PDW06948

Bechtel National, Inc.
Engineers—Constructors

Fifty Beale Street
San Francisco, California
Mail Address: P.O. Box 3965, San Francisco, CA 94119

February 3, 1987

Mr. James B. Sullivan
S&T/EY
508 SA-18
Agency for International Development
Washington, D.C. 20523

Dear Mr. Sullivan:

The enclosed Table 5-18 is a supplement to your copies of the Jamshoro Environmental and Social Soundness Assessment. Please remove pages 5-105 and 5-106 and replace with the enclosed material. The sheets will fit into the document without removing the binding.

Thank you.

David A. Cobb
Supervisor
Biological Sciences Group

DAC/jab
Enclosure (3)

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

Pakistan Water and Power
Development Authority
Lahore, Pakistan

JAMSHORO POWER GENERATION COMPLEX — PHASE II

ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT

EXECUTIVE SUMMARY
FINAL DRAFT

January 1987

BECHTEL NATIONAL, INC.

Funded Under the Joint GOP-USAID Energy Planning and Development Project in Cooperation With Enerplan

2

EXECUTIVE SUMMARY

ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT

JAMSHORO POWER GENERATION COMPLEX - PHASE II

FINAL
DRAFT

Prepared for:

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

LAHORE, PAKISTAN

Funded under the joint GOP-USAID Energy Planning and Development Project in cooperation with Enerplan.

Prepared by:

Bechtel National, Inc.

January 1987

3

ACRONYMS

ER	Environmental and Social Soundness Report
GOP	Government of Pakistan
ROW	Right-of-Way
TLV	Threshold Limit Value
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
WAPDA	Pakistan Water and Power Development Authority
WHO	World Health Organization

TABLE OF CONTENTS

	Page
Introduction	1
Objectives of the Project	4
Description of Proposed Project and Study Area	5
Study Area Project Description	
Environmental Policy and Regulations	9
Government of Pakistan Donor Organizations	
Alternatives Evaluated	13
No Action (Phase I only) Phase II Alternatives	
Environmental and Social Consequences of Phase II	15
Physical Impacts Biological Impacts Socioeconomic Impacts	
Mitigation and Monitoring	23
Conclusion	24

5

FIGURES

Figure		Page
1	Location of Jamshoro Project	2
2	View of the Site Area	6
3	Arrangement of Power Plant Facilities	7
4	Arrangement of Intake Facilities	8

TABLES

Table		Page
1	Major Environmental Legislation and Regulations for Pakistan	10
2	Applicable Environmental Criteria for Phase II Power Generation Units	12
3	Environmental Impacts from Construction and Operation of the Jamshoro Phase II Project - Physical Impacts	16
4	Environmental Impacts from Construction and Operation of the Jamshoro Phase II Project - Biological Resources	19
5	Environmental Impacts from construction and Operation of the Jamshoro Phase II Project - Socioeconomic Impacts	21
6	Proposed Monitoring and Mitigation Activities	24

INTRODUCTION

The Pakistan Water and Power Development Authority (WAPDA) is constructing a major new oil-fired electricity generation complex northwest of the Hyderabad, Province of Sind, Pakistan. The first phase (Phase I) of this complex will be comprised of one 250 MW unit and three 210 MW units for a total of 880 MW. The second phase (Phase II) will be 3 units, 350 MW each, for a total 1,050 MW. The total complex capacity will be 1,930 MW. Site development has started for Phase I.

This Executive Summary provides an overview of the environmental and social effects, and the proposed mitigation measures for Phase II of the project.

This document is based on the Phase II environmental report entitled, "Environmental and Social Soundness Report for Jamshoro Power Generation Complex - Phase II," prepared for WAPDA with cooperation of the United States Agency for International Development (USAID) Islamabad (BNI, 1987). This summary will assist representatives of Pakistan agencies and international funding (donor) organizations such as USAID and The World Bank to have a clear understanding not only of the significant impacts of the project to the natural and human environment, but also of the project's benefits in providing both necessary electrical energy and secondary economic improvement in Pakistan.

Preparation of the Environmental and Social Soundness Report (ER) followed these procedures:

- The Government of Pakistan Environmental Policy and Regulations (Ordinance No. XXVII of 1983)
- USAID Environmental Policy and Regulations (PD-6, 22 CFR 216)
- The environmental policies and guidelines of The World Bank

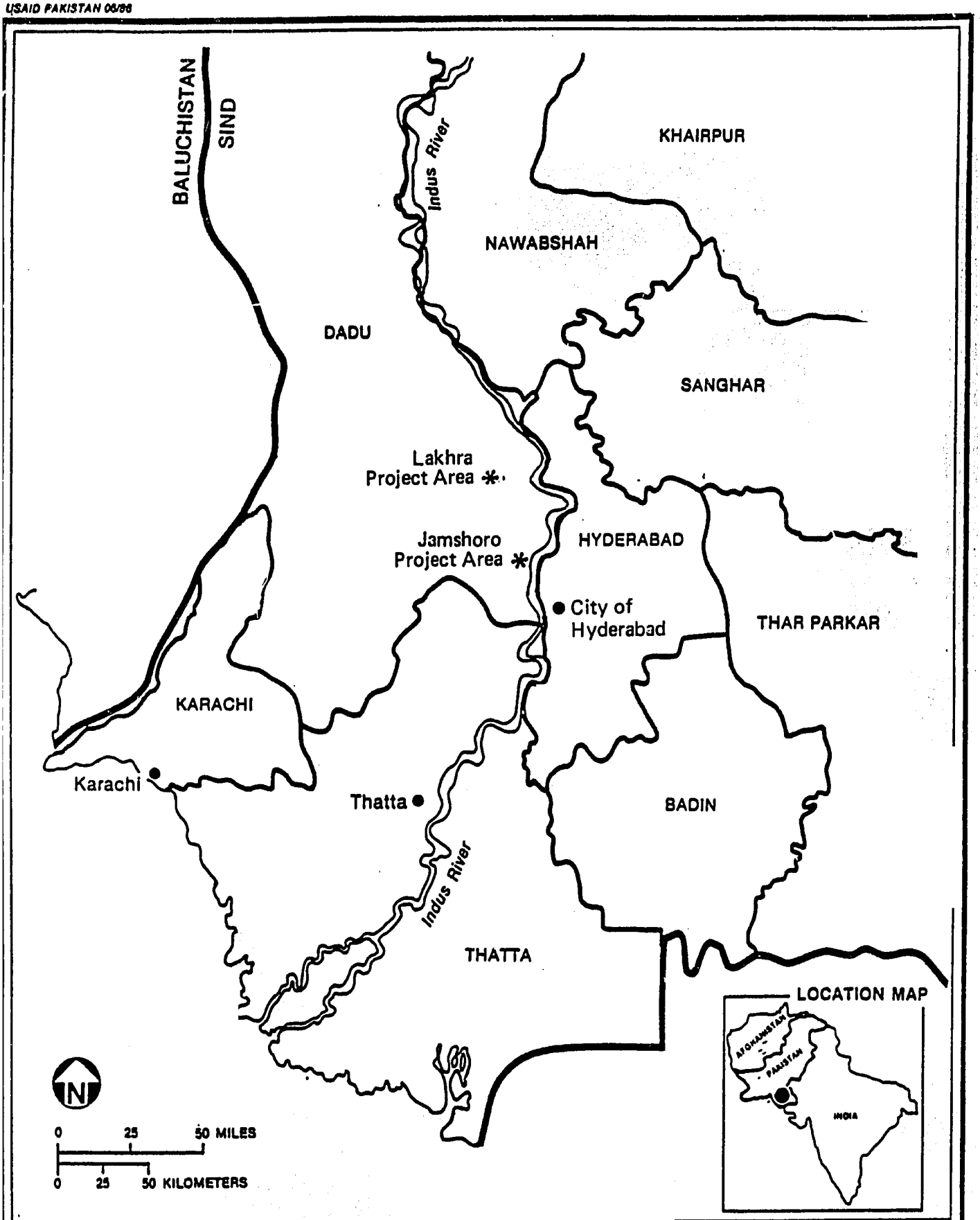


Figure 1 Location of Jamshoro Project Area

SOURCES: GOVERNMENT OF PAKISTAN, 1984; ESE, 1986.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

8

The ER was based on regional and site specific data and information collected during the environmental and social studies carried out for the Lakhra coal mine and power plant project; field and site visits by staff from Bechtel National, Inc.; and consultation with knowledgeable officials and university staff in Pakistan and in Washington, D.C.

The ER includes the following principal sections:

- Description of the purpose and need for Jamshoro Phase II
- Description and comparison of the proposed and alternative actions of the environmental and social setting at the site
- Evaluation of project alternatives
- Description of the natural and social environment of the site
- Assessment of environmental and social impacts of the project
- Recommendations for mitigation and monitoring programs including priorities and estimated costs

OBJECTIVES OF THE PROJECT

Shortage of electric power is a serious limitation to economic and social development of Pakistan. Owing to current and future electrical energy demands, new thermal generating capacity will be required in the early 1990s The Phase II expansion by WAPDA of the Jamshoro Power Generating Complex wil partly meet this urgent national need for electricity, and assist the Government of Pakistan (GOP) to:

- Balance of the national power grid
- Reduce load shedding
- Generate employment
- Provide economic and industrial development

These will be welcome benefits within the Province of Sind as well as throughout Pakistan.

DESCRIPTION OF STUDY AREA AND PROPOSED PROJECT

STUDY AREA

The Jamshoro site is located in the Dadu District of the province of Sind, 4 km northwest of the village of Jamshoro and about 5 km west of the Indus River, the eastern boundary of the Dadu District. To the east of Dadu and the river lies the Hyderabad District and the city of Hyderabad, an urbanized area with close to 750,000 inhabitants. Agriculture is the main economic enterprise in this region of Pakistan, with most suitable agricultural lands occurring near the Indus River, the principal source of fresh water. The project site is adjacent the Indus Highway, about 5 km north of the Sind University and Liaqat Medical College and Hospital. The site itself is semi-arid, and poorly suited for growing crops (Figure 2).

PROJECT DESCRIPTION

The Phase II plant will consist of three 350 MW units and all ancillary facilities and structures to be added to the Phase I facilities now under construction at Jamshoro. Except for the raw water intake facilities on th Indus River, this Phase II will occupy approximately 70 acres. Forty-two acres will lie west of Indus Highway and be used for the power blocks, cooling towers, bulk fuel oil storage, water treatment building, auxiliary boiler, standby diesel generator, and fuel storage tanks. Eighteen acres will lie east of the highway and be the site of raw water pretreatment and wastewater treatment facilities. An additional 10 acres will be occupied by the warehouses, technical buildings, and a workshop. Arrangement of the power plant and intake facilities is shown on Figures 3 and 4.

Fuel oil for the Jamshoro Project will be brought by tanker to the Port of Karachi approximately 150 km to the south. A buried pipeline will transfer the oil the approximately 1050 km from the port to the Complex.

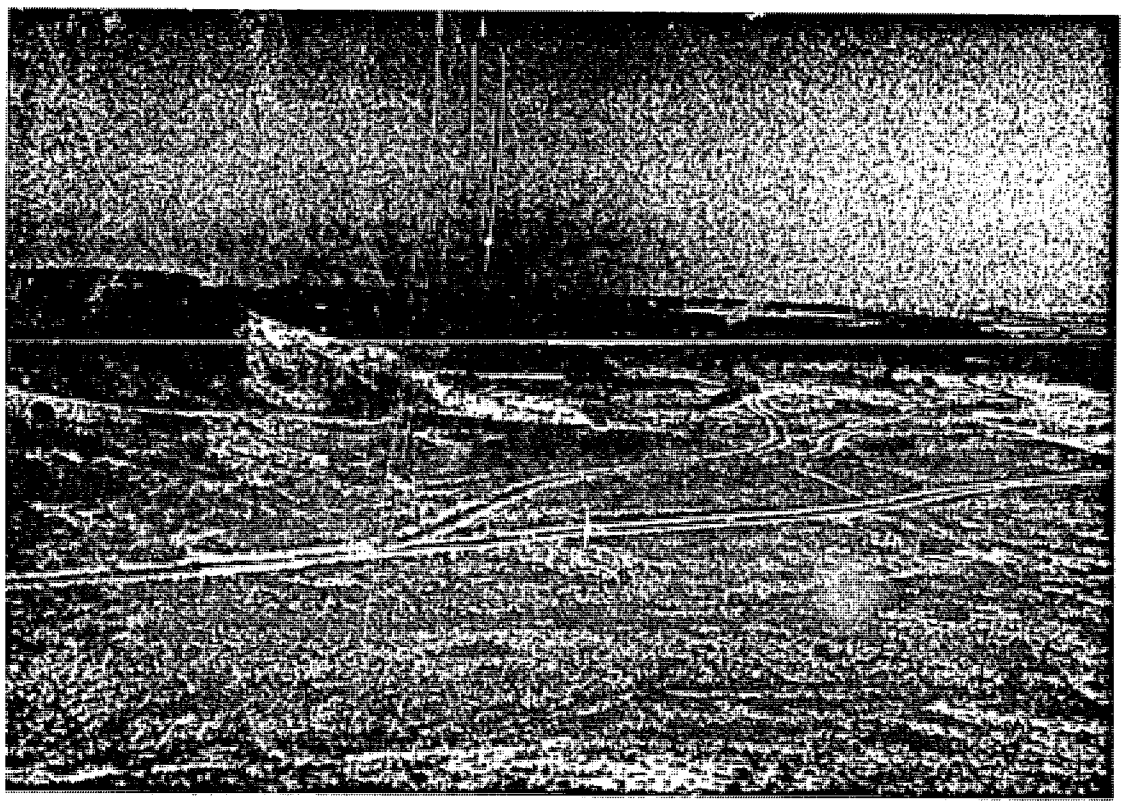


Figure 2 Jamshoro Site Looking North from Meteorological Station. Grazing Goats in Background, 30 September 1986

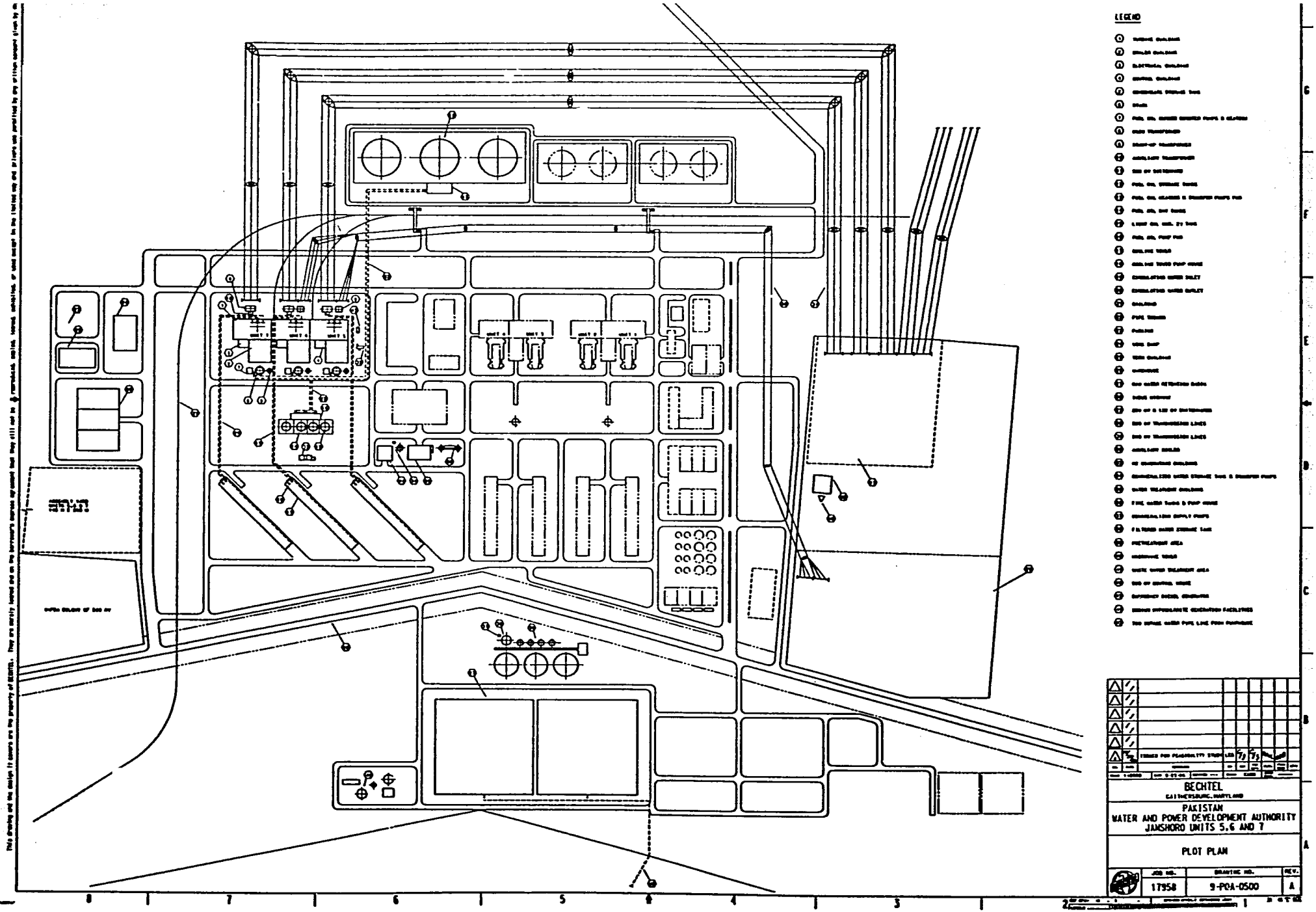


Figure 3 Arrangement of Power Plant Facilitie

13

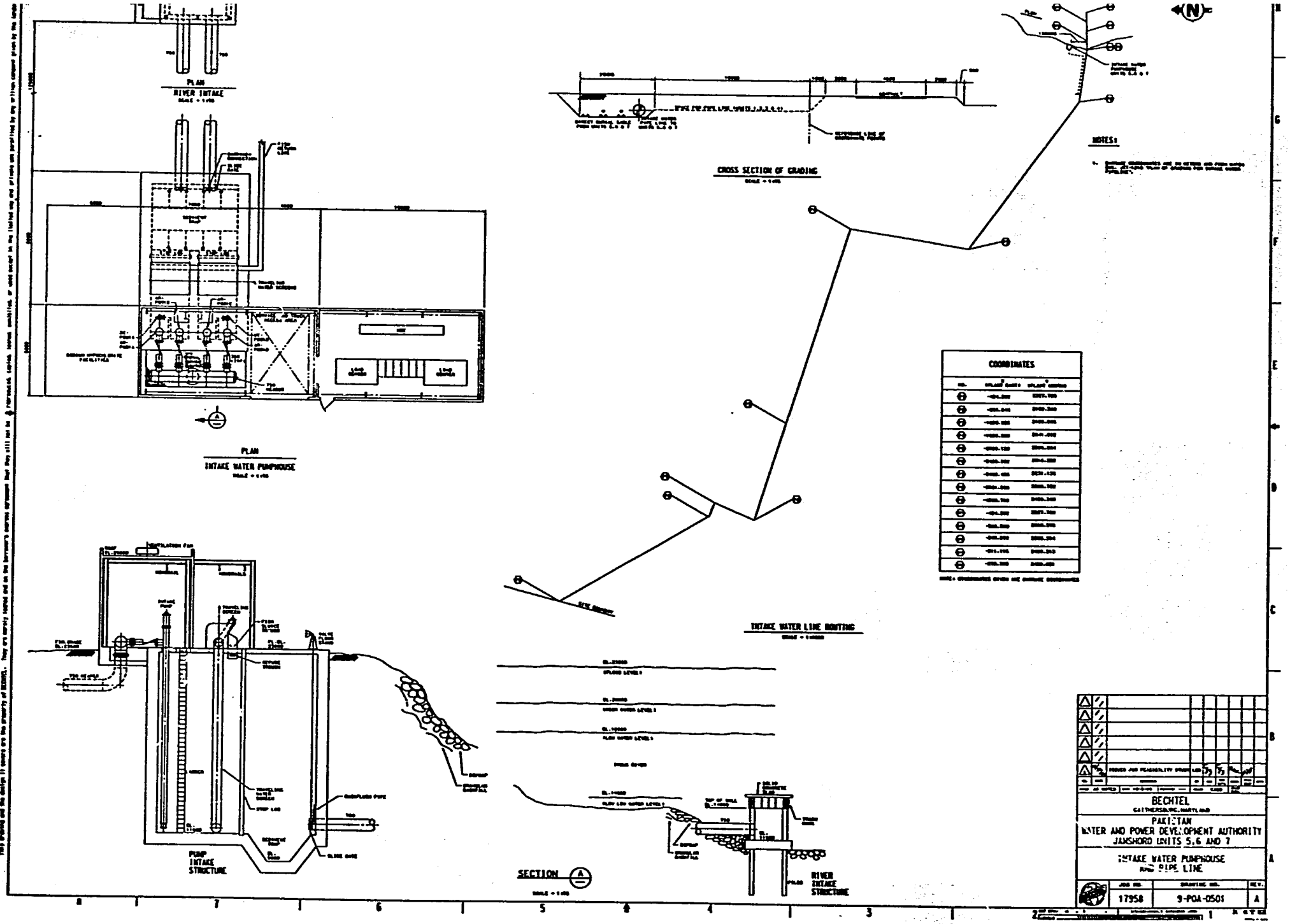


Figure 4 Arrangement of Intake Facilities

ENVIRONMENTAL POLICY AND REGULATIONS

GOVERNMENT OF PAKISTAN (GOP)

The GOP has initiated through the promulgation of the Pakistan Environmental Ordinance of 1983, the mechanisms for formulating national environmental policy and for developing and enforcing national environmental quality standards. Approval of policy and standards is the purview of the Pakistan Environmental Council. Development of standards and their enforcement is administered by the Environment and Urban Affairs Division of the Ministry of Housing and Works.

Additionally, the GOP and Sind Governments have established legislation and regulations governing antiquities, endangered species, national parks, wildlife sanctuaries, game reserves, forestry, and water management. For Phase II of the Jamshoro project, the GOP has also requested the preparation of an Environmental pro forma statement. Major environmental legislation and regulations are reviewed in Table 1.

Table 1

MAJOR ENVIRONMENTAL LEGISLATION AND REGULATIONS FOR PAKISTAN

Type	Authority	Administering Agency	Purpose
Comprehensive Environmental Protection	Ordinance No. XXVII of 1983	Ministry of Housing and Works; Environment and Urban Affairs Div.	Requires environmental *pro forma* statement
Protection of Antiquities	Act No. VI of 1977	Ministry of Culture, Archaeology, Sports, and Tourism; Dept. of Archaeology	Provides protection and preservation of historically important sites
Water Resources	West Pakistan Act of 1958	WAPDA	Requires management of water resources
	Sind Irrigation Act of 1879	Government of Sind, Irrigation and Power Department	Regulates granting of water use from Indus River
Wildlife	West Pakistan Wildlife Ordinance of 1959	Ministry of Food, Agriculture, and Cooperatives Zoological Survey; National Council for Conservation of Wildlife	Promotes conservation and establishes limits on hunting
Wildlife	Sind Wildlife Protection Ordinance	Government of Sind, Ministry of Forests, Wildlife, and Forestry	Promotes conservation and limits hunting
Forests	Forest Act of 1927 No. XVI	Ministry of Food, Agriculture, and Cooperatives; Pakistan Forest Institute; Government of Sind, Ministry of Forest, Wildlife, and Forestry	Provides protection and regulation of exploitation of forests

Sources: ESE, 1986
KBN, 1986

INTERNATIONAL FUNDING ORGANIZATIONS

Multilateral development organizations such as The World Bank have established policies governing the evaluation of potential environmental impacts and the adequacy of pollution control measures of projects they finance. These policies concern the natural and human environment as well as the health and safety of workers. At Jamshoro, construction and operation of Phase II of the project will require consideration and evaluation of the Environmental Guidelines established by the World Bank, based on specific projects needs. The preparation of the Environmental Assessment (ER) for the project involved direct coordination with, and involvement of, the World Bank Office of Environmental Affairs. A set of environmental criteria for the Phase II was one result of this coordinated effort (Table 2).

Bilateral funding organizations, such as USAID, have established policies foı evaluating the environmental consequences of funded projects. USAID's, environmental policies are implemented by means of U.S. environmental procedures as well as by an official USAID policy determination on Environmental and Natural Resource Aspects of Development Assistance. As a condition of USAID-funding, an ER must be prepared for certain types of projects, including thermal power plants.

Table 2

APPLICABLE ENVIRONMENTAL CRITERIA FOR PHASE II POWER GENERATION UNITS

Environmental Resource	Criteria
Air	Emissions: World Bank Guidelines 1. SO_2--450 MT/day (500 tons/day) at annual capacity factor 2. Particulate--100 $\mu g/m^3$ 3. NO_x--260 mg/source (0.6 $lb/10^6$ Btu) Ambient Quality: World Bank Guidelines 1. SO_2--100 $\mu g/m^3$ annual average 500 $\mu g/m^3$ maximum 24-hour average 2. Particulate--100 $\mu g/m^3$ annual geometric mean 500 $\mu g/m^3$ maximum 24-hour average 3. NO_2--100 $\mu g/m^3$ annual average U.S. Environmental Protection Agency Standards 1. SO_2-- 1300 $\mu g/m^3$ 3-hour average (secondary standard), 365 $\mu g/m^3$ 24-hour average (primary standard), 80 $\mu g/m^3$ (annual average (primary standard) 2. Particulate-- 75 $\mu g/m^3$ annual geometric mean (primary standard) 260 $\mu g/m^3$ maximum 24-hour average (primary standard) 3. NO_2-- 100 $\mu g/m^3$ annual average (primary and secondary standards)
Water, Land, and Noise	No specific limitation but general restrictions on effects to human health and welfare.
Social and Cultural	Secondary growth effects to general population and tribal people shall be addressed.
Occupational	TLVs by American Conference of Governmental Industrial Hygienists. Also, World Bank Safety and Health Guidance for Power Plants, Coal and Fuel Oil.

Notes: SO_2 = Sulfur dioxide
MT/day = Metric tons per day
$\mu g/m^3$ = Micrograms per cubic meter
NO_x = Nitrogen oxide
$lb/10^6$ Btu = Pounds per million British thermal units
NO_2 = Nitrogen dioxide
TLV = Threshold Limit Values

Sources: ESE, 1986
KBN, 1986

ALTERNATIVES EVALUATED

The following project alternatives are considered in the ER

NO ACTION (PHASE I ONLY)

In this case, only Phase I would be constructed and operated at Jamshoro. Failure to construct Phase II would worsen the projected shortage of electrical energy in Pakistan with consequent adverse social and economic effects. Although energy conservation in Pakistan would help reduce energy requirements, it will not lower demand sufficiently to eliminate the need for additional generation.

Failure to construct Phase II would avoid any harmful social and environmental consequences associated with the new development. As with any development of the scale of Phase II, there could be unavoidable environmental effects. Phase II would result in estimated additions of 228 MT/day SO_2 and 130 ng/J NO_x. Both, however, are within World Bank guidelines to power generation facilities. Predicted particulate matter emissions would represent only about a 1 percent increase above naturally high dust backgrounds in the areas most affected. Liquid effluents from the facility will either be ponded for evaporation, or suitably treated for use as either process or irrigation water. No uncontrolled liquid or solid wastes will leave the power plant.

Thus, the limited adverse environmental consequences associated with an efficiently designed and operated electrical generation facility were judged insufficient to argue against the Jamshoro Phase II facility. The "no action" alternative was rejected.

PHASE II ALTERNATIVES

During the pre-feasibility study of the Jamshoro Power Generation Complex, the following alternative design components were considered:

POWER GENERATION COMPLEX

The choice of unit size was governed by several factors, including safety and reliability, adherence to World Bank guidelines on pollutant emission control, proximity of the complex to other power generation projects, and integration with the existing national power grid. Costs were also a significant factor, and have been discussed in detail in Section 4.0 of the Phase II Feasibility Study (BNI, 1986b).

POWER PLANT CHARACTERISTICS

Conventional steam and combined-cycle technologies were evaluated, based on operational complexity, efficiency, relative cost, and schedule of implementation. The possibility of conversion of the oil-fired conventional steam system to coal if needed in the future was considered, as were the possible use of coal/oil and coal/water mixtures.

ALTERNATIVE SELECTED

The technical analysis of the pre-feasibility study led to the following conclusions:

1. The three additional 350-MW oil-fired units could be supported at the Jamshoro site in terms of available space, make-up water and transmission feasibility.

2. Sulfur dioxide emissions from the three units burning 3.5 percent sulfur oil should not exceed the World Bank SO_2 emissions criteria limits.

3. Either oil-fired conventional steam or oil-fired combined-cycle units could be constructed, although the latter have a shorter construction period and higher efficiency.

4. Conversion of a conventional oil burning steam unit to coal would not be economically practical based on high capital cost and cost of unit derating.

5. Coal/oil and coal/water mixtures would not be economical.

6. Design provisions to accommodate future coal conversion and burning should be made only if there is a high probability of burning coal in these units in the future.

ENVIRONMENTAL AND SOCIAL CONSEQUENCES OF PHASE II

Potential impacts to the physical, biological and social environments of the construction and operation of Phase II facilities recommended for Jamshoro are presented in Tables 3, 4, and 5.

PHYSICAL IMPACTS

Physical impacts are summarized in Table 3. Air emissions and the resulting impacts to ambient air quality from the combined operations of Phases I and II have caused the most concern with regard to environmental quality in the Jamshoro area. For assessment purposes, estimated stack emissions of the two phases and the resultant ambient air quality can be compared with World Bank guidelines (see Table 5-11 of the ER). The SO_2 and NO_x emissions of Phases I and II are below World Bank guidelines. The dust or particulate matter (PM) emissions are above The World Bank guideline value of 100 mg/m^3. However, the predicted increase in ambient ground level concentrations of PM are considered negligible since the emissions would constitute a maximum of only about 1 percent of a PM annual average natural background concentration at ground level estimated from local air quality data to be 200 ug/m^3.

The areas of maximum air quality impacts are near (but not at) the Liaqat Hospital at Sind University and the tuberculosis sanatorium southwest of the Jamshoro project and near Petaro College northeast of the Jamshoro project. However, the SO_2 and NO_x air quality levels even at these points are below the World Bank guideline values, below the World Health Organization criteria as well as below the U.S. Environmental Protection Agency health-based standards which give particular attention to children and the elderly.

Table 3

ENVIRONMENTAL IMPACTS FROM CONSTRUCTION AND OPERATION OF THE JAMSHORO PHASE II PROJECT - PHYSICAL IMPACTS

IMPACTS	EXTENT/DURATION/SIGNIFICANCE OF IMPACTS*
Construction	
Air Emissions	Site specific/short-term/little significance near source, no significance at distance.
Noise and Vibration	Site specific/short-term/not significant.
Increased Soil Erosion and Runoff	Site specific/short-term/not significant.
Accidental Spills of Toxic Materials	Site specific/short-term/prevented or mitigated by prevention and clean-up programs.
Change in Drainage	Site specific/long-term/not significant.
Change in Surface Water Quality	Site specific/short-term/not significant.
Operation	
Change in Streamflow Quantity and Quality	Site specific/long-term/not significant.
Change in Groundwater Quality	Site specific/long-term/groundwater quality protected by impervious pond lining, monitoring.
Consumptive Water Use from Indus River	Site specific/long-term/minor impact; amount consumed (0.9 cms) is small compared to even lowest flows of the Indus River. Offset by availability of irrigation water at site.
Accidental Spills of Chemicals/Toxic Materials	Site specific/short-term/little potential impact; prevented or mitigated by prevention and clean-up programs.
Generation of Sanitary and Operational Wastewater Streams	Site specific/long-term/minor impacts; wastes either ponded for evaporation or treated for irrigation use.

(continued)

22

Table 3 (Cont'd)

IMPACTS	EXTENT/DURATION/SIGNIFICANCE OF IMPACTS*
Operation: (Cont'd)	
Air Emissions	Regional/long-term/air pollutant emissions and ambient levels are below World Bank guidelines except for particulate matter. However, power plant emission contribution to ambient PM levels is negligible.
Noise and Vibration	Site specific/long-term/not significant owing to plant design and standards (US OSHA).

* Extent refers to the areal effect of the impact, e.g., whether the impact is confined to the site only or extends some distance from the site.
Duration refers to the length of time the impact will last, e.g., whether the impact is short-term, lasts for several years, or for much longer periods.
Significance refers to relationship either to existing pollution control guidelines, professional design standards, or existing natural conditions.

BIOLOGICAL IMPACTS

Impacts to vegetation and wildlife resulting from construction and operation of the Jamshoro Phase II Project (Table 4) are not expected to be significant, owing to extensive pollution control practices, as well as a result of mitigation measures planned for the project. Wildlife densities appear to be low at Jamshoro, a consequence of the arid environment and historically disturbed conditions at the site. Furthermore, what vegetation that does exist is typical throughout much of this region of Sind. No unique ecosystems appear to exist at the site or along the pipeline route. Widespread changes in existing populations or habitat are not expected.

In addition to pollution control, harmful impacts or losses are prevented further by a number of mitigation measures and design details. For instance, the use of traveling screens excludes fish from entrainment into the water system, and evaporation ponds or re-use plans preclude the return of potentially harmful liquid effluents to the Indus River.

SOCIOECONOMIC IMPACTS

A number of socioeconomic benefits will accrue from the construction and operation of Phase II of the Jamshoro Project (Table 5). These include increased local employment, skills training, and electrical power generation. On the other hand, certain undesirable impacts may result if attention is not paid to an increased need for social services including housing, health care, schools, police protection, transportation and communication by a peak onsite construction labor force for Phase II of an estimated 2,500 workers and 3,750 dependents. The net result of development in the Jamshoro area of planned and coordinated development should be strongly positive.

Table 4

ENVIRONMENTAL IMPACTS FROM CONSTRUCTION AND OPERATION OF THE JAMSHORO PHASE II PROJECT - BIOLOGICAL RESOURCES

IMPACTS	EXTENT/DURATION/SIGNIFICANCE OF IMPACTS*
Construction	
Removal of Vegetation	Site specific (70 acres at site; nominal acres for pipeline owing to reburial and recontouring) /long-term/insignificant because of surrounding unaffected areas and lack of uniqueness of affected ecological communities; natural re-vegetation of buried pipeline.
Damage to Vegetation/ Wildlife from Dust and Toxic Materials	Site specific/short-term/not significant; exposures will affect only a very small portion of regional vegetation.
Loss of Wildlife from Dust and Toxic Materials	Site specific/short-term/not significant; accidental exposures to toxic materials will affect only a local portion of regional population; high natural background of dust in area.
Loss of Wildlife Habitat	Site specific/long-term/insignificant; only local area affected; site habitat of limited quality owing to past disturbances and arid nature of region.
Loss of Future Biological Productivity	Site specific/long-term/not significant; small area and of naturally low productivity.
Road Kills of Wildlife	Regional/short-term/not significant given expected low wildlife densities occurring in region; also as evidenced by scarcity of observed wildlife road kills.
Operation	
Avian Hazards from Stacks, Transmissions Lines, and Evaporation Ponds	Site specific/long-term/ probably not significant relative to the size of regional bird population, but evaporation ponds should be monitored in case preventive action is necessary.
Entrainment of Aquatic Species at Water Intake	Site specific/long-term/not significant and mitigated by screened intakes and fish return system.

(continued)

75

Table 4 (Cont'd)

IMPACTS	EXTENT/DURATION/SIGNIFICANCE OF IMPACTS*
Operation	
Formation of Biological Barriers and Corridors	Site specific/long-term/not significant.
Loss of Future Biological Productivity	Site specific/long-term/not significant; small area.
Road Kills of Wildlife	Regional/short-term/not significant given expected low wildlife densities occurring in region; also as evidenced by scarcity of observed wildlife road kills.

* Extent refers to the areal effect of the impact, e.g., whether the impact is confined to the site only or extends some distance from the site.
Duration refers to the length of time the impact will last, e.g., whether the impact is short-term, lasts for several years, or for much longer periods.
Significance refers to relationship either to existing pollution control guidelines, professional design standards, or existing natural conditions.

Table 5

ENVIRONMENTAL IMPACTS FROM CONSTRUCTION AND OPERATION OF THE JAMSHORO PHASE II PROJECT - SOCIOECONOMIC IMPACTS

IMPACTS	EXTENT/DURATION/SIGNIFICANCE OF IMPACTS*
Construction and Operation	
Change in Land Use	Site specific/long-term/not significant.
Increased Demand for Facilities and Services	Regional/long-term/significant if anticipated high demand on area facilities and services is not met; induced development in surrounding area; workers colony with infrastructure facilities and services can mitigate impacts.
Transportation	Site specific/long-term/moderately significant traffic increase; mitigated by staggered workshifts, use of buses for workers, and onsite residential colony; local highways already heavily used.
Changes to Lifestyle, Cultural patterns, and Attitudes	Site specific/long-term/ not significant, particularly if communication among interest groups is encouraged and training programs instituted.
Disturbance of Cultural Resources	Site specific/long-term/area of potential significance because project site is in the Indus River Valley; chance-find procedures and pre-construction survey would mitigate loss of resources.
Change in Employment Patterns	Regional/long-term/significant; peak onsite construction labor force for Phase II is approximately 2,500 workers plus 3,750 dependents; peak operational labor force is 740 workers plus 4,440 dependents.
Occupational Safety and Health Hazards	Site specific/long-term/not significant and mitigated by properly designed and maintained facilities and worker training programs.

* Extent refers to the areal effect of the impact, e.g., whether the impact is confined to the site only or extends some distance from the site.
Duration refers to the length of time the impact will last, e.g., whether the impact is short-term, lasts for several years, or for much longer periods.
Significance refers to relationship either to existing pollution control guidelines, professional design standards, or existing natural conditions.

Disruption of lifestyle and cultural patterns also need not be a problem at Jamshoro. A public information program to relate project information and opportunities for the local population should help counter any negative attitudes to an influx of workers from outside the area. These programs should include ample representation from local interest groups, and receive enthusiastic support from WAPDA.

The proposed project is in the Indus River Valley, an area with a rich archaeological and cultural history. Although sites of importance are not readily apparent in the areas to be developed for Phase II, a comprehensive archaeological survey has not been performed (one has been requested from the Pakistan Department of Archaeology). To protect against accidental disturbance of any cultural resources discovered during construction or operation of Phase II, "chance find" procedures will be implemented at Jamshoro. These procedures provided guidelines for handling discovered artifacts, and for notifying the Pakistan Department of Archaeology to obtain guidance.

Impacts of Phase II construction and operation on transportation are site-specific, long-term and could be moderately significant. These effects can be mitigated through staggered workshifts, the use of buses for transporting workers, or creation of an onsite residential colony. However, additional truck traffic related to Phase II construction and operation will exacerbate on already congested highway local transportation situation, and increase damage to the surface of these roadways.

MITIGATION AND MONITORING

Mitigation measures at Jamshoro will be undertaken to reduce those unavoidable adverse impacts which are a consequence of any large development. Monitoring will ensure that recommended pollution control and mitigation programs are working as planned.

Recommended mitigation monitoring are summarized in Table 6. They are either consistent with existing GOP, WAPDA, USAID and World Bank environmental and social policies, or reflect internationally recognized practices for the protection of the natural environment and of human wellbeing.

CONCLUSION

Development of the Phase II Generation Facilities at Jamshoro will provide local and regional benefits to the People of Pakistan as a result of increased electrical power supply and economic opportunities, including training employment. The environmental costs should not be significant if the proj is designed, constructed, and operated in accordance with GOP, World Bank, USAID and USEPA environmental guidelines to protect the natural and social environment, as well as human health and safety.

It is a worthy and ambitious project and will require cooperation and assistance among GOP agencies and international funding organizations.

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Pipeline design to control effects of erosion on fish and wildlife	Erosion of stream banks and slopes crossed by the pipeline can impact terrestrial and aquatic wildlife habitats.	BANK PROTECTION AT DRAINAGE CROSSINGS AND EROSION CONTROL STRUCTURES/MEASURES TO MINIMIZE EROSION ALONG RIGHT OF WAY SLOPES.	B.	WAPDA
Water Resources Protection:				
Monitoring of key wastewater streams	Ensure efficient plant operation and quality of water for use in irrigation.	DEVELOP MONITORING PROGRAM INCLUDING DATA SAMPLING, DATA ANALYSIS, LABORATORY ANALYSIS AND STAFF TRAINING.	A.	WAPDA, with assistance from PEPA[3]
Monitor groundwater to identify potential contamination	Potential effects on groundwater use and on connected surface water use from evaporation pond leakage.	Develop shallow groundwater monitoring well system.	B.	WAPDA, with assistance from MH
Wastewater handling and treatment	Maximum re-use of wastewater and minimum cost of disposal.	SEPARATE AND TREAT WASTEWATER STREAMS TO ALLOW EVAPORATION OF METAL CLEANING OPERATIONS WASTEWATER AND RECYCLING OF OTHER WASTEWATERS FOR IRRIGATION USE IN ACCORDANCE WITH U.S. EPA STANDARDS.	A.	WAPDA, with cooperation of PEPA[3]
Plant design to avoid water quality degradation from toxic spills and erosion	Discharges or accidental spills of toxic materials could cause water quality degradation.	ENCLOSE LUBE STORAGE TANK, LUBE OIL TRANSFER PUMP, SUMPS AND DRUM DISPENSING AREA WITH 6" PROTECTIVE CURBING. CONTAIN AND DISPOSE OF WASTEWATERS IN LINED EVAPORATION PONDS.	A.	WAPDA
Storm and flood design considerations	Avoid surface water contamination due to flooding and retention or evaporation pond overflowing	FACILITY LOCATED ABOVE 100-YEAR FLOOD PLAIN ELEVATION; WASTEWATER PONDS DESIGNED WITH 3 FEET (1 METER) FREEBOARD	A.	WAPDA, in consultation with GSP
Sanitary wastewater management	Protect human environment from decomposable organics, suspended solids, pathogenic organisms.	DEVELOP A SEWAGE COLLECTION SYSTEM AND TREATMENT PLANT, INCLUDING PRIMARY AND SECONDARY (BIOLOGICAL TREATMENT AND CHLORINATION) TREATMENT.	A.	WAPDA, with verification of PEPA[3], MH

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Solid waste management	Potential contamination of surface and groundwater	Formulate and implement a solid waste management plan	B.	WAPDA, with support of PEPA[3], MH
Water Resources:				
Hazardous and toxic waste management	Potential contamination of surface and groundwater	Prepare hazardous and toxic waste plans. Develop control measures to prevent and cleanup accidental discharges of hazardous and toxic substances.	A.	WAPDA, with support from PEPA[3]
Emergency planning	To standardize procedures during emergency responses to major toxic spills, fires and earthquakes	Develop Emergency Planning and Management Plan prior to construction and operation of all major facilities	A.	WAPDA, with support from PEPA[3], MH
Pipeline erosion control and revegetation	Minimize erosion and release of sediment-rich stormwaters into surface waters	Develop plans with control measures and temporary structures for use during pipeline and facility construction; scheduling techniques, mulching and revegetation of exposed critical areas, sediment traps and diversion dikes.	C.	WAPDA, with assistance from PEPA[3]
Pipeline design and operation to avoid severe oil spill impacts	Accidental oil spills from pipeline rupture at sensitive stream crossings	EFFECTIVE BANK STABILIZATION AT STREAM CROSSINGS; BURY PIPELINE IN STREAM CHANNELS BELOW MAXIMUM PREDICTED SCOUR DEPTH; DEVELOP AND IMPLEMENT SPILL PREVENTION, DETECTION AND CLEANUP PROCEDURES	A.	WAPDA, in consultation with GSP

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will b .equested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD – Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

32

AR:7155d tg:Rev.0

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Air Quality:				
Ambient air monitoring program	To ensure ground levels of various contaminants are within accepted limits.	Develop system of continuous air monitoring stations downwind of plant and at sensitive receptors; place one meterological station near the plant site.	A.	WAPDA, with cooperation of PEPA[3] and using AAQS
Stack emissions source testing	To ensure stack emissions from each unit are within World Bank guidelines and WHO criteria.	Test each unit of the facility annually and sequentially for SO_2, NO_2 and PM emission levels; if SO_2 levels are too high, use low sulphur oil.	A.	WAPDA, with cooperation of PEPA[3], MH
Noise:				
Construction noise abatement	Noise impacts on nearby communities or worker health and safety	INSTALL ENGINE MUFFLERS; MINIMIZE NIGHT TIME NOISY WORK; ENCLOSE OR SILENCE STATIONARY EQUIPMENT; LIMIT CONSTRUCTION EQUIPMENT TO E.E.C. 80 dBA LIMIT.	B.	WAPDA, with verification by MH
Operational noise abatement	Noise impacts on nearby communities or worker health and safety	EQUIP FORCED DRAFT FANS, STEAM VENTS, AND VENTILATION FANS WITH SILENCERS; ENCLOSE PUMPS, MOTORS AND TURBINE IN ACOUSTICALLY DESIGNED ENCLOSURES/ BUILDINGS; SET DESIGN LIMITS ON NOISE FROM ROTATING EQUIPMENT, CONTROL VALVES AND TRANSFORMERS	B.	WAPDA, MH
Cultural Resources:				
Archeological artifact notification and handling	Compliance with Pakistan law, avoidance of unnecessary project delays, protection of cultural resources.	Implement recommended chance-find procedures for cultural resources, including close liaison with Pakistan Dept. of Archeology and notification of any finds within seven days; pre-construction field surveys.	A.	PDA, with cooperation of WAPDA

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Social/Institutional Concerns				
Land use planning	Control secondary growth of residential and business development resulting from project development	Develop land use plans for implementation by local governments; provide guidance for selection of preferred locations for secondary growth; plan for timely development of supporting infrastructure and community services.	B.	MPD, with cooperation of WAPDA
Public Information Program	Seek public acceptance of the proposed project; minimize public concerns and issues; establish good relations with local populus	Establish a public information and communication program in the project community; determine information to be released; develop methods for communication; identify target groups and officials to meet with; schedule presentations and meetings.	B.	WAPDA in cooperation with Sind Universityand representatives of local groups
Train and hire local workforce	Provide economic benefits to project area; encourage good community relation; reduce influx of people from outside area	ESTABLISH PROGRAM TO TRAIN LOCAL WORKFORCE FOR PROJECT JOBS; HIRE QUALIFIED LOCAL SINDHIS WHENEVER POSSIBLE.	B.	ML, MPD, with support of WAPDA
Worker housing plan	Provide safe sanitary living conditions and adequate housing for project work force; minimize high worker turnover and low productivity.	Require construction contractors to provide adequate worker housing; develop housing and services plan based on evaluation of local availability; PROVIDE WORKERS' COLONY DURING OPERATION.	B.	WAPDA with assistance from local universities and technical training schools
Transportation Planning	Traffic-related impacts	Stagger work schedules, on-site housing for workers, bus transport for workers, use of night truck convoys, highway improvements, driver training, load limitations.	C.	WAPDA, ML

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities:
   A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Environmental and Socioeconmic Program, Phase I & II	Standardization of emergency plans and personnel training; standardization and centralization of equipment and data collection and analysis; complex-wide authority and responsibility for protection/correction activities.	DEVELOPMENT OF A SINGLE INTEGRATED PROGRAM FOR IMPLEMENTATION FROM A SINGLE OFFICE FOR BOTH PHASES.	B.	WAPDA, with cooperation of appropriate ministries
Planning for local recession	Local recession following construction.	Project representatives meet with local governments to discuss potential impacts and prepare a plan to address the issue.	C.	WAPDA, with assistance from ML, MPD, local groups
Public Health/Occupation Safety				
Solid and hazardous waste handling	Protect workers and public from exposure health risks	RECYCLE OR CONTAINERIZE AND PACKAGE FOR DISPOSAL IN APPROVED DISPOSAL SITE; TRAIN WORKERS ON PROPER HANDLING.	A.	WAPDA, with assistance from PEPA[3], MH
High voltage safety	Avoid accidental shocking	FENCE AND POST WITH WARNING SIGNS IN AREA CONTAINING TRANSMISSION CABLES; GROUND HIGH VOLTAGE TOWERS.	A.	WAPDA
Worker accident prevention	To minimize worker health and safety risks where design controls are inadequate or not feasible	Develop formal safety procedures and training program for operating and maintenance activities; educate workers on plant hazards.	A.	WAPDA, with assistance from ML, MH
Monitoring of chemical and physical hazards	Potential impacts to worker health and safety from specific work-related hazards	ROUTINE MONITORING OF TOXIC GASES, NOISE LEVELS, HEAT STRESS, TOXIC AND NUISANCE DUSTS; SPECIAL MONITORING OF MAINTENANCE AND NON-ROUTINE ACTIVITIES	B.	WAPDA, with verification of MH

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

Pakistan Water and Power
Development Authority
Lahore, Pakistan

JAMSHORO POWER GENERATION COMPLEX — PHASE II

ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT

FINAL DRAFT

January 1987

BECHTEL NATIONAL, INC.

