/m^3$	Pakistan National Emission Standard $\mu g/m^3$
NOx	224.2×10^3	400×10^3
SO_2	11.6×10^3	400×10^3

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Table 3. Fuel Characteristics

Nitrogen	58 mole %
Carbon dioxide	2.61 mole %
Methane	39.22 mole %
Ethane	0.16 mole %
Propane	0.01 mole %
Sulfur	2 to 100 scf
Flow rate	67.7 x 10^6 **scf/day**
High Heating Value	399 Btu/scf

Table 4. Wind Data

Average wind speed	=	$\frac{3.5 + 5.2}{2}$ km/hr
Mean averages of wind speed	=	1.21 m/sec

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Table 5. Simulation Results From Air Dispersion Model
Short Time NOx and SO_2 Ground Level Concentration

SR No.	Ground Level NOx Concentration $\mu g/m^3$	Area km^2	Ground Level SO_2 Concentration $\mu g/m^3$	Distance km
1.	0 – 83.1	0 – 1.54	0 – 4.31	0 – 0.7
2.	83.1 –132.66	1.54 – 3.14	4.31 – 6.88	0.7 – 1
3.	132.66 – 65.15	3.14 – 12.56	6.88 – 3.4	1 – 2
4.	65.15 –18.82	12.56 – 50.24	3.4 – 0.98	2 – 4
5.	18.82 – 8.0	50.26 – 153.86	0.98 – 0.45	4 – 7
6.	8.0 – 3.34	153.86 – 314.0	0.45 – 0.173	7 – 10

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Table 6. Simulation Results From Air Dispersion Model
Maximum Yearly Average Ground Level Concentration

POLLUTANT	CONCENTRATION ($\mu g/m^3$)	DISTANCE
NOx	132.66 X 0.281 = 37.28	1 km
SO_2	6.88 X 0.281 = 1.93	1 km

Note: The factor 0.281 is used for calculation of annual average ground level concentration.
Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

Table 7. Simulation Results From Air Dispersion Model

Comparison of Maximum Short-Time and Yearly Average Ground Level Concentration With World Bank Standards

	Ground Level Concentration			
Pollutants	**Short-Time**		**Yearly Average**	
	Calculated ($\mu g/m^3$)	**World Bank ($\mu g/m^3$)**	**Calculated ($\mu g/m^3$)**	**World Bank ($\mu g/m^3$)**
NOx	132.66	300	37.28	100
SO_2	6.88	500	1.93	100

Source: Fauji Kabirwala Power Company Limited Environmental Impact Assessment Study, April 1995

ENVIRONMENTAL IMPACT MITIGATION COSTS

Subject	Activity	Estimated Cost (US$)
Liquid effluents	Provide on-site septic tanks and leach fields for collection of sanitary waste. Disposal of sludge from sanitary waste to farms, with consent of local authorities and farmers. Install neutralization tanks for collection of plant wastewater drains.	150,000

Source: NESPAK, April 1995.

ENVIRONMENTAL MANAGEMENT INSTITUTIONAL COSTS

Subject	Activity	Estimated Cost (US$)
Environmental Management and Training	Establishment of Environmental Management Cell	150,000

Source: NESPAK, April 1995.

ENVIRONMENTAL IMPACT MONITORING COSTS

Subject	Activity	Estimated Cost (US$)
Air quality monitoring	Emission and immission monitoring for NOx and dust, etc.	400,000
Testing and checkouts of plant emissions systems	Environmental stack testing	150,000
Water quality monitoring during and after construction	Monitor for: - total suspended solids - pH - total organics - oil and grease - nonpoint runoff of solids - point source discharge erosion and accidental spills	114,000
Chemical effluents monitoring	Monitor for: - chlorine (total residual oxidants) - heavy metals - oil and grease - total suspended solids - organic chemicals - pH - phenolics	54,000

Source: NESPAK, April 1995.