Funded Under the Joint GOP-USAID Energy Planning and Development Project in Cooperation With Enerplan

36

ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT

FOR

JAMSHORO POWER GENERATION COMPLEX - PHASE II

FINAL DRAFT

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

LAHORE, PAKISTAN

Prepared by:

Bechtel National, Inc.
50 Beale Street
San Francisco, California 94105

January, 1987

37

Table of Contents

Section		Page
1.0	Introduction and Summary	1-1
	1.1 Introduction	1-1
	1.2 Purpose and Organization of this Report	1-2
	1.3 A.I.D. Reporting Requirements	1-4
	1.4 Proposed Action and Purpose	1-9
	1.5 Result of No Action	1-10
	1.6 Environmental and Social Impact of Action	1-10
2.0	Purpose and Need for the Jamshoro Project, Phase II	2-1
	2.1 Status of Utility	2-1
	2.1.1 Electric Power Supply Sources	2-1
	2.1.2 Historic Load Demand	2-2
	2.1.3 Future Load Demand Projections	2-2
	2.1.4 Generating Capacity of Existing Facilities	2-4
	2.1.5 Generation Expansion Program	2-7
	2.2 Proposed Power Development Program	2-13
3.0	Description and Comparison of Proposed and Alternative Actions	3-1
	3.1 No Action Alternative	3-1
	3.2 Alternatives to Proposed Action	3-9
	3.3 Proposed Action	3-15
4.0	Environmental and Social Setting	4-1
	4.1 Environment	
	4.1.1 Site Location and Topography	4-1
	4.1.2 Vegetation	4-8
	4.1.3 Wildlife	4-15
	4.1.4 Water Resources	4-21
	4.1.5 Geology, Physiography, Topography and Seismicity	4-29
	4.1.6 Meteorology	4-35
	4.1.7 Air Quality	4-47
	4.1.8 Noise	4-53
	4.2 Social and Institutional Considerations	4-55
	4.2.1 Population	4-55
	4.2.2 Land Use	4-59
	4.2.3 Facilities and Services	4-63
	4.2.4 Transportation	4-66
	4.2.5 Lifestyle, Cultural Patterns and Attitudes	4-68
	4.2.6 Cultural Resources	4-70
	4.3 Economic Considerations	4-72
	4.3.1 Employment	4-73
	4.3.2 Agriculture and Forestry	4-74
	4.3.3 Industry	4-74
	4.4 Public Health	4-75

3541G

as

38

Section				Page

5.0	Environmental and Social Impacts of the Proposed Action			5-1
	5.1	Environment		5-1
		5.1.1	Vegetation	5-1
		5.1.2	Wildlife	5-13
		5.1.3	Water Resources	5-23
		5.1.4	Air Quality	5-40
		5.1.5	Noise	5-67
	5.2	Social and Institutional Considerations		5-70
		5.2.1	Population	5-70
		5.2.2	Land Use	5-75
		5.2.3	Facilities and Services	5-77
		5.2.4	Transportation	5-85
		5.2.5	Lifestyle, Cultural Patterns, and Attitudes	5-89
		5.2.6	Cultural Resources	5-92
	5.3	Economic Considerations		5-93
		5.3.1	Employment	5-93
		5.3.2	Economic Benefits	5-96
		5.3.3	Adverse Economic Impacts	5-98
	5.4	Public Health and Occupational Safety		5-99
	5.5	Combined Effects of Phase I and Phase II		5-105
6.0	Monitoring and Mitigation			6-1
	6.1	Environment		6-1
		6.1.1	Vegetation	6-1
		6.1.2	Wildlife	6-5
		6.1.3	Water Resources	6-8
		6.1.4	Air Quality	6-19
		6.1.5	Noise	6-22
	6.2	Social and Institutional Considerations		6-24
		6.2.1	Adequate Land Use Planning	6-25
		6.2.2	Public Information Program	6-26
		6.2.3	Program for Hiring and Training Local Workforce	6-28
		6.2.4	Provisions of Adequate Commmunity Services and Infrastructure	6-29
		6.2.5	Adequate Housing for Construction Workers and Provision of a Worker's Colony During Operation	6-30
		6.2.6	Transportation Impact Mitigation	6-31
		6.2.7	Chance Find Procedures for Cultural Resources	6-34
		6.2.8	Program for Coordinated Management of Environmental and Socioeconomic Activaties of Phase I and Phase II	6-36
	6.3	Economic Considerations		6-38
	6.4	Public Health and Occupational Safety		6-39
7.0	Costs for Recommended Mitigation and Monitoring			7-1

Section		Page

Appendices

A	List of Preparers	A-1
B	References	B-1
C	Personal Contacts	C-1
D	Scoping Document	D-1
E	Proforma for Environmental Impact Assessment	E-1
F	Summary of Regulations and Permit Procedures	F-1
G	Recommended Solid Waste Management Plan	G-1
H	Meteorological Data	H-1
I	Water Resources Data	I-1
J	Archaeological Chance Find Procedures	J-1
K	Conversion Table for Weights and Measures	K-1

A(0)

LIST OF TABLES

Table		Page
1-1	Acronyms and Abbreviations	1-5
2-1	Historic Peak Demand and Energy Consumption, WAPDA System	2-3
2-2	Load Forecasts (MW) for WAPDA and KESC Systems	2-5
2-3	Existing Generating Capacity in Pakistan (MW) Total System (December 1984)	2-6
2-4	Existing Generating Facilities WAPDA System (December 1984)	2-8
2-5	Existing Thermal Generating Facilities KESC System (December 1984)	2-10
3-1	Comparison of Phase I and Phase II Design Features	3-2
3-2	Characteristics of Phase I Plant Emissions	3-5
4-1	Endangered and Vulnerable Species Potentially Occuring in the Study Area	4-18
4-2	Hyderabad Climatological Data (1931 to 1960)	4-22
4-3	Summary of Indus River Water Quality Upstream of Kotri Barrage	4-26
4-4	Ground Water Quality for Jamshoro Area	4-30
4-5	Generalized Stratigraphy of the Lakhara Anticline Area	4-32
4-6	Meteorological Data Collected at the Lakhara and Jamshoro Monitoring Stations from May 1985 to April 1986	4-46
4-7	Stack Parameters for Two 250-MW Units Firing Lakhara Coal (with Common Stack, Dual Flue)	4-49
4-8	Emissions from Two 250-MW Units Firing Lakhara Coal	4-50
4-9	Summary of Total Suspended Particulate Matter Concentrations for Jamshoro and Lakhara Monitoring Stations May 1985 through September 1986	4-52

35896

41x

Table		Page
4-10	Air Quality Standards and Guidelines for TSP, SO_2 and NO_2 for the World Bank	4-54
4-11	Basic Noise Criteria for Residences in Different Land Use Areas	4-56
4-12	Estimated Community Response to Noise	4-57
5-1	Comparison of Predicted Maximum Concentration (ug/m^3) of SO_2 in Agricultural Area with Known Effect Levels to Kharif and Rabi Crops	5-7
5-2	Comparison of Known Effects of SO_2 to Native Vegetation from Arid Areas to Predicted Maximum Concentrations	5-11
5-3	Reported Effects of SO_2 to Floodplain Trees and Native Woody Legumes in North America	5-12
5-4	Priority Pollutants Detected by USEPA Sampling Program by Waste Stream Sources	5-29
5-5	Proprietary Chemicals Used by Power Plants and Containing USEPA Priority Pollutants	5-31
5-6	Boiler Blowdown Characteristics	5-32
5-7	Recommended Guidelines for Treated Irrigation Water	5-35
5-8	Characteristics of the Proposed Power Plant Emissions	5-44
5-9	Estimated Emissions from Existing Sources (g/s)	5-45
5-10	Jamshoro II Stack Height Sensitivity	5-49
5-11	Comparison of Maximum Predicted Ambient Pollutant Concentrations with World Bank Guidelines	5-50
5-12	Percentile SO_2 Impacts Due to the Proposed Lakhara and Jamshoro Phases I and II Power Plants in the Agricultural Area	5-61
5-13	Air Quality Impacts Due to the Proposed Lakhra and Jamshoro Phases I and II - Power Plants in the Agricultural Areas	5-62

Table		Page
5-14	Comparison of Pollutant with World Bank Guidelines	5-63
5-15	Typical Noise Emissions from Power Plant Equipment	5-69
5-16	Projected Number of Workers and Dependents During Peak Construction and Operation for Phase II of the Jamshoro Project	5-71
5-17	Estimated Number of Workers, Dependents, and Secondary Population Moving into the Project Area for Phase II	5-73
5-18	Available Skilled and Unskilled Workers in Hyderabad Area, and Estimated Number of Local Hires for Phase II	5-95
5-19	Occupational Injury and Illness Incidence Rates, U.S.A. 1983	5-103
6-1	Summary of Recommended Environmental and Socioeconomic Mitigation Activities	6-45
6-2	Proposed Air Quality Monitoring Programs	6-21
7-1	Capital and Recurrent Costs (U.S.$) of Recommended Additional Monitoring and Mitigation Measures	7-3

LIST OF FIGURES

Figure		Page
3-1	Predicted Annual Average SO_2 Concentrations (ug/m^3) (Impacts of Jamshoro - Phase I)	3-6
3-2	Predicted Annual Average NO_x Concentrations (ug/m^3) (Impacts of Jamshoro - Phase II)	3-7
3-3	Predicted Annual Average Particulate Matter Concentrations (ug/m^3) (Impacts of Jamshoro Phase I)	3-8
3-4	Location of Pipeline Route Alternatives	3-10
3-5	Arrangement of Power Plant Facilities	3-18
3-6	Arrangement of Intake Facilities	3-18
3-7	Phase I Water Intake Structure	3-30
4-1	Location of Jamshoro Project Area	4-2
4-2	Terrain in Vicinity of Jamshoro Project Site	4-3
4-3	Jamshoro Site Looking North from Meteorological Station	4-4
4-4	Jamshoro Site Looking East from Meteorological Station	4-5
4-5	Jamshoro Site Looking South from Meteorological Station	4-6
4-6	Jamshoro Site Looking West from Meteorological Station	4-7
4-7	Liaquat Medical Dormatories Looking West From Indus Highway	4-9
4-8	West Bank, Indus River, North Hyderabad, near Proposed Site of Water Intake Structures	4-10
4-9	Cotton Field near West Bank, Indus River, North Hyderabad. Typical of Fields Stressed by Saline Deposits near Surface	4-14
4-10	Soundings of Indus River at Khanot	4-24
4-11	Water Quality Monitoring Stations Locations, 1985	4-25

44

Figure		Page
4-12	Subsurface Profile A-A Jamshoro Site	4-34
4-13	Seismic Risk Map of Karachi, Hyderabad Divisions and Lasbella District, Pakistan, 1984	4-36
4-14	Wind Rose for Lakhra/Jamshoro for Winter Months	4-38
4-15	Wind Rose for Lakhra/Jamshoro for Summer Months	4-39
4-16	Existing and Projected Point Sources in the Project Area	4-48
4-17	Land Use in the Study Area	4-60
5-1	Indus River Water Flow	5-26
5-2	Predicted Annual Average SO_2 Concentrations (ug/m^3) for Scenario B (Impacts of Jamshoro - Phase I and Lakhara Power Plants)	5-53
5-3	Predicted Annual Average SO_2 COncentration (ug/m^3) for Scenario C (Impacts of Jamshoro - Phases I and II and Lakhara Power Plants)	5-55
5-4	Predicted Maximum 24-hr Average SO_2 Concentrations (ug/m^3) for Scenario C (Impacts of Jamshoro - Phases I and II and Lakhara Power Plants)	5-56
5-5	Predicted Annual Average NO_x Concentrations (ug/m^3) for Scenario C (Impacts of Jamshoro - Phases I and II and Lakhara Power Plants)	5-57
5-6	Predicted Annual Average POM Concentrations (ug/m^3) for Scenario C (Impacts of Jamshoro - Phases I and II and Lakhraq Power Plants)	5-58
5-7	Predicted Maximum 24-hr Average PM Concentrations (ug/m^3) for Scenario C (Impacts of Jamshoro- Phases I and II and Lakhara Power Plants)	5-60

A5'

1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

The Pakistan Water and Power Development Authority (WAPDA) is in the process of developing a major oil-fired electricity generating complex at Jamshoro, near the City of Hyderabad in Sind Province, Pakistan. Phase I of the complex, which is now under construction, consists of four generating units with a total capacity of 880 MW. Phase II will expand the complex by adding three 350-MW units (total of 1050 MW) and all associated facilities and structures. The facilities of Phases I and II will be contiguous; the plant will have a total station capacity of 1,930 MW.

This report presents an analysis of the environmental and socioeconomic consequences likely to be associated with construction and operation of Phase II of the Jamshoro Power Generation Complex.

The document discusses the need for, and considers alternative approaches to Phase II. The environmental and socioeconomic setting of the area is described, and possible effects to the natural and human environment resulting from Phase II are outlined. In addition, monitoring and mitigation actions relevant to the proposed activities are discussed.

46

1.2 PURPOSE AND ORGANIZATION OF THIS REPORT

This report provides the Government of Pakistan (GOP), the Pakistan Water and Power Development Authority (WAPDA), the U.S. Agency for International Development (USAID), and other donors a discussion of significant environmental and social effects of the planned oil-fired power plant and associated fuel supply pipeline. The Environmental and Social Soundness Assessment evaluates alternatives and identifies mitigation measures which will avoid or minimize adverse effects to the environment, or which will enhance its quality, so that the expected benefits of development objectives can be weighed against any adverse impacts upon the human and natural environment. In addition, environmental monitoring programs are recommended which will follow the project's impacts and assist in mitigation of environmental effects as they occur.

This assessment is organized as follows:

- Section 1.0 presents a summary description of the proposed action, impacts of the proposed action, and the result of the "no action" alternative.

- Section 2.0 discusses the purpose or and need for the project.

- Section 3.0 describes and compares the proposed and alternative actions.

- Section 4.0 describes the existing environmental and social setting.

- Section 5.0 presents an analysis of the consequences of the proposed action.

- Section 6.0 discusses proposed monitoring programs and mitigation activities.

- Section 7.0 presents costs of recommended monitoring and mitigation.

- Appendices: Contain a list of preparers of this Assessment, bibliographic references from the text, principal personal contacts made in preparation of the report, and technical material supporting report discussions.

In accordance with 22 CFR Part 216.3(a)(4), a scoping session was held in Hyderabad, Pakistan, on October 6, 1986 to further identify environmental and social concerns of the host country. A record of the scoping session and a list of participants is presented in Appendix D. Issues raised at the scoping session are cross-referenced to this report. Issues raised in the Pro Forma Environmental Assessment

48

required by Government of Pakistan Ordinance XXXVII are cross-referenced to this report in Appendix E.

Table 1-1 presents a list of acronyms and abbreviations used in this report. Appendix K presents a metric/English conversion table.

1.3 AID REPORTING REQUIREMENTS

The United States Agency for International Development (AID) has provided the funds to support the Jamshoro Power Generation Complex - Phase II feasibility studies. Owing to this involvement, AID is required by U.S. law to fully consider the environmental and social consequences of the project. Since 1976, AID has required the preparation of environmental assessments under the provisions of 22 CFR 216, "AID Environmental Procedures," for all projects which could potentially have a "significant effect" on the environment. Considering its size and scope, the Jamshoro Project has the potential to significantly affect the environment.

Should the project be constructed as planned, the Government of Pakistan anticipates requesting funding from World Bank which will evaluate the project in accordance with its own environmental policies and guidelines; these have been considered in preparation of this report. The activities of Phase I at Jamshoro are vendor financed and hence, only Pakistan guidelines will apply. Although Phase I facilities were not subject to an evironmental assessme...

Table 1-1

Acronyms and Abbreviations

Acronyms

AAQS	Ambient Air Quality Standards
BOD_5	Biochemical Oxygen Demand (5 days at 20°C)
cfs	cubic feet per second
cms	cubic meters per second
CO	carbon monoxide
COD	chemical oxygen demand
cusecs	cubic meters per second
dB	decibels
dBA	decibel (A weighted sound level)
°C	degrees Centigrade
E.E.C.	European Economic Community
GCII	Gilbert Commonwealth International, Inc.
gpm	gallons per minute
GOP	Government of Pakistan
GWh	kWh x 10^6
ha.y.	hectare/year
hr	hour
ISC	Industrial Source Complex
ISO	International Organization for Standardization
KESC	Karachi Electric Supply Corporation
km	kilometer
kV	kilovolt
kWh	kilowatt hour
$L_{eq(1)}$	environmental equivalent noise level
m	meter
MBtu	British Thermal Units x 1,000,000
mg/L	milligrams per liter
MgO	magnesium oxide
mm	millimeters
m/s	meters per second

AR:7149d

50

Table 1-1 (cont'd)

Acronyms

MW	megawatt
ng/J	nanograms/Joule
NCCW	National Council for Conservation of Wildlife
NO_x	oxides of nitrogen
PAEC	Pakistan Atomic Energy Sector
PEPA	Pakistan Environmental Protection Agency
PM	particulate matter
ppb	parts per billion
Rs	rupees
SO_2	sulfur dioxide
T&T	Telephone and Telegraph Authority of Pakistan
TDS	total dissolved solids
TSP	total suspended particulate
TSS	total suspended solids
u	micron
ug	micrograms
U.S.	United States of America
USAID or AID	United States Agency for International Development
USEPA or EPA	United States Environmental Protection Agency
VOC	volatile organic compounds
WAPDA	Pakistan Water and Power Development Authority
WB	World Bank
WHO	World Health Organization

presented here for Phase II, attempts were made whenever sufficient information was available to assess the combined effects of Phases I and II of the Jamshoro Complex in this environmental and social soundness document.

The objectives of this environmental assessment are:

- To ensure that the environmental consequences of project activities are identified and considered

- To ensure that appropriate environmental safeguards are adopted, prior to a final decision to proceed

This assessment also responds to the Government of Pakistan Ordinance XXXVII of 1983, "Control of Pollution and Protection of the Living Environment," and serves as the primary reference document for a Pro Forma environmental document prepared to satisfy requirements of the Pakistan Environmental Protection Agency (see Appendix E).

Environmental assessments conducted by U.S. AID in foreign locations are not subject to the standardized procedures normally followed for domestic U.S. projects. Generally, only the most significant environmental effects of a proposed action are identified. These significant effects are then used as the basis for the evaluation of project alternatives before proceeding to a final decision.

The requirement for an analysis of the social effects of a project is described in AID Handbook 3, Appendix 3F, "Social Soundness Analysis." According to the Handbook, the social soundness analysis has three objectives:

- To ensure the compatibility of the project with the social and cultural environment in which it is to be introduced

- To increase the likelihood that new institutions introduced among a population will be diffused among other groups

- To ensure distribution of benefits and of burdens among different groups

Both the environmental and social soundness assessments are presented herein. They consider the above objectives and present a technical analysis to:

- Inform decision-makers and project designers of the potential environmental and social impacts of proposed projects

- Provide a consistent basis for evaluation of technical alternatives

- Identify possible mitigation activities

52

Environmental and social soundness assessments do not recommend a specific technical course of action for a project, nor do they determine whether a project should or should not be undertaken. Instead, AID environmental and social soundness assessments provide decision makers with information that should be evaluated in conjunction with other detailed investigations relating to engineering, economics, and financing to produce an effective project design. This assessment was prepared in coordination with World Bank and is in compliance with their environmental guidelines, since World Bank financial participation in the project is possible.

1.4 PROPOSED ACTION AND PURPOSE

Phase II of the Jamsboro Power Generating Complex will consist of three 350-MW units and all associated facilities and structures, including a pipeline from Karachi to the plant site. The facilities of Phases I and II will be contiguous; the total station capacity will be 1,930 MW.

The shortage of electric power is one of the most serious limitations to the economic and social development of Pakistan. WAPDA's planned expansion of the Jamshoro Power Generating Complex, as represented by the 1,050 MW Phase II development, will partly meet the urgent national need for electricity. In addition, the project will also assist the Government of Pakistan (GOP) to:

- Balance the national power grid

524

- Reduce load shedding and associated adverse economic consequences of this disruption

- Generate employment

- Provide domestic economic and industrial development

1.5 RESULT OF NO ACTION

The no-action alternative would involve no construction of Phase II power generation facilities at Jamshoro. To meet its existing and projected energy needs and alleviate load shedding and associated socioeconomic impacts, Pakistan has projected that it will need approximately 800-1,400 MW of new capacity each year until the turn of the century. Although national energy conservation could produce benefits, it would not by itself lower demand sufficiently to eliminate the need for additional generation. Therefore, the no-action alternative would worsen the current shortage of electrical energy and the associated socioeconomic impacts.

1.6 ENVIRONMENTAL AND SOCIAL IMPACT OF ACTION

The construction and operation of Phase II of the Jamshoro Project will have impacts on the physical, biological, and social environments. However, the majority of these impacts will be site specific, short term, and insignificant. The few that are potentially significant

54

would be mitigated or prevented, and actions to achieve this are presented in this report.

The impacts of Phase II will be directly affected by the construction and operation of the Phase I facilities. However, in some cases the information regarding Phase I environmental protection methods is insufficient to assess completely the impacts of the Phase I development and to compare these with Phase II. For example, both Phase I and Phase II will withdraw fresh water for operations from the Indus River. Phase II will employ screening and a fish return system, while Phase I will not. Biological monitoring upstream and downstream of the point of discharge will be necessary to assess environmental effects of Phase I, but not for Phase II intake.

On the other hand, air emissions from Phase I have been estimated satisfactorily based on power generation capacity, fuel quality, and state-of-the-art operations. Thus, the combined effects of air emissions for Phase I and II are projected and discussed in this report.

The impact of air emissions on the region should be minimal. The estimated increase of particulate emissions will represent only approximately 1 percent of the present background value, although it should be noted that natural annual average ambient particulate levels of approximately 200 u/m^3 in the Hyderabad region already exceed the World Bank guideline of 100 ug/m^3 (annual average).

56*

Biological impacts will be localized, site specific, and considered not significant in view of population densities and distribution of affected flora fauna and habitat. No unique ecosystems are involved extensively and, in certain instances, potentially harmful environmental consequences can be avoided. In addition, irrigated landscaping and expanded agriculture using treated wastewater from the project should result in a net improvement in the quality of the local environment.

Both beneficial and adverse impacts on the socioeconomic environment will occur with the construction and operation of Phase II of the Jamshoro Project. Economic benefits will include growth in the agricultural and industrial sectors resulting from the local availability of irrigation water, increased generation of electricity, increased business activity for the project area and Sind Province, and increased taxes and duties collected by the Governments of Pakistan, Sind, and the Dadu and Hyderabad Districts.

A change in employment pattern will occur with the peak onsite construction labor force estimated at 2,500 workers plus 3,750 dependents. During operation, a peak labor force of 740 workers is anticipated with 4,440 dependents. The increased population will result in an increased demand for facilities and services. Development of secondary infrastructure will mitigate a majority of the impacts, as will the provision of a workers' colony with adequate facilities for workers and their dependents.

52

A program to inform the public about the project will help reduce negative attitudes and inform the local population both of the benefits and any adverse impacts of the project. The success of this information program will require preparation of a communication plan and involvement of local concerned individuals, especially representatives of academic institutions, clinics, and hospitals.

To ensure that environmental and mitigation programs continue to provide the desirable effects intended, several continuing monitoring programs should be instituted to verify success. These include programs to monitor ground-level air pollutant levels, measure stack gas emissions, check for soil contamination from evaporation ponds, ensure the quality of irrigation water, and verify the effectiveness of training activities and socioeconomic programs.

Continuing coordination of environmental and socioeconomic activities between both Phases I and II is essential for the success of these programs. This will require formation of a management team charged with the specific responsibility of directing these activities. If this is not done, it will be extremely difficult to isolate the causes of spills or to assign responsibility for remedial actions should problems occur.

2.0 PURPOSE AND NEED FOR THE JAMSHORO PROJECT, PHASE II

2.1 STATUS OF UTILITY

The shortage of electric power is one of the primary factors limiting the economic and social development of Pakistan. Development of additional sources of electric power is necessary to meet current and potential energy demands.

2.1.1 ELECTRIC POWER SUPPLY SOURCES

Electric power in Pakistan is supplied by:

- Water and Power Development Authority (WAPDA)
- Karachi Electric Supply Corporation (KESC)
- Pakistan Atomic Energy Commission (PAEC)
- Private sector

WAPDA is responsible for the electric power supply for all of Pakistan except a few areas that are the responsibility of KESC, including the city of Karachi and certain areas in the province of Baluchistan. A nuclear generating facility at Karachi owned and operated by PAEC feeds directly into the KESC system. Electric energy generated by private sector facilities is dispersed throughout Pakistan. The interconnection of the WAPDA and KESC systems was upgraded to 220 kV in 1985.

59x

2.1.2 HISTORIC LOAD DEMAND

Pakistan has experienced a shortage of electric energy in recent years. The historic peak demand and energy consumption of the WAPDA system are presented in Table 2-1. During the period 1976 to 1984, the peak demand and energy consumption in WAPDA's system increased at an average annual growth rate of 10.8 percent and 11.0 percent, respectively. The 11-percent annual growth of consumption just equals the increased supply. The annual increases in peak demand and energy consumption would surely have been higher had sufficient generating capacity been available to meet the actual load.

Heavy load shedding - scheduled regional power outages - have adversely affected the social conditions and economic development of Pakistan. This is particularly true in the industrial and agricultural sectors which together account for more than 50 percent of energy consumption.

2.1.3 FUTURE LOAD DEMAND PROJECTIONS

Expanded generating capacity in the country is required to meet not only the growth in the existing loads, but also the increased electric demand anticipated within the country. The additional capacity will be provided primarily by hydroelectric and thermal power generation units; additional thermal capacity is required to make up a reduction in

Table 2-1

Historic Peak Demand and Energy Consumption, WAPDA System(1)

Year	Peak Demand		Energy Consumption	
	MW	% Increase	GWh	% Increase
1976-77	1,620		8,734	
77-78	1,836	13.3	10,089	15.5
78-79	1,972	7.4	10,609	5.2
79-80	2,076	5.3	12,124	14.3
80-81	2,473	19.1	13,206	8.9
81-82	2,846	15.1	14,768	11.8
82-83	3,163	11.1	16,492	11.7
83-84	3,295	4.2	18,052	9.5

(1) Does not include peak demand and energy consumption of the KESC system.

Source: WAPDA Power System Statistics, Ninth Issue, November 1984.

generating capacity of hydroelectric units during the low water season (January through June), during which the net available hydroelectric capacity can be reduced by as much as 60 percent of rated capacity. In addition, Pakistan has instituted a national energy conservation program addressed to industry, the commercial building sector, and agricultural users. This program will foster more efficient end-use of electricity and oil. WAPDA is also negotiating with the World Bank for support of a program of rehabilitation for all existing thermal plants.

Pakistan is a developing country, and there is substantial opportunity for the expansion of the country's electric power supply system to satisfy increasing needs for power. Table 2-2 presents the load forecasts for WAPDA, KESC, and the integrated WAPDA and KESC systems. For the integrated system, both undiversified and diversified load forecasts are shown. The diversification between the two systems is assumed to be 97 percent. The load for the integrated system is projected to increase at an average annual growth rate of 9.5 percent between 1985 and 2000.

2.1.4 GENERATING CAPACITY OF EXISTING FACILITIES

The existing generating capacity of all power supply sources in Pakistan for the total system is 5,233 MW (Table 2-3). The capacity for each of the entities (WAPDA, KESC, PAEC, and private sector) that

Table 2-2

Load Forecasts (MW) for WAPDA and KESC Systems

Year	WAPDA	KESC	Total Undiversified (MW)	Total Diversified (MW)
1985-86	4,121	908	5,029	4,883
1986-87	4,517	998	5,515	5,354
1987-88	4,955	1,098	6,053	5,877
1988-89	5,436	1,197	6,633	6,440
1989-90	5,963	1,304	7,267	7,055
1990-91	6,541	1,422	7,963	7,731
1991-92	7,176	1,550	8,726	8,472
1992-93	7,872	1,689	9,561	9,283
1993-94	8,636	1,824	10,460	10,155
1994-95	9,473	1,970	11,443	11,110
1995-96	10,392	2,128	12,520	12,155
1996-97	11,400	2,298	13,698	13,299
1997-98	12,506	2,482	14,988	14,551
1998-99	13,506	2,656	16,162	15,691
1999-2000	14,587	2,842	17,429	16,921
2000-2001	15,754	3,040	18,794	18,247
2001-2002	17,014	3,253	20,267	19,677
2002-2003	18,375	3,481	21,856	21,219
2003-2004	19,661	3,690	23,351	22,671
2004-2005	21,038	3,911	24,949	24,222
2005-2006	22,510	4,146	26,656	25,880
2006-2007	24,086	4,395	28,481	27,651
2007-2008	25,772	4,658	30,430	29,544
2008-2009	27,576	4,938	32,514	31,567
2000-2010	29,506	5,234	34,740	33,728

Source: WAPDA

Table 2-3

Existing Generating Capacity (MW) in Pakistan
Total System (December 1984)

Entity	Existing Generating Capacity (MW)	Percentage of Total System Capacity
WAPDA	3,989	76
KESC	1,028	20
PAEC	125	2
Private Sector	91	2
Total	5,233	100

Sources: WAPDA Power System Statistics, Ninth Issue, November 1984
KESC Total Generating Capacity and System Load Demand, November 1984.

own and operate these facilities is listed. The WAPDA system has a total generating capacity of 3,989 MW consisting of 2,547 MW of hydroelectric and 1,442 MW of thermal units. The hydroelectric capacity constitutes 64 percent of the total installed capacity of the WAPDA system. The existing generating facilities of the WAPDA system are shown in Table 2-4.

The KESC system has a total generating capacity of 1,028 MW, composed entirely of thermal units. KESC's system is augmented by the nuclear generating facility operated by PAEC, which has a generating capacity of 125 MW. The thermal generating facilities of the KESC system are shown in Table 2-5. The additional generating capacity of the private sector totals 91 MW, which constitutes only 2 percent of the total system capacity.

2.1.5 GENERATION EXPANSION PROGRAM

In the latest power plant development plan, WAPDA (1986) has identified the following goals:

- Electrification of 90 percent (40,700) of the villages in Pakistan by June 1990

65X

Table 2-4

Existing Generating Facilities
WAPDA System (December 1984)

Name of Power Station	Number of Units and Capacity (MW)	Total Installed Capacity (MW)
Hydroelectric		
Tarbela	8 x 175	1,400
Mangla	8 x 100	800
Warsak	6 x 40	240
Dargai	4 x 5	19.6
Malakand	3 x 3.2 2 x 5	20 (5 units)
Rasul	2 x 11	22
Chichoki	3 x 4.4	13
Shadiwal	2 x 6.75	14
Nandipur	3 x 4.6	14
Kurram Garhi	4 x 1	4
Renals	5 x 0.22	1
Subtotal Hydroelectric		2,547
Thermal		
Multan Steam	4 x 65	260
Faisalabad Steam	2 x 66	132
Faisalabad Gas Turbines	8 x 25	200
Shahdara	2 x 13.25 4 x 14.75	85 6 units)
Guddu Steam	2 x 110 1 x 210	430 3 units)
Sukkur Steam	4 x 12.5	50
Hyderabad Steam (Gas Turbine Auxiliary)	2 x 7.5 1 x 5.7 1 x 8 1 x 15	43 5 units)

Table 2-4 (Cont'd)

Name of Power Station	Number of Units and Capacity (MW)	Total Installed Capacity (MW)
Kotri Gas Turbines	2 x 15 4 x 25	130 (6 units)
Quetta	2 x 7.5	83
Steam	1 x 5.7	(6 units)
Gas	1 x 12.25	
Gas	1 x 25	
Gas	1 x 35	
REPCO (taken over by WAPDA)	1 x 1.5 1 x 2.0 1 x 2.28 1 x 3.30	9 (4 units)
MESCO Steam (taken over by WAPDA)	2 x 10	20
Subtotal Thermal		1,442

Source: WAPDA Power System Statistics, Ninth Issue, November 1984.

674

Table 2-5

Existing Thermal Generating Facilities
KESC System (December 1984)

Name of Power Station	Number of Units and Capacity (MW)	Total Installed Capacity (MW)
Korangi Steam	2 x 66 2 x 125	382 (4 units)
West Wharf	2 x 15 2 x 33	96 (4 units)
Site Gas Turbine	5 x 20	100
Korangi Town Gas Turbine	4 x 20	80
Dual Fuel	12 x 1.25	15
Pipri No. 1 Steam	1 x 200	200
Pipri No. 2 Steam	1 x 200	200
Total		1,073

Note: Some of the existing units are due for retirement; therefore, the total KESC installed capacity on interconnection with the national grid in 1985 will amount to 1,028 MW.

- Complete elimination of load shedding by January 1990

- Addition of 2,900 MW of generation by December 1989 and 11,198 MW by December 1995

- Addition of about 1,900 km of 500-kV and 220-kV transmission lines by 1990-1991

- Implementation of load management and tariff rationalization measures

- Continuation of electrical loss reduction program

- A total investment outlay (excluding Kalabagh project) of about Rs 116 billion by 1991

- To ensure a self-financing ratio of 40 percent, an annual increase in average energy sale price of about 23 percent over the next 4 years (not considering inflation)

The existing electrical energy generating capacity cannot supply either the current or projected energy demands to attain these goals. Consequently, a generation expansion program for the integrated power system of Pakistan is planned from 1985 to 2000 to meet the estimated 800 MW/year of additional generating capacity required in the early

69

1990s to alleviate the existing shortage and to provide for future needs. Pakistan plans to add 21,101 MW of new capacity by the year 2000, compensating not only for the needs of the 1990s, but for continuing needs through the end of the century.

Of this new capacity, 9,151 MW will be hydroelectric (approximately 43 percent of the additional capacity); therefore, hydroelectric plants will continue to provide a large portion of the electric energy in Pakistan. In addition, Pakistan plans to add 4,500 MW of nuclear capacity by the year 2000. This constitutes approximately 21 percent of the additional capacity. The remaining capacity will be based on coal (13 percent), oil (11 percent), gas (9 percent), and combined cycle (3 percent).

2.2 PROPOSED POWER DEVELOPMENT PROGRAM

As part of its program of constructing new facilities, WAPDA is planning the construction of a major oil-fired electricity generating complex at Jamshoro on the Indus River upstream of the city of Hyderabad, referred to herein as the "Jamshoro Complex." At the present time, WAPDA is about to issue a Letter of Award for the first of seven generating units. It will have a capacity of 250 MW. Preliminary activity has begun toward authorization of the second, third, and fourth units, each at a capacity of 210 MW, for a total

capacity of 880 MW. These first four units comprise Phase I of the Jamshoro Complex. The fifth, sixth, and seventh units are expected to have a capacity of 350 MW each for a total station capacity of approximately 1,930 MW. These three units comprise Phase II of the Jamshoro Complex.

The fuel oil supply for the Jamshoro Complex will be imported through the existing port of Karachi and transported via pipeline to the site.

Tenders for Jamshoro Unit I were opened in January 1986, and are presently in advanced stages of evaluation. The award is expected to be announced in the near future. A contract for Jamshoro Units 2, 3, and 4 is being negotiated with the Chinese suppliers. Site preparation work on Phase I has already begun.

3.0 DESCRIPTION AND COMPARISON OF PROPOSED AND ALTERNATIVE ACTIONS

This section presents a description of the proposed project and alternatives considered for the proposed project, including the alternative of not building the Phase II facilities (no action alternative).

3.1 NO ACTION ALTERNATIVE

In this case there would be no construction of Phase II power generation facilities at Jamshoro. Phase I facilities, presently under construction at the site, would require approximately 100 acres of land. Phase II facilities would require an additional 70 acres of land; and approximately 1100 acres of land along the pipeline route would be temporarily disturbed during construction. Table 3-1 compares facilities for the two phases of the Jamshoro Complex.

Allowing for limited economies of scale, for the purpose of much of this report Phase II was considered to represent a doubling of Phase I in the analyses of certain impacts presented in Section 5.

Table 3-2 presents projected air emissions for Phase I alone. Figures 3-1, 3-2, and 3-3 depict projected ground level concentrations of SO_2, NO_x and particulates for Phase I only.

Table 3-1

COMPARISON OF PHASE I AND PHASE II DESIGN FEATURES

Design Feature	Phase I	Phase II
Unit Size	1 x 250 MW and 3 x 210 MW	3 x 350 MW
Fuel	Furnace oil	Furnace oil
River Water Intake		
Flow	4,300 gpm (unit 1 only)	15,000 gpm
Design	For Unit 1, two 60% capacity high water pumps and two 60% capacity low water pumps suspended from an intake tower. Bar screens with 10 cm spacing are provided to protect pumps. Units 2, 3, and 4 are similar	Submerged low velocity intake in the river with two piping leading to an onshore pumphouse. The pumphouse will have three 1/3-capacity pumps, traveling water screens with 9.5 mm mesh and fish return line, and a sediment trap
Wastewater	The following information was obtained from Unit 1 document, but Units 2, 3, and 4 are similar	All wastewater streams except metal cleaning waste will comply with USEPA effluent guidelines so as to be suitable for reuse in irrigation. Individual streams are treated as follows:
	Cooling tower blowdown will be released for irrigation	Cooling tower blowdown will be discharged continously except when chlorine residual exceeds 0.2 mg/l
	Steam generator blowdown will be discharged to the evaporation pond	Steam generator blowdown will be recycled to the cooling tower
	Water treatment wastes will be neutralized and then discharged to the evaporation pond	Water treatment wastes will be neutralized and then discharged to the evaporation pond
	Plant drains will be treated for removal of oil and grease then discharged to the evaporation pond	Plant drains will be treated for removal of oil, grease, and suspended solids and then neutralized
	Wastewater from air preheater washing and boiler chemical cleaning will be neutralized and then discharged to the evaporation pond	Metal cleaning wastes from steam generator chemical cleaning and non-chemical cleaning of the steam generator and air preheater will be neutralized and discharged to a lined evaporation pond
	Sanitary wastes from the plant building will drain to septic tanks. Contents of septic tanks will be transferred to the evaporation ponds	Sanitary wastes will receive secondary treatment and then be dicharged to the lined evaporation pond

Table 3-1 (Cont'd)

Design Feature	Phase I	Phase II
Solid Waste	All streams containing suspended solids are sent to the evaporation ponds	Suspended solids concentration in the coolin tower blowdown will meet USEPA effluent guidelines and therefore this stream will no produce any solid waste Streams from the water treatment systems that contain suspended solids will be recycled to the retention basins. Periodic dredging of the retention basins will be required to remove the settled solids. Since this material consists of silt from the river water and nonpolluting treatment chemicals, it will be placed in a landfill Solids from the plant drains will be placed in a landfill. Oil and grease will be disposed of off-site or recycled in the plant Solids from metal cleaning wastes will remain in the evaporation pond Solids from sanitary treatment will be placed in a landfill
Noise	Maximum noise level at the site boundary will be 70 dBA	Maximum noise level at site boundary will be 70dBA
Air Quality		
Emissions	Combined emissions of SO_2 and NO_2 from Phase I and Phase II are less than the World Bank criteria	See Phase I
	SO_2, NO_2, and particulated emissions are less than pre-1990 Pakistan standards but exceed post-1990 standards for NO_2 and particulates	SO_2, NO_2, and particulate emissions are less than the pre-1990 and post-1990 Pakistan standards
Ambient Concentrations	Combined concentrations of 24-hour and annual SO_2, 24-hour particulate and annual NO_2 are less than EPA and World Bank standards. The annual particulate concentration exceeds the World Bank and EPA standards due to high background	See Phase I

74

This page intentionally left blank

Table 3-2

Characteristics of the Phase I Plant Emissions
Jamshoro Oil-Fired Unit

Characteristics	Phase I[1]
Capacity (MW)	250 + 3 x 21
Estimated Emissions[2] (g/s)	
SO_2	3,897
NO_x	471
Particulate Matter	282
Stack Characteristics	
Height (m)	150
Diameter (m)	4.5
Gas Velocity (m/s)	20
Gas Temperature (K)	400
Oil Sulfur Content (maximum percent)	3.5

(1) Phase I consists of one 250 MW Japanese unit and three 210 MW Chinese units. Data were obtained by Mr. K. Kosky from the Pakistan Water and Power Development Authority (7 October 1986)
(2) At 100% capacity

76X

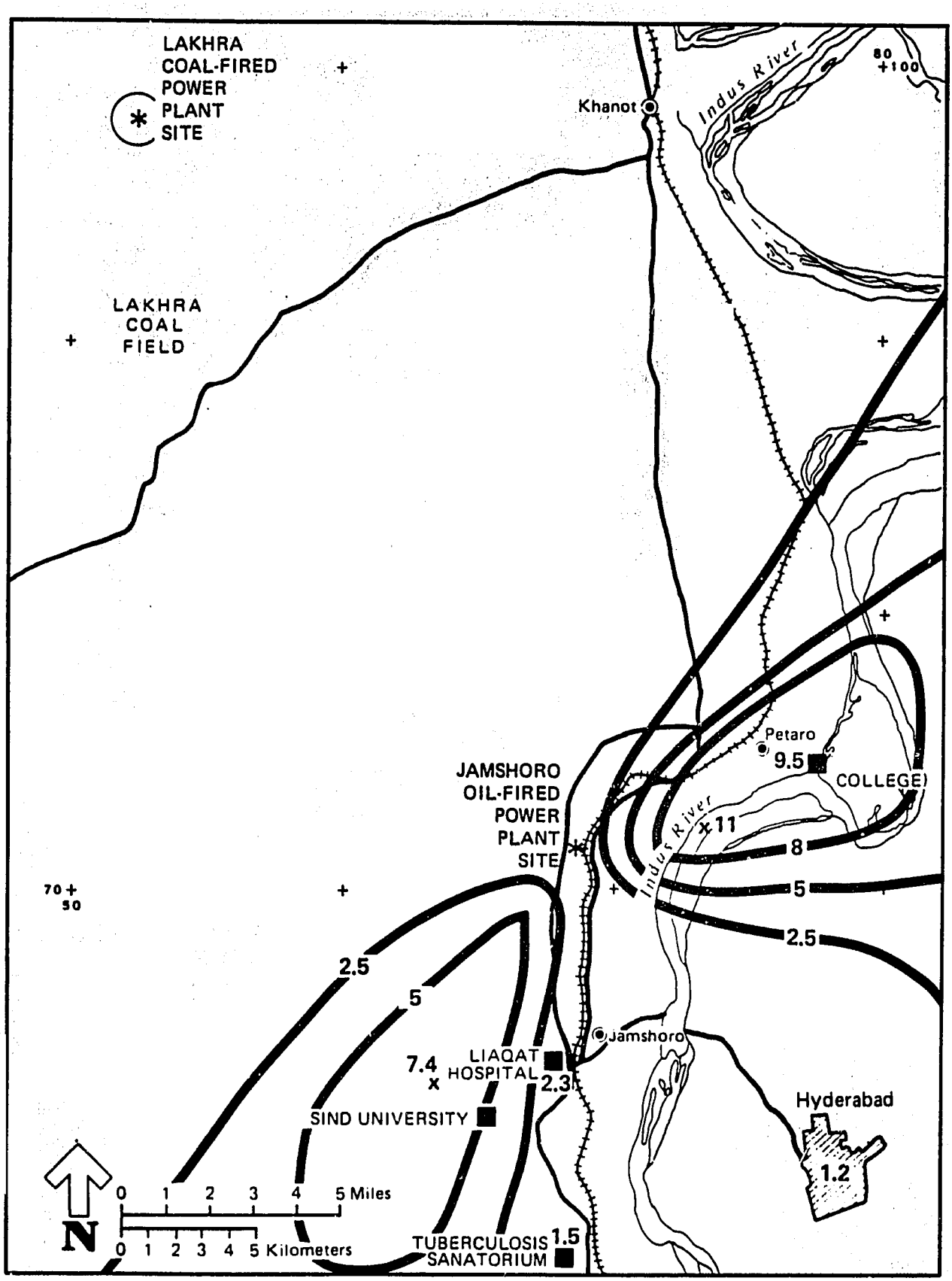


Figure 3-1 Predicted Annual Average SO_2 Concentrations ($\mu g/m^3$)
(Impacts of Jamshoro - Phase I)

77

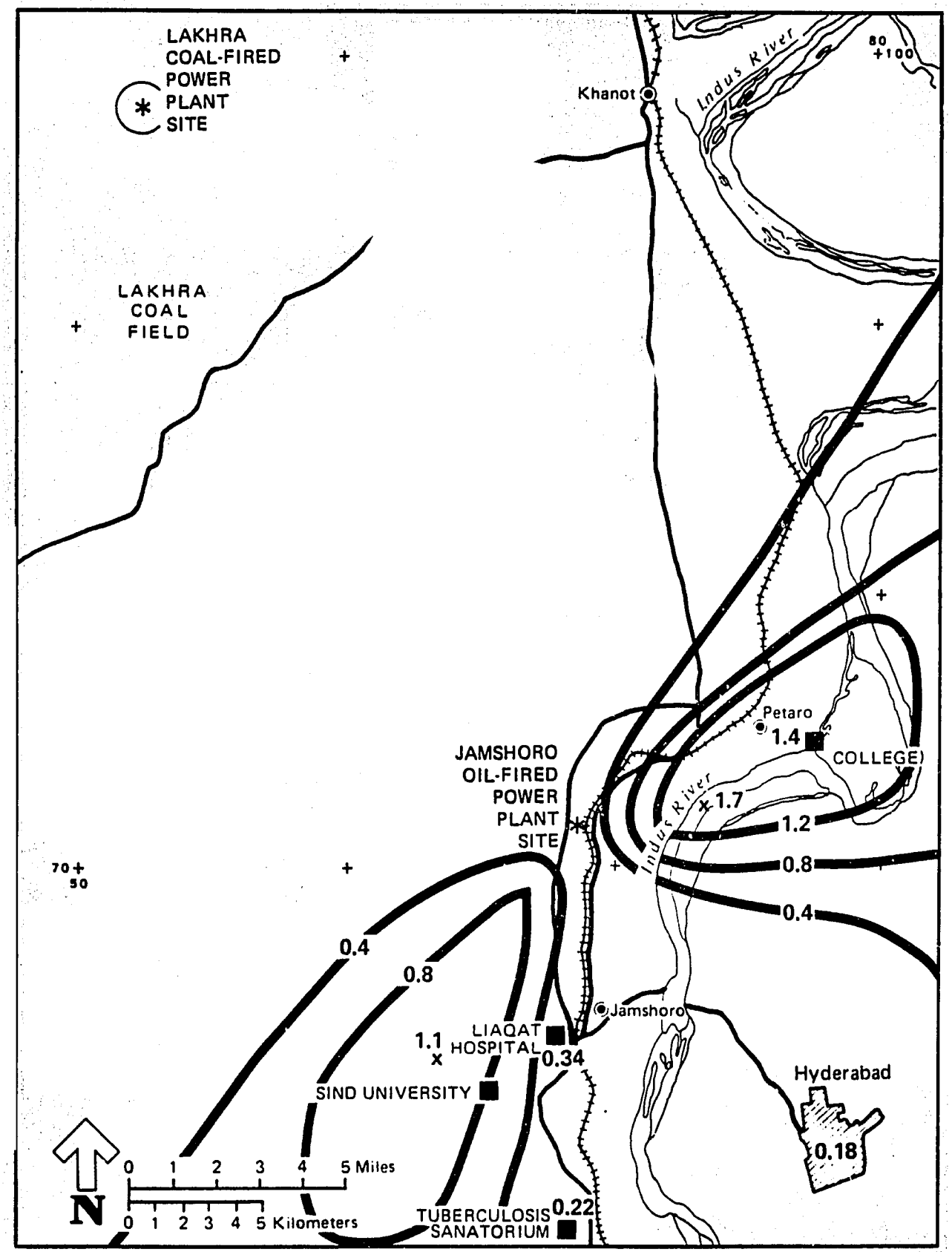


Figure 3-2 Predicted Annual Average NO_X Concentrations ($\mu g/m^3$)
(Impacts of Jamshoro - Phase I)

78X

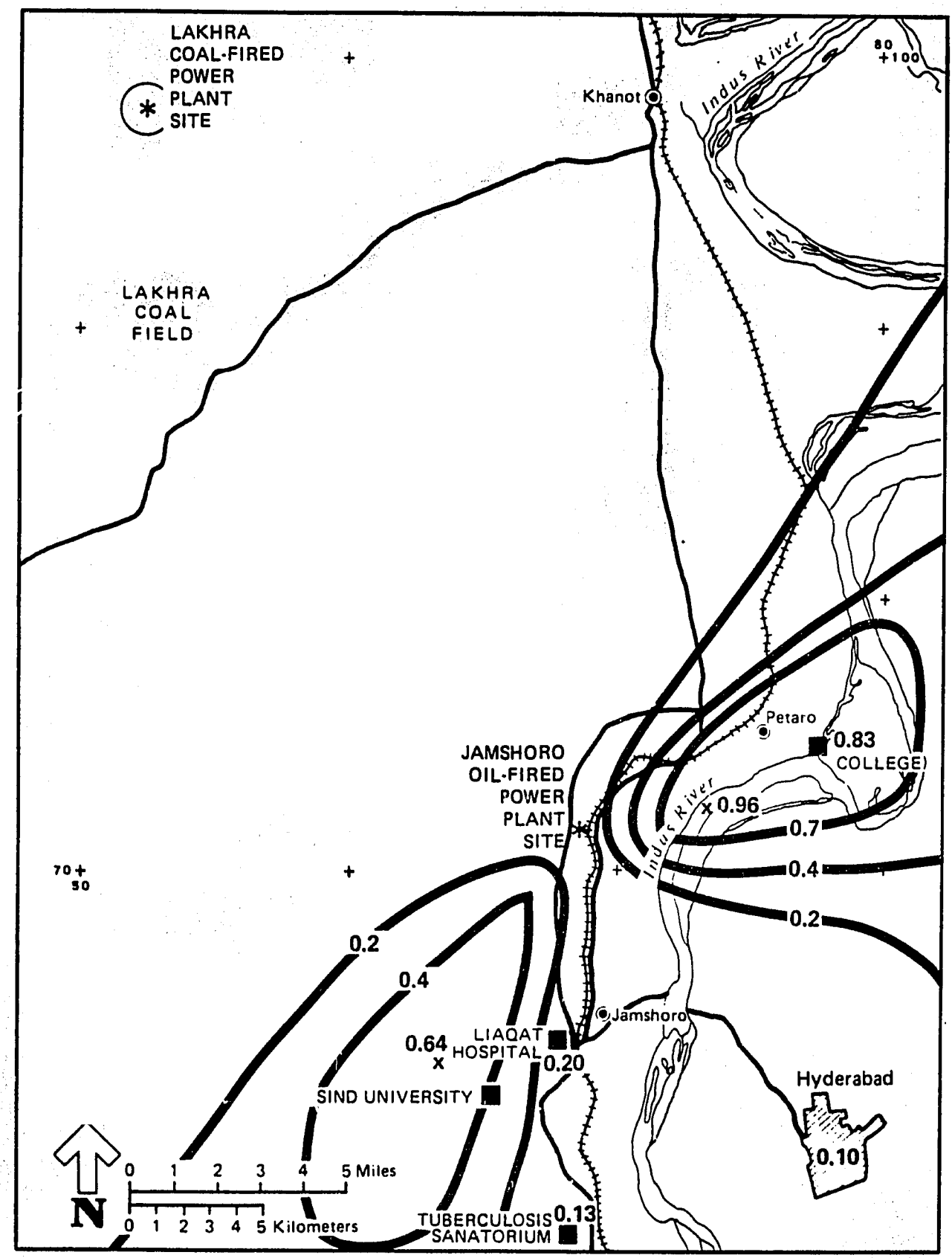


Figure 3-3 Predicted Annual Average Particular Matter Concentrations ($\mu g/m^3$) (Impacts of Jamshoro - Phase I)

79

Major associated ancillary facilities include an oil transport pipeline from Karachi (Figure 3-4), and a railroad spur. The rail spur will be required for Phase I whether Phase II is completed or not. The oil transport pipeline from Karachi will be used only if Phase II facilities are constructed. In the Jamshoro Pre-Feasibility Study (BNI, 1986a), and the Jamshoro Feasibility Report (BNI, 1986b), it was determined that the pipeline is not economically justified for the 880 MW Phase I alone. In that case, oil would be transported by rail from Karachi.

3.2 ALTERNATIVES TO THE PROPOSED ACTION

During the pre-feasibility study of the Jamshoro Power Generation Complex (BNI, 1986a), a number of alternative design components were considered and rejected during the final designs of Phases I and II. At that stage, selection of alternatives was based on a number of factors including environmental and sociological considerations, costs, reliability and safety. A summary of alternatives considered and reasons for selection of individual components follows. The report on that study (BNI, 1986a) should be consulted for details of this alternative selection process.

3.2.1 POWER GENERATION COMPLEX

Total generation capacity at the complex and the choice of individual unit size was governed primarily by the economics of the power plant

80X

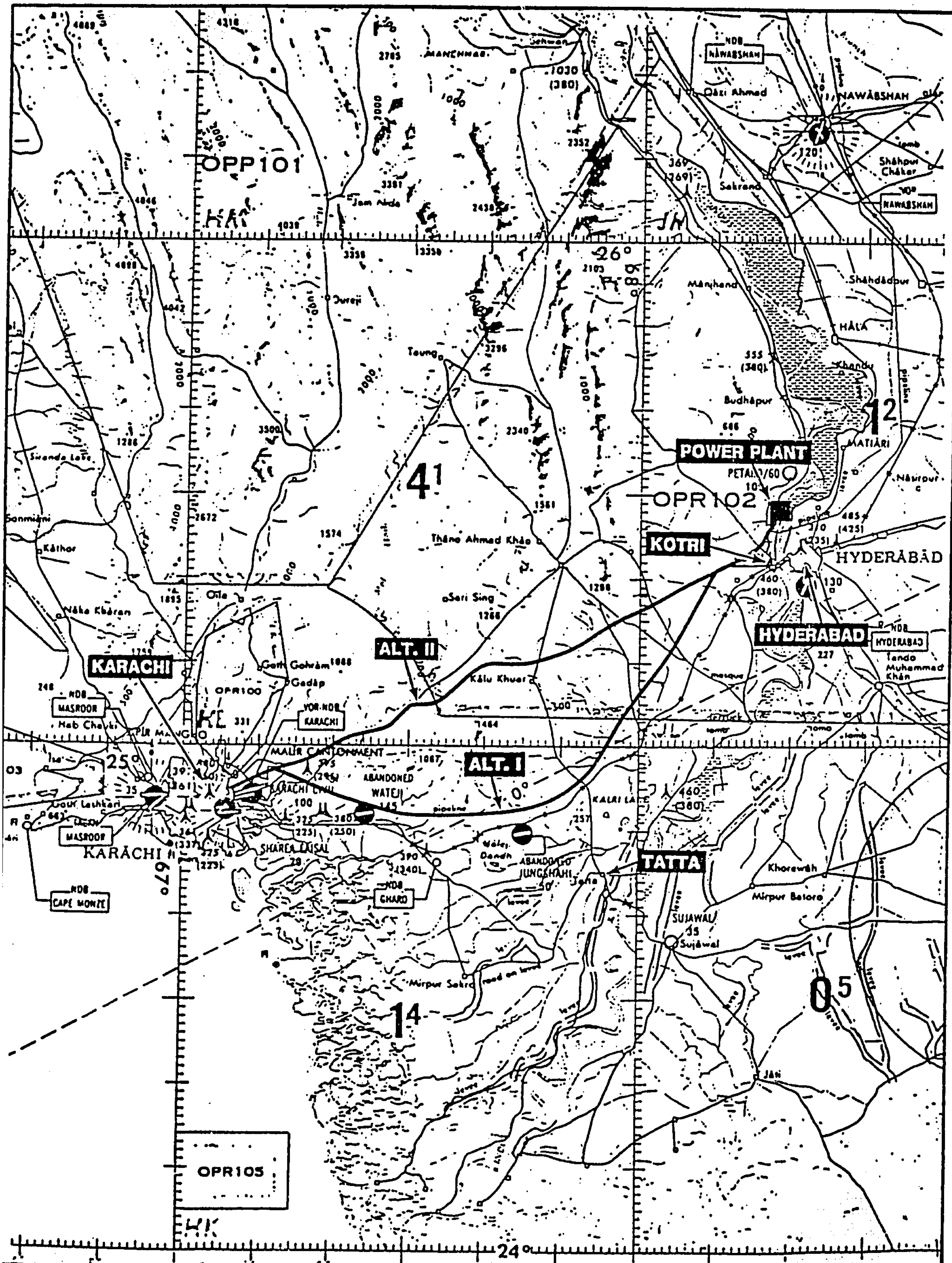


Figure 3-4 Location of Pipeline Route Alternatives

and the requirement for safe and reliable operation of the power system. The complex was sited near an existing switchyard and transmission lines to facilitate its integration into the existing grid.

3.2.2 FUEL SUPPLY

Fuel characteristics, sulfur content, and costs of furnace oil, coal, and other distillates were compared. The maximum sulfur content of fuel oil for the project is set at 3.5 percent by WAPDA's current purchase agreements. The transport requirements and costs of these fuels, including various mixtures, were evaluated and given high priority in the selection process. Reliability and safety of available alternatives were compared, including pipelines, railroads, and trucks for both oil and coal or coal slurry (BNI, 1986a). Use of natural gas as a fuel is currently prohibited by national policy, so was not considered.

3.2.3 POWER PLANT CHARACTERISTICS

The evaluation of conventional steam and combined-cycle technologies was based on operational complexity, efficiency, relative cost, and schedule of implementation. The possibility of conversion to coal of the oil-fired conventional steam system was considered, as were the possible use of coal-oil and coal-water mixtures.

80-X

Based on the technical analyses of the pre-feasibility study, the following conclusions were reached:

- The Jamshoro site is capable of supporting, in terms of available space, make-up water (additional water permits are required for the conventional steam Units 6 and 7), and transmission capability, three additional 350 MW oil fired units as required by WAPDA in addition to Phase I.

- Sulfur dioxide emissions generated by Phase I units and three additional 350 MW units burning oil with a maximum 3.5 percent sulfur will meet the World Bank SO_2 emissions criteria limit of 500 tons/day SO_2 for an unpolluted or moderately polluted area.

- Either oil-fired conventional steam or oil-fired combined-cycle units can be constructed. The costs of combined-cycle units would be about the same as the conventional steam units. Combined-cycle units would have the advantage of a shorter construction period and higher efficiency when operated above 80 percent load. However, there is very limited long-term operating experience with combined-cycle units burning No. 6 furnace oil and conventional steam units are being planned at this time.

83

The furnace oil proposed in the pre-feasibility study has a carbon residue content of 20 percent maximum. Based on information from General Electric, carbon residue in excess of 10 percent maximum would result in caking of the fuel nozzles in a combined-cycle facility.

- It was not considered economically practical to plan to convert the conventional steam units designed for oil to either domestic or imported coal. The capital cost and derating of the unit would be too high.

- It is technically possible to construct Phase II to provide for future conversion to coal fuel. However, this would include larger furnaces to accommodate coal, and space for the future equipment required to burn coal including coal storage areas, pulverizers, coal bunkers, coal handling equipment, precipitators, ash handling equipment, and flue gas desulfurization equipment. The cost of additional land to allow for this conversion, the inefficiency of dual purpose boilers, and the likelihood that more expensive oil would continue to be used rather than convert the facility and take it off-line for an extended period, all argued for a facility designed and built exclusively for oil-firing.

- Coal/oil mixtures were not considered economical at the present time. Therefore, no further consideration has been given to that alternative.

844

Coal/water mixtures are also not considered economical at this time for reasons similar to those that argued against a facility designed to permit future conversion to coal. Low-rank coals available in Pakistan do not slurry as well as the higher rank coals (slurry densities of about 50 percent can be obtained with Lakhra coal compared to 70 to 75 percent for the higher rank coals).

Cost estimates for these alternatives were prepared and an economic analysis carried out comparing the cost of technically and operationally viable generation, fuel supply, and fuel transportation alternatives. Basic assumptions were then made as follows.

- The Phase II site will be at Jamshoro adjacent to Phase I, owing to the efficiency of shared facilities and to Phase I's advantageous position on the national power grid

- Consideration will be for a maximum of three additional units of 350 MW each for a total complex capacity of 1,930 MW

- These three units will be connected to the existing 500 kV transmission substation

- The three units will be fired by oil with a 3.5 percent sulfur content (maximum)

Power is required now; therefore, the construction schedule should be as short as possible consistent with normal sequencing practices

Oil will be imported through the port in Karachi and transferred to the site via pipeline.

Detailed costs comparisons supporting these assumptions are presented in Section 9 of the Jamshoro Power Generation Complex Feasibility (BNI, 1986b).

3.3 PROPOSED ACTION

The engineering feasibility study funded by USAID (BNI, 1986b) has recommended that a Phase II consisting of three 350 MW units and all ancilliary facilities and structures be added to the Phase I facilities now under construction at Jamshoro. Except for the raw water intake facilities, which are located at the Indus River, the plant will occupy approximately 42 acres west of the Indus Highway. This area will contain the power blocks, cooling towers, bulk fuel oil storage, water treatment building, auxiliary boiler, standby diesel generator, fuel oil day tanks, and light oil storage tank.

Another area of 18 acres east of the highway will include raw water pretreatment and wastewater treatment facilities. In addition, 10 acres will be occupied by the warehouses, technical building, and

workshop. Land along the pipeline route will be temporarily disturbed during construction; approximately 1,150 acres would be disturbed if the Sui Gas Transmission route is selected, or approximately 1,070 acres if the Super Highway pipeline route is selected; a nominal number of acres will be required for pump stations and fuel storage areas along either route. Arrangement of the power plant and intake facilities is shown on Figures 3-5 and 3-6. Figure 3-4 shows the proposed pipeline alternatives. General descriptions of these facilities are given below. Additional details of the arrangement of facilities and equipment are presented in Section 3 and Section 7 of the Jamshoro Feasibility Report (BNI, 1986b).

3.3.1 POWER BLOCK, TURBINES, AND GENERATION EQUIPMENT

Each unit's power block will consist of a turbine bay, a heater bay, and either a control or electrical building. A railroad access bay will be located at the north end of each turbine bay. Turbines will be enclosed, and the turbine building will be a structural steel frame enclosed by precast concrete panels. The transformer area will be located on the west side of the turbine building. Steam generating boilers will be located outside, together with boiler forced draft fans and gas recirculation fans. One auxiliary steam boiler will be located north of Unit 5.

Heating, ventilating, and air conditioning will be provided as required for enclosed power block areas to maintain environments suitable for both personnel and equipment.

87

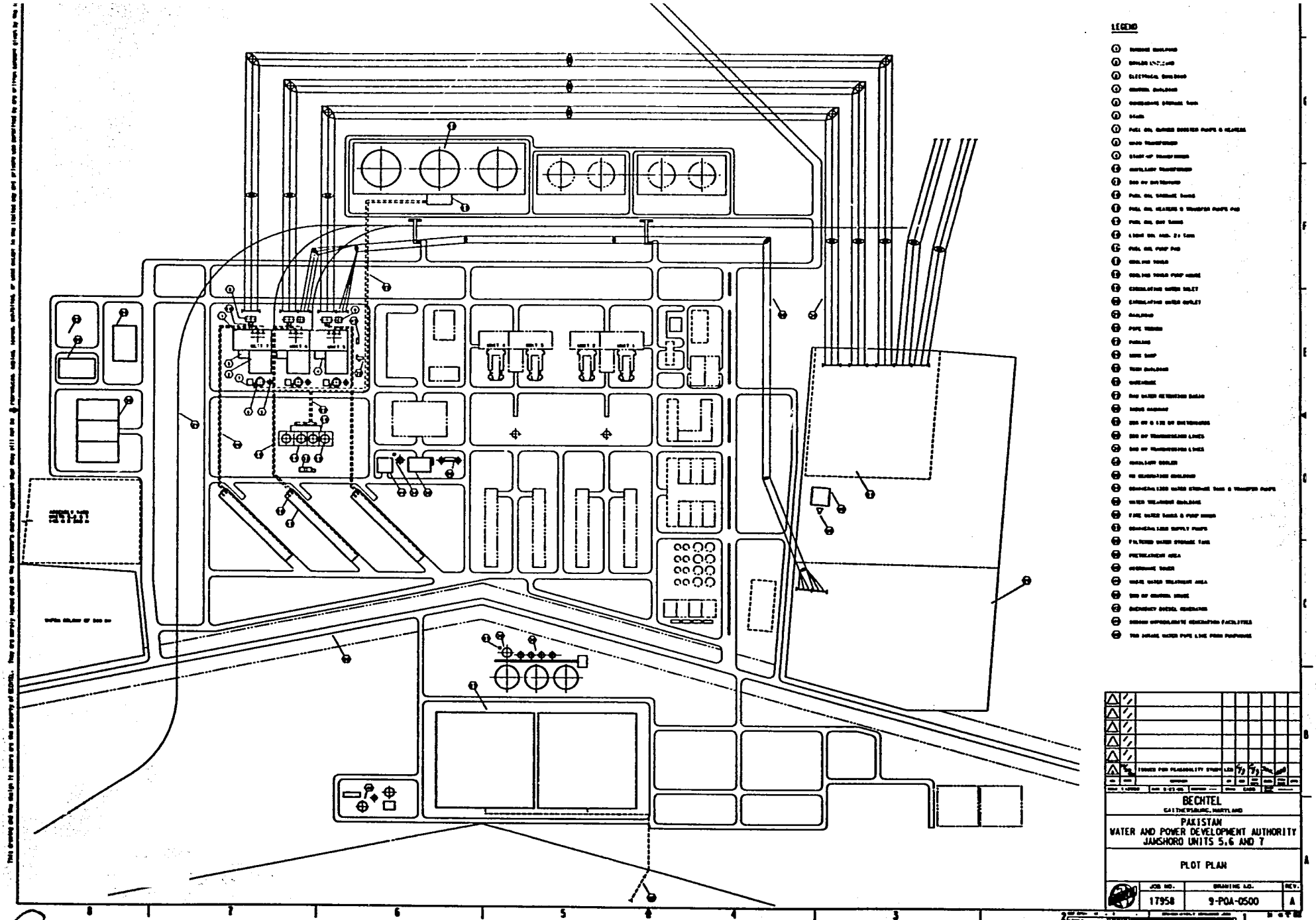
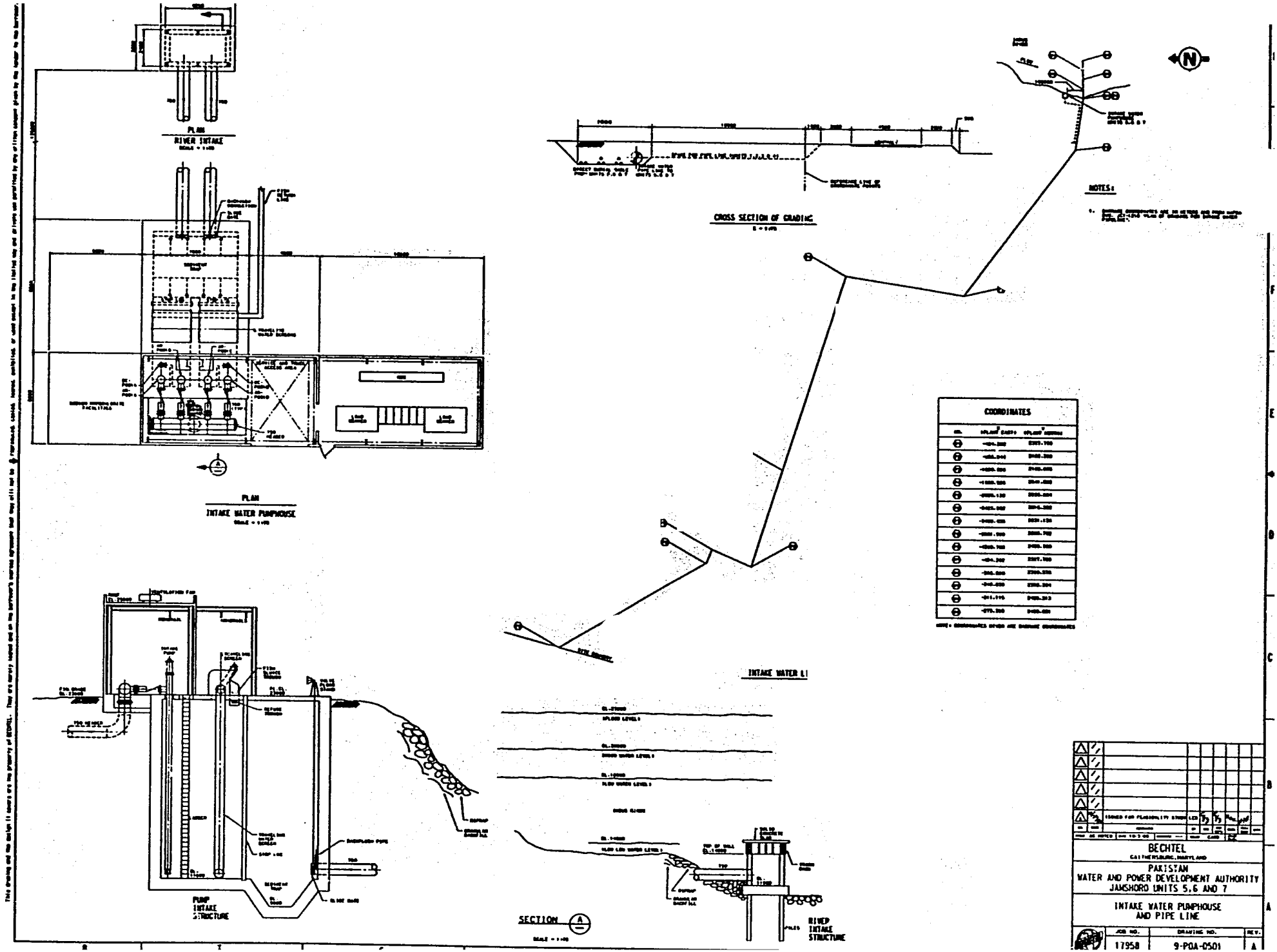


Figure 3-5 Arrangement of Power Plant Facilities


PLAN
RIVER INTAKE
PLAN
INTAKE WATER PUMPHOUSE
CROSS SECTION OF GRADING
NOTES:
COORDINATES
INTAKE WATER LI
PUMP INTAKE STRUCTURE
SECTION
RIVER INTAKE STRUCTURE
BECHTEL
PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
JAMSHORO UNITS 5,6 AND 7
INTAKE WATER PUMPHOUSE AND PIPE LINE
JOB NO.
17958
DRAWING NO.
9-POA-0501
REV.
A

One control building and two electrical buildings will be provided to serve the three generating units. These will be three-story structures containing the main control room and control equipment, chemical feed and storage equipment for condensate polishers and feedwater chemical injection, an electrical equipment room, and a chemical storage area.

3.3.2 TRANSMISSION AND SWITCHYARD

The three Phase II Jamshoro units (Units 5, 6, and 7) will be connected to the WAPDA 500-kV transmission system by two transmission tie lines via a new switchyard. These tie lines will be overhead, single-circuit lines on galvanized steel lattice structures

3.3.3 COOLING TOWERS AND PUMPS

Mechanical draft cooling towers located east of the power blocks will be used for the three Phase II units. Each 18- by 144-meter (59- by 470-foot) cooling tower basin will terminate in a transition section leading to a 30- by 30-meter (100- by 100-foot) cooling tower pumphouse. The cooling tower, basin, and transition section will be constructed of reinforced concrete.

3.3.4 RIVER WATER TREATMENT

The river water pretreatment area will be located northeast of the power blocks and east of the Indus Highway. The following equipment will be located in this area:

904

- Two 160- by 160-meter (525- by 525-foot) retention ponds, which will receive water from the river intake

- Three 40-meter-diameter (130-foot) water pretreatment clarifiers

- Four water pretreatment pressure filters

- One 4,250 m^3 (1,123,000-gallon) filtered water storage tank

- The domestic water treatment system, which will supply water to both the plant and the housing colony.

The water treatment and storage equipment in this area will be shared by the three units.

3.3.5 WASTEWATER TREATMENT

The wastewater treatment area for Phase II facilities will be located east of the Indus Highway adjacent and south of the pretreatment area. The following wastewater treatment equipment will be located in this area:

- One 946 m^3 (250,000-gallon) concrete retention basin for wastewater equalization

- One 225 m^3 (59,000-gallon) neutralization tank

- One 2.5 m^3/min (650-gpm) oil/water separation system

- Two 3.5-meter-diameter (11.5-foot) pH adjustment tanks

- One 1,892 m^3 (500,000-gallon) boiler drain storage tank.

The wastewater treatment system will be shared by the three Phase II units, and will be located northeast of Unit 5. The largely domestic sanitary waste from the colony will be subjected to secondary treatment and made available for landscape irrigation.

A 36.5- by 22.5-meter (120- by 74-foot) building will house the following water treatment equipment, which requires indoor installation

- Three demineralizer trains for providing boiler makeup water

- Acid storage tank, caustic storage tank, and caustic dissolver tank

- Acid and caustic day tanks

- Office and lavatory facilities for water system operators.

All chemical storage, holding, and preparation areas will be curbed to contain spills and will be lined with acid-resistant brick. Six emergency eye wash and safety shower stations will be provided at appropriate locations throughout the building. A limestone-filled pit

92X

will be provided under the acid storage tank to neutralize potentially large spills in the event of tank rupture.

The floor area surrounding the demineralizer trains will be curbed to contain spills, and each train will be provided with an acid-resistant brick-lined trench to transport spills and regeneration wastes to the wastewater treatment system for neutralization.

3.3.6 FUEL TRANSPORT

Fuel oil will be received at the Port of Karachi, offloaded from tankers, and temporarily stored at the port using existing facilities. A new heated, insulated pipeline system will commence at Karachi and terminate at the fuel oil storage area within the power generation complex at Jamshoro. The system will utilize a 12-inch diameter pipeline and will require a pump and heating station at the head of the pipeline and a second pump station at the pipeline midpoint.

Two alternative pipeline routes from Karachi to the power generation complex were considered. One is termed the Sui Gas Transmission route, and identified as Alternative I; the other is the Super Highway route, identified as Alternative II. The locations of these alternative routes are shown on Figure 3-4.

Maximum fuel storage volume at Karachi is anticipated to be 500,000 barrels. Storage capacity at the intermediate pump station will be 40,000 barrels. The location of the fuel oil storage at Karachi is not

defined. Storage may be located at the Karachi port, where it is understood that space is very restricted, or at the Karachi refinery. Storage could also be in more than one location.

Should additional oil berths be installed at Qasim Port in Karachi, then fuel oil could be imported and transferred to Pipri, which is approximately 10 km east of Karachi. In this event, the initial pipeline station would be located at Pipri a few kilometers from both alternate pipeline routes. A reduction in pipeline length of about 10 km would be possible if the Pipri terminal is used.

3.3.7 FUEL AND LIGHT OIL STORAGE

Bulk storage of No. 6 fuel oil for use in the boilers will be provided in three 65-meter-diameter (213-foot) by 15-meter-high (49-foot) single-walled tanks located west of the units adjacent to the storage facilities for Units 1-4. The storage tanks will provide approximately 25 days' storage at 80 percent of plant load for Phase II.

The three storage tanks will be contained within an area that provides a retention volume sufficient to hold the entire contents of the largest tank, in accordance with standards of the U.S. National Fire Protection Association. A vehicle access ramp will be provided into the area. An equipment area will be located at the eastern perimeter of the area outside the retention walls. A filtering and metering station will be located at the storage area for the estimated annual fuel oil supply of 1,235,000 tonnes (8,300,000 barrels).

94x

A 2,105 m^3 (556,100-gallon) fuel oil day tank will be provided for each unit. The 14-meter-diameter (46-foot) by 17-meter-high (56-foot) tanks will be located east of Units 5 and 6 in an area shared with the light oil and fuel oil additive storage tanks. The area containing the day tanks and light oil tank will be subdivided into smaller areas by 150-millimeter-high (6-inch) curbs that serve to retain and isolate smaller oil spills. Larger spills will be contained within the higher walls that border the entire area containing all the tanks.

Nine burner fuel oil pumps for supplying oil to the three units will be located on a covered 50- by 10-meter (164- by 33-foot) equipment pad located on the west side of the storage area.

Fuel oil additive (MgO) will be stored in a 3.7-meter-diameter (12-foot), 57.5-kiloliter (15,200-gallon) tank located adjacent to the equipment pad. A room at the north end of the equipment pad will house the foam equipment for the day and light oil tanks.

One 1,245-kiloliter (329,000-gallon) light oil storage tank will be provided for the site. The 12-meter-diameter (39-foot) by 11-meter-high (36-foot) tank will be located east of Unit 5 within the same area as the fuel oil day tanks.

3.3.8 FIRE PROTECTION

Two 1,892-kiloliter (500,000-gallon) fire water storage tanks and the fire pumphouse will be located northeast of Unit 5 adjacent to the water treatment building. Three 50 percent fire pumps, one electric-motor-driven and two diesel-engine-driven, will draw water from either or both of the tanks and discharge to an underground fire main that supplies the various manual and automatic suppression systems throughout the plant. Makeup to the tanks will be from the raw water pretreatment system.

Post indicator valves will be provided at appropriate locations in the fire main to allow isolation of sections without jeopardizing overall station fire suppression capability. Hydrants will be located along the fire main throughout the plant to provide yard and building exterior coverage. Hose houses will be provided.

Foam extinguishing systems will be provided for the fuel oil storage tanks and the day and light oil storage tanks. Automatic fire suppression systems will be provided in areas within the power blocks and other plant buildings that have high fire potential and require rapid, automatic response. Fire and smoke detection systems will be located throughout the plant as necessary to provide early warning and allow personnel action. Procedures described in this section are in accordance with standards set forth by the U.S. National Fire Protection Association.

96x

An emergency management plan coordinating activities within and between Phase I and II facilities should be prepared under the direction of WAPDA. It is also essential that response plans and training programs be coordinated between the two phases and emergency equipment standardized throughout all Jamshoro facilities. This management plan can be prepared by the contractor for Phase II construction. Coordination between the phases should be the responsibility of WAPDA.

3.3.9 SERVICE GAS FACILITIES

The service gas facilities will be located east of the power blocks and will consist of the oxygen and hydrogen generating, bottling, and storage facilities and the nitrogen bottle storage area. The service gas facilities will be shared by the three units. The manifolds and storage equipment will be installed outdoors within a security fence.

3.3.10 CONDENSATE STORAGE TANKS

One condensate storage tank will be provided for each unit. Each condensate storage tank will have a capacity of 900 m^3 (238,000 gallons) and will be located to the east of each unit's power block adjacent to the stack. The tanks will be 8.4 meters (28 feet) in diameter, 17 meters (56 feet) high, and will be fabricated of stainless steel. A concrete ringwall with oil sand pad foundation will be provided for each tank.

3.3.11 LUBE OIL STORAGE AREAS

Two 37.9 m^3 (10,000-gallon) lube oil storage tanks will be installed for each unit. The 3-meter-diameter (10-foot) tanks will be located outdoors west of the turbine building. The storage tanks will be of welded carbon steel construction.

Each lube oil storage tank area will be enclosed by a 150-millimeter (6-inch) curb that encloses, in addition to the storage tanks, a lube oil transfer pump, a sump, and a drum dispensing area.

3.3.12 SODIUM HYPOCHLORITE GENERATION FACILITY

The sodium hypochlorite generation facility will be located adjacent to the water treatment building and will occupy a 22- by 22-meter (72- by 72-foot) area containing the following:

- Provisions for receiving and storing salt
- Sodium hypochlorite generation system
- Sodium hypochlorite storage tank
- Sodium hypochlorite injection pumps for raw water, domestic water, and circulating water.

The facility will be shared by the three units.

98d

3.3.13 RIVER WATER INTAKE AND PUMPHOUSE

Separate conceptual designs currently exist for the Phase I and Phase II water supply intakes at the Indus River. Phase II will withdraw water at the rate of 945 liters/sec (15,000 gpm). The Phase II concept consists of an intake with two buried pipelines from the river approximately 755 mm (30 in.) in diameter connected to an onshore pumphouse (Figure 3-6). The Indus River hydrologic and subsurface conditions, as well as constructibility, operability, and licensability of the system were considered in the development.

The intake system will consist of a reinforced concrete river intake with trash rack, velocity cap, and the buried pipes, connecting the intake to a shoreline pumphouse. The intake will be supported on piles to provide protection against river bottom scouring. The intake will be submerged at all normal and high water levels. However, at the design water level (lower low water - LLW), it will act as a surface intake. To prevent heavy sediment from entering the intake, it will be located about 2.75 meters (9 feet) above the river bottom.

The pumphouse will be constructed of reinforced concrete and will include stop logs, traveling water screens, and a sediment trap. A fish return line will also be provided. The electrical equipment room, pumps, and chlorine facility will be enclosed by a metal building providing weather protection.

The Phase I intake facilities employ a different design (Figure 3-7). This system includes neither intake screening nor a fish return system.

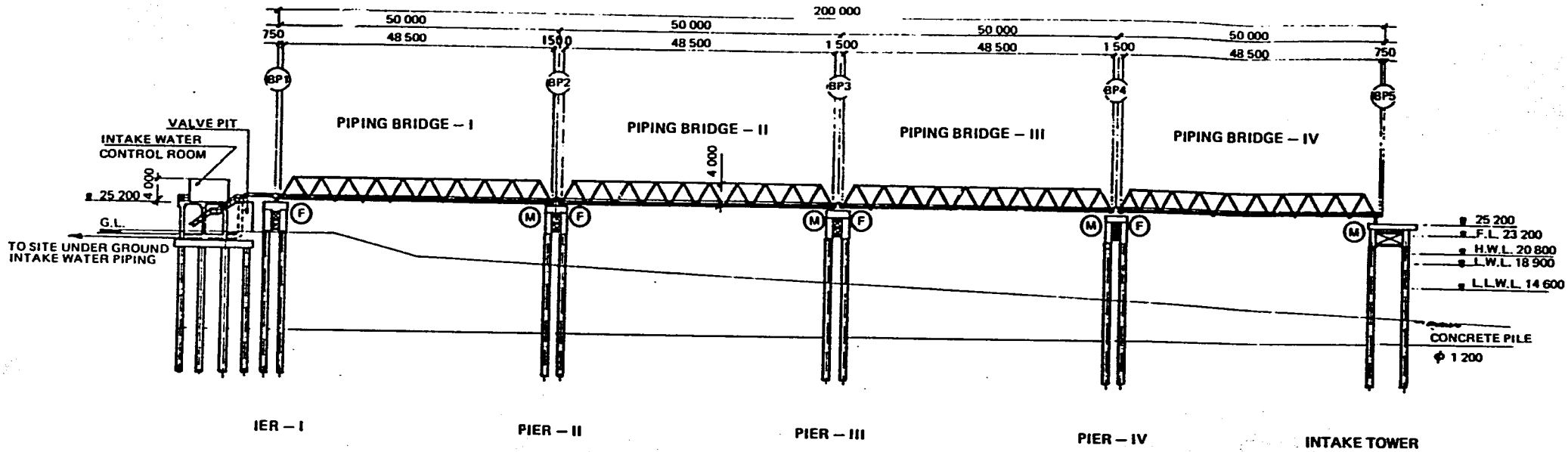
Biological surveys have not been carried out in the Indus River at the points of intake and no accurate assessment of biological impacts of the two intakes can be made. In both cases, however, intake volumes represent a relatively small portion of even the low-water flow in the river (less than 2 percent). The Phase II screening and fish-return system will reduce impact further with only the existing Phase I intake being unscreened. In the absence of data indicating particular problems, at these low relative volumes of water withdrawn from the river, minimal environmental harm is anticipated.

3.3.14 FUEL OFFLOADING FACILITIES AT PORT OF KARACHI

Fuel oil for Jamshoro Phases I and II will be transferred from tankers at existing facilities at the Port of Karachi. These port facilities were observed directly from a small launch during field site surveys in October, 1986. The site visit around the port via launch supported reports of clean operations. No surface oil was observed in the area of transfer facilities, although no water samples were taken. The harbor appeared relatively free of flotsam and jetsam and the water appeared clear and clean.

100*

SIDE VIEW SECTION S = 1/400



PLAN S = 1/400

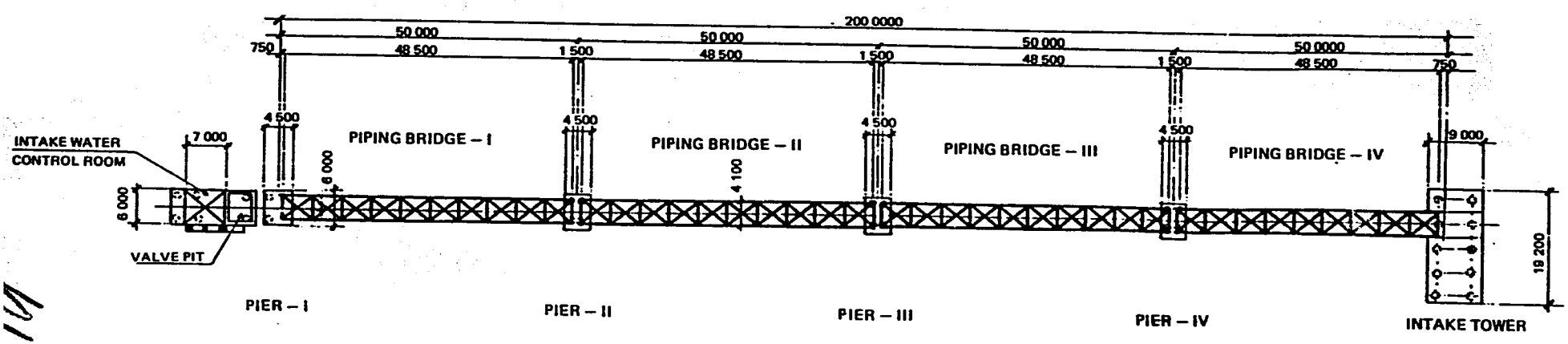


Figure 3-7 Phase I Water Intake Structure

Details concerning spill prevention, clean-up, and storage at the port were unavailable for preparing this report. However, representatives of the Port of Karachi stated that these plans exist. Despite favorable observations, WAPDA should obtain details of these plans either to confirm their adequacy, or so they can discuss with GOP and donors any need for additional preparation, equipment, or training of personnel to respond to emergencies.

4.0 ENVIRONMENTAL AND SOCIAL SETTING

4.1 ENVIRONMENT

4.1.1 SITE LOCATION AND TOPOGRAPHY

The Jamshoro site is located in the Dadu District of the province of Sind (Figure 4-1). The site is 4 km northwest of the village of Jamshoro and about 4 km west of the Indus River, which forms the eastern boundary of the Dadu District. To the east is the Hyderabad District containing the city of Hyderabad, an urbanized area with a population of 750,000. The site is approximately 13 km northwest of the city of Hyderabad.

Agriculture is the main economic enterprise in the Dadu District, with the more suitable agricultural lands occurring close to the Indus River. Away from the river, particularly to the west, the land is quite dry, and vegetation low and sparse. The site is located along the Indus Highway, about 5 km north of Sind University and Liaquat Medical College and Hospital.

The terrain in the vicinity is generally level, with several small hills of about 20 to 30 m in height on and surrounding the site (Figure 4-2). The site is semi-arid with patchy vegetation (Figures 4-3 to 4-6). Site preparation for Unit 1 is currently underway; prior

103X

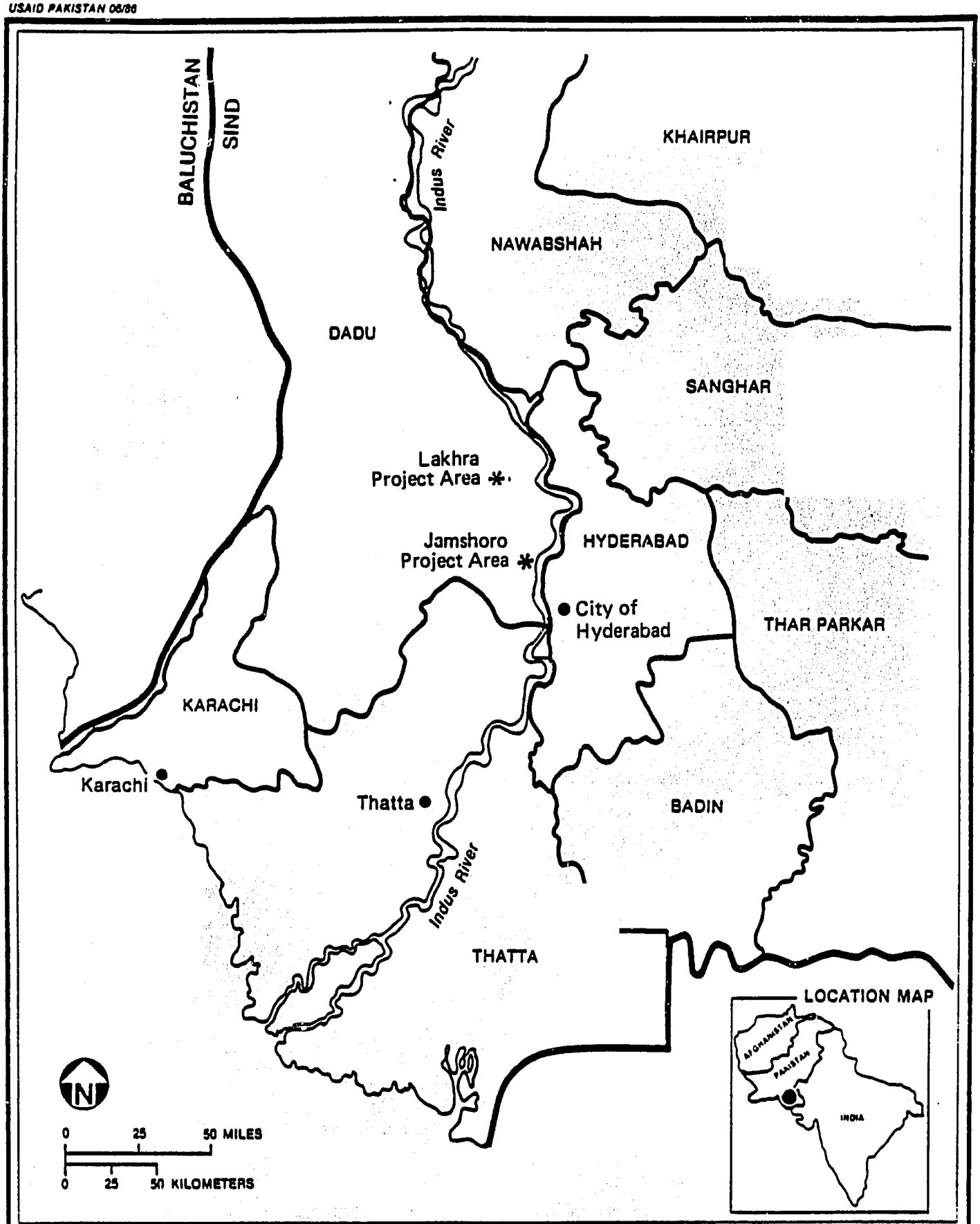


Figure 4-1 Location of Jamshoro Project Area

SOURCES. GOVERNMENT OF PAKISTAN, 1984. ESE, 1986.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

104

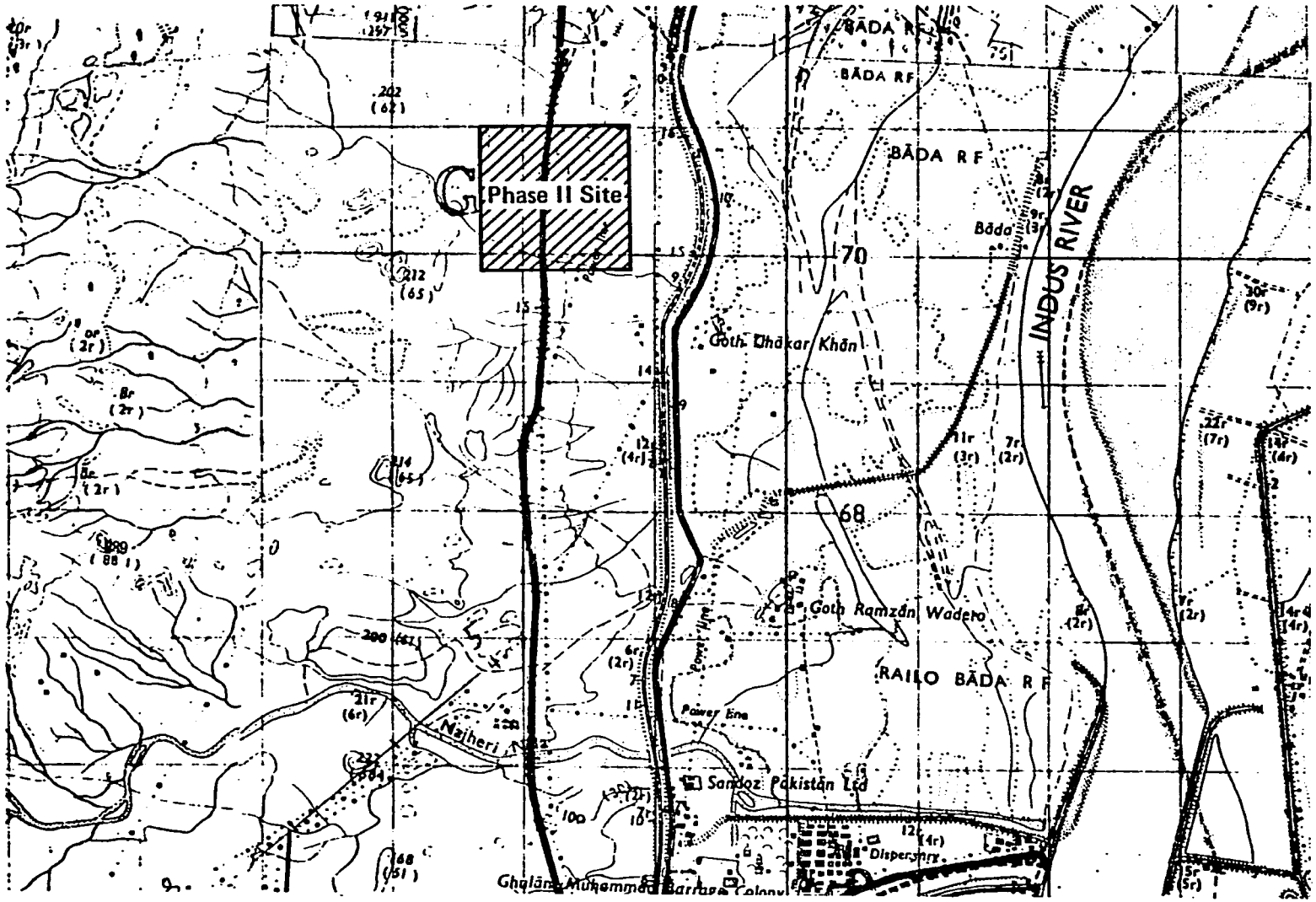


Figure 4-2 Terrain in Vicinity of Jamshoro Project Site

105X

Figure 2 Jamshoro Site Looking North from Meteorological Station. Grazing Goats in Background, 30 September 1986

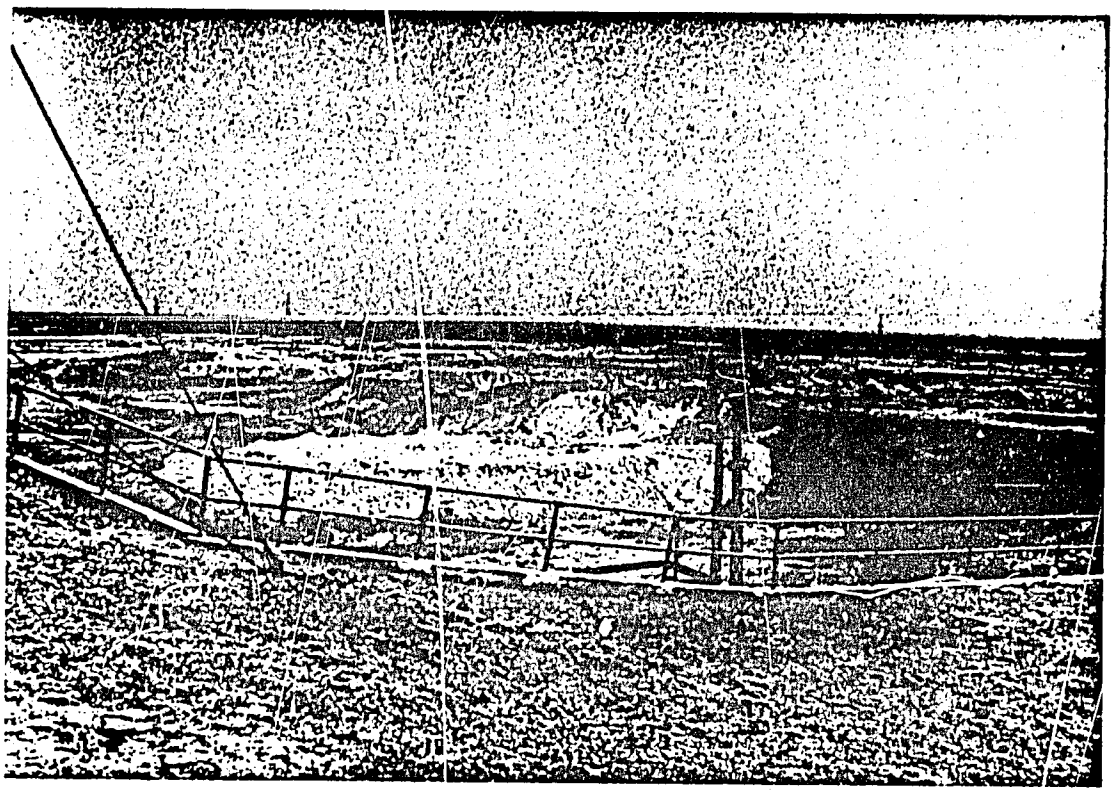


Figure 4-4 Jamshoro Site Looking East from Meteorological Station. Indus River in Distance, 30 September 1986

107X

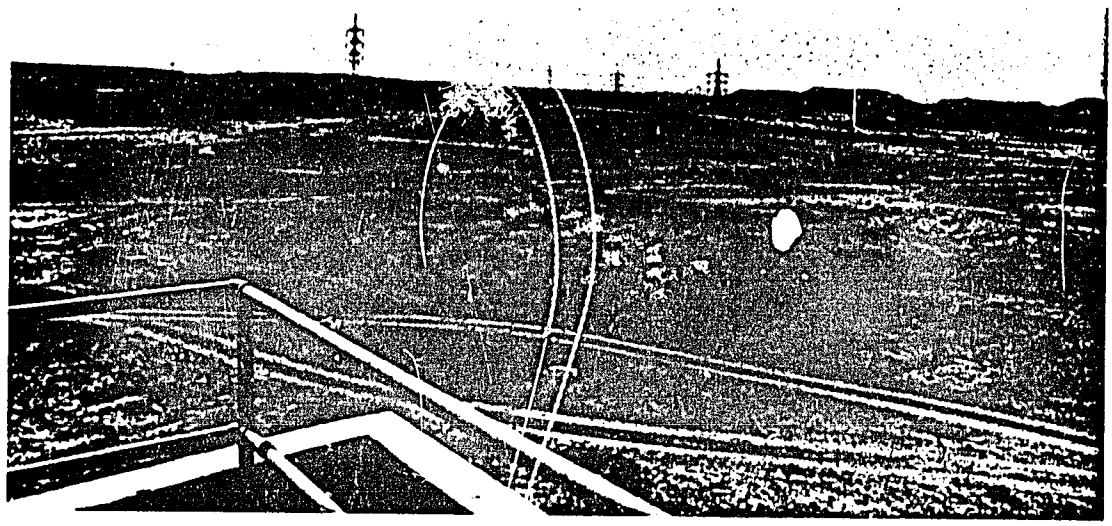


Figure 4-5 Jamshoro Site Looking South from Meteorological Station. 30 September 1986

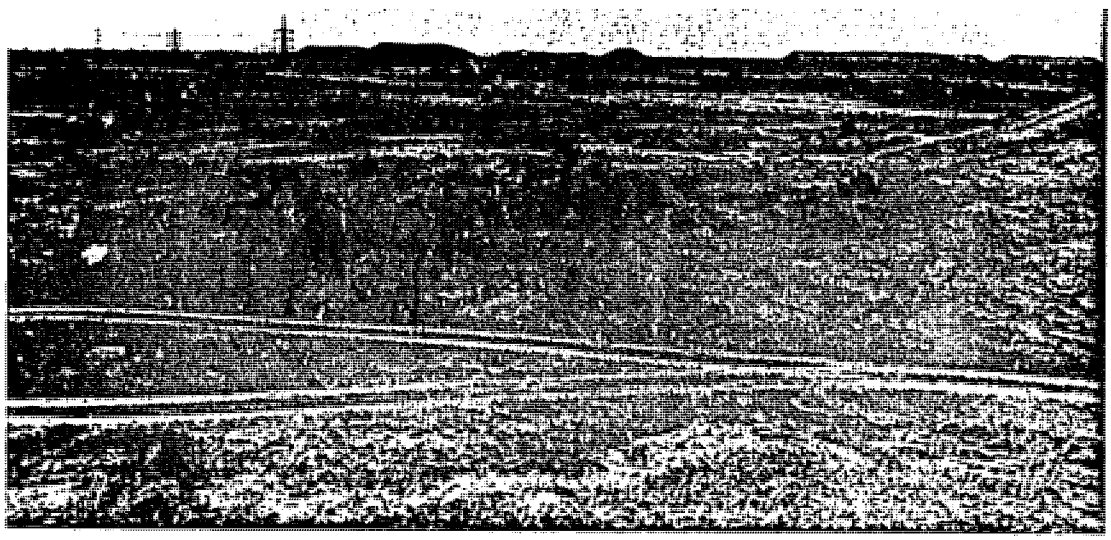


Figure 4-6 Jamshoro Site Looking West from Meteorological Station. 30 September 1986

109X

to commencing work, the site was an undeveloped, open area. Several small villages occur in the vicinity (see Section 4.2.1); generally the rural population near the site is sparsely distributed.

4.1.2 VEGETATION

4.1.2.1 Natural Vegetation

The province of Sind is an arid and semi-arid land through which the Indus River flows, bordered by a fringe of vegetation from several meters to several kilometers wide (Figures 4-7 and 4-8). The ecological resources of Sind and the study area are influenced both by the river and by the prevailing regional climatic conditions. The area can be considered divided into two sub-areas: the Indus floodplain to the east and the piedmont area to the west. The Indus Highway or Dadu Road, running north-to-south, is an approximate dividing line between these two sub-areas. To the east, the river provides moist conditions, whereas to the west the area is dramatically more arid.

Comprehensive ecological surveys for the study area do not exist. The ecological descriptions contained in this section are based on ecological descriptions for Pakistan from the scientific literature, selected references including the Environmental Impact Assessment for Lakhra site reconnaissances (KBN, 1986), and discussions with federal and provincial natural resource agencies and with university scientists. From these resources, it is apparent that no unique

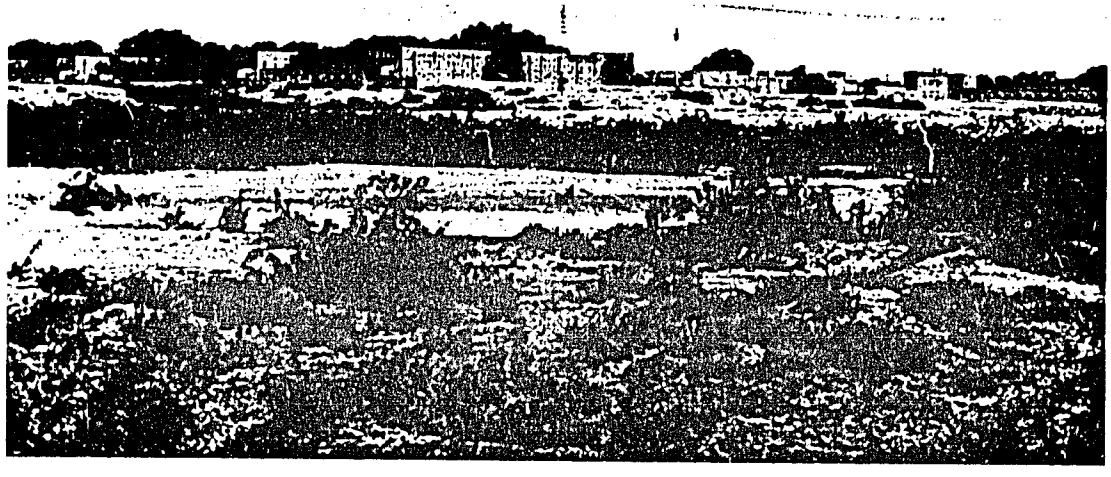


Figure 4-7 Liaqat Medical College Dormatories Looking West from Indus Highway. Scrub Vegetation in Foreground Typical of This Portion of Sind Province, 30 September 1986

111

Figure 4-8 West Bank, Indus River, North of Hyderabad, near Proposed Site of Water Intake Structure, 30 September 1986

vegetation that would be adversely affected by the proposed development exists in the area.

Much of the undeveloped, open areas of the Jamshoro region are characterized as a tropical scrub forest community (Figure 4-7, foreground). This ecological community runs north and south in the Indus Plain (Arid Lands Information Center, 1981). Topographically, the area is a combination of sandy plains and dry stream beds (Figures 4-3 to 4-6). In some areas rock outcroppings comprised of limestone, sandstones, and shale occur. These topographical areas differ in relief, microrelief, soil depth, moisture availability, and nutrients, conditions which are important in determining the vegetative composition in the area (Shaukat et al., 1980). The composition of the ecological communities varies from low-growing grasses and herbaceous vegetation (e.g., Salsola baryosoma) to shrubs and trees such as "jand" or mesquite (Prosopsis cineraria) and "babul" or acacia (Acacia senegal), although the vegetation is dominated by perennial xerophytic shrubs. Characteristic species include "pilu" or salvadora (Salvadora oleoides), "farash" or tamarix (Tamarix aphylla and T. gallica), and mesquite. The vegetation is simple in its organization and the plant cover is scanty. The greatest amount of plant cover, 10 to 15 percent, is observed during the monsoon season in July and August. During the dry winter season the plant cover was observed to be approximately one percent. Plant cover is patchy with most vegetation found in non-perennial stream beds.

Prior to cultivation, the floodplain areas along the Indus River contained tracts of riverine forests dominated by acacia ("babul"), mesquite, and poplar ("bhan"). These natural areas have been severely reduced by diking and cultivation. These areas have been planted in wheat, cotton, and other crops, and there are also irrigated forest plantations. The present plant composition is a mixture of natural and man-introduced vegetation.

The Jamshoro site and the surrounding area west of the Indus Highway are arid and sparsely vegetated. The site is technically characterized as tropical scrub forest (KBN, 1986). Because of topographical differences, fewer dry stream beds, and proximity to human activity, Jamshoro has less vegetative structure than more interior locations. West of Jamshoro, there are more extensive stands of acacia and mesquite, especially along dry stream beds. The Jamshoro site is dominated by very patchy distribution of herbaceous and some shrub vegetation. Topographical maps show the presence of several forest reserves well to the southeast and northeast of the site on both sides of the Indus River. These areas contain a mixture of natural and maintained vegetation.

4.1.2.2 Farming

Approximately 1 km to the east of the Jamshoro Complex site, the area drops into the Indus floodplain, where a mixture of irrigated cultivated land, planted forests, and remnant riverine forest occurs.

Along the levees of the Indus River, poplar, tali, and shisham occur. Acacia trees are common throughout this area. Acacia and shisham are grown in the planted forest plantations managed by the Department of Forestry (KBN, 1986).

Agriculture is the main economic enterprise in Pakistan. The agricultural year is divided into two main cropping seasons: (1) rabi (or asari), and (2) kharif (or saoni). Rabi crops are sown after the rainy season in October and November and harvested in the spring in April and May. These crops include wheat, barley, gram, and oil-seeds. Eighty to ninety percent of the rabi crop is wheat. These crops require lower temperatures and lower rainfall. Kharif crops are sown between April and May and harvested in October and November. They include rice, maize, millets (jowar and bajra), cotton, and sorghum (Kureshy, 1978). Major agricultural problems in the area are waterlogging and saline soils (Figure 4-9). Heavy use of fertilizers (e.g., ammonium sulfate) is required, according to representatives of the Agriculture Research Institute at Tandojam and the Agriculture Extension Service at Hyderabad.

During the site visit, a herd of goats was seen grazing on sparse perennial grassland on the site (Figure 4-3). No evidence of organized farming on the site was apparent.

Figure 4-9 Cotton Field near West Bank, Indus River, North of Hyderabad Typical of Fields Stressed by Saline Deposits near Surface, 30 September 1986

4.1.3 WILDLIFE

4.1.3.1 Natural

The wildlife habitats of the area reflect the same influence as the vegetative communities: semi-arid habitats west of the Indus Highway, and the mesic riverine or Indus plain habitats requiring more water (Minton, 1966; Ahmad and Ghalib, 1975; Beg, 1975). Wildlife in Pakistan, however, has declined during the past three or four decades because of loss of habitat and hunting. A variety of reptiles, amphibians, birds, and mammals can be expected to exist in the Jamshoro area, including:

Reptiles	Amphibians
gecko	Indian burrowing frog
grass skink	Indus toad
fringe-toed sand lizard	tiger frog
longtailed desert lacerta	
Indian monitor	
Indian sand boa	
streaked Kukri snake	
Indian krait	
sawscaled viper	
Birds	**Mammals**
white throated munia	hedgehog
little brown dove	sand-colored rat

117

Birds (Cont'd)

common babbler

collared turtle dove

desert warbler

black partridge

tawny eagle

Mammals (Cont'd)

Indian gerbil

Indian hare

desert cat

chinkara (gazelle

desert fox

Indian fox

jackal

hyena

wolf

Reptiles are the dominant faunal group observed in the semi-arid habitats.

Because of the proximity to water and greater vegetative diversity, riverine habitat to the east of the site has a different wildlife population. Although some of the same species found in the semi-arid habitats also occur in the riverine habitat (Minton, 1966; Ahmad and Ghalib, 1975; Beg, 1975), including the geckos, skinks, turtle doves, Indian hares, and jackals, species more typical of this area and more tolerant of human habitation include turtles, Punjab snake-eyed lacertas, dhamans, Indian cobras, herons, bitterns, kites, vultures, stilts, cuckoos, owls, swallows, shrikes, crows, various species of song birds, wild pigs, hog deer, and jungle cats.

4.1.3.2 Threatened and Endangered Species

A number of reptiles, birds, and mammals considered rare, vulnerable, or endangered by the Government of Pakistan or by the United States Fish and Wildlife Service potentially occur in the region (Table 4-1). The U.S. Department of the Interior, under the statutory authority of the Endangered Species Act of 1973 and its Amendments, list the Indian monitor lizard, the Indian softshell turtle, and the chinkara (a gazelle) as endangered. The first two species were placed on the endangered species list because they are listed by the Committee on International Trade of Endangered Species (CITES). They are considered species threatened with extinction that are or may be affected by trade. The chinkara was placed on the list in concern for overexploitation of its population because of hunting and habitat destruction in Pakistan. Section 7(a) of the Endangered Species Act, as amended, requires United States Federal agencies to ensure that the activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of such a species or to destroy or adversely modify its critical habitat. An opinion of August 31, 1981 from the Office of the Solicitor, U.S. Department of the Interior, indicates that Section 7 does not apply to actions in foreign countries. Section 8(a) of the Act authorizes the provision of limited financial assistance for the development and management of programs that the Secretary of Interior determines to be necessary or useful for the conservation of endangered species in foreign countries (Federal Register Vol. 50, No. 207, Friday, October 25, 1985).

Table 4-1

Endangered and Vulnerable Species Potentially Occurring in the Study Area

Scientific Name	Common Name	Status	Potential Habitat/ Locality
Birds:			
Anas poecilorhyncha	Spotbill Duck	Endangered-GOP	Riverine, migrant
Grus antigone	Sarus Crane	Endangered-GOP	Riverine
Mammals:			
Felix viverrina	Fishing Cat	Endangered-GOP	Riverine
Axis porcinus	Hog Deer	Endangered-GOP	Riverine forest
Gazella sp.	Chinkara	Endangered-GOP/USA	Scrub forest
Platanista indi	Indus Dolphin	Endangered-GOP	Indus River
Reptiles:			
Varanus bengalensis	Indian monitor	Endangered-GOP/USA	Semi arid, open
Trionyx gangeticus	Indian softshell turtle	Endangered-USA	Riverine area

Sources: Government of Pakistan, Zoological Survey Department, 1986.
U.S. Department of Interior, 1985.

Although Pakistan possesses wildlife protection laws and regulations, wildlife protection has been primarily linked to the preservation of game animals to provide hunting opportunities. The Ministry of Food, Agriculture, and Cooperatives has overall responsibility for wildlife protection. This responsibility is delegated to the National Council for Conservation of Wildlife (NCCW). NCCW has published a list of endangered species in Pakistan, and wildlife management boards have been set up to advise local administrations. For instance, the province of Sind has the Sind Wildlife Management Board. Endangered species are covered under this law as "protected animals" (Sind Wildlife Protection Ordinance, 1972). The Government of Pakistan lists five additional species it considers endangered or vulnerable (Table 4-1).

No endangered species are known to occur at the proposed plant site (KBN, 1986), although the endangered desert monitor may occur in the area west of the Jamshoro site (David Ferguson, U.S. Dept. of Interior, pers. comm.). The chinkara at one time occurred west of the site, but because of hunting and habitat destruction, is no longer reported in the area. The fishing cat, spotbill duck, sarus crane and Indian softshell turtle have some potential to occur in the vicinity of the proposed water intake area and associated pipeline corridor in the riverine area; however, their occurrence is considered transitory because of existing human activity and agricultural activity. No riverine forests occur in this area and the likelihood of the hog deer occurring in the area of the intake structure and pipeline corridor in

the Indus floodplain is remote. Although it is not believed that threatened and endangered species exist at the site, WAPDA should consider conducting a field survey to confirm this before construction begins.

4.1.3.3 Livestock

Livestock production is an important economic activity for the area both in terms of subsistence food production and in income-producing activities. Cattle, water buffalo, sheep, and goats are the main livestock species produced in the area. In support of the livestock production, large amounts of fodder crops are grown. Livestock grazing occurs to the east of the site in the cultivated areas of the Indus floodplain. Goats have been seen grazing on and to the west of the site during the monsoon season when natural vegetation emerges and the seasonal farming families of the Khosa Baluch return to these areas (KBN, 1986). During a site visit in September, 1986, approximately 100 goats in two flocks were being tended by goatherds on the site. However, to our knowledge, no permanent farming exists on the site. Seasonal use of the land for grazing appears typical of this region of Sind.

4.1.4 WATER RESOURCES

4.1.4.1 Surface Water

The major surface water feature of the region is the Indus River, which is the major freshwater supply for agricultural, domestic, and industrial uses.

Several non-perennial river beds or streams transport water during short periods of the rainy season or following heavy rainfall events. Surface drainage in the region generally flows east to the Indus River. During heavy rains, the non-perennial stream beds are occasionally filled with sufficient water to wash away sections of th Indus Highway and collapse bridges between Hyderabad and Khanot (JICA, 1981).

Monthly climatic conditions for the Hyderabad area are shown in Table 4-2. Average annual rainfall for the area is about 155 mm (6.1 inches), with about 80 percent of the total rainfall occurring in the wet season between July and September. Evaporation rates from open water surfaces for the region were calculated from meteorological data to be about 3,218 mm (127 inches) per year.

Water levels in the Indus River are controlled by a series of barrages constructed to control flooding and to provide a supply of water during the dry season. A cross section of the Indus River at Khanot indicates

103X

Table 4-2

Hyderabad Climatological Data (1931 to 1960)

Month	Average Wind Speed (m/s)	Average Wind Direction	Temperature (°C)			Precipitation (mm)			Evaporation From Water Surfaces	
			Mean	Minimum Daily	Maximum Daily	Mean	Maximum (Monthly)	Maximum (24 Hour)	mm	(inches)
January	1.6	N	17.1	10.1	24.2	4.1	30.0	17.8	152.4	(6.0)
February	1.6	N	20.6	12.8	28.6	4.8	35.1	33.0	154.9	(6.1)
March	2.0	SW	25.9	17.7	34.2	1.0	12.2	6.1	226.1	(8.9)
April	2.5	SW	30.8	22.2	39.4	1.5	17.0	17.0	393.7	(15.5)
May	4.0	SW	34.1	25.9	42.3	4.1	27.9	14.0	406.4	(16.0)
June	5.3	SW	34.3	27.9	40.6	6.3	47.5	38.4	434.3	(17.1)
July	4.8	SW	32.5	27.5	37.5	68.1	273.6	109.5	302.3	(11.9)
August	4.7	SW	31.3	26.5	36.1	43.7	276.6	118.4	274.3	(10.8)
September	4.0	SW	30.9	25.1	36.8	14.7	192.5	78.0	254.0	(10.0)
October	2.0	SW/N	29.3	21.5	37.1	2.8	26.2	34.3	233.7	(9.2)
November	1.3	N	24.2	16.2	32.2	1.0	13.7	13.7	182.9	(7.2)
December	1.5	N	19.1	11.8	26.4	2.5	26.4	26.4	203.2	(8.0)
Annual	2.9		27.5	20.4	34.6	154.7	526.5	118.4	3.218.2	(126.7)

Sources: Pakistan Meteorological Service, 1985.
ESE, 1986.

that the river is about 230 m (750 ft) across and up to 9 m (30 ft) deep (Figure 4-10).

Flow upstream of the Kotri Barrage increases significantly during the rainy season between July and September. The highest flows between 1981 and 1983 during this rainy season are generally above 300,000 cubic meters per second (cusecs) (11,000,000 cubic feet per seconds [cfs]). The lowest flow upstream of the Kotri Barrage for the period between 1981 and 1983 was 799 cusecs (28,230 cfs). At Sehwan, approximately 110 km (68 miles) north of Jamshoro, the extreme daily minimum flow was 895 cusecs (31,600 cfs), which was recorded for seven consecutive days in April, 1975. The average of the extreme daily minimums for the recording period at Sehwan was 1,363 cusecs (48,160 cfs). Discharge flow rates upstream and downstream of the Kotri Barrage (1981-1983), and discharge characteristics at Sehwan (1972-1975 and 1979), are summarized in Appendix I.

Water quality data for the Indus River at the Kotri Barrage have been obtained from an ongoing monitoring program conducted by the Public Health Engineering and Research Laboratory in Pakistan between February 1979 and February 1985. In May 1985, a water quality monitoring program was initiated by WAPDA, USAID, and USAID's contractor, TAMS, to obtain water quality data relevant to the Lakhra Coal Project. Monthly samples are collected from six sample locations between Khanot and Hyderabad (Figure 4-11). Samples are collected and analyzed by WAPDA personnel. Results of available water quality data are summarized in Table 4-3 and are presented in detail in Appendix I.

125X

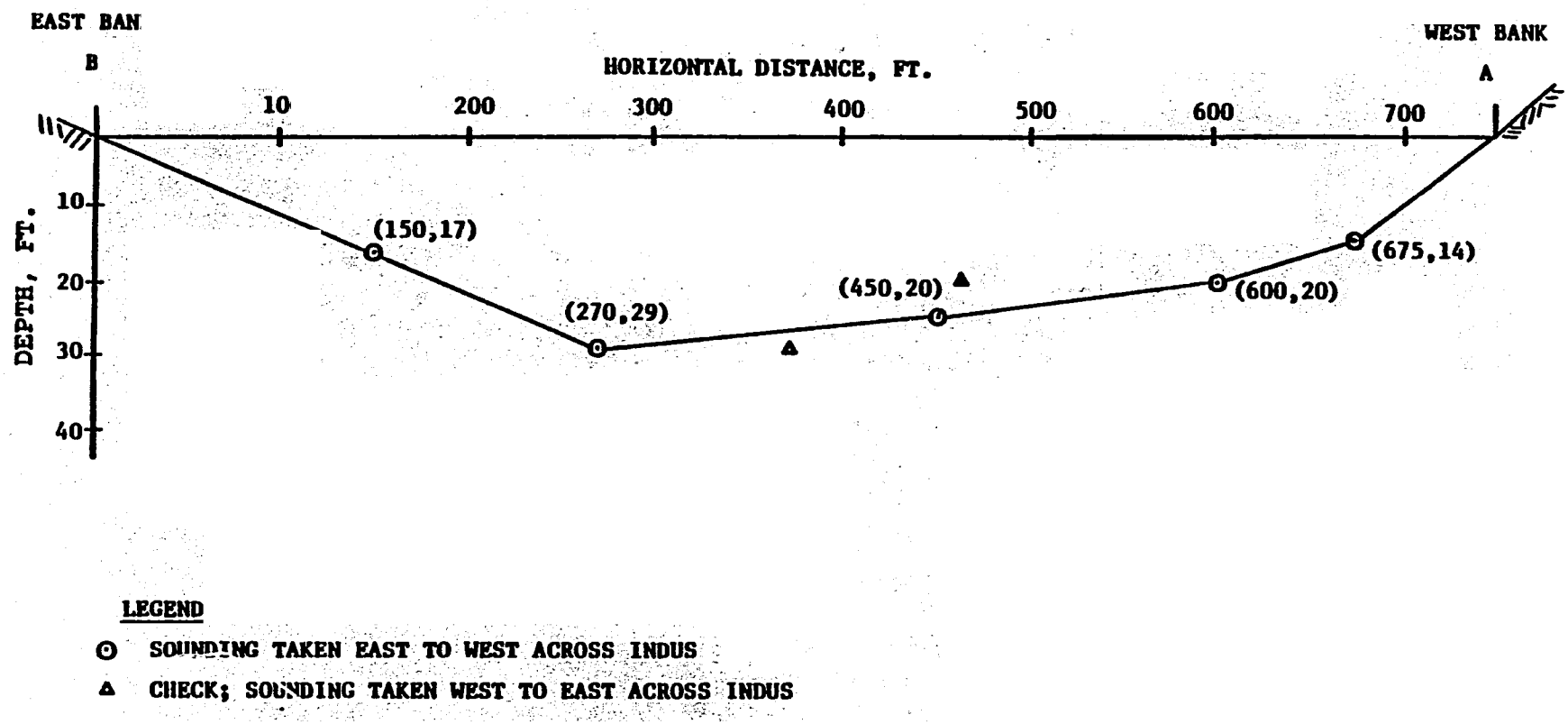


Figure 4-10 Soundings of Indus River at Khanot

SOURCE: GCII, 1985.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

USAID PAKISTAN 08/86

126

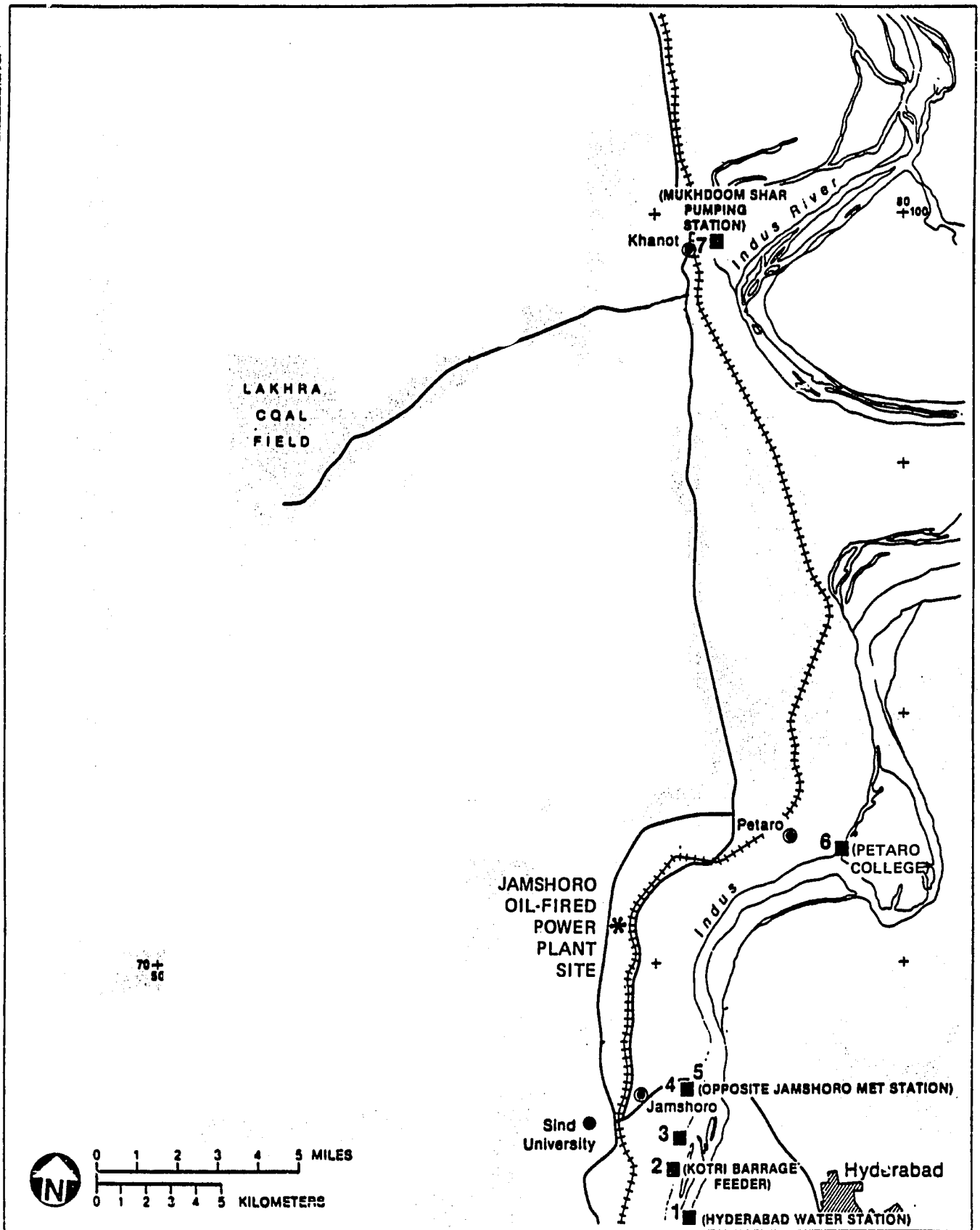


Figure 4-11 Water Quality Monitoring Stations Locations, 1985

SOURCE: GCII, 1985.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

1272

Table 4-3

Summary of Indus River Water Quality Upstream of Kotri Barrage

Parameter	1980-1984 From Public Health Engineering Research Laboratory, Hyderabad*				1985-1986 From WAPDA**			
	Mean	Maximum	Minimum	Standard Deviation	Mean	Maximum	Minimum	Standard Deviation
Temperature (°C)	26.4	40	14	6.3	25.1	32.8	19	5.24
pH	7.5	7.8	7.2	0.09	7.8	8.5	7.1	0.36
Alkalinity (mg/l)	102	140	40	24.5	107.8	227	70	38.1
Conductivity (umhos/cm)	335	510	230	48.5	327	1100	100	175
Suspended Solids (mg/l)	487	2200	10	811	410	1800	1	[illegible]
D.O. (mg/l)	9.7	24	4	4.2	8.0	16.5	5.9	[illegible].4
C.O.D. (mg/l)	20	720	2	64				
B.O.D. (mg/l)	6.3	12.8	1	2.8				
CL^- (mg/l)	51.6	100	30	12.5	19.5	50	6	[illegible].9
SO_4^{-2} (mg/l)	98.5	149	64	11.8	40.9	120	8	[illegible].6
$NO_2^- + NO_3^-$ (mg/l)	2.0	3.8	0.9	0.54	0.72	6.0	0.01	[illegible].33
Fl^- (mg/l)	0.34	0.68	0	0.15				
Na^+ (mg/l)	14	44	2	12.7				
Ca^{+2} (mg/l)	39	56	12	8.9				
Mg^{+2} (mg/l)	17	32	28	7.8				
Fe^{+3} (mg/l)	0.1	1.1	0	0.18	0.49	3.7	0.01	[illegible].53
Total - PO_4 (mg/l)					1.0	4.0	0.15	[illegible].68
O - PO_4 (mg/l)	0.02	0.08	0	0.024				
Cu (mg/l)					0.17	1.1	0.01	[illegible].17
Cr^{+6} (mg/l)	0	0	0	0				
$N-NH_3$ (mg/l)	0.21	1.1	0	0.25				
F-Coliform (NPN/100 ml)	105.5	180	70	19.7				

Note: Blank fields indicate data not available for this parameter.

*Summary of bimonthly samples taken upstream of Kotri Barrage near left divide wall.
**Summary of data obtained from 5 stations; samples taken monthly from May, 1985 through August, 198[illegible]

Source: KBN, 1986

The results of these monitoring programs show that the river contains levels of suspended solids ranging as high as 2,000 mg/L, particularl during periods of high flow. Concentrations of sulfate (SO_4^{-2}) and chloride (Cl^-) are generally below 50 mg/L with average values less than 100 mg/1. The highest SO_4^{-2} and CL^- concentrations, 400 and 296 mg/1 respectively, were measured at only one station downstream o Kotri Barrage (Hyderabad water station) and do not appear to be representative of Indus River water quality upstream of this structure. All other SO_4^{-2} and Cl^- concentrations observed were substantially below the World Health Organization (WHO) International Standards for Drinking Water of 400 and 200 mg/1 respectively. Iron concentrations are generally less than 5 mg/1 with mean values well below 1 mg/1; however concentrations above the WHO Guidelines of 0.3 mg/1 have been frequently observed. Phosphate and nitrate concentrations are generally less than 2 mg/1. Concentrations of calcium and magnesium are about 40 and 20 mg/1 respectively. The pH of the Indus ranges from 7.1 to 8.5, which is within the WHO drinking water guidelines.

Downstream of the Jamshoro intake facility, the uses of Indus River water are primarily irrigation, domestic water, and support of an active local freshwater fishery.

4.1.4.2 Ground Water

Shallow ground water in the region occurs in small amounts in perched water table systems; however, this source of water is local, of small

quantity, and usually too poor in quality for use as drinking water supply. There is little or no potable ground water; no significant aquifers are in the region. Soils in the region are anisotropic with large variations in physical characteristics, reflecting the properties of variable deposition of sediments from the Indus River during different time horizons. The percentage of usable quality water within about 90 m (300 ft) from the surface is extremely limited. For these reasons, ground water development is difficult and uneconomical. The usable fresh ground water available throughout the entire province of Sind is not substantial enough to be considered as a water resource at present or as having any future potential.

In the irrigated areas along the Indus River, the ground water is subject to effects of waterlogging and salinization. After meeting crop requirements, the irrigation water from the Indus River either evaporates or seeps into the ground. The percolation of seepage from the irrigation channels and from irrigated land has increased the ground water recharge and disturbed the equilibrium of inflow to and outflow from the ground water reservoir. Thus, the water table began rising such that in most irrigated areas the water level is at or near the surface. Tube wells have been constructed in the region to lower the water table by pumping to prevent or reduce waterlogging. Ground water from the tube wells is usually either discharged to the river or reused for irrigation, depending on the water quality.

Detailed information to determine ground water characteristics (such as location of aquifers' transmissivities, and direction and rate of ground water flows in the region) is not available.

The results of available chemical analyses of the ground water obtained in the Jamshoro area are shown in Table 4-4, along with WHO Guidelines for Drinking Water for those parameters that were analyzed. Ground water at each site contains high sulfates and high dissolved solids. The pH values range from 7.8 to 8. There is reportedly limited use of this water for domestic purposes in the Jamshoro area.

4.1.5 GEOLOGY, PHYSIOGRAPHY, TOPOGRAPHY AND SEISMICITY

The regional geology, physiography, and topography are typical of the Southern Montaine Front (Sind) division of the Calcareous Geological Zone. The area is arid in fact and in appearance. Although mostly level, or sloping gradually toward the Indus River to the east, numerous rocky hills and outcrops do occur throughout the region (Figures 4-3 to 4-6).

Rock units that crop out in the Sind were formed mainly from biological, chemical, and terrigenous sedimentation in the "Baluchistan Trough" (a shallow to deep marine basin) from the Late Cretaceous to the Pliocene time periods. Limestones, sandstones and shale are the predominant lithologies with locally important deposits of evaporates, conglomerates, and coal occurring as a result of deposition along the

Table 4-4

Ground Water Quality for Jamshoro Area

Test	Jamshoro	WHO Drinking Water Guidelines [1]
Sulphate (SO_4), mg/l	1080-2750 ppm	400
Chloride (Cl), mg/l	35-175 ppm	250
pH, units	7.8-8	6.5-8.5
Bicarbonate (HCO_3), mg/l	2.5-5 ppm	--
Calcium (Ca), mg/l	15.5-67 ppm	--
Sodium (Na), mg/l	70.5-190 pp	200

1. World Health Organization Guidelines, 1984.

margins and emergent areas within the basin. Minor units of volcanic rocks occur in the form of basaltic flows and ash beds.

The Lakhra anticline, an emergent area in Sind, is the major structural feature in the region of the Jamshoro site. The Lakhra anticline is located west and northwest of the city of Hyderabad and the Jamshoro site, and is a north-south trending structural high, approximately 60 km (40 miles) in length along the axis or crest. The axis plunges to the north and south at approximately 0.5° to 1°, and rock units to the east and west of the crest dip at 2° to 10°. The oldest formation exposed in the region is the Lower Ranikot Formation, which crops out along the crest of the anticline. Successively younger formations occur along the flanks of the anticline in the direction of dip. The generalized stratigraphy in the region of the Lakhra anticline is summarized in Table 4-5.

Minor folds and faults occur along the flanks of the anticline and generally trend north and north-east. Faults on the eastern flank dip to the east at 70° to 90°, whereas the western faults are vertical or dip slightly to the west. The throw ranges from a few feet to as much as 100 feet. Locally, these features control drainage and topography.

The Lakhra anticline and other folds and faults modify drainage systems, depending on the relative amount of uplift and the resistance of the rock units. Drainage in the region generally flows east to the Indus River. West of the Lakhra anticline, drainage flows south to th

133X

Table 4-5

Generalized Stratigraphy of the Lakhra Anticline Area

Age/Period	Group	Formation	Lithology	Thickness (ft)
Recent/(Subrecent)		Alluvium	Unconsolidated stream, colluvial, and eolian deposits of sandstone, siltstone, shale, and limestone fragments. Unconformity at the base.	0-10
Tertiary/Pliocene		Manchar	Interbedded sandstone and shale: soft, crumbly sandstone predominates the upper portion; soft, clayey shale predominates the lower portion. Unconformity at the base.	0-3000
Tertiary/Early Eocene	Laki		Mostly fine, crystalline, massive, and hard limestone with marl, calcareous shale, sandstone, and lateritic clay. Distinctive hard ferrigenous basal laterite or shale.	0-3000
Late Cretaceous to Tertiary/ Paleocene	Ranikot	Upper Ranikot	Fossiliferous sandstone, limestone and shale with all gradations between each occurring. Limestone is hard, massive and cliff-forming, whereas the shale is slope forming.	0-890
		Lower Ranikot	Unfossiliferous sandstone interbedded with shale, siltstone, and coal. The sandstone and shale display rich variegated colors and both are generally soft.	1500-3085
		Cardita	Sandstone and shale with minor fossiliferrous limestone and prominent volcanic rocks. Sandstone is soft, friable, and calcareous. Shale is gypsiferous and earthy. At least two basaltic flows are present - one of which marks the top of the formation. Unconformity at the base.	200
Late Cretaceous		Pab Sandstone	Sugary textured sandstone with minor limestone, shale, conglomerate, and basalt flows. Conformable with Hemipneustes Limestone.	350-900
Late Cretaceous		Hemipneustes	Hard well-jointed, crystalline, reefoid limestone.	300

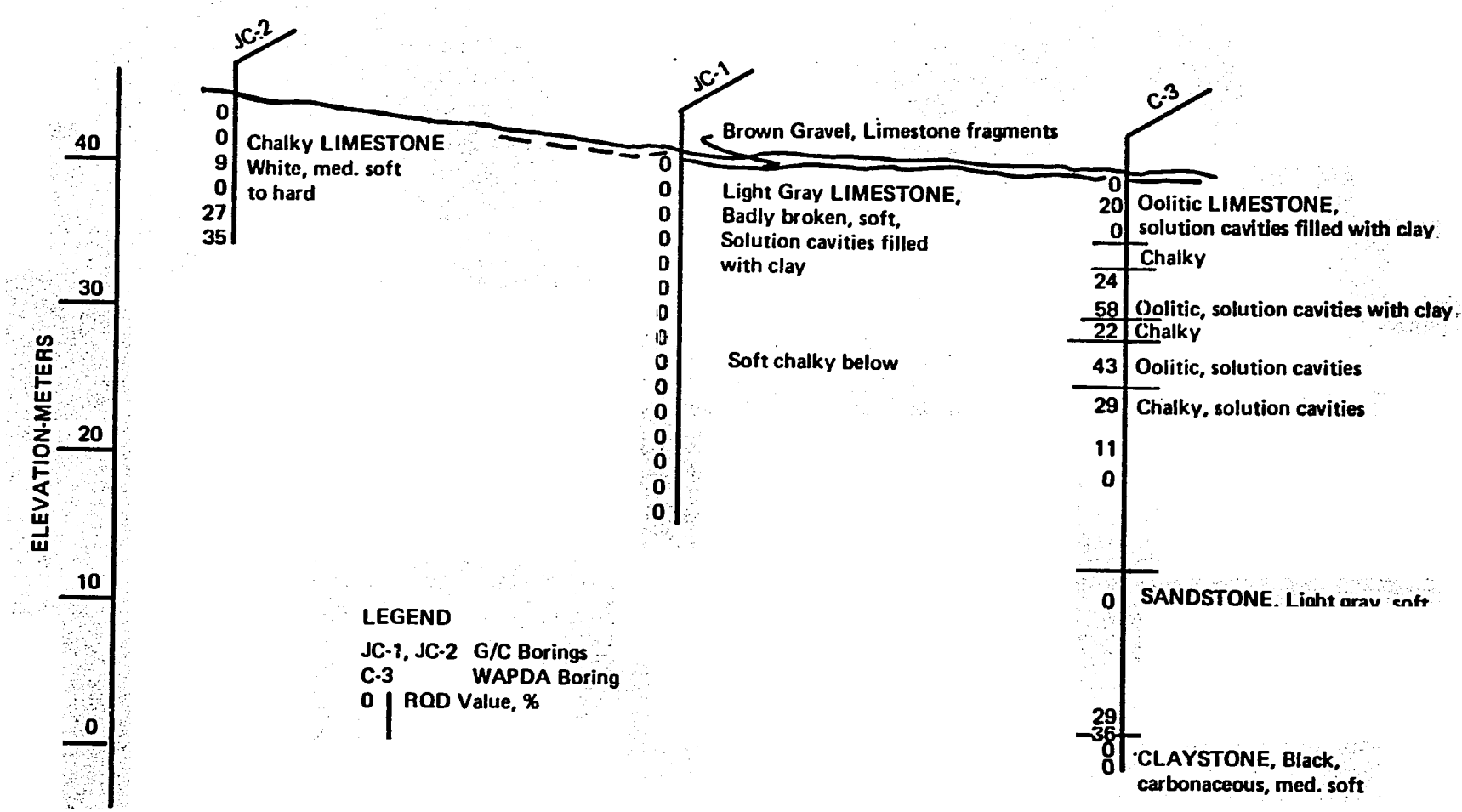
Source: Hunting Survey Corporation, Ltd., 1960.

southern end of the anticline, then east to the Indus River. At the northern tip of the anticline, drainage is to the north, possibly controlled by bedding planes and faults. Within the anticline, drainage is easterly across the crest of the anticline.

A total of 41 borings of various depths have been drilled within the Jamshoro site area. The most recent information includes two informatory borings drilled by Gilbert Commonwealth International, Inc. (GCII) to confirm the geological conditions of the site. The area allocated for Phase II facilities is generally sloping from the southwest corner toward the northeast corner of the site. The high point of the site is at an approximate elevation of 45 meters, while the low point is at an approximate elevation of 28 meters. Elevation drop is approximately 17 meters over a distance of 900 meters. The overall slope of the site is about 1.9 percent. According to the borings, the Jamshoro site is covered by thin overburden soils which consist of coarse, broken rock fragments with a thickness of from zero to 0.25 m deep. Thick limestone bedrock underlies the thin overburden boils. The limestone is soft to hard and exhibits moderate strength.

The weathering process of limestone has occurred to a depth of more than 25 m indicated by softening and decomposition in the cores. Iron staining has also occurred throughout the depth of the holes along fractures and bedding planes. Solution cavities were found in the upper and lower chalky limestone. Such cavities were frequently filled with calcareous clayey material. The soil and rock profile is presented in Figure 4-12.

135X



NOTES

1. RQD- Rock Quality Designation: total length of recovered core pieces measuring 10.2 cm. (4 in.) or more in length, expressed as a percentage of the total length of the core run.

Figure 4-12 Subsurface Profile A-A Jamshoro Site

The proposed site is located in Seismic Risk Zone 1, which corresponds to minor damage and Modified Mercalli Intensities between V and VI. Recorded earthquakes in the vicinity of the proposed site that occurred between 1819 and 1980 had magnitudes between 4.3 and 6 on the Richter Scale. Two major active faults are near the site (Figure 4-13): the Surjam Fault and the Jhimpir Fault. Maximum magnitudes of earthquakes occurring along the Surjam Fault and the Jhimpir Fault are 6.1 and 5.6 on the Richter Scale, respectively.

The Surjam fault is about 30 km (19 miles) west of Jamshoro site. The Jhimpir Fault is 25 km (16 miles) southwest of the Jamshoro site. Horizontal ground accelerations, calculated by GCII, taking into account the maximum intensities of recorded local earthquakes and the site's proximity to the active faults, are about 0.10 gravitational acceleration (g) for the site.

4.1.6 METEOROLOGY

4.1.6.1 Climatology

Pakistan lies on the western boundary of the monsoon region, which is one of the major climate regions of the earth. This climate region extends from Pakistan to Japan and northern Australia in the east. The word monsoon is derived from an Arabic word meaning "season;" in meteorology it has come to be associated with prevailing winds and wet or dry weather that reverse with the seasons. Generally, monsoon is

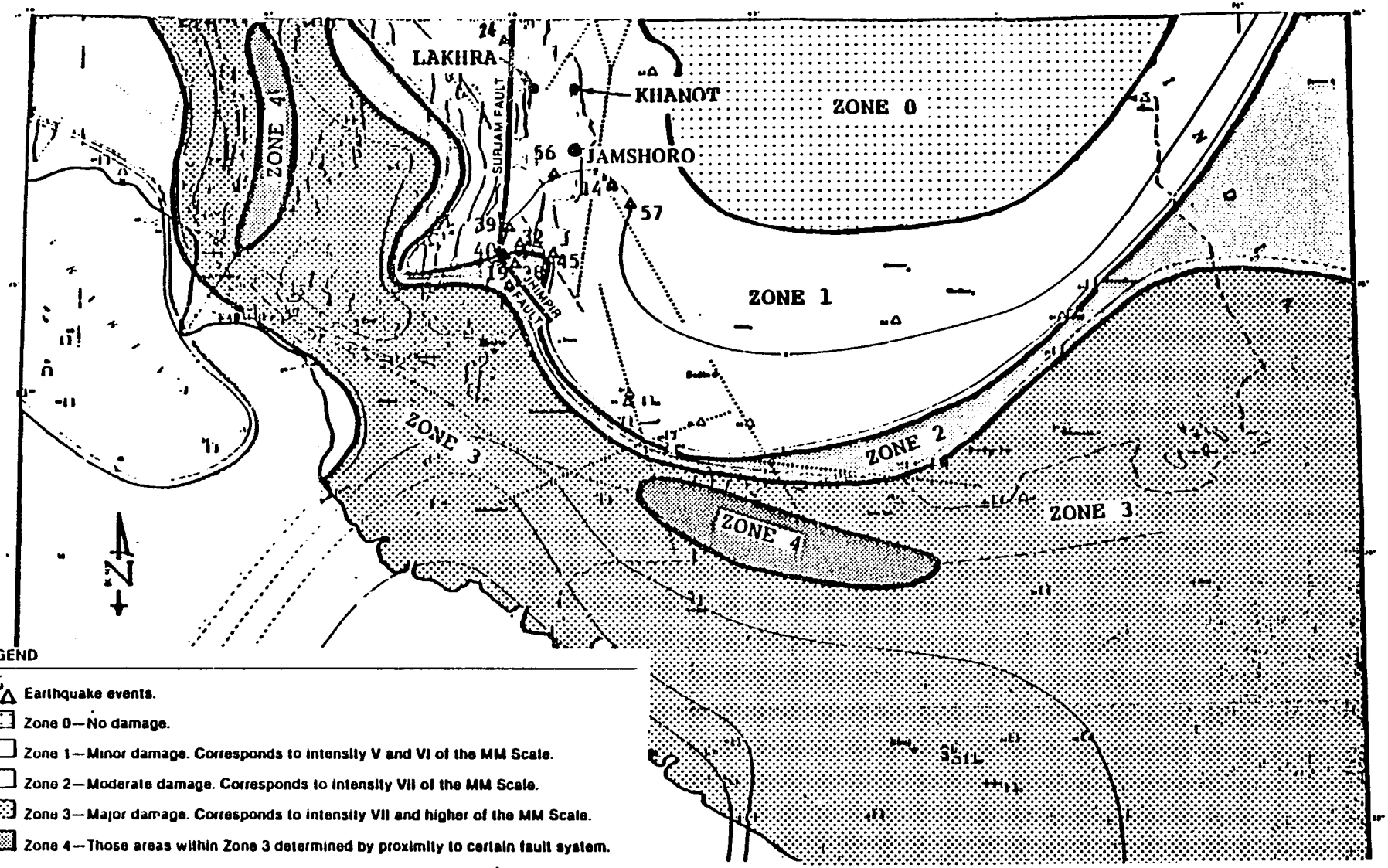


Figure 4-13 Seismic Risk Map of Karachi, Hyderabad Divisions and Lasbela District, Pakistan, 1984

SOURCE: GCII, 1985.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

USAID PAKISTAN 08/86

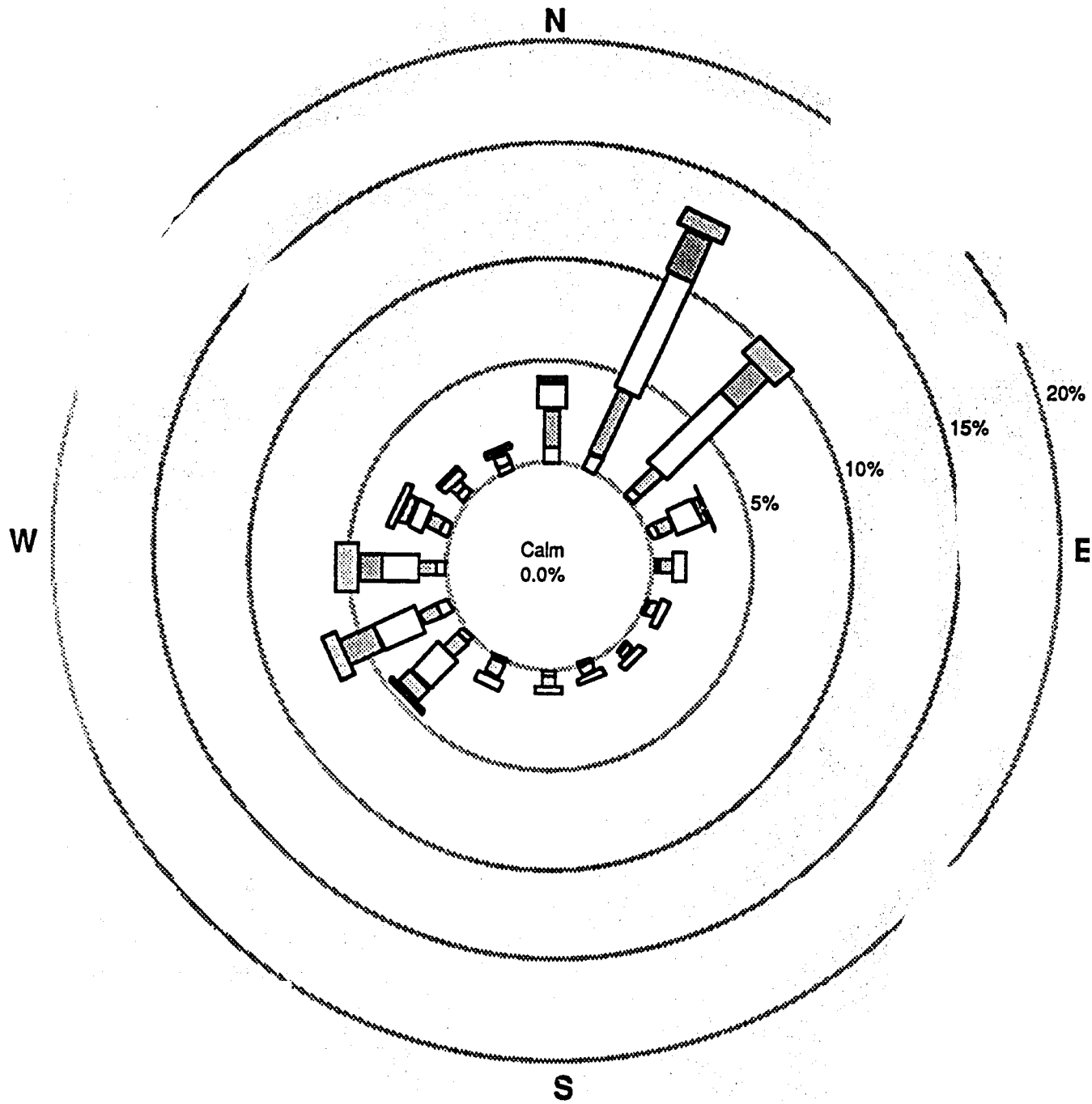
138

used to describe wind systems where the seasonal reversal is pronounced and exceeds a minimum number of degrees. Nieuwolt (1977), for example, has defined a monsoon as a system that shares a seasonal change direction of at least 120 degrees, and both winds must have a constancy higher than 40 percent and mean resultant speed of more than 3 per second (m/s).

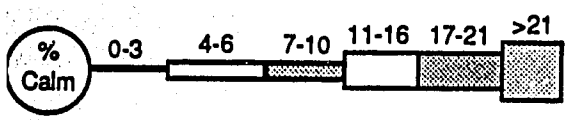
The winds in Pakistan are generally from a northerly direction in winter and from the southwest in summer (Figures 4-14 and 4-15). The causes of the reversal of the wind system are related to the large sizes of the Asian continent and adjacent oceans and the very high and extensive mountain ranges of the continent. These ranges, which are oriented in an east-west direction, form a barrier between tropical and polar air masses, and produce strong synoptic systems which are relatively stationary over much of the year.

The climate of Pakistan is more continental than that of other parts of the Indian subcontinent, which come under a more typical monsoon regime. The summer monsoon brings maritime influences and rain, but the strength of the winds fluctuates on an annual basis. Cyclones in the monsoon season cause significant rainfall, but their frequency is variable.

Rainfall throughout Pakistan is minimal. It occurs coincidentally with high temperatures; thus, the majority of rainfall evaporates, causing extremely arid conditions.



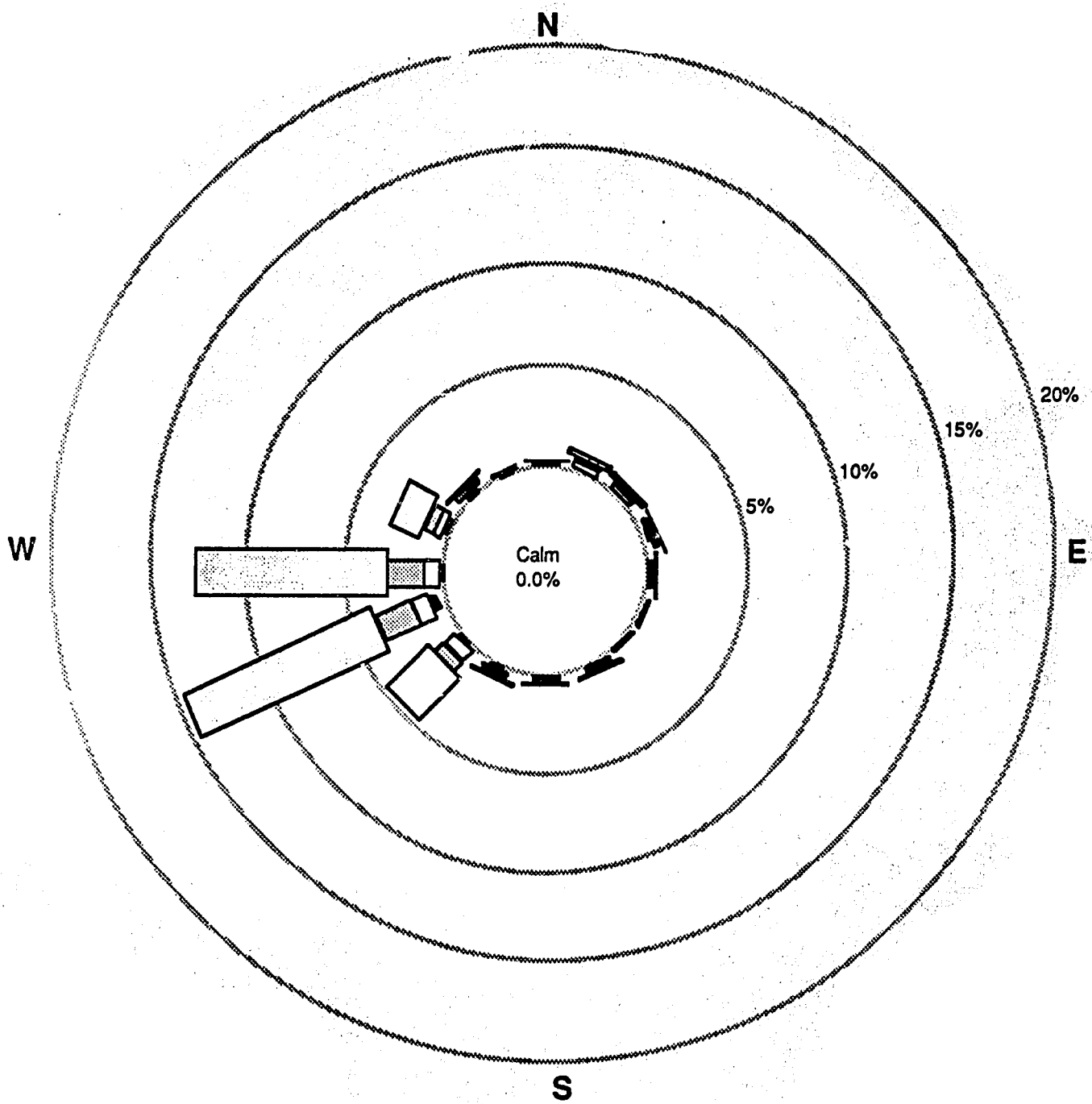
Wind Speed Classes (Knots)
Direction from which wind blows.



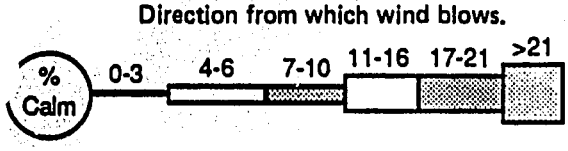
Note: Total Annual Obs = 6,524

Frequency in Percent
October 1, 1985 – April 30, 1986
(7 Months)

Figure 4-14 Wind Rose for Lakhra/Jamshoro for Winter Months



Wind Speed Classes (Knots).
Direction from which wind blows.



Note: Total Annual Obs = 6,524

Frequency in Percent
May 1, 1985 – September 30, 1985
(5 Months)

Figure 4-15 Wind Rose for Lakhra/Jamshoro for Summer Months

141+

Pakistan has four well-defined seasons, similar to the remainder of the subcontinent, with variations to their duration. The seasons of Pakistan are:

1. Cold Weather Season: mid-December through March
2. Hot Weather Season: April through June
3. Monsoon Season: July through September
4. Post-Monsoon Season: October through mid-December

The cold weather season is characterized by high barometric pressure (mean monthly pressure greater than 1,015 millibar [mb]), relatively low temperatures, and low amounts of precipitation. The mean monthly temperature varies from below four degrees Celsius (°C) (40 degrees Fahrenheit [°F]) in the mountain areas, to approximately 10°C (50°F) north of the plain area and to approximately 18°C (65°F) in the south. Rainfall during this season increases northward and westward, with 25 mm (one inch) or less in the middle and lower Indus Plain, 118 to 197 mm (5 to 8 inches) in the upper Indus Plain, and 300 mm (12 inches) or more in the north and northwest.

The hot weather season is characterized by high temperatures and low rainfall amounts. The mean maximum daily temperature varies from 40 to 46°C (105 to 114°F). The highest temperatures have been recorded in the south and southwestern parts of Pakistan. Rainfall amounts are low, varying from approximately 40 to 120 mm (2 to 5 inches) over the plains to approximately 160 to 200 mm (6 to 8 inches) in the

mountainous areas. The rainfall is associated with western disturbances that occur in more northerly latitudes, causing thunderstorms over the hills and widespread dust storms over the plains.

The monsoon season is characterized by moderate temperatures, large rainfall amounts, and persistent southwest winds. The winds are due to the establishment of low-pressure systems over the Indo-Pakistan subcontinent in May and June. The monsoon current in Pakistan is well established by July and remains constant through August. In some years, the monsoon remains active into September. During July, the mean monthly temperature exceeds 32°C (90°F) throughout the majority of the Indus Plain and western Pakistan. The average rainfall during the season decreases from approximately 1,000 mm (40 inches) in the north Indus Plain to approximately 200 mm (8 inches) or less in the south.

The post-monsoon season is characterized by retreat of the monsoon regime and is a transitional period between the monsoon regime and cool-season conditions. The high-pressure system begins to establish itself over Pakistan in mid-November. Without any active wind system, the weather produces generally dry conditions, with the least rainfall amounts in October and November.

The Jamshoro site is located in southeast Pakistan, and exhibits an arid climate that is influenced by the monsoon season with winds predominately from the southwest during the months of March through September, and from the north from October through February. Data taken by the Pakistan Meteorological Service (PMS) in Hyderabad during

143X

1931 through 1960 (see Table 4-2) demonstrate the influence of the monsoon season. Rainfall in the area is about 155 mm/year (6.2 inches), with a majority of the rainfall occurring in the months of July and August.

4.1.6.2 Site Meteorology

WAPDA currently is operating air quality and meteorological stations at the Jamshoro oil-fired power plant site and the proposed Lakhra coal-fired power plant site. A complete description of these stations is presented in Environmental Baseline Monitoring System and Program for the Lakhra Coal Mining and Power System Project (TAMS, 1985).

The Jamshoro monitoring station is located approximately 4 km (2.4 miles) west of the Indus River and approximately 5 km (3 miles) north of Liaquat Medical College. The station is located on a small hill (30 m in height) and records from a 10 m meteorological tower. The meteorological parameters measured are wind speed, wind direction, temperature, precipitation and solar radiation. Air quality instrumentation has also been installed and includes ambient continuous analyzers for NO_x, SO_2 and CO and two TSP monitors. A calibration system is present for these analyzers. Both the meteorological and air quality data are fed into a data acquisition system. There is also an acoustic radar system (monostatic) at this site for detection of mixing heights.

The Lakhra site is located approximately 20 km (12 miles) west of the village of Khanot. Meteorological data collected at this site are also representative of the Jamshoro area because of the proximity of the two sites and the relatively simple terrain characteristics. Wind speed, wind direction, temperature, precipitation and solar radiation data are gathered continuously. TSP data (two monitors) are also collected.

The meteorological data used for the baseline descriptions and the impact analysis for the Jamshoro oil-fired power plant were processed to obtain a set of representative site-specific meteorological data that can be used to:

- Characterize the meteorology of the Jamshoro area
- Estimate the air quality impacts of the power plant on the surrounding area using an atmospheric dispersion model

Raw meteorological data were processed by the CRSTER model preprocessor. The generated output file was converted to a card image format data file compatible with the ISC model. The processing of the meteorological data is described in detail in Appendix H.

In evaluating air quality impacts of air pollution emissions from a power plant, site-specific meteorology is important in characterizing the conditions under which pollutants disperse in the atmosphere. Five meteorological parameters are needed to characterize the dispersion meteorology of an area:

1. Wind Direction - determines the transport directions toward which the plume will travel and potentially affect receptors downwind of the plant

2. Wind Speed - determines the amount of dilution of plume concentration and height to which the plume will rise

3. Temperature - affects the height to which the plume will rise and also is used in estimating afternoon mixing heights

4. Atmospheric Stability - determines the extent of plume spread or dispersion in the vertical and horizontal directions

5. Mixing Height - determines the maximum vertical extent or volume of air in which the plume can disperse.

Wind speed, wind direction, and temperature were measured directly at the Jamshoro and Lakhra sites. Atmospheric stability can be determined using various techniques, but is usually determined using a technique that incorporates wind speed, cloud cover, and cloud ceiling values as well as recognition of day or night time conditions. This technique, referred to as the "Turner Stability Scheme," was used to develop atmospheric stabilities for the Lakhra area. Hourly mixing depth is generally calculated from a technique suggested by Holzworth (1972), which determines hourly mixing depths based on an interpolation scheme

using morning and afternoon mixing depths calculated from radiosonde data (meteorological soundings made from a free-released balloon). For the Jamshoro area, radiosonde data are not taken by the PMS in Hyderabad; however, seasonal mixing heights were inferred from radiosonde data taken by the PMS in Karachi.

Meteorological data on the air pollution sources are used in an atmospheric dispersion model to estimate concentrations of pollutants over a wide area. An atmospheric dispersion model is a series of mathematical formulae that calculates temporal and spatial concentrations of pollutants, using the meteorological data to determine the direction pollutants will travel (wind direction), the dispersion of the plume in the atmosphere (wind speed, stability), and the height to which further dispersion of pollutants can take place (mixing depth). Information from the source includes the stack height, stack diameter, volumetric flow rate, exit gas velocity, exit gas temperature, and pollutant emission rate. For this project, these data were used to calculate the height to which the plume will rise in the atmosphere, and the concentrations of pollutants in the plume.

Meteorological data representative of the Jamshoro site and obtained from data available at the Lakhra and Jamshoro sites are summarized in Table 4-6 for wind speed, direction, and temperature. Figures 4-14 and 4-15 present a wind rose of wind speed and direction data. Information on atmospheric stability is presented in Appendix H.

147

Table 4-6

Meteorological Data Collected at the Lakhra and Jamshoro Monitoring Stations from May 1985 to April 1986

Month	Number of Observations	Temperature (°C)			Prevailing Direction	Wind Data (mph)		
		Average	Minimum	Maximum		Average	Minimum	Maximum
Lakhra								
May 1985	367	43	29	58	North-northeast	20	3	41
June	720	39	32	55	West	31	5	53
July	744	37	27	49	West-southwest	27	5	46
August	721	35	26	48	West-southwest	24	2	46
September	84	34	29	43	West	25	12	38
October	108	33	21	46	West-southwest	17	6	31
November	720	28	15	45	North-northeast	12	2	29
December	659	20	5	37	North-northeast	13	1	34
January 1986	698	17	3	29	North-northeast	15	2	30
February	168	19	9	29	West-southwest	13	3	24
Jamshoro								
January 1986	324	17	10	24	North-northeast	13	3	24
February	555	19	11	28	Northeast	11	2	28
March	637	24	14	34	North-northeast	11	2	34
April	512	30	18	41	North-northeast	15	1	41

Source: ESE, 1986.

4.1.7 AIR QUALITY

4.1.7.1 Existing Air Pollution Sources

Within the Hyderabad area, there are only a few major existing air pollution point sources. These point sources, shown in Figure 4-16, include the Kotri Gas Turbine Power Station, the Hyderabad Thermal Power Station, and the Zeal Pak Cement Plant. In addition to these sources, WAPDA plans to construct a coal-fired power station located at the Lakhra site.

Area sources in the Hyderabad vicinity include vehicular traffic and other emission from anthropogenic activities (e.g., open burning of refuse, fugitive dust from construction and demolition, and agricultural activity). It was not possible within the scope of this study to include these sources in the modeling. With the exception of vehicular traffic, these area sources are considered minor contributors to existing air quality and are mainly confined to the City of Hyderabad. No data on traffic emissions are available.

The most potentially significant source of air pollution that can interact with the emissions from the Jamshoro plant is the proposed Lakhra coal-fired power station. That plant will consist of two 250 MW units firing Lakhra coal with a sulfur content of approximately 5.0 percent. Stack parameters and estimated emissions for two 250 MW units are presented in Tables 4-7 and 4-8. Because of the potential

149X

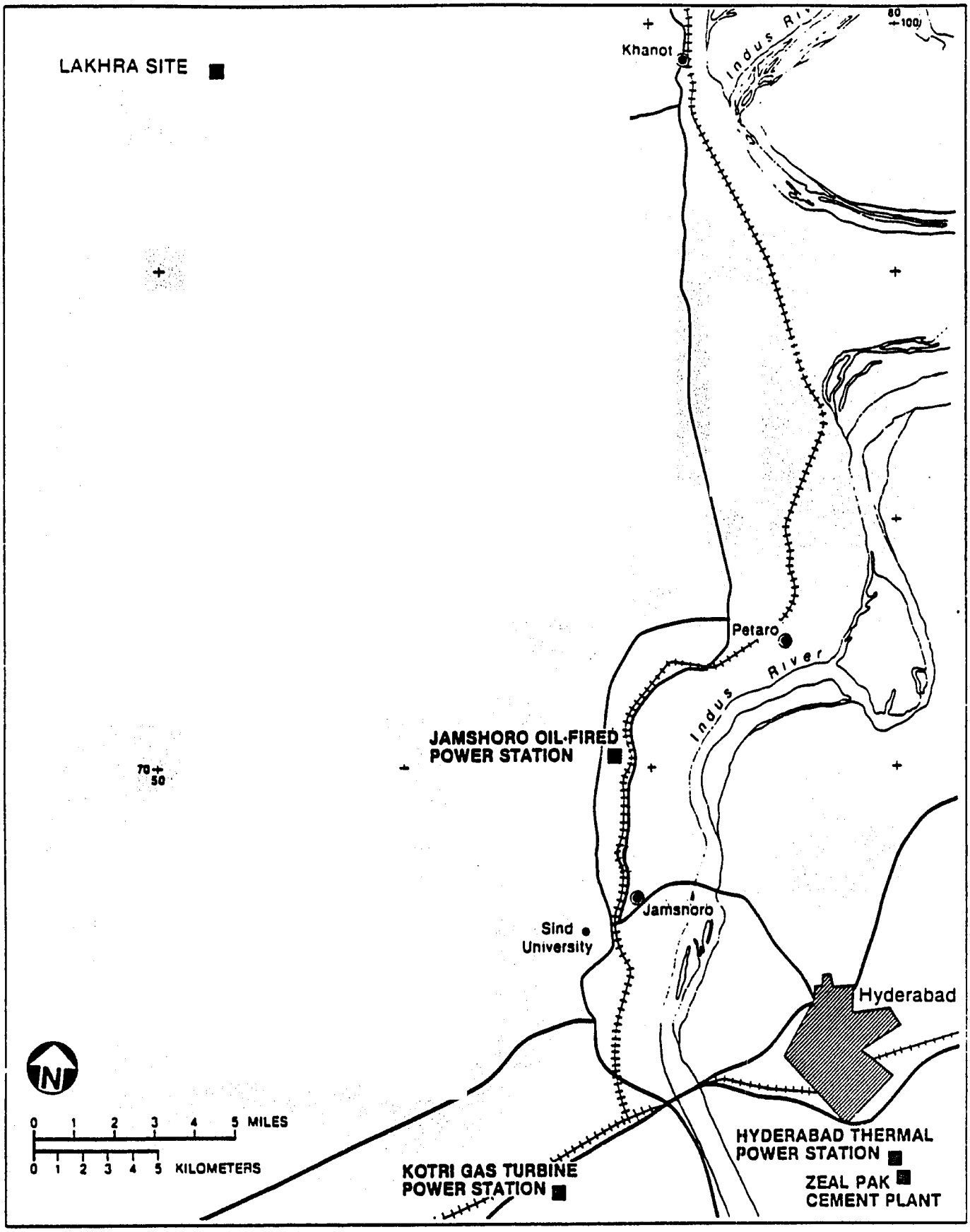


Figure 4-16 Existing and Projected Point Sources in the Project Area

SOURCE: ESE. 1986.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

152

Table 4-7

Stack Parameters for Two 250-MW Units Firing Lakhra Coal
(With Common Stack, Dual Flue)

Parameter	Value
Stack Height (m)	183
Stack Diameter (m)	7.93
Stack Temperature (k)	423
Stack Velocity (m/s)	22.9

Source: GCII, 1986

151X

Table 4-8

Emissions from Two 250-MW Units Firing Lakhra Coal

Pollutant	Emissions: Maximum at 100 Percent Load (g/s)	Emissions: Metric Tons Per Day	Emissions: Metric Tons Annual*
SO_2 - uncontrolled	11,167	967.0	229,000
PM	113	9.8	2,300
NO_x	417	36.0	8,500

*Assumes 65 percent capacity factor.

Source: ESE, 1986

interaction with the Jamshoro units, impacts from the Lakhra coal-fired plant were evaluated in the modeling analysis.

4.1.7.2 Ambient Air Quality

Ambient air quality data obtained from the monitoring equipment were evaluated to determine the general background concentrations of air pollutants in the area. A summary of the TSP data collected at the Lakhra and Jamshoro sites is presented in Table 4-9. The relatively high average TSP concentration in the Jamshoro area is primarily due to the arid nature of the region and the suspension of wind-borne dust. Because most of the particles are considered above the respirable range (i.e., particulate diameter exceeding 10 μm) and are most likely native soil, the health significance of the observed levels is low. For SO_2, CO, and NO_2, maximum concentrations at Lakhra were generally less than 0.01 ppm (26 μg/m^3), 0.5 ppm (0.6 μg/m^3) and 0.01 ppm (19 μg/m^3), respectively. These concentration levels are generally indicative of the relatively clean, unpolluted environment and are probably representative of the Jamshoro area as well.

Currently, the Government of Pakistan has not promulgated ambient air quality standards; however, there are other guidelines that allow an evaluation of the impacts predicted from the Jamshoro Power Project. Such guidelines are promulgated by the World Bank and World Health Organization and are generally accepted as air quality levels necessary

153X

Table 4-9

Summary of Total Suspended Particulate Matter Concentrations
for Jamshoro and Lakhra Monitoring Stations
May 1985 through September 1986

Site Location	Station Number	Number of Observations	Concentrations $\mu g/m^3$) Maximum	Minimum	Mean	Standard Deviation
Jamshoro	J-1	37	478	64	213	102.6
Jamshoro	J-2	89	61	7	110	110
Lakhra	L-1	23	553	35	180	110
	L-2	19	537	56	219	123.1

Sources: WAPDA, 1985.
ESE, 1986.

based on observed air monitoring data for those areas where existing pollution sources are located, and on atmospheric dispersion modeling for those areas where future sources are proposed.

Table 4-10 presents ambient air quality standards for the World Bank (WB). These standards are for 24-hour and annual averaging times for SO_2, NO_2, and TSP.

Air emission standards are presently being considered for adoption by the Pakistan Environmental Protection Agency. These are in the draft stage, however, and as such have not been used to guide decisions in these studies.

4.1.8 NOISE

Site-specific noise measurements have not been made in the vicinity of the site. However, values for background sound can be estimated based on typical noise data from technical literature and the general character of the site. A typical daytime noise level (equivalent sound level for a 1-hour period: $L_{eq(1)}$) for suburban areas at the outskirts of a city is 50 dBA. A nighttime $L_{eq(1)}$ is typically 40 dBA. Levels in rural areas are typically 5 to 10 dBA less (Eldred, 1974). The highway to the east of the site is the main source of noise during the day, but is only lightly used at night.

153X

Table 4-10

Air Quality Guidelines
for TSP, SO_2, and NO_2 for the World Bank

Pollutant	Averaging Time	
	24-hour	Annual
TSP	500 $\mu g/m^3$	100 $\mu g/m^3$
SO_2		
ambient	500 $\mu g/m^3$	100 $\mu g/m^3$
in-plant	1,000 $\mu g/m^3$	100 $\mu g/m^3$
NO_2	-- $\mu g/m^3$	100 $\mu g/m^3$

Source: WB, 1984.

There are no known national regulations on permissible environmental noise levels which pertain to the site. However, the International Organization for Standardization (ISO) has published a recommendation suggesting "methods for measuring and rating noises in residential, industrial and traffic areas with respect to their interference with rest, working efficiency, social activities and tranquility," (ISO/R 1996-1971). The rating method is based on a comparison of the noise intrusion with a criterion based upon either a pre-existing background level or a fixed level established by authorities.

Assuming that background levels are approximately 40 dBA at night to 50 dBA during the day, Table 4-11 offers recommended levels to be used as a basis for reducing noise impacts.

The ISO recommendation estimates the response from the community by comparing the intruding noise with the appropriate criterion value. If the intruding sound exceeds the criterion value, a response from the community is likely. An estimate of the public reaction which may be normally is expected is presented in Table 4-12.

4.2 SOCIAL AND INSTITUTIONAL

4.2.1 POPULATION

Sind is the second most populous province in Pakistan with a 1981 population of 18,966,000 people. This represents a 34 percent population increase since 1972 and a 3.5 percent per year growth rate,

15/X

Table 4-11

Basic Recommended Noise Guidelines for Residences in Different Land Use Areas

Land Use	Nighttime Criteria L_{eq} (1) dBA	Daytime Criteria L_{eq} (1) dBA
Rural	35	45
Suburban	40	50
Urban	45	55
Urban with some commercial and areas near major roads	50	60
Mostly commercial	55	65
Industrial	60	70

Source: International Organization for Standardization, Recommended Practice (ISO/R 1996: 1971)

Table 4-12

Estimated Community Response to Noise

Amount Intruding Noise Exceeds Criterion (dBA)	Estimated Community Response*
0	No reaction
5	Sporadic complaints
10	Widespread complaints
15	Threats of community action
20	Vigorous community action

*The customs, habits and attitudes of the local people may result in significantly different reactions.

Source: International Standards Organization, Recommended Practice (ISO/R1996:1971)

159X

which is above the national average of 2.97 percent. Sind's population and population growth are concentrated in urban areas, primarily Karachi. Forty-three percent of the population is already urban, and Sind is still Pakistan's most rapidly urbanizing province. It is difficult to accurately quantify these changes, however, because fluxes due to seasonal migration complicate growth patterns.

The Hyderabad District has 2,080,000 people. Forty-six percent (956,800 people) are in urban areas, with 37 percent (750,000 people) concentrated in the City of Hyderabad. The growth rate is 2.3 percent (calculated in 1981) and population density is 361 persons/km^2.

Dadu has a much smaller population (1,074,000) that is still 90 percent rural and relatively dispersed. This district is growing rapidly, with a growth rate in 1981 of 3.4 percent, which is approximately the same as the growth rate of 3.5 percent for Sind Province. Although the proposed site is in the Dadu Kotri Taluka (subdivision), its close proximity to the City of Hyderabad results in its being influenced socially and economically by the urbanized Hyderabad.

The combined population of towns and villages within 15 km of the plant site is about 60,800, as shown below.

Town or Village	Population
Chakur Rajar	800
Barrage Colony	2,000
Petaro	2,000
Jamshoro Colony	8,000
Kotri	48,000
Total	60,800

Source: WAPDA, 1986c.

The age and sex structure of the rural population in the Jamshoro area is similar to the national profile, with about 45 percent of both sexes in the 0-14 age group. Thirty-five percent of the people of this area are in the 15-39 age group, with most of the workers being in this category. Twenty percent of the population falls into the 40-75 age range, which includes approximately equal numbers of men and women. The rural population of Kotri Taluka is sparsely distributed in villages of 20 to 300 people spread out along the Indus Highway and the Indus River (KBN, 1986).

4.2.2 LAND USE

The study area is within the Division of Hyderabad and the two districts of Hyderabad and Dadu (Figure 4-17). The two districts are separated north and south by the Indus River. The Hyderabad District lies east of the Indus River. The Dadu District lies west of the Indus River and north of the City of Hyderabad. The Jamshoro site is located in the Dadu District in the Kotri Taluka, just west of Hyderabad. To the south lies the Thatta District.

Three major land-use types are found in the study area: urbanized areas around Hyderabad and southeast of Jamshoro; farm areas which are east of Jamshoro and north and south of along the Indus River; and non-farm areas primarily west of the Indus Highway including the Jamshoro site (Figure 4-17). Farm areas include areas currently under cultivation or areas fallow in the year of the census but cultivated

161+

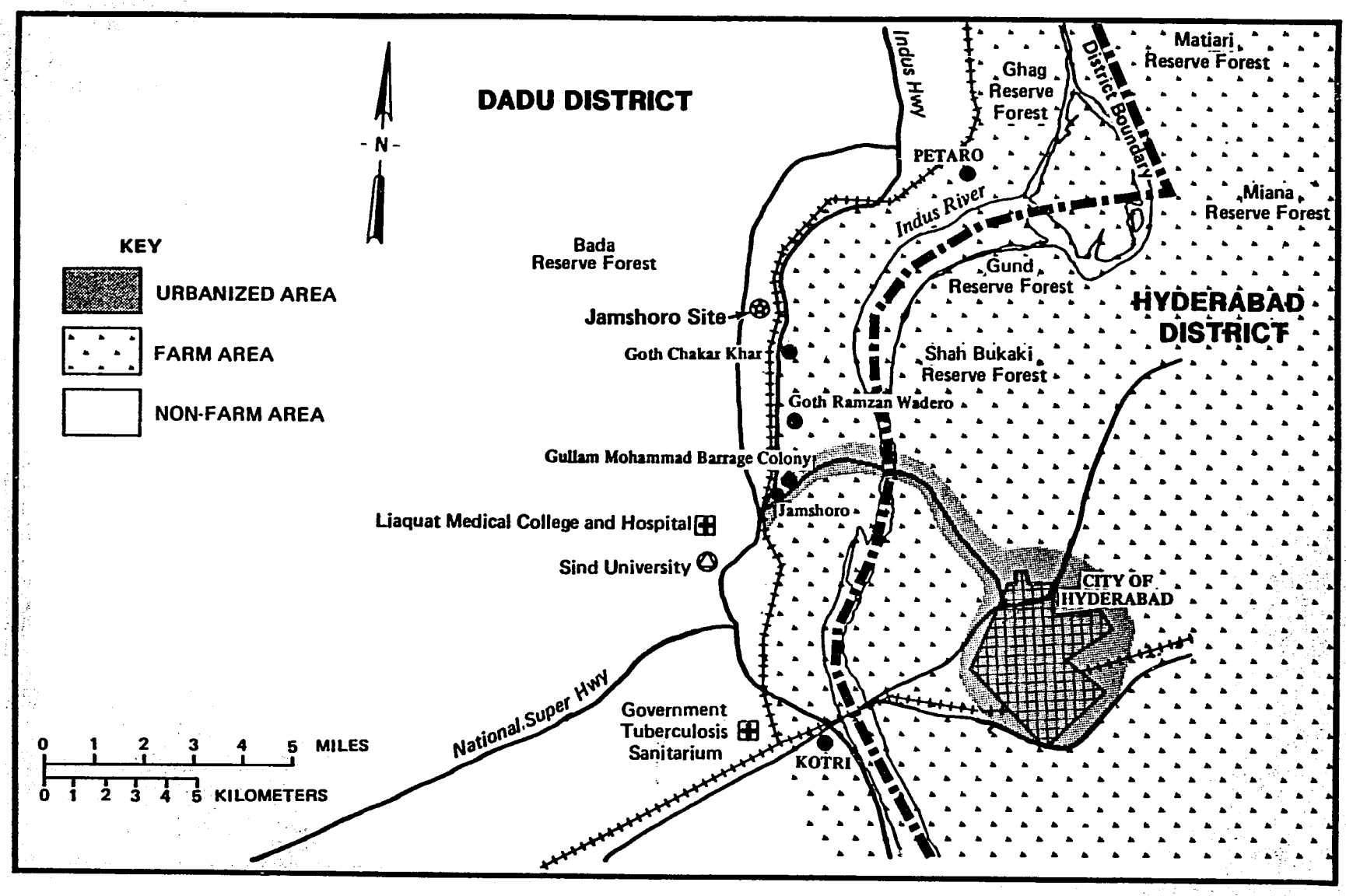


Figure 4-17 Land Use in the Study Area

the preceding years, areas used for farm buildings, and farm areas under forests. Non-farm areas include all areas not being farmed. These are undeveloped areas and contain scattered villages.

Based on 1979-80 reports, the Hyderabad District is the more developed of the two districts, with 34 percent (178,000 hectares) of its farmable land areas under cultivation. The Dadu District, the larger of the two districts, has only 13 percent of its farmable land under cultivation (201,000 hectares) (Sind Bureau of Statistics, 1984).

The Jamshoro site is a non-farm area. Part of the site is currently being excavated for construction of Unit 1. Parts not being excavated are undeveloped, open areas. Scattered seasonal goat grazing occurs in the site vicinity and throughout the region. No structures, other than those related to construction activities, occur at the site. The land for the Jamshoro Complex is owned by WAPDA, with the exception of approximately 80 acres of land for a Phase II workers' colony, which will be procured.

The area has extensive agricultural and forestry activity. Principal crops in the Jamshoro area are rice, cotton, fodder, sugar cane, maize, and fruit trees. Cotton is the primary crop grown along the river. These crops were observed being grown in the study area along with fodder (e.g., Egyptian clover) east of the Indus Highway. Primary cultivation of these crops occurs on the east side of the Indus River.

There are a number of government forest reserves along the Indus River including the Ghag Reserve, Bada Reserve, Miana Reserve, Gund Reserve, and the Shah Bukaki Reserve Forests. The forest reserves in the area are considered very good for the region (T. A. Ansari, 1986). Several commercial forests also occur within 15 km to the east of the site. Acacia and tamarisk are the primary species planted. Acacia is used in the Lakhra mines for support timbers and for firewood. Tamarisk is used primarily as timber and secondarily for furniture.

The only urbanized land in the study area is in the vicinity of the City of Hyderabad and along the road between Hyderabad and Jamshoro. Hyderabad is the headquarters for the District and Division of Hyderabad, and the fourth largest city in Pakistan with over 750,000 people. It is an important industrial and commercial center of the Lower Indus Plain producing textiles, oil, soap, leather goods, tiles, brick, glass, footwear, and carpets.

Sind University, Meran University, and Liaquat Medical College and Hospital are on the west side of the Indus River. These developments are approximately 6 km (4 miles) south of Jamshoro.

Scattered villages are located north of Hyderabad and east of Jamshoro along the highway in the floodplain (Figure 4-16). These are farm villages with houses constructed of solid brick or mud. There is a major truck stop at the intersection of the Indus Highway and the road to Hyderabad which provides goods and services to the area. At Petaro,

there is a government cadet school, which is a boy's military school with classes 7 through 12, and an enrollment of approximately 550 students.

4.2.3 FACILITIES AND SERVICES

4.2.3.1 Housing

In 1980, there were 294,097 houses in the Hyderabad District. Seventeen percent of the housing units in urban areas of the Hyderabad District were rented; the remainder were owner-occupied or rent-free. In 1980, there were 152,923 houses in the Dadu District; 4 percent of the homes in the district were rented, the remainder were owner occupied or rent-free (Pakistan Population Census Organization, 1983a,b). No data are available on vacancy rates. According to WAPDA almost all units are occupied.

Seventy to eighty percent of the dwellings in the Jamshoro area are small, one-room houses. These are generally very crowded, with an average of seven people per housing unit. Most homes use kerosene for lighting and wood or brush for cooking and heating (Pakistan Population Census Organisation, 1983a,b). Traditional homes are frequently cooled by a curved roof ventilator that funnels air into the home. No dwellings other than recently construc
site.

165X

4.2.3.2 Security

Police protection in the Jamshoro area is provided by the Government of Sind. Security at the project site is provided by WAPDA. The monitoring and control of banditry ("dacoity") in Pakistan is the responsibility of the federal government. Dacoit activity occurs in some areas of the Hyderabad and Dadu Districts, including the vicini of the Jamshoro site.

4.2.3.3 Health Care

The Liaqat Medical College is located about 5 km south of the Jamshoro site (Figure 4-7). It includes a medical school, a dental section, and two hospitals. It is one of the largest medical institutions in Pakistan. The two hospitals have a combined total of 1,100 beds with a 10- to 20-percent vacancy rate. The medical staff includes 200 physicians and 120 nurses, as well as 500 physician trainees and 150 nursing trainees. These two hospitals serve the Jamshoro area. There is a dispensary associated with the barrage colony just south of the site, and a government tuberculosis and respiratory disease sanatorium further south near Kotri.

4.2.3.4 Education

The literacy ratio in the Hyderabad District in 1981 was 28.7 percent. It was 41.2 percent in urban and 18.1 percent in rural areas. The male literacy ratio was 36.5 percent as compared to 19.8 percent of females

(Pakistan Population Census Organisation, 1983a). In the Dadu District, the literacy ratio was 21.5 percent. It was 39.6 percent in urban and 18.5 percent in rural areas. The male literacy ratio was 32.5 percent as compared to 8.6 percent of females (Pakistan Population Census Organisation, 1983b).

Two primary schools, kindergarten through Class 8, are located in Jamshoro and serve the project area. The current combined enrollment is approximately 530 students. The age of students in kindergarten through Class 5 is 4 to 16 years; and in Classes 6, 7, 8, it is 10 to 15 years. Numerous primary, middle, and secondary schools are located in Hyderabad and the surrounding communities.

Sind University is located south of the project site. It has approximately 5,000 students and offers a full range of programs. The university has a history of student activism. Several technical training schools are located in Hyderabad and the surrounding areas.

4.2.3.5 Communications

The nearest major telephone exchange to the site is in Hyderabad. The Hyderabad area has two central offices; systems at both central offices are 100-percent loaded at present.

Telephone and Telegraph Authority of Pakistan (T&T) personnel realize that the existing switchgear is no longer adequate to serve the needs

167X

of the Hyderabad area and are planning to install a 20,000-line digital switching office in 1987 or 1988. The new switching office will be located about 5 km (3 miles) northwest of the existing central office at a location known as Qasimabad.

The new digital switching equipment which T&T plans to install in the Hyderabad area in 1987 or 1988 will have about 4 times as much capacity as the existing switching equipment. The new equipment should be able to handle the normal load growth in the Hyderabad area for many years.

Although it is not well defined at this point, a fiber optic carrier system is planned between Karachi, Hyderabad, Islamabad, and Lahore. Current plans call for installation about 1990 or 1991. The capacity of this fiber system will be vastly superior to the existing 960-channel microwave system and will ease traffic problems on the domestic long-distance trunks.

4.2.4 TRANSPORTATION

The study area is bisected by the Indus Highway, connecting Karachi and Peshawar. The highway is a 5.5 km (18 foot) wide asphalt-paved road running north-south on the west side of the Indus River valley from Kotri and Jamshoro on the south through Khanot to Dadu, Larkana, and Shikarpur to the north. At Jamshoro, the Indus Highway connects to the segment of the National Super Highway between Karachi and Hyderabad on the west side of the Indus River. North/south transport of equipment,

goods and travelers, including workers, is via the Indus Highway. The Indus Highway normally carries more traffic than the National Super Highway. However, a six-year repair and renovation program is underway which includes both the Kotri Barrage and the National Super Highway north of Kotri and Hyderabad. When this program is completed, heavy loads will travel via the Super Highway.

Improvements to the Indus Highway are also planned. The Sind Department of Highways has developed plans, specifications, and cost estimates to expand the Indus Highway to a full 7.3 m (24 ft) width and upgrade the load-carrying capacity to 10,000 kilogram (22,000 lb) axle loading. An application has been made to the Government of Pakistan for funding of the project. As a first step, the Indus Highway was recently proclaimed to be a part of the National Super Highway System. Improvement of the road will benefit the project for the movement both of materials and workers.

Traffic counts on the Indus and National Super Highways were made in early 1986, but the data are not yet available. Estimates indicate that from 2,500 to 4,000 vehicles a day use the Indus Highway between Jamshoro and Khanot. Between Karachi and Jamshoro and estimated 10,000 to 12,000 vehicles a day use the National Super Highway. Most of the traffic coming north turns east at the truck stop near Jamshoro and goes to Hyderabad. Motorized transport involves buses, vans, trucks, cars and motorcycles. Large numbers of crowded buses can be counted daily on the Indus Highway. It has been estimated that 45 percent of

the motorized vehicles are trucks, 45 percent are automobiles, and 10 percent are buses (KBN, 1986).

domestic animals (horses, camels, oxen, donkeys) that are either ridden or pull two-wheeled carts carrying passengers or goods.

The truck stop south of Jamshoro is a major feature on the Indus Highway in this region. The truck stop provides petrol and diesel fuel as well as a large variety of equipment and vehicle repair services.

Rail service to the region is provided via a single-line, broad-gauge track of the Pakistan Railways which runs parallel to the Indus Highway, passing east of Jamshoro. The closest airport is at Hyderabad, which has scheduled service by Pakistan International Airlines.

4.2.5 LIFESTYLE, CULTURAL PATTERNS, AND ATTITUDES

Within the study area are several very different ethnic groups that interrelate through complex socioeconomic patterns (Helweg, 1985) and will be involved in the construction and operation of the project.

Pakistan has 19 million Sindhis, most of whom are engaged in traditional agriculture. Their culture is historically feudal and hierarchial, with acceptable tasks and privileges defined by social

stratification. Sind is also a politically volatile area with a population traditionally distrustful of outsiders (Helweg, 1985).

Syeds, Baluchs, Samata, Qureshis, Kazis, Memons, Sheikhs, Soomras, and Hindus also live in the Dadu District. The majority of people in the district are Muslim tribal people, and the mosques and prayer sites scattered around the rural landscape reflect their heritage.

There are about 6.5 million Baluchis in Paki tan, and 1.4 million of them live in the Sind Province. They live compatibly with the local Sindhis in the area, but adhere closely to their own traditions. The Baluchis have branched into many tribes, with the Khosas and Rinds dominating in the area. The Rinds were the first settlers, but they were replaced in many areas by the Khosas. The Rind tribe now occupies the Indus riverbanks, and the Khosas live in the semi-desert region to the west of the Jamshoro and north towards the Lakhra coal fields.

Pakistan's Punjabi population is well over 50 million. Punjabis traditionally have provided much of the financial backing, upper-level management, engineering and planning expertise for many projects in Pakistan. It is possible that Punjabis may participate in the Jamshoro project because of their skills.

The settled areas along the Indus to the east of the site consist of multi-caste and single caste Baluch, Sindhi, and Sindhi/Baluch villages. Separation and hierarchy are dominant principles governing

171X

social patterns in the study area (Helweg, 1985). Ethnic groups live separately, and members of class and kin subgroups cluster with their own kin. Each social group does certain types of work, and social mobility appears to be restricted.

Women's opportunities vary according to region, social level, and village type. "Purdah," the practice of keeping women secluded in the home, is practiced throughout Sind, but women have more freedom in the more socially homogenous villages. Where they are among their own people, they may be more active around the village and participate in agricultural work, but where they live in proximity to others, their commercial activities are restricted and often limited to doing handicrafts in the home, mainly sewing and embroidery.

Women generally manage domestic matters including family finances. Decisions regarding matters outside the immediate sphere of the family, such as where to locate the home or to seek employment, are generally made by the men.

4.2.6 CULTURAL RESOURCES

Sind is situated in the Indus River Valley, setting of one of the world's earliest civilizations. The early Indus civilization, typified by the Harappan Culture, remains the focus of most archaeological investigations conducted in the region. These classical archaeological studies have included investigations of pre-, proto-, and early Harappan neolithic sites. In more recent times, mesolithic site and

paleolithic site studies, settlement and subsistence studies, and cultural ecology studies have been conducted. Another area of research for archaeology in Pakistan is characterization and analysis of the Aryans. Associated with these investigations are studies into the decline of Indus civilizations due to climatic changes, invaders, or depletion of the soil.

Successive waves of people have moved down the Indus Valley from Central Asia and the Iranian Plateau into India. The region has been ruled by many invading groups including Aryans, Persians, Greeks, Arabs, Turks, Mongols, and English. As a result, Sind and the study area reflect contributions of numerous invading cultures. The city of Hyderabad, the capital of Sind, has been occupied by numerous invaders. Historical structures in the city include Makai Fort and the tombs of the Mirs and Talpurs, early rulers.

Based on conversations with the Director General, Department of Archaeology, Government of Pakistan in Karachi, archaeological and historical sites considered significant ("protected antiquity") by the Pakistan Government are not likely to exist at the Jamshoro site and along the pipeline route. Significant sites probably include remnants of large agricultural settlements and other structural ruins. Project location maps have been sent to the Director General; his concurrence on the absence of known, protected resources for those areas will be obtained before construction activities begin. Although sites of

importance are not readily apparent in the areas to be developed for Phase II, no comprehensive archaeological surveys have been performed. However, because the Complex site and pipeline alternatives are located on portions of ancient Indus River terraces, archaeological remains may be located in this area. Field surveys to determine the presence of previously unrecorded archaeological remains at the site and along the pipeline route will be conducted before construction activities begin.

4.3 ECONOMIC CONSIDERATIONS

4.3.1 EMPLOYMENT

In Sind, labor is organized through a system of labor contractors ("Mistris," "Jamadars" and subsidiary "Jorisars") and landowners ("Zamindars"). These leaders are key figures in the social structure, and their influence extends into all areas of the workers' lives. A Zamindar generally lives in one of the major urban centers and manages his enterprises through associates. There may be several such landowners in a community, but one usually dominates. According to the traditional system, carpenters, washermen, barbers, blacksmiths, cobblers, etc., provide services to the zamindar in return for a portion of the harvest. In turn, the zamindar has many obligations. He mediates on behalf of his workers with police, officials, and merchants. He also provides help and advice to his clients.

The Mistri acts as the central labor contractor for construction. Like the zamindar, he mediates between his workers and the outside would and is their advisor, confidant, and patron. He also manages their housing and board (Helweg, 1985). Wage labor is replacing this traditional system, but the zamindar still controls production and distributes goods (Helweg, 1985).

The city of Hyderabad is the primary source of non-agriculture employment opportunities. To the north, in the Lakhra region, coal mining is a primary source of employment.

4.3.2 AGRICULTURE AND FORESTRY

Over half the people in the Dadu and Hyderabad districts work at occupations classified as agricultural, animal husbandry, forestry, hunting, or fishing. Sixty-seven percent of the Dadu population is directly involved in agriculture. This is a subsistence economy with little or no commercial agriculture. Hyderabad is a nearby urban market for agricultural produce. Most of the region's cultivated land is east of the Indus River. It is not known how much leverage a zamindar has over subsistence agriculture.

In the arid areas, most of the rural farmers grow maize or sorghum. Near dry riverbeds or on gradually sloped terrain, vegetables are grown behind grass windbreaks.

175

The major truck stop at Jamshoro provides goods and services to the entire region. Fresh agricultural produce, (mainly fruits and vegetables) and fish are sold there, brought in by entrepreneurs operating along the Indus Highway.

Cutting acacia trees for mine timbers and other trees for use in the furniture industry is a primary economic activity in this region. Practically all of the natural forest has been destroyed, and most trees are now harvested from riverine second-growth forest reserves. As discussed in Section 4.2.2, extensive forest reserves occur along the Indus River east of Jamshoro. These areas provide timber for the Lakhra mines (KBN, 1986).

4.3.3 INDUSTRY

Karachi is the main business center of Sind with several major industries. Hyderabad, also industrialized, has 156 registered industrial units. (Pakistan Population Census Organization, 1983a,b).

Large-scale industries found in the vicinity of Hyderabad include the oil-fired power plant under construction at Jamshoro, the Zeal Pak cement factory, and light industries located at the Hyderabad Industrial Estate east of the City Center. The Zeal Pak Cement Industries limestone quarry is the largest in Pakistan. There is a pipe rolling mill and a fabric jute mill at Kotri. A major

pharmaceutical factory owned by Sandoz, Inc., is located at Jamshoro. One million tons of coal mined in the Lakhra coal field each year fuel brick kilns throughout Pakistan.

The Dadu District has a smaller industrial base with 43 units registered in 1981 (Pakistan Population Census Organization 1983a,b)

Quantitative information is not available on other economic activities in the area. Labor, mine timbers, food and water flow from the riverside villages, agricultural areas, and reserve forest. Mine and power plant equipment parts, fuel and other supplies come from Karachi and Hyderabad. Truck stops and shops, along the Indus Highway and in the villages act as intermediate points for some of the commerce.

4.4 PUBLIC HEALTH

Several health problems occur in the region associated with inadequat nutrition, overcrowded housing, debilitating work conditions, or poor access to health care. Gastrointestinal ailments, including parasiti diseases, are the most frequent cause of severe illness (United Nations Center for Regional Development, 1981).

As described earlier, the major surface water feature of the region is the Indus River, which is the major supply for agricultural and domestic water uses in the region. The major drainage system is a non-perennial system, the Majheri Nala, south of Jamshoro. It flows

177X

from the northeast to the south where it enters the Indus River. During the monsoon season it occasionally is a source of water. Forty-four percent of the rural water supply in Sind Province come from well water and 33 percent from springs, streams and rivers.

There are no wells and no piping or plumbing for water supply or wastewater disposal at Jamshoro. Indus River water is delivered by tanker trucks, transferred into large drums/barrels and distributed by truck. Water is commonly poured into large, centrally located cement holding containers for communal use. The water is untreated and potentially contaminated with water-borne pathogenic organisms. Water-related diseases are particularly likely where water is impounded for a long period and/or used frequently by many people.

As discussed in Section 4.1.7, the air quality of the study area is considered to be relatively clean and non-polluted. On occasion, total suspended particulates resulting from airborne dust have been relatively high. However, these particulates are coarse with sizes generaly above 10 mm which is above the respirable size range. They do not present a significant health concern.

Section 5.0

ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROPOSED ACTION

The previous section of this report described the existing conditions and extent of the resources existing in the Jamshoro area. Section 5 discusses potential effects of Jamshoro Phase II on these natural and socioeconomic environments.

5.1 ENVIRONMENT

The natural environment at the site reflects the arid nature of the region and the disturbance of man's activities for many years. Although no pristine areas at or near the site have been identified, areas which have remained relatively undisturbed for some years have reverted to a scrub forest which provides habitat for local animals. These subsections of the report discuss the potential impacts of Phase II development on plants and animals. Section 6 addresses methods by which harmful effects can be mitigated and how the success of pollution control activities should be monitored.

5.1.1 VEGETATION

The activities associated with the construction and operation of Phase II of the Jamshoro power generation complex that may affect vegetation include clearing and grading the plant site, burial of the pipeline,

construction and operational activities that result in increased levels of dust, combustion of oil that produces NO_x, SO_2, and particulate matter, and accidental spills of toxic materials. The potential impacts that may be associated with these activities include removal of vegetation and damage to vegetation from exposure to dust or toxic materials. Although dusting and toxins can lead to reduced vigor and productivity in extreme cases, these are not expected to present significant problems during construction and operation of Jamshoro Phase II.

5.1.1.1 Clearing and Grading Impacts

Approximately 70 acres at the Jamshoro site will be subject to clearing and grading prior to construction of the power generation facility. This will result in the loss of a portion of the sparse tropical scrub forest vegetation presently on the site. The vegetation at the site is dominated by herbs and perennial xerophytic shrubs, ranging from one percent cover in the dry winter season to 10-15 percent cover during the monsoon season. The loss of this vegetation is not considered significant because of (1) the large amount of undisturbed similar habitat in the surrounding area, (2) the lack of uniqueness of the vegetation, (3) the scant vegetative cover, (4) the low productivity of this habitat type, and (5) the heavily-grazed, disturbed nature of the vegetation in this area. More extensive stands of acacia and mesquite along dry streambeds to the west of the Jamshoro site and remaining areas of natural riverine forest along the Indus River to the east will

not be disturbed by site development. Disturbance that does occur can be offset by revegetation and by landscaping, using treated wastewater available in large quantities from the project. Topsoil should be set aside for these restoration activities.

Pipeline burial will result in disturbance of an additional area of tropical scrub forest vegetation. In this case, the impact will be minimal because the pipeline alternative route is either parallel to the super highway, or follows an existing disturbed linear utilities corridor for much of its length. This land is already heavily impacted by roadside activities.

Spills from a leaking or ruptured pipeline could have potentially more serious, widespread, and prolonged effects on the local vegetation. The best protection from these problems is a spill prevention, detection, and clean-up plan. This should be prepared by WAPDA or its contractor, and be placed in operation prior to use of the oil transport pipeline.

Increased dust levels resulting from construction activities also may affect the surrounding vegetation. The native plants, however, are adapted to similar natural conditions. The natural dust levels in th area are high, and dust storms frequent. The scant vegetative cover provides only limited wind erosion control and existing vegetation is comprised of species which must be adapted to such exposure to survive. Effects of increased dust levels on surrounding vegetation are expected to be minimal.

Accidental spills of hazardous materials (e.g., fuel oil and lube oil) resulting from construction and operational activities for the Jamshoro power complex also may affect vegetation adversely. These effects would be very limited in extent, however, owing to the level terrain and use of containment structures. In no event should accidental spills reach the Indus River.

5.1.1.2 Combined Impacts

The combined impacts resulting from vegetation removal, and vegetation damage due to exposure to dust or toxic materials for Phases I and II of the Jamshoro power generation complex can be expected to be greater than the impacts of Phase II as described above. At this time, however, the magnitude of the increase cannot be predicted accurately, although the site acreage affected in Phase I is expected to be about equal that of Phase II. Phase I alone would not use a pipeline for oil transport, eliminating impacts associated with construction and operation of that facility. The combined impacts of Phases I and II resulting from air emissions are discussed below.

5.1.1.3 Air Emissions Impacts to Vegetation - Phases I and II

Air emissions may have impacts on vegetation in the area surrounding the plant. In addition to emissions control of NO_x and stack gas monitoring, monitoring at ground level will be conducted to ensure that levels remain at acceptable levels as recommended by the USEPA and World Bank guidelines.

When SO_2 in the atmosphere enters foliage through pores in the leaves, it reacts with water in the leaf interior to form sulfite ions, which are toxic at higher levels. Only very high concentrations of SO_2 can cause immediate injury to sensitive plants, but if the plant is subject to long-term exposure to excess SO_2, sulfate may accumulate in the leaves and result in reduced yield and other impacts on growth.

Under certain conditions, atmospheric sulfur dioxide can have beneficial effects on agricultural vegetation. At low concentrations, atmospheric sulfite is oxidized to sulfate ions within the leaf and can be used by the plant as nutrient. Sulfur dioxide fumigation of crops (in the laboratory and in the field) grown on sulfur deficient soils have resulted in increased production and yields for low level exposures. Discussion with agricultural officials in the Hyderabad indicated that localized sulfur deficiencies occur in the region. At this time, however, beneficial results from emissions SO_2 cannot be assured with confidence. Thus, the practice at Jamshoro is to control these levels to the greatest extent possible, and to monitor at ground level to detect sulfur levels in agricultural areas.

The response of plants and animals to sulfur dioxide is a complex process that involves pollutant concentration and the duration and frequency of exposure, the genetic composition of the organism, and the environmental factors under which exposure occurs (e.g., light intensity, temperature, and soil moisture). The usual pattern of

183X

pollutant exposure from operation of an electrical generating facility is that of a few episodes of high concentrations for a short duration, interspersed with long periods of low concentrations. Effects on most vegetation will be from the short-term higher doses. Consequently, the 3-hour, 8-hour, and 24-hour average SO_2 concentrations are more important for predicting impacts on vegetation from a point emission source than the annual average concentration.

Based on the seasonal wind patterns during the April to November growing season (i.e. Kharif), the locations of maximum predicted short-term concentrations are east-northeast from the stacks and decrease with distance. The important crops grown during this season are cotton, sorghum, rice, millet, and maize. Table 5-1 compares the maximum predicted concentration of sulfur dioxide in the vicinity of Petaro College, approximately 9 km northeast of the site. This area is primarily agricultural land. Predicted concentrations for some Kharif crops (sorghum and vegetables) are slightly above the threshold level for injury. However, based on the literature, no effects are predicted for cotton, the major crop grown in the area during this season. Chronic effects, including reduced yields, may be observed in some vegetables during Kharif. Without quantitative production figures in the area, it will be difficult to accurately predict the extent of

Table 5-1

Comparison of Predicted Maximum Concentration ($\mu g/m^3$) of SO_2 (Phases I and II) in Agricultural Area with Known Effect Levels to Kharif and Rabi Crops

Season/Crop	Reported Threshold Effect Level, Exposure and Duration	Predicted Concentration and Duration	Possible Effects from Predicted Levels
Kharif Crops:			
Cotton	5240-1hr: Threshold of injury[2]	1079 - 1 hr*	None
	2096 - 34 hr: Threshold injury[1]	535 - 3 hr*	None
Sorgham	131 - 24 hr: Threshold injury[1]	100 to 352 - 24 hr.	Minimal damage to foliage[1]
Maize	5240 - 1 hr: Threshold injury[2]	1079 - 1 hr*	None
	2100 - 3 hr: Threshold of visible injury[2]	535 - 3 hr*	None
	13,100 - 3 hr: Threshold injury for zea mays[1]	535 - 3 hr*	None
Legumes	1310 to 2620 - 1 hr: Estimated visible injury threshold[2]	1079 - 1 hr*	None
	790 to 1570 - 3 hr: Estimated visible injury threshold[2]	535 - 3 hr*	None
Vegetable Crops	1,153 - 3 hr: Estimated threshold injury[1]	535 - 3 hr*	None
	131 - 24 hr: Estimated lilelihood of injury[1]	100 to 352 - 2 hr.	Foliar damage possible to some crops; also possible reduction in productivity

185X

Table 5-1 (Cont'd)

Season/Crop	Reported Threshold Effect Level, Exposure and Duration	Predicted Concentration and Duration	Possible Effects from Predicted Levels
Rabi Crops:			
Wheat	4978 - 1 hr: Scute necrosis(1)	1079 - 1 hr*	None
	1179 - 1 hr: Threshold injury(1)	1079 - 1 hr*	None
	131 - 24 hr: Threshold injury(1)	100 to 352 - 24 hr.	Possible damage to foliage, or some loss of productivity
	123 - growing season: Reduced yield(1)	26 - 46 annual	None
	390 to 790 - 24 hr: Severe fishier injury(1)	100 to 352: 24 hr.	None
	2,380 - growing season: Reduced yield(1)	26 to 46 annual	None

(1) Irving and Ballow, 1981
(2) EPA, 1982
* Predicted levels at Petaro College

During the Rabi season, October to May, when wheat, barley, gram, and oil-seed are grown, the winds are primarily from the north and no important agricultural areas are expected to be affected during most of this season. However, during the latter part of this season, the winds shift, affecting the same areas that were affected during the Kharif season. Table 5-1 compares the maximum predicted concentrations with known effect levels of Rabi crops. Possible adverse effects to wheat may result, but would have to be determined by field examination of crops and comparison with unaffected regions by agriculture experts.

Native vegetation communities in the region include arid rangelands and remnants of riverine forest and tropical scrub forest. The forest communities are located in the Indus River Valley and have largely been replaced by agriculture (see Section 4.1.2).

Native vegetation is subject to two kinds of effects from stack emissions of SO_2. One or a few short exposures to very high concentrations may result in acute immediate injury affecting growth and health of the plants and often accompanied by obvious foliar injury. In addition, chronic effects on growth, resistance to disease and vigor (not necessarily accompanied by visible foliar injury) can result from a high frequency of exposures throughout the growing seaso to episodic, moderately high SO_2 concentrations. Such levels are not expected at Jamshoro, however.

Table 5-2 lists high short-term exposures to SO_2 reported to have caused injury to native plants in other arid regions. These exposures are within, or close to, the maximum SO_2 doses expected to result from Phase I and II stack emissions, suggesting that episodes of acute damage to native vegetation may occur. These impacts, however, would most likely affect vegetation within one to two kilometers of the plant and occur during the season of least growth, and noticeable impact should not occur.

Limited potential impacts on native vegetation at Jamshoro due to chronic exposure to lower concentrations can be inferred from experimental fumigations on test species from arid regions of the United States which show that arid climate species tend to be more tolerant of sulfur dioxide than species requiring more water (EPA 1982).

Acacia, poplar, and tamarisk are the primary tree species in the area. Acacia and tamarisk are found naturally. All three species are considered forestry product species and are grown in the forest reserves that occur to the east of the Jamshoro site. Some threshold doses of SO_2 reported for floodplain trees and a native woody legume in North America are shown in Table 5-3. The data show that broadleaf deciduous trees are less tolerant of SO_2 than arid climate species, and that some species could be affected by predicted stack emissions. Physiological processes are sufficiently similar among these plants to suggest that chronic exposure to SO_2 concentration may adversely affect trees in the Jamshoro area, especially near the plant. Forest reserves on the east side of the river, however, should not be affected.

Table 5-2

Comparison of Known Effects of SO_2 to Native Vegetation from Arid Areas to Predicted Maximum Concentrations

Species	Known Effect Level (ug/m^3). Exposure and Duration	Reported Effects at Threshold Levels	Predicted Maximum Concentration (ug/m^3) and Duration	Predicted Effects from Jamshoro
87 species in Southwest U.S. desert	1300 to 26,000-2 hrs	no foliar injury below 5200[1]	5557-1 hr to 2134-3 hr	Possible effects to some species
Grasses: C_3 Atriplex sp. and C_4 Atriplex sp. fromarid habitat, California U.S.A.	1300-8 hrs	reduced photosynthesis[2]	934-8 hr	None
Desert grass (Oryzopsis hymenoides) in New Mexico, U.S.A.	80,170,330-6 weeks; 650,1300,2600-6 weeks	no effects[3] reduced dry wt.[3]	352-24 hr	None
Five perennials in Mojave Desert, U.S.A.	572-16 and 32 weeks; 1742 and 5200-16 and 32 weeks	no effect in 3 species mortality and reduced growth in 2 species mortality and growth reduction in all five[4]	26-46-annual	None

(1) Hill et al., 1974
(2) Winner and Mooney, 1980
(3) Ferenbough, 1978
(4) Thompson et al., 1980

189

Table 5-3

Reported Effects of SO_2 to Floodplain Trees and Native Woody Legumes in North America

Species	SO_2 Concentration (ug/m^3)	Time Period	Effect
Cottonwood (*Populus deltoides*)	650	80 hrs	Reduced height growth and leaf number[1]
Green Ash (*Fraxinus pennsylvanicus*)	650	80 hrs	Reduced height growth[1]
Sycamore (*Platanus occidentalis*)	650	80 hrs	Reduced height growth[1]
Riverbirch (*Betula nigra*)	850	30 hrs	Reduced growth and leaf area[2]
Silver Maple (*Acer saccharinum*)	2,600	2 to 8 hrs	Reduced height growth[1]
Yellow Poplar (*Liriodendron tuliperfera*)	2,600	2 to 8 hrs	Reduced height growth[1]
Tree of Heaven (*Ailanthus altissima*)	260	1 week	Reduced biomass[3]
Black Locust (*Robinia pseudoacacia*)	1,300	4 hrs	Reduced root mass[4]
Red Oak (*Quercus rubra*)	234	5 hrs/day for 29 days	Reduced mycorrhizal infection[5]

(1) Jensen and Dochinger
(2) Norby and Kozlowski
(3) Marshall and Furnier, 1981
(4) Suwannapinut and Kozlowski, 1980
(5) Reich et al., 1985

5.1.2 WILDLIFE

The activities associated with the construction and operation of Phase II of the Jamshoro power generation complex that may affect wildlife include clearing and grading the plant site, burial of the oil and water pipelines, construction and operational activities which generate increased levels of dust and noise, discharge of air emissions, cooling water withdrawal, combustion of oil that produces NO_x, SO_2, and particulate matter, and accidental spills of toxic materials. The potential impacts associated with these activities include:

- Loss of habitat and resultant displacement of wildlife
- Reduction in future biological productivity of wildlife ha
- Dust effects on wildlife and associated habitat
- Wildlife road kills from heavier volumes of road traffic
- Noise and human disturbance effects
- Increased silting and sedimentation effects on aquatic species
- Toxic effects of air emissions on wildlife

Avian mortality resulting from collisions with stacks or cooling towers

Entrainment of aquatic species resulting from cooling water withdrawal.

The natu[illegible] Jamshoro site is semi-arid and appears not to be particularly rich biologically. In addition, recent continuing disturbances in the site region have disturbed and degraded the environment considerably. Therefore, loss of habitat, reduced productivity, and other direct and indirect effects of construction and operation are not anticipated to have significant environmental consequences locally. At the Indus River, screened intake of water, no return of wastewater to the river, and limited construction on the banks should reduce effects of water withdrawal on the riparian environment and associated birds, fish and wildlife.

5.1.2.1 Clearing, Grading and Operations Impacts

Clearing and grading of the Jamshoro plant site will result in the loss of approximately 70 acres of tropical scrub forest vegetation and associated wildlife habitat. Phase I can be expected to affect approximately the same acreage. Loss of this habitat at the site may affect a variety of wildlife species. Some wildlife may be killed during construction activities. With the loss of vegetation, other

mobile wildlife may be displaced into surrounding areas. Displacement of individuals into adjacent habitat may cause population adjustments resulting from carrying capacity limitations, competitive interactions, territoriality, or other ecological interactions. These losses and changes in populations of affected wildlife species, however, are not expected to be significant given the localized area affected and the size of regional wildlife populations unaffected in the surrounding, similar habitat.

Increased bird deaths can be anticipated as a result of collisions with transmission wires and stacks. This probably must be accepted as an unavoidable consequence of the project. No effective methods to reduce this mortality have been devised; lighting the structures can actually attract birds at night and increase the number of kills.

Although the construction of the plant and pipeline burial will result in the loss of future biological productivity in localized areas, this is not considered significant because of the surrounding unaffected areas and the lack of uniqueness of the affected ecological communities. Following pipe laying and backfilling, the pipeline corridor is expected to eventually regain its biological productivity over time as natural recolonization of the native vegetation occurs. Loss of some portion of the biological productivity of the 30-meter wide right-of-way resulting from only partial restoration is not considered significant because of the extent of similar undisturbed habitat in the

area and the proximity of either pipeline alternative to an existing disturbed right-of-way (i.e., Sui pipeline or Indus Highway).

Construction and operational activities (e.g., transportation) will result in the generation of fugitive dust which will settle on vegetation in exposed areas. As discussed in Section 5.1.1, dust effects on vegetation are expected to be minimal because of the adaptation of native vegetation to similar natural dust exposure. Increased dust levels will not significantly degrade wildlife habitat or directly harm wildlife.

Increased traffic on the Indus Highway and on the Jamshoro site access road resulting from plant construction, and to a lesser degree plant operation, will result in additional road kills of wildlife. Small mammals (rodents) and reptiles (snakes and lizards) are the faunal groups most likely to be affected. Some wildlife populations may experience localized density reductions. This incremental increase in traffic and resultant death, however, is not likely to be significant given the population densities expected to occur in the region.

Increased levels of silting and sedimentation of the Indus River upstream of the Kotri Barrage may result from construction of the intake facility for cooling water withdrawal. Construction activities will cause a short-term, localized increase in turbidity. Because the Indus River experiences natural conditions of high turbidity and resident aquatic species must be adapted to such levels to survive in this

habitat, no significant effects on aquatic species are expected to result from temporary, localized turbidity increases induced by installation of the subsurface water intake.

Accidental spills of hazardous materials (e.g., fuel oil and lube oil) resulting from construction and operational activities also may affect wildlife. Animals may be harmed if contacted by hazardous materials or if displaced by loss of habitat. In the unlikely event of an oil spill, some death of wildlife could occur, but the numbers of organisms affected would be small compared to the size of regional wildlife populations. The chance of an oil spill occurring and reaching the Indus River is remote because the proposed pipeline alternatives do not cross the Indus River or parallel the river closely.

Accidental spills of toxic materials at the Jamshoro site should have minimal, if any, effects on wildlife in the surrounding areas. Resident wildlife will be displaced from the site by clearing and grading activities during site construction and spilled toxic materials will be largely contained through curbing around facility components (e.g., lube oil storage tank area). Spills of fuel oil occurring during transfer at the Port of Karachi could be potentially damaging to the local marine environment.

Water will be withdrawn from the Indus River above the Kotri barrage for use in plant systems (e.g., cooling tower makeup), which may result in

195X

entrainment of fish and their larvae. No Indus River dolphin are reported from this portion of the river. The subsurface intake is designed for a flow inlet velocity of 0.12 meters per second. The pump house is designed with 9.5 mm mesh traveling screens with a washing system to return trapped fish to the river.

Despite low intake velocities at the intake, some small or larval fish and invertebrates may be entrained. Death of most of these small organisms is likely to result. Significant losses of fish or larvae are not expected, however, because of the large numbers of immature or larval fish present and the widely-dispersed distribution of planktonic larvae or weak swimmers (immature fish) in the Indus. Migratory adult fish (e.g., palla) using this area of the Indus River during high flows should not be significantly affected because of the intake screen and their mobility, which allows them to avoid entrainment.

Overall, effects of the water withdrawal intake structure on regional populations of aquatic organisms are not expected to be significant. Moreover, the volume of water drawn represents less than 1 percent of river volume at lowest flow. During high flows, the relative amount of water withdrawn would be decreased even further to a fraction of a percent. No water is returned to the river by this facility.

Some death of birds may result from collisions with stacks, cooling towers, or other tall structures at the plant site. Overcast or foggy conditions and attraction to navigation or safety lights on such

structures may increase the chance of collisions. Waterfowl are known to migrate north and south along the Indus River, which is approximately 4 kilometers east of the Jamshoro site. Other birds (e.g. passerine species) also are known to be more common in the riverine habitat to the east of the site, because of the proximity to water and greater vegetative diversity and cover. Although some collisions of birds with plant facilities will occur, the diversity and density of birds in the semi-arid habitat at the plant site is lower than in the wetter areas east of the site, and the number of collisions resulting in mortality is expected to be insignificant relative to the sizes of regional bird populations.

No endangered species are known to occur at the proposed Jamshoro plant site, and consequently, none is expected to be affected by construction or operation of the plant. The current range of the Indian monitor and former range of the Chinkara (both endangered) are to the west of the Jamshoro site and will not be affected by any project components.

The fishing cat, spot bill duck, sarus crane, and Indian softshell turtle, which inhabit riverine areas, have the potential to occur in the vicinity of the proposed water intake and the associated pipeline corridor through the riverine area. Their occurrence, however, is considered transitory because of existing human activity and associated disturbance of the area. Effects on these species would be limited to noise and human disturbance, which might result in some localized displacement of individuals.

197X

The hog deer, which inhabits riverine forests, is unlikely to occur in the area of the water intake or the pipeline corridor because no riverine forest exists in this area. The Indus dolphin is not likely to be affected by the project as it reportedly does not inhabit the section of the Indus River between the Kotri Barrage to the south and Sukbur approximately 250 km to the north (S. I. Hussaini pers. comm.).

The pipeline route is not close to and does not cross the Indus River. Thus, during most of the year fuel oil contamination is unlikely to reach the river even in the event of a pipeline spill. However, several dry wadis carrying stormwater from winter rains to the Indus would be crossed. A spill during these storms could result in transfer of oil directly to the Indus, with the potential for significant environmental damage downstream. It is thus essential that all wadi crossings be designed and constructed to ensure integrity of the oil pipeline from Karachi, and to reduce the chance of damage from malicious mischief.

Oil spills during transfer of fuel could degrade the marine habitat at the Port of Karachi. WAPDA should verify the adequacy of the Port's spill prevention and clean-up plan to make sure spills are as few as possible, and that trained personnel and adequate equipment are available to handle spills if they occur despite the precautions.

5.1.2.2 Combined Impacts

The combined impacts on wildlife of the construction and operation of the 7 units comprising Phases I and II can be expected to be greater than the impacts of Phase II alone. At this time, however, it is difficult to assess all impacts of the Phase I facilities and to arrive at a satisfactory estimate of total effects to the local environment of the complete Janshoro Complex. Where possible, however, estimates of Phase I activities and their effects have been made. Estimates of the air quality effects have been particularly satisfactory owing to similar construction and operation procedures for both phases of the Jamshoro project.

5.1.2.3 Air Emissions Impacts to Wildlife - Phases I and II

Documented air pollution effects from fossil fuel energy facilities to wildlife have ranged from death and injury to animals exposed to high levels of emissions to subacute physiological and behavioral changes from lower exposures (Newman, 1980). The primary effects observed at subacute levels include respiratory stress, reduction in the immune response of animals, and decreased abundance of vertebrate and invertebrate animals.

Studies have established an apparent genetic variability in the sensitivity of animals to low levels of SO_2. Insects have been shown to be sensitive to SO_2. Wentzel and Ohnesorge (1961), correlated

insect pest infestation of spruce forests in Germany by sawflies with SO_2 and other emissions. A significant reduction in parasitism by natural biological controlling agents also was observed in the areas of high SO_2 emissions. Insectivorous birds show a reduced nesting in areas with increasing SO_2 emissions (Newman et al., 1985).

In Montana, simulated field studies using low levels of SO_2 have demonstrated ecological effects, including reduced trappings and movements of small mammals and invertebrate consumers in a grassland ecosystem (Preston and Gullet, 1979). Studies of laboratory animals have shown changes in pulmonary function at concentrations as low as 420 $\mu g/m^3$ for 1 hour (EPA, 1982). Studies on donkeys exposed to short-term concentrations (1 hour) below 786 mg/m^3 SO_2 and 0.8 to 1.51 mg/m^3 sulfate aerosol showed no effects. Respiratory effects have been observed in dogs and monkeys subjected to chronic exposures of 13,400 $\mu g/m^3$ SO_2 for 21 hours/day for 21 days, levels far in excess of that predicted for any location to be affected by this project.

The predicted long-term maximum ground level concentrations of SO_2 and particulates for both cases are theoretically within the range to cause chronic effects (e.g., changes in behavior) to small mammals and birds living within several kilometers of the plant site at the times of highest SO_2 concentration. However, average annual levels of SO_2 are considerably below levels expected to result in chronic effects to humans or wildlife.

5.1.3 WATER RESOURCES

The overall impact of the project on the surface waters and ground water of the region, once the project is complete, would be minor and site-specific, although long-term. The Phase II facilities are designed to the principle of "zero discharge." Wastewater from the plant will be ponded for evaporation in some cases, and treated for irrigation use in others.

The changes that the construction and the operation of the Jamshoro plant complex will bring about that could potentially affect water resources include:

- Changes in Indus River streamflow quantity and quality due to operational water requirements
- Generation of sanitary and operational wastewater streams
- Increase in stormwater runoff, erosion, and sedimentation
- Generation of solid waste
- Accidental spills of materials such as petroleum products and chemicals.

The effects of these changes on the surface waters and ground water are addressed below.

701

5.1.3.1 Effect of Water Use Requirements

The project will put a long-term demand on the water resources of the region, both for makeup water for project operations and potable water for various uses. The water will be taken from the Indus River, which is the only major freshwater supply in the region for agricultural, domestic, and industrial water use. WAPDA should ensure that design of the intake structures and water transport facilities for Phases I and II are coordinated to avoid unnecessary duplication of facilities and associated environmental disturbance.

There are no other sources of surface or ground water in the region with potential to be developed. The influent streams tributary to the Indus River run intermittently, carrying flood flows during storm events only. The ground water in the region is of small quantity and poor quality, and therefore not considered a viable source.

The Jamshoro plant site is about 4 km west of the Indus River. The intake and the associated facilities are located at the River upstream from the Kotri Barrage and downstream from Lloyd Barrage. These two barrages are part of a series built for irrigation purposes to regulate the seasonal flow of the Indus River.

The amount of water withdrawn from the River under normal plant operations to satisfy the makeup water and service water requirements would be about 0.9 cubic meters per second (cms) (32 cubic feet per

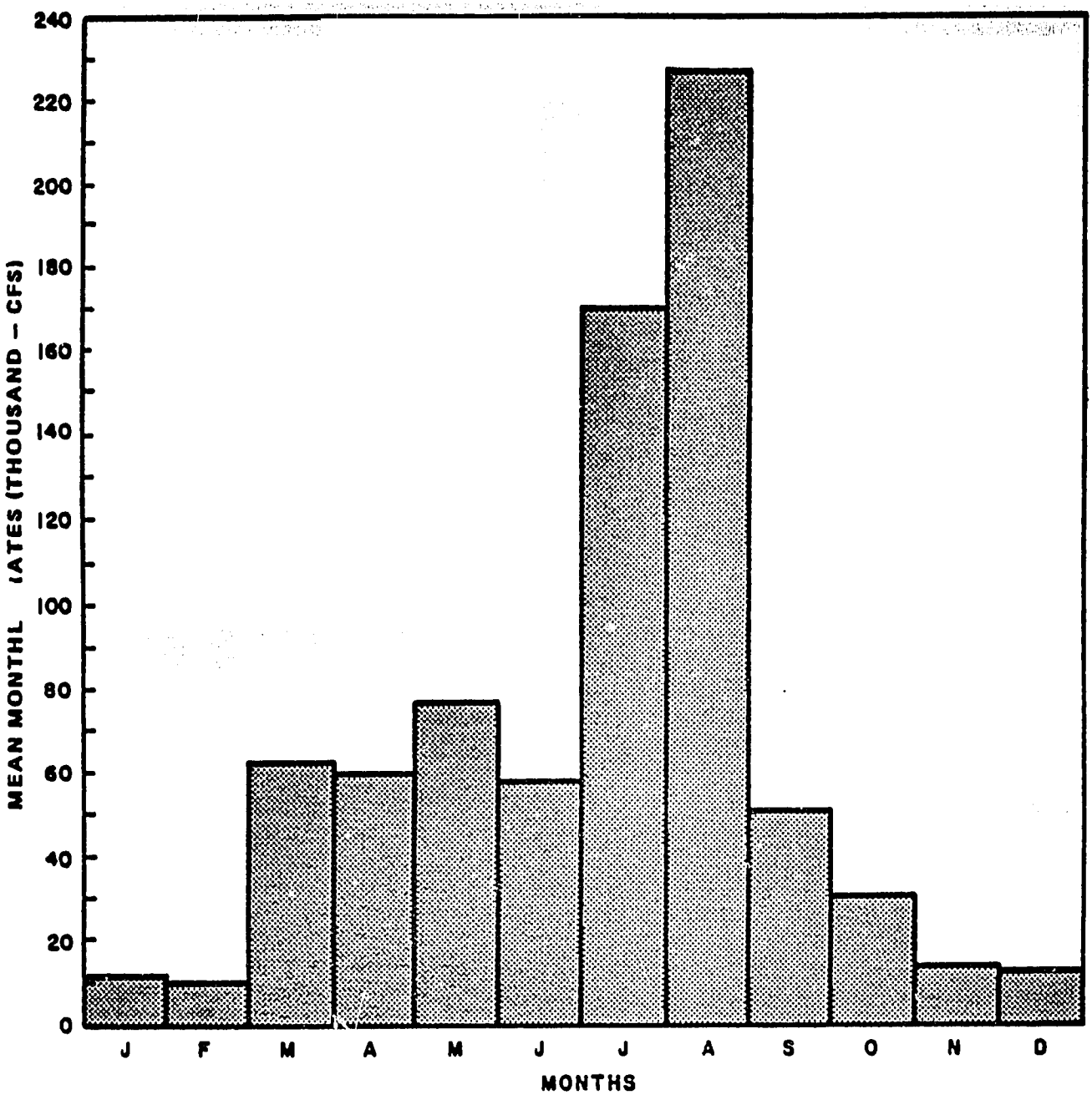
second [cfs]). None of this water will be returned directly to the river.

Approximately 108,660 l/day of treated Indus River wastewater will be recycled for process use in the facility. In addition, an estimated 20,784 m^3/day of water treated to USEPA standards will be available for irrigation use. This will be used primarily to irrigate landscape and windbreaks at the site and colony. The water quality must be monitored to protect public health.

The lowest measured flow of the Indus River upstream of the Kotri Barrage, as measured between 1981 and 1983, was 799 cms (28,230 cfs). At Sehwan, approximately 110 km (68 miles) north of Jamshoro, the seven-day minimum flow was 895 cms (31,600 cfs) as measured in April 1975. For the recording period at Sehwan the average of the extreme daily minimum was 1,363 cms (48,160 cfs). The flows upstream and downstream of the Kotri Barrage, and the discharge characteristics of the Indus River at Sehwan (1972-1975 and 1979) are summarized in Appendix I. Figure 5-1 shows the long-term average monthly flows of the Indus River. The project will have a negligible effect on the quantity of the Indus River at the intake site as well as downstream from it.

The water of the Indus River at the intake site is generally of good quality. However, total suspended solids as high as 2,000 mg/l have been measured during the high flow periods of July and August.

203X



Source: WAPDA

Figure 5-1 Indus River Water Flow

204

The water quality data for the Indus River at the Kotri Barrage have been obtained from an ongoing monitoring program conducted by the Public Health Engineering and Research Laboratory in Pakistan between February 1979 and February 1985. The available water quality data are presented in detail in Appendix I.

The ambient water quality characteristics of the Indus River will not change as a result of the project's withdrawal of water at the Kotri Barrage.

5.1.3.2 Effect of Wastewater Streams

During project construction and operation, sanitary wastewater and several streams of operational wastewater will be generated. No wastewater will be discharged to the Indus River. Water will either be contained in evaporation ponds for evaporative disposal or treated to USEPA standards and made available for irrigation locally. No release of untreated wastewater effluents will be made to the surface waters or ground water.

The construction of the temporary construction facilities including water supply and sanitation will be concurrent with the site preparation work so that there will be no uncontrolled release of wastewater to the environment.

205X

The major streams of wastewater that the project will generate include:

Cooling tower blowdown (20.16×10^6 l/d)

Chemical and non-chemical metal cleaning wastes ($1200-1500 \times 10^4$ l/y)

Low volume wastes

- Boiler blowdown (327×10^3 l/d)
- Ion exchange water treatment wastes (rinse and regenerants) (1060×10^3 l/d)
- Laboratory and sampling drains (miscellaneous low flows)
- Yard and floor drains (216×10^3 l/d)
- Water treatment clarification wastes (miscellaneous low flows)

Sanitary waste (545×10^3 l/d)

The chemical constituents of these waste streams are specific to the processes involved. Table 5-4 presents a list of compounds commonly

Table 5-4

Priority Pollutants[1] Detected in USEPA Sampling Program by Waste Stream Sources

Priority Pollutant	Waste Stream Source[2] Cooling Tower Blowdown	Low Volume Waste[3]
1,2-Dichloroethane	0	X
1,2-Dichlorobenzene	0	X
Phenol	X	X
Toluene	X	X
Beryllium (Total)	X	0
Cadmium (Total)	X	X
Chromium (Total)	X	X
Copper (Total)	X	X
Cyanide (Total)	X	X
Lead (Total)	X	X
Nickel (Total)	X	X
Selenium (Total)	X	X
Silver (Total)	X	X
Zinc (Total)	X	X

(1) Only compounds for which the increases in net discharges were greater than 10 micrograms per liter (µg/L).

(2)
X = Present in greater concentration in the effluent than in the influent at least once
0 = Never present in greater concentration in the effluent than in the influent

(3) Low volume wastes include boiler blowdown, waste streams from water treatment, and effluent from floor and yard drains

Source: USEPA, 1982.

207

found in power plant wastewater effluents by waste stream. The information in the table was compiled by the U.S. Environmental Protection Agency (USEPA). Samples were analyzed for 129 compounds designated by USEPA as priority pollutants. The proprietary chemicals used by power plants and containing USEPA priority pollutants are shown in Table 5-5. Boiler blowdown characteristics are shown in Table 5-6.

Blowdown from recirculating cooling water may contain contaminants from corrosion of condenser tubes and other system components; chemical additives to control erosion, scaling, and biofouling; and from ambient air. Metallic oxides (e.g., of chromium, beryllium, copper, nickel, and zinc), which are of environmental concern, originate as corrosion products in the cooling water system. Corrosion and scaling inhibitors at Jamshoro will contain phosphorous. Biofouling control is usually accomplished by chlorination, resulting in total residual chlorine (free chlorine and chloramines) and, potentially chlorinated organics (e.g., chloroform) in the discharge. Air pollutants absorbed by the cooling tower water, such as sulfate and nitrates, would not be expected to be measurable unless the cooling tower is located in the vicinity of plume downwash.

Metal cleaning wastes are generated by water washing and chemical cleaning of boiler waterside and fireside, air preheater, and condensate feedwater system surfaces. Washing is done prior to chemical cleaning, and on an infrequent basis after the initial preoperational wash. The chemical cleaning waste stream is generated during preoperational

Table 5-5

Proprietary Chemicals Used by Power Plants and Containing USEPA Priority Pollutants

Proprietary Chemical (Point of Application)[1]	Specific USEPA Priority Pollutant Contained in Product
Nalco Chemicals	
25L (CT)	Copper
37 (BW)	Chromium)[2]
38 (CW)	Chromium[2]
75 (BW)	Phenol
201 (CT)	Chlorinated Phenols
344 (CT)	Acrylonitrile
375 (CW)	Chromium
425L (BW)	Copper
Calgon Chemicals	
CL-70 (CT)	Zinc Chloride
CL-35 (BW)	Sodium Dichromate[2]
CL-68 (CW)	Sodium Dichromate[2], Zinc Chloride[2]
Dearborn Chemicals	
712 (CW)	Chlorinated Phenols
Betz Chemicals	
Betz 40P (CW)	Chromate and Zinc Salts
Betz 403 (CW)	Chromate and Zinc Salts
Dianodic 191 (CW)	Chromate and Zinc Salts
Dow Chemicals	
Dowicide GB (Algacide)	Chlorinated Phenols
Hercules Chemicals	
CR 403 (CT)	Zinc Dichromate[2], Chromic Acid[2]
DuPont	
Karmex (CW)	Chlorinated Phenols
Drew Chemicals	
Biosperse 201 (CW)	Chlorinated Ethanes
Ashland Chemicals	
1,1,1-Trichloroethane (FA)	Chlorinated Ethanes
Burris Chemicals	
Sodium Dichromate (CT)	Sodium Dichromate[2]

(1) Point of Application: BW-Boiler Water; CT-Cooling Tower; CW-Cooling Water; FA-Fuel Additive

(2) Chrome based substances will not be specified for Jamshoro Phase II

Source: USEPA, 1982

209x

Table 5-6

ɔiler Blowdown Characteristics

Pollutants	Number of Data Points	Mean Concentration (mg/l)	Standard Deviation
Copper	258	0.14	0.2888
Iron	273	0.53	2.0609
Oil and Grease	151	1.74	4.5311
Phosphorus	19	17.07	12.5154
Suspended Solids	230	66.26	500.3967

Source: USEPA, 1982

cleaning of the boiler waterside and on a 2- to 4-year cycle thereafter. The preoperational cleaning waste contains oil and grease, mill scale, and miscellaneous debris in addition to boiler scale and cleaning agents. It may be acidic or alkaline depending on the chemical agents selected to remove waterside scale buildup. Alkaline cleaning wastes are typically high in ammonia salts; acid cleaners generate wastes containing high metal concentrations. All wastes from chemical cleaning are high in decomposable organics, total dissolved solids, and total suspended solids (TSS).

Nonchemical cleaning of the boiler fireside, air preheater and condensate feedwater system generates waste streams high in metallic corrosion products, ash residues, and debris. These waste streams are generally characterized by high TDS, TSS, and other pollutants.

Low volume wastes include boiler blowdown, water treatment system waste (from demineralizers, clarifiers, etc.), laboratory drains, and plant and yard drains. Source of pollutants in these waste streams include source water, process chemicals, and leaks and spills. Common pollutants observed in these miscellaneous waste streams include various metals, phosphates, chlorides, sulfates, and oil and grease

Sanitary waste stream constituents of environmental concern include decomposable organics (as reflected by high "BOD_5", COD), suspended solids, nutrients in the form of phosphate, nitrate, and ammonia, and pathogenic organisms.

211

The plant wastewater management system will ensure an effluent meeting the USEPA effluent limitations for new electric power plants as defined by USEPA 40 CFR 433. The guidelines shown in Table 5-7 are recommended for wastewater effluents leaving the plant for agricultural use. Treated sewage is not a part of this flow, but is recommended for separate handling. These are based on USEPA recommended guidelines for water to be discharged to surface water of the U.S.

Design provisions will be made as appropriate for sampling and analysis of effluents, according to recognized standard procedures (APHA, 1980 or equivalent), such that conformance to guidelines can be demonstrated.

Sanitary waste will receive secondary treatment (stabilization and disinfection) prior to discharge of effluent to surface evaporation ponds to reduce the potential for adverse health effects.

The use of evaporation ponds by waterfowl can result in illness or death to these creatures. This danger can be reduced by elimination of vegetation at pond edges if it occurs. If waterfowl persist in using ponds, the only completely successful and practical method to prevent bird access is by covering ponds with netting. Other systems (flashing lights, noisemakers) are generally not successful over a long period of time. WAPDA should monitor pond use by waterfowl, and be prepared to take appropriate protective action should harmful effects on birds become extensive.

Table 5-7

Recommended Guidelines for Treated Irrigation Water

Waste Stream*	Limitations* Suspended Solids (mg/1)	Oil and Grease (mg/1)	Total Copper (mg/1)	Total Iron (mg/1)	
Low Volume Wastes	30 (max.) 100 (max.)	15 (avg.) 20 (max.)	--	--	
Metal Cleaning Wastes	30 (avg.) 100 (max.)	15 (avg.) 20 (max.)	1.0 (max.)	1.0 (max.)	
Cooling Tower Blowdown	--	--	--	--	Free available chlorine in no case to exceed 0.2 mg/1 (avg.), 0.5 mg/1 (max.); chlorination periods and concentrations maintained to minimum necessary to achieve biofouling control. No discharge of 126 priority pollutants contained in circulating water additives, except: Total Chromium - 0.2 mg/1 (max.); Total Zinc - 1.0 mg/1 (max.) (see U.S. EPA Regulation 40 CFR 423)
Sanitary Waste					Secondary treatment, with the following effluent limits: TSS - 30 mg/1 (30 day average), BOD_5 - 30 mg/1 (30 day average), fecal coliforms 200/100 ml (Geom. mean)

*All waste streams subject to the following limitations: pH, 6.0-9.0; no discharge of polychlorinated biphenyls (PCBs) such as those commonly used for transformer fluid. These limits apply to the individual waste stream categories listed in that permitted quantities of listed constituents in the discharge are obtained by multiplying listed concentrations by flow of the corresponding waste stream.

213X

Circulating water treatment chemicals containing chlorine and sulfuric acid only should be used, since they are readily available and represent no cost penalty.

The effluent limitations for pH (6-9) and suspended solids, (30 mg/1 average, 100 mg/1 maximum) conform to World Bank Standards as well as those of U.S. EPA, and should, therefore, be reasonable for this application. Polychlorobiphenyls (PCBs) for transformer fluid or similar applications should definitely not be used at Jamshoro, consistent with USAID and World Bank policies on new projects. This is on the basis that PCBs are persistent in the environment, undergo bioaccumulation in the food chain, and have recently been linked to adverse health effects in humans. Moreover, acceptable substitutes to PCBs are readily available.

The limits for sanitary waste, taken from the U.S. EPA (40 CFR 133) are considered standard practice in the U.S. for discharge of secondary treatment effluent to surface water in the interest of preventing undue degradation of water quality and risk of health hazards to the general public. It is recommended that sanitary wastes from the project be subjected to secondary treatment and discharged directly to evaporation ponds rather than be made available for irrigation purposes. Irrigation canals are frequently used for bathing and as a source of domestic water in this region. This would argue for tertiary treatment of any sanitary waste prior to release to these canals. Given the large amount of

irrigation water available from other plant operations, extensive treatment of sewage is not warranted.

5.1.3.3 Effect of Increased Stormwater Runoff and Soil Erosion/Sediment

Increased impervious surfaces at the project sites will permanently increase the stormwater runoff volumes and rates. However, the site drainage from the completed facility will be either recycled or discharged to evaporation ponds for disposal. Therefore, the net effect on streams in the vicinity would be reduced runoff relative to natural conditions. The seepage to the ground water will also be diminished at project locations.

Local increases of stormwater runoff will occur during the construction of the project facilities, with the runoff carrying increased sediment loads because of increased erosion rates of the areas disturbed. Expected increase in erosion rates will vary depending on rainfall intensity, prevailing soil cover, and soil characteristics of disturbed areas. Employing best management and erosion control practices during the construction activities will, however, ensure minimum increase in runoff and erosion rates, and consequently in sediment production. The residual effects would, therefore, be minimal, and only for the duration of construction.

7154

Highly fractured and weathered limestone is the predominant rock formation in the region. Permeability in limestone is high due to the highly fractured condition. The overburden soils are generally less than one meter thick, and granular in texture. The soils of the power plant site at Jamshoro are the result of flood plain deposits from the Indus River and therefore are of alluvial origin, exhibiting a loamy fine sand texture.

Generally, in view of low rainfall and low erosive potential of areas subject to disturbance by the project construction activities, the primary concern for erosion control during the construction activities will be the protection of structures. However, loss of soils from sheet, gully, and stream channel erosion, especially on agricultural lands, is also of potential concern, as is degradation of surface water quality and sedimentation of streambeds by eroded soils, primarily in the Indus River. These adverse impacts will be minimized by employing site-specific erosion and sediment control measures.

Two alternate routes for the pipeline from Karachi to the project site have been selected, referred to as the Sui Gas Transmission route and the Super Highway route. Conditions of soils, water table, and size of stream crossings have been examined along these two routes. Several major stream crossings exist that are over 200 meters in width. No ground waters of special concern are reported to exist along the Sui Gas Transmission route; however, the existence of salt bogs and shallow

pools of standing water in some wadis indicates shallow ground water conditions.

5.1.3.4 Effect of Solid Wastes

A recommended solid and liquid wastes management plan for Jamshoro Phase II is presented in Appendix G. No information is available on waste management for Phase I. However, it is recommended that WAPDA coordinate these activities between the two phases. If Phase I waste treatment techniques vary extensively from activities on Phase II, pollution control for the Jamshoro Complex will be made considerably more difficult and will certainly be less successful. The recommendations of Appendix G will likely apply to Phase I and can be used as a guideline for the entire project.

5.1.3.5 Effect of Accidental Spills of Environmentally Harmful Materials

Adverse impacts of a temporary nature on the surface waters, ground water, and Port of Karachi waters will result if accidental spills of petroleum products and industrial chemicals occur. Therefore, the risk of such occurrences will be minimized by storing and transferring such materials at locations away from drainage ways particularly close to the Indus River and by the use at the port of spill prevention and clean-up procedures meeting modern industry standards. Large storage tanks will be bermed to contain the full tank volume in case of rupture.

K
217

Spills of oil at the Port of Karachi could have wide-spread detrimental effects on the marine habitat, particularly in the short-term. Ecological damage would be most severe within the intertidal zone at the shoreline and the subtidal habitats just below this region. Effects to the harbor fish populations would likely be less, owing to their general ability to escape from the toxic materials.

Although immediate damage from oil spills can be severe, substantial recovery after a period of several years can be expected. Often, frequently repeated smaller spills can have worse effects because of exposure of organisms over longer periods. These effects are prevented by proper operation and maintenance at the port.

5.1.4 AIR QUALITY

The air quality impacts due to the proposed project will include impacts from the construction activities and from the operation of the power plant. The following paragraphs present an assessment of these air quality impacts.

5.1.4.1 Air Quality Impacts of Construction Activities

During construction activities, air pollutants will be generated through exhaust emissions from vehicles and equipment, fugitive dust emissions, and open burning. The possible air quality impacts of these emissions may be summarized as follows.

218

Exhaust emissions will include emissions from construction vehicles and equipment as well as emissions from commuting and delivery traffic. Construction vehicles such as trucks, dozers, loaders and rollers, and construction equipment will primarily burn diesel fuel. Combustion of diesel fuel will lead to exhaust emissions of carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOC), sulfur dioxide (SO_2), and particulate matter (PM). Other vehicular traffic associated with the construction activities will include commuting and delivery traffic of light-duty and heavy-duty vehicles. These exhaust emissions will include the same pollutants (i.e., CO, NO_x, VOC, PM, and possibly SO_2, depending on fuel type), as produced by heavy-duty construction vehicles and equipment, although the emission rates will differ according to vehicle type. The traffic is not expected to be significant and construction vehicles and equipment operation will be limited to the site. Therefore, air quality impacts due to exhaust emissions are estimated not to be significant.

During construction activities, fugitive dust will be emitted. The highest fugitive dust emissions are expected to occur during the construction of buildings and roads and are associated with land preparation, ground excavation, cut and fill operations, individual facility construction, and vehicular traffic on temporary roads. Fugitive dust emissions are lower under wet, humid conditions. However, natural fugitive dust control from snow and rain does not generally apply to the proposed site. The quantity of fugitive dust emissions

will therefore depend more on the level of construction activities than on meteorological conditions.

During heavy construction and dry weather, the quantity of fugitive dust emissions is estimated to be about 1.2 tons of PM per acre per month. A large fraction of fugitive dust will settle prior to crossing the borderline of the site and the impact of fugitive dust emissions outside the site will therefore be significantly less.

Vehicular traffic to, from, and around the site is also a source of fugitive dust. Dust emission on paved roads is considerably less than on unpaved roads. Road emissions are expected to be significantly less than those due to other onsite construction activities.

Limited periods of burning of waste material such as paper and wood are anticipated during the construction activities.

5.1.4.2 Air Quality Impacts of the Power Plant

During operation of the power plant, air pollutants such as sulfur dioxide (SO_2), NO_x, and PM will be emitted from the stacks. Emissions due to the pipeline and other supporting activities will be insignificant compared to the power plant stack emissions. Therefore, our air quality impact analysis pertains to these stack emissions.

The proposed power plant consists of three 350 MW oil-fired units. In addition, one 250 MW Japanese oil-fired unit and three 210 MW Chinese oil-fired units are also planned for the Jamshoro site and two 250 MW coal-fired units have been proposed for the nearby Lakhra site 20 km to the north. Phase I comprises Japanese and Chinese units at the Jamshoro site, while the three 350 MW units make up Phase II. The characteristics of all these proposed power plant emissions are summarized in Table 5-8. Other existing sources in the Jamshoro area are small compared to these proposed power plants and, therefore, hav not been included in the air quality analysis. Table 5-9 presents th emissions of two of the largest existing sources.

The following three scenarios were considered in the air quality analysis:

Scenario A: The four units of Jamshoro - Phase I.

Scenario B: The four units of Jamshoro - Phase I and the two units of Lakhra.

Scenario C: The four units of Jamshoro - Phase I, the two units of Lakhra, and the three units of Jamshoro - Phase II.

The World Bank guidelines on air quality (World Bank, 1984) pertain tc both ambient air quality and emissions from the stacks. These guidelines concern sulfur dioxide (SO_2), nitrogen oxides (NO_x), dust

1214

Table 5-8

Characteristics of the Proposed Power Plant Emissions

Characteristics	Lakhra Coal-Fired Units[1]	Jamshoro Oil-Fired Units Phase I[2]	Phase II
Capacity (MW)	2 x 250	250 + 3 x 210	3 x 350
Estimated Emissions[3] (g/s)			
SO_2	11,167	3,897	4,071
NO_x	417	471	315
Particulate Matter	113	282	243
Stack Characteristics			
Height (m)	183	150	150
Diameter (m)	7.9	4.5	6
Gas Velocity (m/s)	22.9	20	14
Gas Temperature (K)	423	406	408
Oil Sulfur Content (maximum percent)		3.5	3.5
Coal Sulfur Content (maximum percent)	5.0		

(1) Source: ESE, 1986.
(2) Phase I consists of one 250 MW Japanese unit and three 210 MW Chinese units. Data were obtained by Mr. K. Kosky from the Pakistan Water and Power Development Authority (7 October 1986).
(3) At 100% capacity.

Table 5-9

Estimated Emissions from Existing Sources (g/s)

Pollutant	Source: Kotri Gas Turbine Power Station	Source: Hyderabad Thermal Power Station
SO_2	1.8	14
NO_x	104	28
Particulate Matter	4.1	2.9

Source: ESE, 1986.

223

(i.e., particulate matter), and transboundary acid deposition. In the air quality analysis, the impacts of the power plant on ambient air quality were addressed and the calculated impacts were first compared with the World Bank and USEPA ambient air quality guidelines. Then, estimated emissions of the power plant were compared with the World Bank guidelines. Finally, the issue of acid deposition was addressed.

The ambient air quality impacts were calculated with the ISC atmospheric dispersion model. This model is recommended by the U.S. Environmental Protection Agency in its guidelines on air quality modeling (EPA, 1986). The time-averaged concentrations calculated were as follows: 3-hour; 24-hour and annual average for SO_2; annual average for NO_x; and 24-hour and annual average for particulate matter (PM).

The air quality simulations were based on available meteorological data. The meteorological data used represent one year of data collected at the Lakhra (from May, 1985, to January, 1986) and Jamshoro sites (from February, 1986, to April, 1986). It should be noted that there are uncertainties in the collection of these meteorological data, so some uncertainties may be associated with the results of the air quality simulations. Also, air quality and meteorological data have been used from several locations in order to prepare an estimate of yearly conditions at the site. The magnitude of the ground-level concentrations and the location of the areas of maximum impact should thus be viewed with these uncertainties in mind. However, since the air

quality analysis involves a set of assumptions that tend to overestimate the air quality impacts, a significant margin of safety exists for the associated health impacts and the uncertainties in the meteorological data should not strongly affect the major conclusions of the air quality analysis.

Background concentrations of SO_2, NO_x, and particulate matter (PM) were assumed to be 26, 19, and 200 $\mu g/m^3$ respectively, as discussed in Section 4.9. To provide a conservative estimate of air pollutant contamination, the values for SO_2 and NO_x correspond to maximum measured concentrations in the area and therefore will lead to overestimates of predicted ambient concentrations. The value for dust corresponds to the annual average concentration.

The power plants were assumed to operate at 100 percent capacity for the 24-hour average simulations, and at 65 percent capacity for the annual average simulations. The sulfur content of the oil was assumed to be 3.5 percent maximum, which corresponds with current WAPDA purchase specifications.

The stack height of 150 m was selected through a sensitivity modeling study. The purpose of this sensitivity study was to determine the stack height that would minimize the local impacts of SO_2 emissions as well as long-range acid deposition. Atmospheric dispersion calculations were carried out for five stack heights: 122, 130, 140, 150, and 175 m. The

7754

140 m height corresponds to the good engineering practice (GEP) stack height recommended by the U.S. Environmental Protection Agency (USEPA). The results of these simulations are presented in Table 5-10. It appears that a stack height of 150 m allows the 24-hour average SO_2 concentrations to be below the levels of the U.S. EPA standards for ambient concentrations. The USEPA standards are being used at Jamshoro owing to their consideration of effects to children and the elderly. They are more stringent than World Bank guidelines in this regard. The 3-hour average SO_2 concentrations show three exceedences of the U.S. EPA standard; however, a higher stack height would increase the potential for long-range acid deposition with little benefits for local ground-level concentrations. Therefore, a stack height of 150 m was selected for the Jamshoro Phase II power plant.

The predicted ambient concentrations of SO_2, NO_x, and PM are presented in Table 5-11, along with the corresponding World Bank guidelines for each scenario. These results show that SO_2 and NO_x concentrations are less than the World Bank guideline values for all scenarios. The background PM concentration is about 200 $\mu g/m^3$, which is above the World Bank guideline of 100 $\mu g/m^3$ for annual average concentrations. Note that the impact of the power plant PM emissions represents about 1 percent of the background value and is therefore negligible.

The World Bank also provides guideline values of 100 $\mu g/m^3$ and 1000 $\mu g/m^3$ for 24-hour and annual average SO_2 concentrations

Table 5-10

Jamshoro Phase II Stack Height Sensitivity

	Phase II Stack Heights (m)[1]				
	22	130	140	150	175
SO_2 Concentrations ($\mu g/m^3$)[2]					
3-Hour Average					
Maximum	(3	(3)	(3)	(4)	(4)
Liaqat Hospital	64	645	640	636	627
Petaro College	64	609	571	535	433
U.S. EPA Standard	130	300	1300	1300	1300
24-Hour Average					
Maximum	40	388	369	352	329
Liaqat Hospital	13	133	131	130	127
Petaro College	27	261	248	236	210
U.S. EPA Standard	36	365	365	365	365

(1) Phase I Stack Height is 150 m, Lakhra Stack Height is 183 m.
(2) Concentrations include background SO_2 value of 26 $\mu g/m^3$ and impacts from Jamshoro Phase I and II and Lakhra.
(3) More than three exceedances of EPA 3 hour SO_2 standard of 1,300 $\mu g/m^3$.
(4) Three exceedences of EPA 3 hour SO_2 standard of 1300 $\mu g/m^3$.

227

Table 5-11

Comparison of Maximum Predicted Ambient Pollutant Concentrations with World Bank Guidelines

$\mu g/m^3$

(Annual average values correspond to emissions when plant is operating at 65% capacity, maximum 24-hour average values for 100% capacity)

Pollutant	Scenario A	Scenario B	Scenario C	World Bank Guidelines
SO_2				
Annual average	36	37	46	100
Annual increment(1)	10	11	20	50
Maximum 24-hour avg.	172	172	52	500
NO_x				
Annual average	21	21	21	
Annual increment(1)	2	2	2	
PM				
Annual average	200(2)	200(2)	200(2)	10
Annual increment(1)	1	1	2	
Maximum 24-hour avg.	15(3)	15(3)	22(3)	500

(1) Annual average concentration due to the power plant emissions; the annual increment corresponds to the annual average value minus the background value.
(2) Estimated background value.
(3) Power plant impacts.

228

within the plant site. These values would not be exceeded since the largest SO_2 ground level concentrations occur away from the plant as discussed below.

Because of the presence of sensitive receptors such as the Liaqat hospital at Sind University, the tuberculosis sanatorium south of the proposed project, and the college near Petaro, and because of possible synergism between the adverse health effects of SO_2 and the high background dust levels, the calculated air quality impacts were also compared with the health-based criteria of the World Health Organization and the stringent health-based standards of the U.S. Environmental Protection Agency. A conservative approach to modeling of ground level concentrations also reflects the fact that extrapolation of air quality from other areas was necessary for Jamshoro. The maximum air quality impacts are also in agreement with the criteria suggested by the World Health Organization. These criterion are 105 to 115 $\mu g/m^3$ for annual average SO_2 concentration, 500 $\mu g/m^3$ for maximum 24-hour average SO_2 concentration, 160 to 185 $\mu g/m^3$ for annual average PM concentration, 500 $\mu g/m^3$ for maximum 24-hour average PM concentration, and 100 $\mu g/m^3$ for annual average NO_x concentration. Furthermore, the maximum air quality impacts are also in compliance with the primary air quality standards of the U.S. Environmental Protection Agency. These standards are 80 $\mu g/m^3$ for annual average SO_2 concentration, 365 $\mu g/m^3$ for the 24-hour average SO_2 concentration, 100 $\mu g/m^3$ for annual average NO_2

229

concentration, 75 $\mu g/m^3$ for annual average PM concentration, and 260 $\mu g/m^3$ for the 24-hour average PM concentration.

Figure 5-2 presents the annual average SO_2 concentrations due to proposed power plants of Lakhra and Jamshoro Phase I. Note that background SO_2 concentrations are not included and that average capacity of the power plants is assumed to be 65 percent. The maximum concentration of 11 $\mu g/m^3$ occurs about 5 km east of the Jamshoro stacks. The Lakra power plant should contribute negligibly to air pollution in the vicinity of Jamshoro as shown in Table 5-10.

The prevailing wind directions from the southwest or northeast lead to two major zones of air quality impacts. The largest impacts occur in the area that extends between the east and northeast directions over the Indus River Valley, with a zone of highest impacts around Petaro and its nearby college. The second area of impacts is southwest of the power plant. It does not include any sensitive receptors since the Liaqat hospital and the tuberculosis sanatorium are located east of this area of impacts. However, because of uncertainties in the meteorological data, the areas of maximum air quality impacts could be closer to the sensitive receptors than the modeling results predict.

These two areas of air quality impacts are determined by wind speed and direction, atmospheric stability, the sources configuration (stack height and plume rise), and the emission rate.

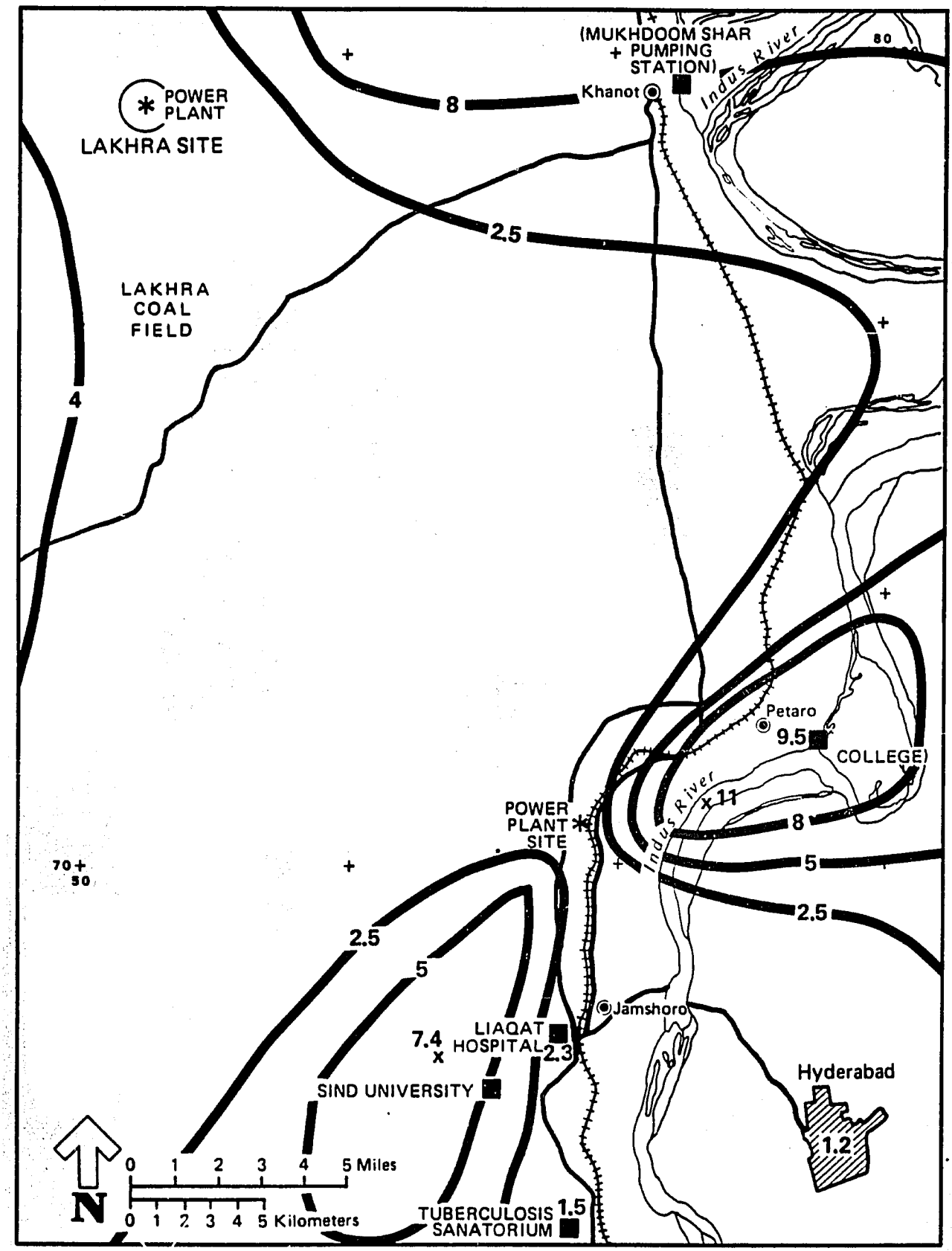


Figure 5-2 Predicted Annual Average SO_2 Concentrations ($\mu g/m^3$) for Scenario B (Impacts for Jamshoro — Phase I and Lakhra Power Plants)

231

The annual average SO_2 concentrations due to the proposed power plants of Lakhra and Jamshoro Phases I and II are presented in Figure 5-3. The same pattern as in Figure 5-2 is predicted, with a maximum air quality impact of 20 $\mu g/m^3$, about 5 km east of the Jamshoro stacks.

The maximum 24-hour average SO_2 concentrations due to all proposed power plants of Lakhra and Jamshoro Phases I and II are depicted in Figure 5-4. These SO_2 concentrations correspond to the values of maximum impact over a one-year period and therefore may correspond to different days for different receptor locations. Consequently, the SO_2 concentration contours present a more complex pattern than the contours obtained for annual average values. Areas of maximum 24-hour average impacts are similar to these obtained for annual average impacts. The maximum ground level concentration of 326 $\mu g/m^3$ occurs about 10 km southwest of the Jamshoro stacks.

Figure 5-5 presents the contours of the annual average NO_x concentrations that result from the impacts of the proposed Lakhra and Jamshoro Phase I and II power plants. The maximum impact, with a ground level concentration of 2 $\mu g/m^3$, is located about 5 km east of the Jamshoro stacks.

Figure 5-6 presents similar contours for the annual average PM concentrations. The maximum impact is in the same location and shows a predicted value of 2 $\mu g/m^3$.

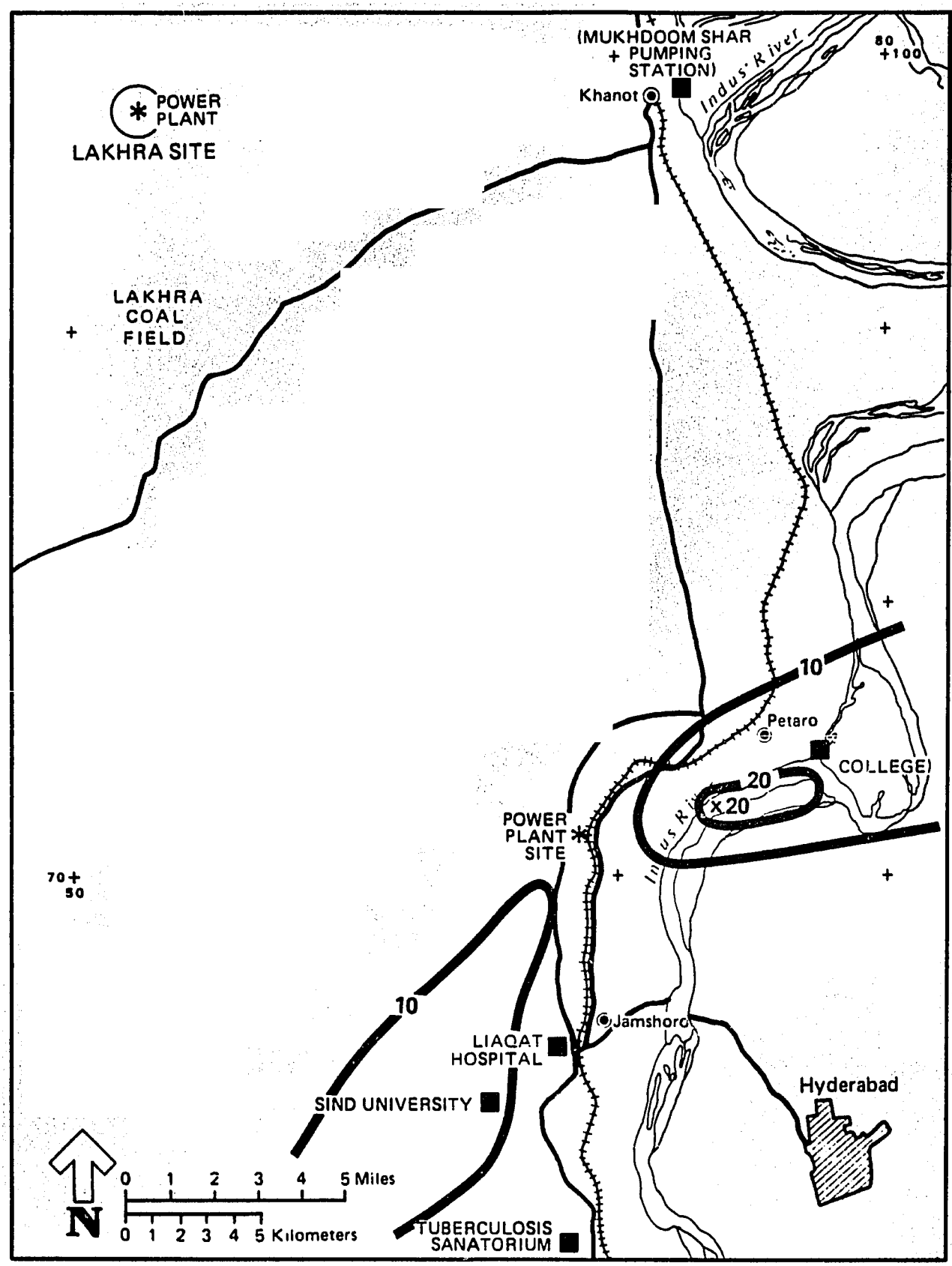


Figure 5-3 Predicted Annual Average SO_2 Concentrations ($\mu g/m^3$) for Scenario C (Impacts of Jamshoro — Phases I and II and Lakhra Power Plants)

235

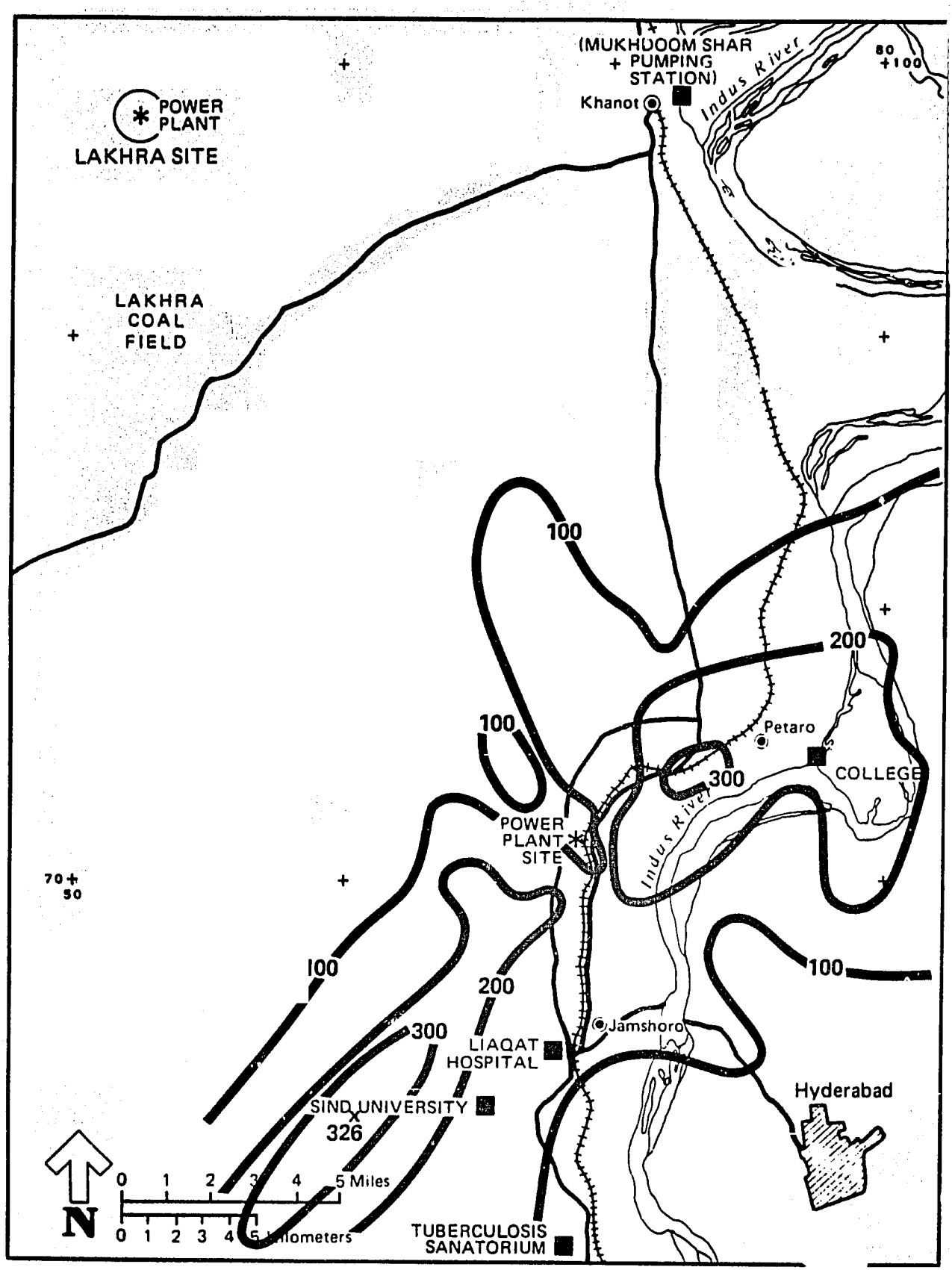


Figure 5-4 Predicted Maximum 24-h Average SO_2 Concentrations ($\mu g/m^3$) for Scenario C (Impacts of Jamshoro — Phases I and II and Lakhra Power Plants)

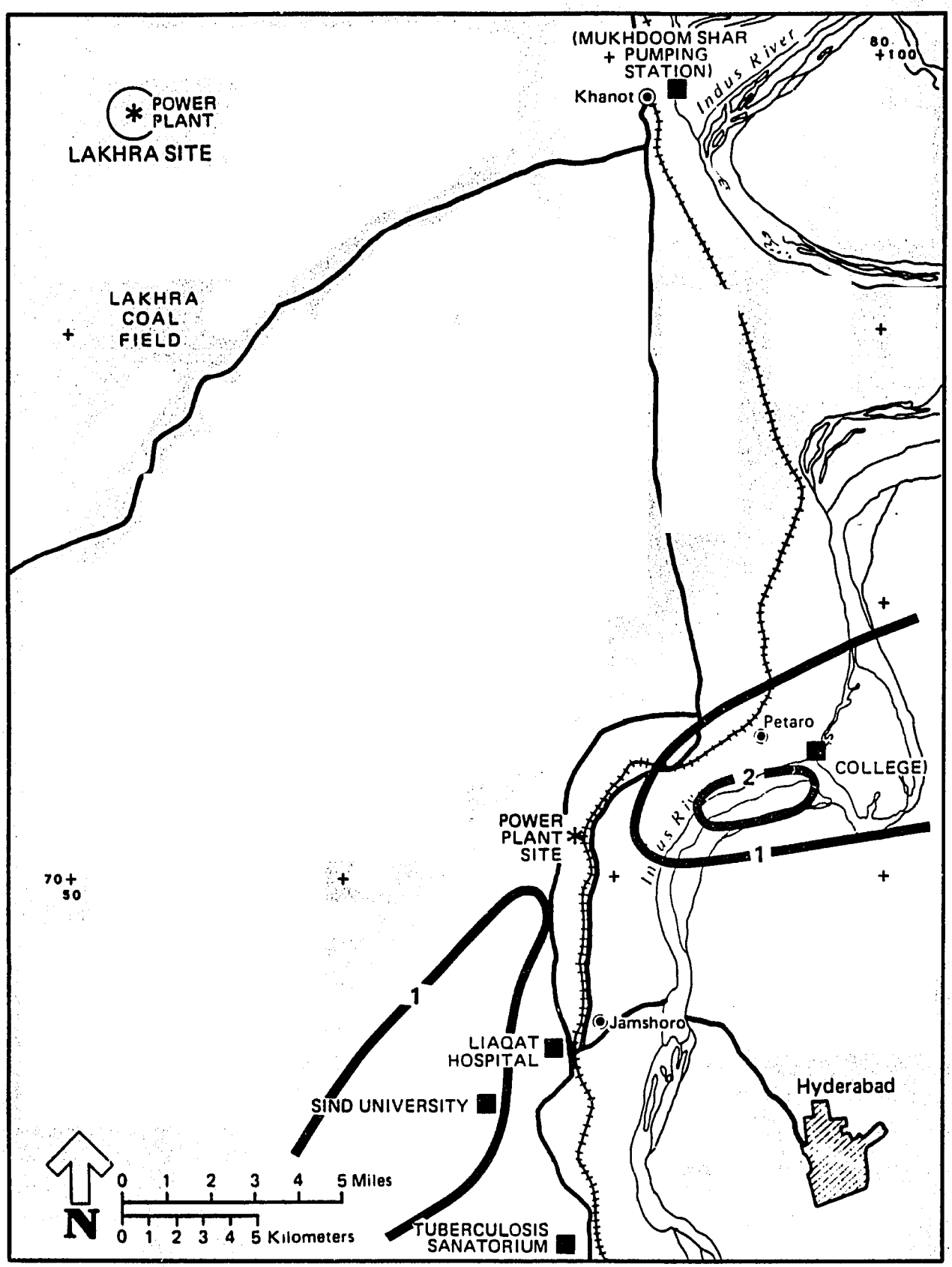


Figure 5-5 Predicted Annual Average NO_x Concentrations ($\mu g/m^3$) for Scenario C (Impacts of Jamshoro — Phases I and II and Lakhra Power Plants)

235X

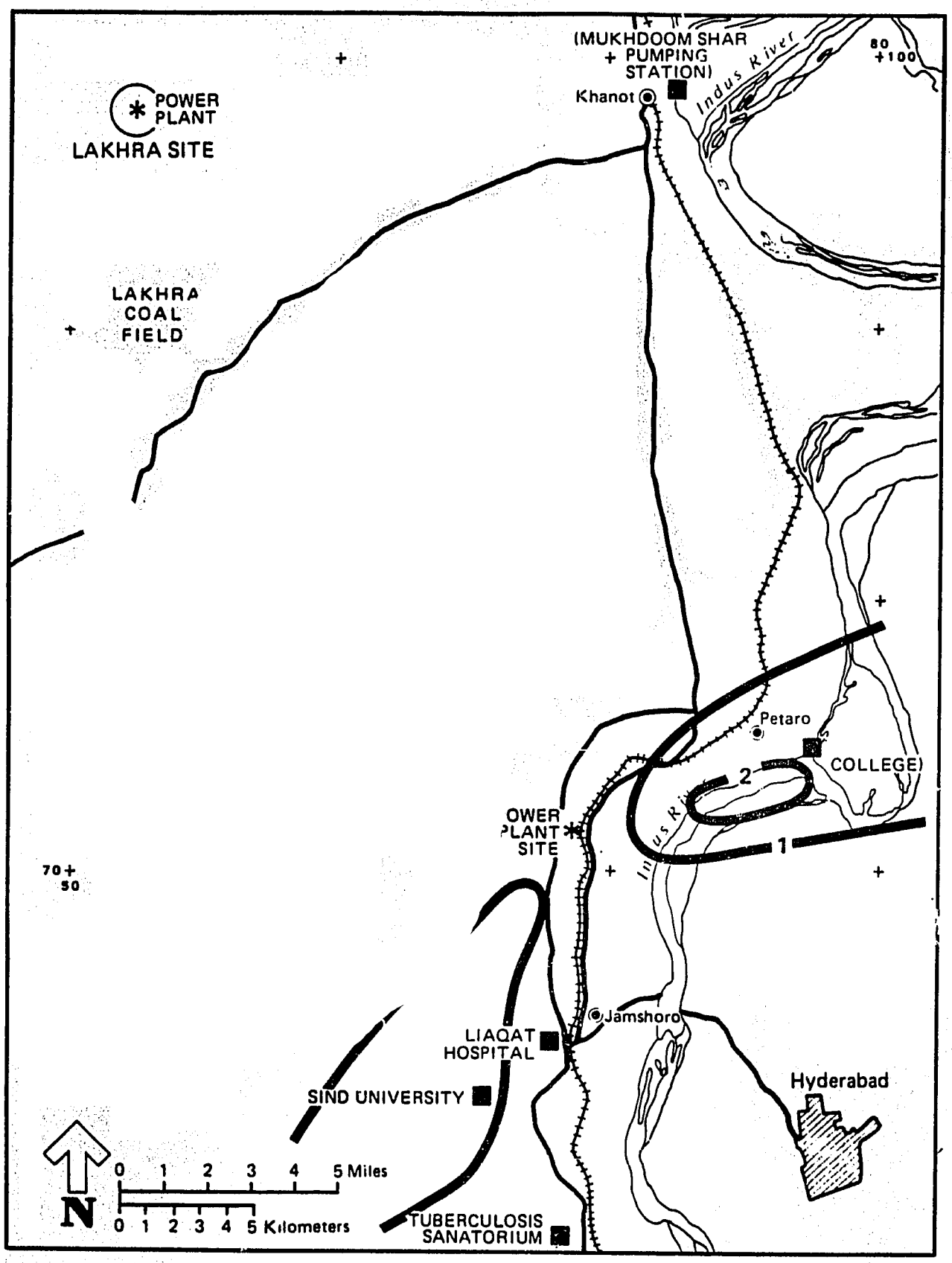


Figure 5-6 Predicted Annual Average PM Concentrations ($\mu g/m^3$) for Scenario C (Impacts of Jamshoro — Phases I and II and Lakhra Power Plants)

236

Figure 5-7 shows the contours for the maximum 24-hour average PM concentrations. The maximum impact is about 10 km southwest of the Jamshoro stacks, where the ground level concentration is 22 $\mu g/m^3$.

The major sensitive receptors in the vicinity of the Jamshoro power plants include the Liaqat hospital at Sind University located about 8 km south, a tuberculosis sanatorium about 16 km south, the city of Hyderabad about 13 to 17 km southeast, and Petaro College about 9 km northeast from the power plants. The air quality impacts of the power plant SO_2 emissions are presented in Table 5-12 for the Liaqat Hospital and the Petaro College. These two areas represent the closest sensitive receptors to the power plants. The maximum 24-hour average SO_2 concentrations at the Liaqat hospital and the Petaro College are about 20 percent and 40 percent of the World Bank guidelines value. All concentrations at these receptors are also below the U.S. EPA standards for 3-hour and 24-hour average SO_2 concentrations.

The agricultural areas extend along the Indus River, east of the railroad tracks. Figures 5-3 through 5-7 show that this area will be affected by emissions from the proposed Jamshoro power plants. The impacts due to all proposed power plants (i.e., Lakhra and Jamshoro Phases I and II) are summarized in Table 5-13.

The air pollutant emissions of the Jamshoro project are presented in Table 5-14. The SO_2 emissions of Phases I and II of 447 metric tons (492 short tons) per day are below the World Bank guidelines value of 500 short tons per day. This is based on a maximum sulfur content of

237X

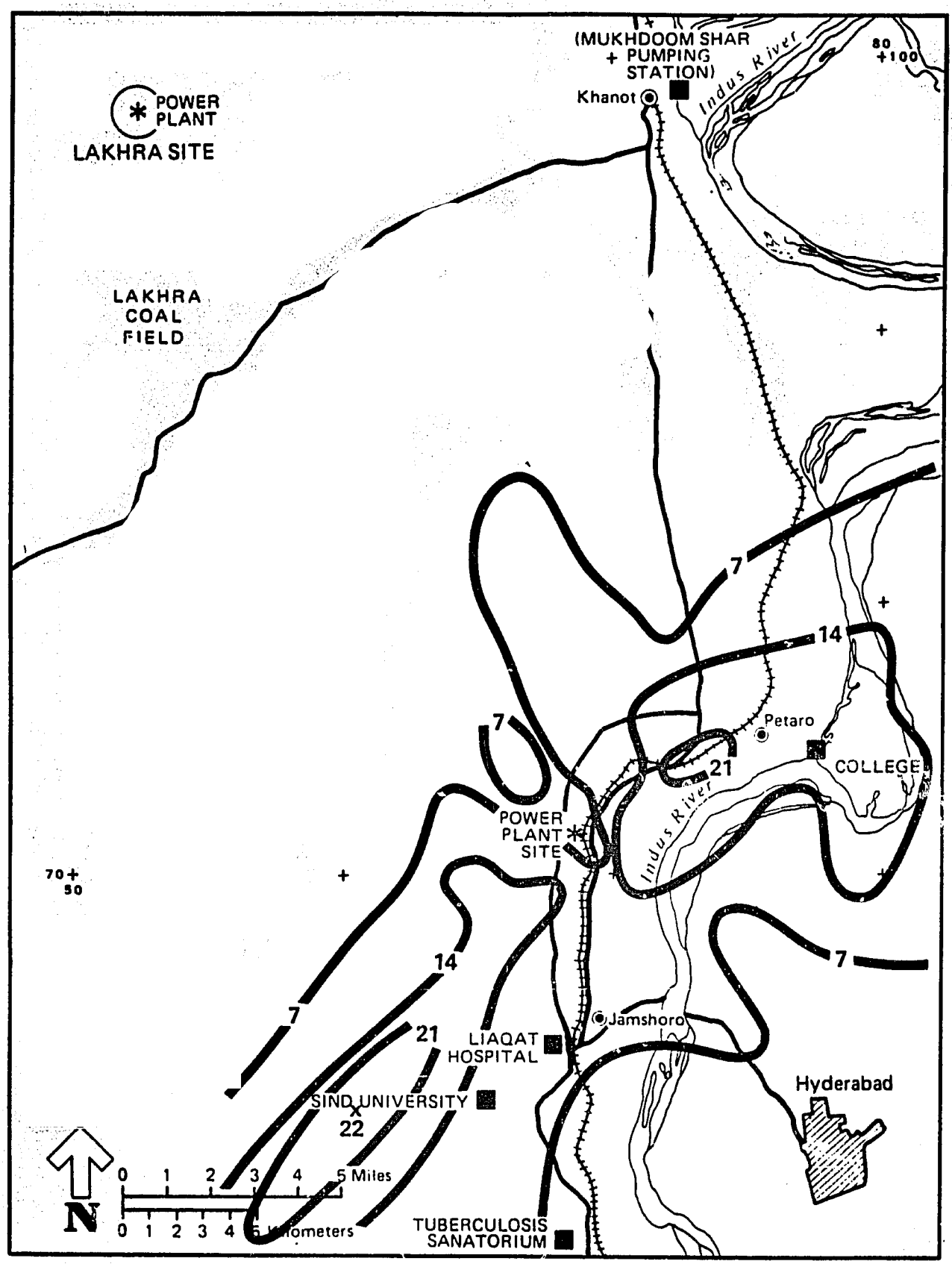


Figure 5-7 Predicted Maximum 24-h Average PM Concentrations ($\mu g/m^3$) for Scenario C (Impacts of Jamshoro — Phases I and II and Lakhra Power Plants)

238

Table 5-12

Percentile SO_2 Impacts of the Proposed Power Plants (Scenario C) at Sensitive Receptors ($\mu g/m^3$)

Sensitive Receptors Concentrations[1]

Percentile (%)[2]	Liaqat Hospital 3-h Avg.	Liaqat Hospital 24-h Avg.	Petaro College 3-h Avg.	Petaro College 24-h Avg.
Peak (Single Occurrence)	610	104	509	210
Percentile (%)[3]				
1	192	76	346	200
5	44	44	227	131
10	2	23	157	106
20	0	9	50	78
30	0	2	3	56
40	0	1	0	33
50	0	0	0	14
60	0	0	0	3
70	0	0	0	0

Notes:

(1) Concentrations at the sensitive receptors do not incl... background SO_2. The 3-hour and 24-hour average SO_2 USEPA standards are 1300 and 365 $\mu g/m^3$, respectively.

(2) Jamshoro Phase I and II Stack Height - 150 m, Lakhra Stac Height - 183 m.

(3) Percentile concentrations are best defined by an example. A 3-hour average 1 percentile concentration of 7 $\mu g/m^3$ means 1% of the calculated 3-hour average concentrations are higher than 7 $\mu g/m^3$ and 99% are below 7 $\mu g/m^3$.

239K

Table 5-13

Air Quality Impacts Due to the Proposed Lakhra and Jamshoro Phases I and II - Power Plants in the Agricultural Area*

Pollutant	Range of Concentrations ($\mu g/m^3$)
SO_2	
Annual average	4 to 20
Maximum 24-hour average	100 to 320
NO_x	
Annual average	1 to 2
PM	
Annual average	1 to 2
Maximum 24-hour average	5 to 21

* Impacts do not include background pollutant concentrations

210

Table 5-14

Comparison of Pollutant Emissions with World Bank Guidelines

Pollutant	Jamshoro Phase I	Jamshoro Phase II	Total	World Bank Guidelines
SO_2 (metric tons per day)(1)				
with 3.5% S oil	219	228	447	454
NO_x (ng/J)	(2)	130	-	130
Dust (mg/m^3)				
at stack temperature	(2)	205	-	100
at 25°C	(2)	280	-	-

(1) At 65% capacity.
(2) World Bank guidelines for NO_x and dust emissions pertain to emissions per unit and, therefore, Phase I emissions are not considered here.

241

the oil of 3.5 percent and an annual operating capacity of 65 percent. Phase II complies with the World Bank NO_x emissions criteria of 0.3 lb/MBtu (i.e., 129 ng/J). The dust (PM) emissions are above the World Bank guideline value of 100 mg/m^3. It should be noted, however, that the contribution of the power plant emissions to ambient PM levels is negligible.

5.1.4.3 Transboundary Air Pollution

Transboundary air pollution and associated acid deposition are likely to occur because the emissions of SO_2 and NO_x from the proposed power plants will lead to the formation of sulfate and nitrate via atmospheric chemical reactions and the subsequent deposition by dry and wet processes of these two acidic species. The deposition of sulfate and nitrate species is expected to occur primarily by dry processes from October to June when precipitation is small and by wet processes during the monsoon season from July to September. Prevailing winds are generally from the north from November to May and from the southwest from June to October. Thus, air pollution from the proposed power plant is likely to be transported toward the Indian Ocean during the winter months and toward the northwest during the rest of the year.

The extent of acid deposition due to the emissions of the proposed power plants could be estimated through a comprehensive mathematical modeling study. However, such a study would require detailed information on the

background concentrations of oxidants (such as ozone and hydrogen peroxide) and other species (such as iron and manganese particulate species) and on the atmospheric conditions (e.g., clouds, fog, relative humidity, atmospheric stability, wind flow, and temperature). Such a modeling study is beyond the scope of this assessment and the estimate of the acid deposition impact of the proposed power plant emissions was therefore limited to a mass balance calculation.

The emissions of SO_2 from the proposed power plants are about 10 times larger than the emissions of NO_x. Therefore, this analysis focused on the atmospheric oxidation of SO_2 to sulfate and the deposition of acid sulfate.

Atmospheric dispersion was assumed to occurr under neutral conditions, with a mixing height of 1,500 m. The Jamshoro and Lakhra sites are about 150 km from the Pakistan-India border. Prevailing winds toward India occur during the months of June through October (see Table 4-6) The Monsoon season with heavy rain occurs during the months of July through September (see Section 4.1.6). The average wind speed was assumed to be 10 m/s (see Table 4-6). A wind trajectory toward the northeast direction from the Jamshoro/Lakhra sites would travel over India for about 1,000 km. The width of a plume emitted from the Jamshoro or Lakhra power plant stacks would be about 25 km at the Pakistan-India border and 140 km at the northern border of India with an average value of about 80 km over India. In addition, it was assumed

243X

that the change in wind direction would cover a sector of 45°. The area in India that would be impacted by the power plant plumes would therefore be about 600,000 km^2. The chemical reactions oxidizing SO_2 to sulfate were assumed to take place at 1 percent per hour under clear sky conditions (i.e., during June and October) and at about 3 percent per hour during the rainy season with, in addition, a nearly instantaneous aqueous reaction between SO_2 and 1 ppb of H_2O_2 (Seigneur et al., 1985).

During the non-rainy season, the fraction of SO_2 oxidized to sulfate emitted by the power plant that would potentially be deposited to the northeast, including India, would be approximately 2.1 percent. This represents 7 percent (of maximum calculated sulfate deposited in India) of 30 percent (fraction of sulfate during non-rainy season). During the rainy season, the amount of sulfate is estimated to be 4.2 percent (.07 transported x .60 emitted). All of the sulfate can be presumed to be deposited by rain.

These small amounts are not anticipated to be of environmental significance, particularly given the minimal population and semi-arid nature of lands to the northeast.

The total SO_2 emissions from the Lakhra and Jamshoro Phases I and II would be 19,135 g/s. Assuming a 65 percent annual capacity, a mass balance calculation provides an upper limit of sulfate deposition in

India of 1.6 kg/(ha.y). The Phase II units contribute about 20 percent of this value; i.e., about 0.3 kg/(ha.y). It should be emphasized that because of the assumption made in this calculation, this value for sulfate deposition is likely to be an overestimate. Damages to ecosystems due to acid deposition are believed to occur only for values of sulfate acid deposition larger than about 20 kg/(ha/y). Therefore, the proposed power plants should not create an acid deposition problem although they would contribute to acid deposition to some extent. The limits of the total Jamshoro project emissions of less than 454 metric tons of SO_2 per day should minimize potential long-range acid deposition impacts.

5.1.5 NOISE

5.1.5.1 Construction

The noise from the proposed site will begin during the initial stages of construction when the site clearing and grading occur. Once the major excavations and pile driving have been completed, the major sources of noise will be hoists, cranes, backhoes, trucks, mobil compressors, and welders. Diesel generators to provide onsite electrical needs will also be a source of noise. Material handling noise such as dropping pipe and structural steel will also occur occasionally. Noise during the initial month of clearing, grading, and excavation may be 5 to 10 dB higher than during the later phases of construction.

245X

Steam venting will occur during plant startup when high velocity steam is used to clear the inside of steam piping. This is typically 10 to 40 dB higher than normal construction activities. Steam venting occurs for a few minutes, two to three times a day, over a period of a week or two for each plant.

5.1.5.2 Operation

The major sources of noise at a 350 MW electric generating facility include those shown in Table 5-15.

The plant equipment will be designed with specific noise criteria limitations and/or sound abatement. Most of the equipment will be located inside a building, which will reduce the noise emitted to the community. The community will be located approximately 0.5 km from the plant boundary. Noise reaching this area is expected to be minimal during operations. Construction noise may present an annoyance on occasion. However, this is expected to be within the normal range for such operations, and not at a level to cause serious or prolonged disturbance.

2116

Table 5-15

Typical Noise Sources

Equipment[1]	Sound Power Level - dBA
Forced draft fa	115-125
Motor	100
Cooling tower	115
Pump	105
Air compressor	110
Turbine	118
Generator	105
Transformer	100
Boiler	109
Steam venting (intermittent)	105-135
Control valve	90-120

(1) Without sound abatement

247X

5.2 SOCIAL AND INSTITUTIONAL CONSIDERATIONS

5.2.1 POPULATION

abor force for Phase II of the Jamshoro Power Generation Complex is estimated to be approximately 2,500 workers. Peak labor force requirements will occur in the 4th year after award of contract. Labor force requirements will decrease as the project moves from construction to operation, stabilizing at an estimated 740 workers.

Table 5-16 shows the projected peak number of workers and dependents directly associated with Phase II. Estimates of the number of dependents for construction and operation were based on patterns at the large oil-fired Guddu Generating Station, where there were significant numbers of single workers in the early years of the project, and increased numbers of dependents later in the project. During 1986, 18 years after the start of project activities at the Guddu facility, there were 6 dependents for each worker. For the Lakhra coal-fired power plant, it was estimated that there would be approximately 1.5 dependents for each worker during the fourth year of project activity, and that the maximum number of dependents during operation would be approximately 6 for each worker. Using the same estimates for Phase II of the Jamshoro Project, a total of 6,250 workers and dependents will be directly associated with Phase II construction, and 5,180 workers and dependents will be associated with Phase II operation.

Table 5-16

Projected Number of Workers and Dependents During Peak Construction and Operation for Phase II of the Jamshoro Project

	Peak Construction	Peak Operation
Workers	2,500	740
Dependents	3,750	4,440
Total	6,250	5.180

249K

It is difficult to predict the influx of people from outside the project area resulting from project workforce requirements. If labor requirements for construction and operation are filled by importing workers from other areas, the influx will be great. If the local labor force is used, the influx of people will be less. It is estimated that during Phase II peak construction, approximately 1,700 workers will be hired locally, and 800 will come from outside the Hyderabad area. During Phase II operation, approximately 640 workers will be hired locally, and 100 will be from outside the area. Project labor force requirements, and the availability of workers in the project area, are discussed in Section 5.3.1.

In addition to project workers and their dependents, other people will be attracted to the vicinity of the Jamshoro Project. At Guddu, a secondary development of approximately 5,000 people was associated with the project-related population of 20,000. Using the same ratio for estimating the secondary population for Phase II of the Jamshoro Project, approximately 1,550 secondary residents will be associated with the construction-related population of 6,250, and approximately 1,300 with the project population of 5,180 during operation. Adding the secondary population growth to the projected peak number of workers from outside the area and their dependents results in a total project-related influx of approximately 3,550 people during construction, and 2,000 during operation. Table 5-17 summarizes the estimated influx of workers, dependents, and secondary population to the area.

Table 5-17

ESTIMATED NUMBER OF WORKERS, DEPENDENTS, AND SECONDARY POPULATION MOVING INTO THE PROJECT AREA FOR PHASE II

	Peak Construction	Operation
Workers	800	100
Dependents	1,200	600
Secondary Population	1,550	1,300
Total	3,550	2,000

251X

The total Phase II project-related inmigration of 3,500 during construction and 2,000 during operation represents a 0.4 and 0.2 percent increase respectively in the Hyderabad area population of 810,000. This is small when compared to the annual growth rates in the Hyderabad and Dadu districts of 2.3 and 3.4 percent.

In order to assess impacts to the area resulting from increased population, it is necessary to consider the number of people associated with both Phases I and II of the Jamshoro Power Generating Complex. Although workforce requirements for Phase I are not assessed here, it is assumed that the population increase resulting from workers, dependents, and secondary development would be at least equal to that estimated for Phase II. Depending on schedules for construction and operation of Phases I and II, and the number of people hired from outside the area, the total population increase for both phases could be at least double that estimated for Phase II alone, or approximately 4,000 to 7,000 people.

No permanent population displacement is anticipated due to site development or pipeline construction and operation for Phase II of the Jamshoro Project. No people are currently living at the site. The first 8 km of the pipeline alternatives are along city streets through an industrial section of east Karachi. This area will be temporarily disturbed during pipeline construction. The pipeline route will then follow the Super Highway or the Sui Gas Transmission right-of-way for much of its length. The final pipeline routing will avoid dwellings

and settlements. Disturbed areas will be returned to their original condition after construction.

5.2.2 LAND USE

Phase II of the Jamshoro Complex will occupy 70 acres of land, in addition to the land occupied by the Phase I facility. The Phase II workers' colony will require about 150 acres. The site is considered non-farm land, although scattered seasonal grazing occurs. Much of the area in the vicinity of the site is currently being excavated in preparation for construction of Phase I facilities. The land for the Jamshoro Complex is owned by WAPDA, with the exception of an 80-acre portion of the land required for a workers colony for Phase II, which will be procured.

The development of the site will alter the existing land use and ownership. The change in land use is considered positive and involves a more beneficial use of the land. The loss of grazing areas is not considered a significant impact because the site was not heavily vegetated prior to excavation. The reduction in the amount of tillable land is also considered a minor impact because the land is not presently cultivated, and large areas of similar land exist in the site vicinity. Moreover, treated water from the plant will be made available for irrigation both on the site (landscaping) and for agricultural purposes in the area surrounding the facility. The changes in land use at the plant site will occur at the beginning of construction and continue throughout the life of the project.

253X

The land required for a workers' colony for Phase II will be acquired. Depending on how compensation for the land is rendered, the loss of land ownership may be positive or negative.

Pipeline construction will result in the disturbance of an approximately 150-km corridor, 30 meters in width, totaling about 1,100 acres of land. The proposed pipeline routes follow existing rights-of-way for much of their length. Land use alteration for the pipeline will be short-term, during construction only. Once the pipeline is in place, the pipeline trench will be backfilled and the land returned to its original use.

The power plant site is accessible directly from the Indus Highway; no additional land will be disturbed for construction of offsite access roads.

Some conversion of non-farm land and agricultural areas to business and residential areas will result from secondary development. New development will most likely occur along the road from Hyderabad to the site, and in towns and villages in the project area. Businesses will be established in response to the increased need for goods and services. New residential areas will also be established to provide housing for secondary population growth. The loss of farm land is not considered a significant impact since the area is small in relation to the amount of farmland in the Hyderabad and Dadu Districts. The conversion of undeveloped non-farm land to business and residential

areas is considered a positive impact. However, adequate land use planning should be conducted to determine the location of secondary development in the area, and to prevent uncontrolled growth.

No land use plans for the Jamshoro area have been identified during preparation of this report. Given the potentially significant effects of this project on the surrounding rural community, the Government of Sind should coordinate with WAPDA to prepare a suitable plan to guide future development in the area. This will discourage haphazard growth and optimize the future provision of public facilities in the region including roads, power, irrigation canals, sewerage, and potable water services.

5.2.2 FACILITIES AND SERVICES

As discussed in Section 5.2.1, the influx of workers and dependents directly associated with Phase II construction and operation will peak at approximately 2,000 and 700 respectively. It is estimated that approximately 1,550 additional people will be associated with secondary development during construction, and 1,300 during operation, and that the total population increase for Phase I will be at least equal to that for Phase II. This section discusses the effects of increased population on housing, health care facilities, schools, police protection, and communications.

255x

5.2.2.1 Housing

Project housing needs are an important community concern. During Phase I, it is planned that construction contractors will provide housing for construction workers. A workers' colony is planned for Phase I operation workers and their dependents

During Phase II construction, the contractors should provide safe, sanitary living conditions for their employees being relocated to the area. Although vacancy rates are not available, it does not appear that adequate available housing currently exists in the surrounding communities for the estimated 800 workers who will move into the area during peak Phase II construction; and housing availability will be reduced by population increases associated with Phase I activities.

It is recommended that housing be provided for workers in temporary structures at the site. Plant construction workers hired locally may choose to live at home and commute to the site. If temporary housing is not provided by the construction contractors and housing needs are to be satisfied by the local private sector, careful planning and coordination by WAPDA and local government officials and businessmen will be required to ensure the availability of adequate housing in the community.

The pipeline construction workforce will be housed by construction contractors in temporary camps along the pipeline route.

286

Two alternative strategies are discussed here for housing workers during Phase II operation: first, if workers are housed in Hyderabad and the surrounding communities; and second, if workers are housed at colony at the Jamshoro project site. The potential social impacts of these two alternatives are discussed below.

During Phase II operation, an estimated 2,000 people will move into th area as workers, dependents, and secondary population. In addition, housing will be required for secondary population growth associated with Phase I. No data were available on housing vacancy rates in Hyderabad and the surrounding area. As mentioned above, it does not appear that adequate housing exists for the total population increase in the area. A shortage of housing would have several potential effects on the area, including inflated prices for housing and land, increased secondary employment generation, and increased pressure on community services and infrastructure.

Housing needs most likely would be accommodated by the private sector. Inflation in land and housing prices will be associated with increased economic activity in the area; a housing shortage would contribute further to inflation in the price of land and housing. However, the construction of new housing in the area to accommodate project needs could have a positive effect on the local economy, if proper planning is carried out by local government officials and businessmen in coordination with WAPDA.

257

Secondary employment generation will be higher if workers were housed in the community than if workers are housed in a colony, since all goods and services would be provided by the local economy. An increased number of support businesses will spring up around the site, along the Indus Highway, and in Hyderabad and the surrounding area to provide for the increased need for food and essentials. An increased number of secondary businesses would mean a larger secondary population for the area to absorb.

The pressure on medical care facilities, schools, and police protection services, and estimated project-related needs for such services are discussed later in this section. If these facilities are not provided by the project at the workers colony, the Dadu and Hyderabad Governments and the Government of Sind will be responsible for providing them. In addition, the cost of providing water, power, and telephone facilities for the project population will fall to the District and Province Governments.

Impacts to the transportation system would also be greater if workers were housed in the surrounding communities and commuted to and from the site. Increased use of the transportation system to accommodate project needs are discussed in Section 5.2.4. If a workers' colony was not provided, the project would probably provide bus transportation for workers to and from the site.

The estimated capital cost for providing a bus system for operation workers would be approximately U.S.$600,000, based on 6 buses carrying 45 workers during operation. Recurrent costs would include training and salaries for bus drivers, and equipment maintenance and repair.

The planned workers' colony would reduce impacts to the area. The workers' colony would provide housing and community services for 60 to 100 percent of the workforce and their dependents.

The type of housing provided in the colony will depend on the basic pay scale of the employee. According to WAPDA policy, the type of housing provided to WAPDA employees depends on the basic pay scale of the employee, as follows:

WAPDA Basic Pay Scale	WAPDA Housing Class	WAPDA Square Footage
19-20	I	3000
18	II	2500
17	III	1500
14-16	IV	1000
11-13	V	606
1-10	VI	520
17-20	Single Officers' Quarters	
1-16	Single Workers' Quarters	

The cost of a workers' colony for Phase II operations is estimated to be Rs. 250,000,000 (WAPDA, 1986a). The workers' colony will include a school, hospital, recreation center, mosque, shopping center, and playgrounds and parks.

259

The housing requirements during operation for Hyderabad and the surrounding communities will be for those workers who move into the area and choose not to live in the colony, and for the secondary population. As discussed in Section 5.2.1, it is estimated the approximately 100 operation workers will be from outside the Hyderabad area. Assuming one housing unit per worker, 100 houses would be the maximum required in the community, if all workers from outside the Hyderabad area choose not to live in the colony. With seven persons per household, the secondary population of 1,300 would require approximately 200 housing units in the community. Again, planning and coordination between local government officials, businessmen and WAPDA is necessary to ensure that adequate housing can be provided by the private sector for the up to 300 new households associated with Phase II operations.

5.2.2.2 Health Care

Adequate health care facilities must be provided for the increased population associated with project development. It is recommended that health care facilities be provided by construction contractors for construction workers and their dependents. Health care provision for the secondary population will be the responsibility of the Government of Sind. The ability and willingness of the provincial government to provide health care services should be determined by the Ministry of Health and WAPDA; the project should coordinate with the Ministry in

A60

planning for health care for the secondary population. The need for rural health care centers and clinics in the Jamshoro area also needs to be determined by the Government of Sind and the Ministry of Health, in cooperation with WAPDA, before project construction begins.

WADPA will provide medical and dental health care services to workers and their dependents free of charge. If no workers' colony is provided, health care services would be the responsibility of the Government of Sind. As discussed in Section 4.2.3, Liaqat Medical College and Hospital, administered by the Government of Sind, is located to the south of the site. It is a 1,100 bed facility with a vacancy rate of 10 to 20 percent. The facility appears adequate to handle population increases of 3,550 during construction and 2,000 during operation. However, it is not known if the current hospital staff is large enough to handle projected population increases. In addition to Phase II population increases, Liaqat Medical College and Hospital will also accommodate population increases from Phase I of the Jamshoro Project.

5.2.2.3 Education

Education needs of construction workers and their dependents will be the responsibility of the Government of Sind. WAPDA should coordinate with the provincial government to determine if existing educational facilities are adequate for the anticipated population growth, and to plan for new facilities if required.

During operation, the workers' colony will include a school for colony residents and their dependents. Educational needs for the secondary population will be the responsibility of the provincial government. Again, coordination by WAPDA with government officials is necessary to ensure that these facilities can be provided.

5.2.2.4 Police Protection

Providing police protection and maintenance of law and order for the increased population in the community will be the responsibility of local governments. Security for the project site and the colony will be provided by WAPDA.

5.2.2.5 Communications

As is discussed in Section 4.2.3, the telephone system in Hyderabad is not adequate for current community needs. Plans exist to install new equipment in 1987 or 1988. The new equipment should be able to handle all telecommunication needs of the Jamshoro Project as well as the normal load growth in the Hyderabad area for many years. If this equipment is installed as planned, no project funds will be required to upgrade area telecommunications to meet the needs of the project.

However, if delays occur in installing the new switching equipment, serious limitations in telecommunications will affect the Jamshoro Project. Providing telephone lines to the site will require removing

262

lines now used by other subscribers. The number of lines available for the Jamshoro Project will be far less than that required, and reliability and quality of service will be poor.

5.2.4 TRANSPORTATION

Both Phases I and II of the Jamshoro power generation complex will require the availability of transportation facilities to provide for the movement of both materials and workers to and from the project site. The existing transportation infrastructure that will be affected by movement of project materials and workers includes the Indus and National Super Highways, and rail service via a single-line, broad-gauge track that parallels the Indus Highway from Karachi to Hyderabad and then passes east of the Jamshoro site.

The combined impacts of the construction and operation of Phases I and II of the Jamshoro Complex on transportation can be expected to be greater than the impacts of Phase II. With overlapping construction schedules, the combined project-related traffic might be expected to be approximately double that of Phase I. Although the magnitude of the increase cannot be accurately predicted, combined impacts including greater traffic volumes, congestion, and frequencies of accidents would be expected to increase, particularly in the area around the Jamshoro site.

5.2.4.5 Construction

The existing rail system (between Karachi and Hyderabad) in conjunction with a rail spur to the Jamshoro site (to be constructed) may provide transport of heavy equipment, materials, and workers to the site. Although transportation of materials and workers is feasible, rail transport is not expected to be the predominant means of transportation. Highway transport seems preferable because of recent road improvements and continuing railroad clearance restrictions. Although the railway will probably be used for some transport of equipment and materials, the impact on the existing rail system between Karachi and Hyderabad is not expected to be significant.

Movement of materials and workers is expected to be primarily by road transport. Shipment of construction materials will originate in Karachi or Hyderabad, and be accommodated primarily by trucks, the majority of which will be similar to those currently using the Indus and National Super Highways. Workers will rely on project-supplied buses for transportation to and from the site.

The increase in highway traffic associated with the construction of Phases I and II of the Jamshoro power generation complex cannot be projected accurately at this time. Over the construction and startup period, many thousands of highway trips of various lengths will be made, transporting materials and workers to and from the project site.

Hdl

The existing road facilities have handled heavy volumes in the past; however, road improvements may be required to accommodate the anticipated transport of materials and workers, particularly between Hyderabad and the Jamshoro site. Increased levels of traffic are expected to affect the Indus Highway and the National Super Highway. Transportation of construction materials and workers will increase the volume of truck, bus, and other vehicular traffic. Transport of materials and equipment between Hyderabad and the Jamshoro site will result in increased truck traffic on the Indus Highway and the National Super Highway. The transportation of large equipment or oversize loads may temporarily slow traffic and cause congestion on the highways.

Local-hire workers will commute to and from the Jamshoro site, which will also result in increased traffic volumes in the surrounding area. The number of offsite workers for Phases I and II and associated vehicles transporting them to and from the site is not yet known. Reliance on buses will ameliorate increases in local traffic levels to some degree.

Localized heavy traffic congestion, however, may occur periodically at the intersection of Indus Highway and the Jamshoro site access road and at the truck stop south of the site. Congestion will be heaviest and occur most frequently at shift change times and when slow (e.g., oversize) loads are being transported. At the site entrance, vehicles both entering and leaving the Indus Highway will be affected at times.

365X

Traffic may be delayed onsite at the intersection while waiting for vehicles to turn right (i.e., south) and enter the highway. North/south highway traffic may also be slowed or delayed at times while vehicles turn off the 2-lane highway to access the site. It is recommended that improvements be made to the intersection, which may include the addition of turn lanes, widening of the highway in the area, and construction of a pedestrian bridge or overpass.

A rise in the frequency of accidents also may result from the increased traffic resulting from transportation related to construction activities. Increased traffic volumes, and particularly, traffic slowing and turning at the intersection of the Indus Highway and the site road may result in an increased number of accidents.

5.2.4.6 Operation

The transportation systems utilized for construction activities will be adequate to accommodate operational activities. The level of traffic during operations will be considerably less than during construction when the workforce is larger and construction materials are being delivered to the site. Local traffic will be reduced when the workforce decreases as the project moves from construction to operation.

In addition to the repair and renovation program underway for the National Super Highway, the Sind Department of Highways plans improvements to the Indus Highway. Improvements to the Indus Highway

(i.e., bringing it up to National Super Highway standards) would benefit logistics for Phase II of the Jamshoro project. For example, expanding the highway to a full 2.3 m lane width could reduce the potential for accidents. Access to the site, however, is not contingent on the planned improvements.

If the Phase II facilities are not constructed, fuel for the Phase I units will be transported by rail, rather than by pipeline. Impacts to the existing rail system between Karachi and Hyderabad might be significant if only Phase I was constructed.

5.2.5 LIFESTYLE, CULTURAL PATTERNS, AND ATTITUDES

No significant adverse impacts to lifestyle and cultural patterns are expected to result from the influx of outsiders into the project area or from changes in the local economy; favorable impacts to lifestyle will occur due to changes in the economy. Project development may result in a negative community attitude if steps are not taken to address the sensitivities of the local population.

Significant adverse impacts to the lifestyle and cultural patterns of the people in the Jamshoro area are not anticipated because the project-related population increase is small when compared to the annual average growth rates, and because the people in the rural areas near the site have already been exposed to urban influences. The current population of the town of Jamshoro is approximately 8,000. The

de7x

peak project-related population growth of 4,000 to 7,000 people for Phases I and II would represent a significant increase in the number of people in the immediate vicinity of the site. However, it is likely that population increases will be distributed to Hyderabad and the surrounding communities. The population of the city of Hyderabad is 750,000; the combined population of towns and villages within 15 km of the site is approximately 60,000. The average annual growth rate in the Hyderabad and Dadu districts from 1972 to 1981 was 2.6 and 3.4 percent respectively. As discussed in Section 5.2.1, the Phase I and II population increase of 4,000 to 7,000 represents a 0.5 to 0.9 percent increase to the Hyderabad area population of 810,000, which is not considered significant when compared to the annual growth rates. The impact to the cultural patterns and lifestyle of local residents due to the influx of outsiders is not expected to be significant.

In addition, although the Jamshoro area is rural, the people in the vicinity of the project site are not isolated from urban influences because of their proximity to the city of Hyderabad. Therefore, significant adverse impacts to the cultural patterns of the people in the Jamshoro area resulting from urbanization are not expected.

Lifestyle differences may exist between construction workers, who are expected to have few dependents, and local inhabitants whose social structure is family-oriented. Impacts of construction are considered short-term. Lifestyle differences between the operation workforce and local inhabitants are not expected to be significant.

Favorable impacts to the people in the project area will occur due to changes in the local economy. An improved standard of living will result from the increased availability of electricity and growth in the economic activity in the area. The overall economic development of the area is expected to ease social problems related to unemployment and underemployment.

In addition to addressing the impacts to lifestyle and cultural patterns, it is important to assess the attitude of the local population toward the project. The Lakhra Social Soundness Analysis (Helweg, 1985) indicated a sensitivity of the Sindhis to proposed energy development and a distrust of outsiders. Measures should be taken to create a positive attitude toward the project. Without community acceptance, construction and operation could be delayed or prevented. An understanding of the project by the local population will help to develop a positive community attitude. A public information program to relate project information to the local population should be established to convey information on project benefits and potential adverse impacts. Implementation of a public information program is discussed in Section 6.2.

Use of the local labor force would also serve to establish good community relations. Training programs to ensure utilization of the local labor force should be established early in the project. Training programs for the local labor force are discussed in Section 6.2.

269K

In order to utilize the existing social structure for project implementation, WAPDA should use the local labor contractors and landowners (Mistris, Jamadars, and Zamadars), who are key figures in the social structure of the area, for hiring workers.

5.2.6 CULTURAL RESOURCES

Because the plant site and large portions of the proposed pipeline alternatives are in the Indus River Valley, archaeological remains are likely to be encountered. The area has a high probability for containing archaeological remains. These sites may include small agricultural habitations, ceramic scatters, lithic scatters, resource procurement areas, and ancient agricultural fields. Because of the high probability that these small, poorly defined archaeological sites exist throughout much of the Indus River Valley, the project may impact some of these archaeological sites.

Significant, previously recorded, large archaeological sites with well defined features and standing structures will probably not be disturbed. Information on the existence of protected sites for the plant site and the pipeline route will be obtained from the Pakistan Department of Archeology prior to construction. Field surveys to determine the presence of previously unrecorded archaeological remains at the site and along the pipeline route will be conducted before construction activities begin.

5.3 ECONOMIC CONSIDERATIONS

5.3.1 EMPLOYMENT

Construction of Phase II of the Jamshoro Power Plant Complex will require up to 2,500 workers over a 4-year period. Phase II operation will require approximately 740 workers. Of the peak construction work force of 2,500, it is estimated that 1,300 skilled and 1,200 unskilled workers will be required. During operation, an estimated 530 skilled workers and 210 unskilled workers will be required (Bastien, 1987; BNI, 1986b).

Labor force requirements will be satisfied using both the local labor force and workers from outside the area. Skilled workers will come from urban areas such as Hyderabad. It appears that both skilled and unskilled labor are available in the project area. Although the official unemployment rate in the area is low, less than 5 percent, unemployment and underemployment are major problems throughout Pakistan. The unemployment register of the Hyderabad area for December 1984 listed 90 unemployed engineers of various specialties, which is likely to be an under-representation (Helweg, 1985).

Until recently, the attraction of higher paid positions for craftsmen and artisans in the Gulf had resulted in a shortage of skilled manpower. The 1984 Hyderabad unemployment register listed only one bricklayer, one carpenter, one blacksmith, three diesel mechanics and

four welders looking for work. However, a large influx of craftsmen and artisans are expected to return to Pakistan over the next two years as the pace of Gulf construction slows down.

Unskilled workers should be plentiful. In the Hyderabad area almost 4,000 unskilled men were registered as unemployed in March 1985 (Pakistan Population Census Organization, 1983a,b).

It is anticipated that all unskilled labor force requirements for Phase II construction and operation will be satisfied using the local work force; and that approximately 500 skilled construction workers and 430 skilled operation workers will be hired locally (Bastien, 1987).

Table 5-18 summarizes information on available skilled and unskilled workers in the Hyderabad area, and presents the estimated number of skilled and unskilled workers to be hired locally. Phase I requirements for skilled and unskilled workers, and the estimated number of workers to be hired locally, have not been obtained.

To maximize the use of the local labor force, construction managers should utilize local labor contractors and landowners (Zamindars, Jamadars, and Mistris) to recruit available unskilled labor.

Table 5-18

Available Skilled and Unskilled Workers in Hyderabad Area, and Estimated Number of Local Hires for Phase II

	Available Workers in Hyderabad Area	Phase II Construction			Phase II Operation		
		Local Hires	Other	Total	Local Hires	Other	Total
Skilled	90+ engineers; craftsmen and artisans returning from Gulf	500	800	1,300	430	100	530
Unskilled	4,000	1,200	0	1,200	210	0	210
				2,500			740

273

Most construction jobs will be temporary and the labor force requirements will decline substantially as the project moves into operation. A recession in the economy will occur as the number of workers decreases and the need for secondary services is reduced. The extent and timing of the recession will depend on the overall scheduling of work force requirements for Phases I and II.

5.3.2 ECONOMIC BENEFITS

It is anticipated that many economic benefits will come to the Hyderabad and Jamshoro area, and the Province of Sind, as a result of the project. These benefits will be in the form of increased generation of electricity for the agricultural and industrial sectors, increased employment in an area of chronic underemployment, increased economic activity, and taxes and duties collected by the Government of Pakistan, the Government of Sind, and the Dadu and Hyderabad District Government.

The main long-term benefit of the project will be the increased generation of electricity. Amelioration of electric power shortages and outages, both at the national level in Pakistan and at the regional level in Sind, resulting from the power provided by the Jamshoro Complex will encourage agricultural and industrial growth.

Salaries paid to workers at Jamshoro will provide a stimulus and a short-term benefit to the local economic system. Increased money will

be available for the purchase of local goods and services. A percentage of project materials and supplies will be purchased through local vendors. Industries may be attracted to the Jamshoro area as the local economy improves. Increased small business activities should result as well. Since Jamshoro already has a commercial center, the development of a squatters' settlement in the vicinity of the site is not as likely as it would be for a project located in a remote area (Helweg, 1985). The likelihood of a squatters' settlement near the site will be reduced by the workers' colony which includes shops and other amenities. A few enterprises, such as cottage industries, restaurants, and tea houses, may occur near the site, and increased business activity will occur in established settlements such as the truck stop area at Jamshoro.

Several types of taxes and duties will be collected from the Jamshoro Project by the Government of Pakistan, the Government of Sind, and the District Governments. Income taxes on workers' salaries will be collected by the Government of Pakistan. Duties and sales taxes are normally paid on the value of equipment imported into Pakistan. Other taxes that would be paid by the project include taxes on profits of expatriate companies working on the project, octroi charges (taxes on commodities brought into a town), and road tolls.

275X

5.3.3 ADVERSE ECONOMIC IMPACTS

Adverse impacts to the economy may include inflation in the price of goods, services, and land associated with increased demand, and costs to the Governments of Sind and of Pakistan for provision of community services to accommodate population growth. Impacts may also occur at the end of construction when work force requirements are reduced and local unemployment increases.

Since the Jamshoro Complex will be located close to the urbanized area of Hyderabad, inflation in the price of goods and services will probably not be great. Overall economic benefits will outweigh the effect of inflation in prices of goods and services. Inflation in land prices may be significant if construction workers are not housed at the site (see Section 5.2.3).

The cost of providing community services for secondary population growth will fall to the Government of Pakistan and the Government of Sind. These services will include health care, education, and police protection. However, taxes collected from project activities will provide revenue to fund services for project related population growth.

As discussed above, short-term economic problems will occur as work force requirements decrease at the end of construction activities. However, the overall effect of the project to the economy will be positive.

5.4 PUBLIC HEALTH AND OCCUPATIONAL SAFETY

Thermal power generation and pipeline facilities represent the use of well developed industrial technology for which occupational safety and health hazards are relatively well defined. The hazards associated with plant operation are controlled primarily through the use of two strategies. The first strategy involves the preparation of engineering designs that minimize safety hazards and control health hazards associated with routine operations. This strategy is the most effective means of minimizing impacts to worker health and safety. This engineered approach to health and safety is an integral part of the Jamshoro facility design.

The second strategy necessary to control health and safety impacts is implementation of an effective facility program for health and safety. Formal procedures that detail the methods to be used for the safe completion of both routine and nonroutine operating and maintenance activities are necessary. The program must also be designed to educate workers regarding plant hazards and the methods to be employed to control them.

Effective implementation of these two strategies will minimize impacts to occupational health and safety at the Jamshoro facility.

277

Examples of the first strategy, to engineer health and safety into the facility, are as follows:

Installation of thermal insulation on steam pipes to prevent burns

Provision of shields or guards for moving parts to prevent traumatic injury

Installation of handrails, toeboards and non-slip surfaces for all elevated platforms, walkways, stairways, and ramps to prevent slips and falls

Adequate grounding and insulation of electrical equipment to prevent electric shocks

Provision of adequate sanitary and washing facilities to reduce worker dermatitis from extended contact with chemical agents in the workplace

Provision of facility ventilation to minimize heat stress

Specification of low noise equipment and the enclosure of noisy equipment or workstations to limit worker noise exposures to 90 dBA on an 8-hour time-weighted-average basis

- Design of equipment and provision of exhaust ventilation to maintain the concentration of toxic combustion gases and process dusts in the workplace below recognized acceptable levels (i.e. SO_2:2 ppm, NO_2 3:ppm, CO: 50 ppm, nuisance dusts 10 mg/m^3) (ACGIH, 1985).

The facility health and safety program must be designed to effectively protect the worker where engineering controls are not feasible, or are inadequate. The health and safety plan must address issues such as:

- Provision and use of personal protective devices:

  - Footwear, respirators and protective eyewear and coveralls for boiler cleaning or other hazardous maintenance activities

  - Issue and use of hearing protection devices in hazardous noise areas

- Provision of emergency equipment such as eyewashers, showers, and escape equipment

- Establishment of procedures regarding confined spaces that address, breathing apparatus, detection of fire or explosive hazards, ventilation, use of low voltage equipment, and entry and rescue procedures

Establishment of procedures for deenergizing equipment pric to maintenance, or for working on energized equipment

Establishment of an effective employee health and safety training program

The establishment of good housekeeping practices.

The production and transmission of electrical power enjoys low occupational injury and illness incidence rates relative to other general industry classifications. Table 5-19 is a summary of industrial injury and incidence rates for a number of industries by standard industrial code in the United States. As indicated by the table, an electric power facility has the potential for achieving low impacts to occupational health and safety relative to other economic activities. The Jamshoro facility design represents the use of proven standard power generation and pipeline technology and, as such, should not present any unique occupational health and safety problems. The facilities incorporate health and safety considerations in their design, and, in conjunction with the implementation of a facility health and safety program, should result in acceptable levels of impact to worker health and safety.

More specifically, based on the design and engineering of the project and the use of a tall stack for emitting air emissions, no significant impacts to the air quality of the study area are anticipated. Air emissions from the facility have been calculated and the predicted

Table 5-19

Occupational Injury and Illness Incidence Rates
U.S.A. 1983

Industry	tal Cases[1]
Agricultural, Forestry, and Fishing	11.9
Mining	8.4
Construction	14.8
Manufacturing	10.0
Transportation and Public Utilities	8.2
Electric Services	6.2
Wholesale and Retail Trade	7.2
Services	5.1
Finance, Insurance, and Real Estate	2.0

Note
(1) Incidence rates per 100 full-time workers.

Source: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Injuries and Illnesses in the United States by Industry, 1983, Bulletin 2236, June 1985.

2817

emissions are below the criteria established by both the World Bank and U.S. EPA for air pollutants, with the exception of particulate matter. However, baseline concentrations of particulate matter are above World Bank Guidelines and the contribution of the plant to particulate pollution will be minimal (see Section 5.1.4). The World Bank and U.S. EPA criteria are based on protecting the public health from adverse effects of air pollutants; U.S. EPA criteria are more strict than World Bank Guidelines, and were used to address air quality concerns at the hospital to the south of the site.

In addition, no impacts to the public health are anticipated from wastewater release from the plant. The plant wastewater management system is designed to produce effluent that will meet U.S. EPA effluent limitations for new electric power plants, USEPA 40 CFR 433. U.S. EPA effluent limitations were selected as recognized applicable standards so that conformance to standards can be demonstrated.

Some wastewater will be collected in evaporation ponds. These ponds will be designed to minimize percolation and prevent ground water contamination. A detailed description of the impacts on water resources and quality is presented in Section 5.1.3.

Solid wastes generated at the facility during construction and operation activities will include sludges, boiler cleaning wastes, containers, wood, debris, and trash. Under most circumstances, the disposal of these items should not impact the disposal capacity of

area. However, materials that are considered hazardous in nature could present a public health problem if disposed of improperly. A recommended solid waste management plan is presented in Appendix (

There are also public health impacts associated with exposure to high voltage electrical power transmission lines. These impacts include hazard and nuisance shocks, and can be prevented by fences and warning signs.

5.5 COMBINED EFFECTS OF PHASE I AND PHASE II

This environmental and social soundness evaluation has been carried out principally for Phase II of the Jamshoro Project. In many cases, however, a full understanding of impacts in the Jamshoro area could only be gained through consideration of combined activities occurring during construction and operation of both phases. This required access to Phase I design and operations information is not readily available to preparers of this report. Nevertheless, certain assumptions have been made based on available Phase I specifications and on WAPDA policy that allow at least a preliminary estimation of net effects of the project on the ecology and social environment of the Jamshoro area. Table 5-18 presents a review of these Phase I and Phase II impacts, together with an estimate of combined effects anticipated for the entire Jamshoro Complex.

Table 5-18
COMPARISON OF PHASE I AND PHASE II
ESTIMATED ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

CATEGORY	PHASE I PLAN AND IMPACT	PHASE II PLAN AND IMPACT	CUMULATIVE IMPACT
WASTEWATER	Cooling tower blowdown will be released for irrigation. Steam generator blowdown will be discharged to the evaporation pond. Water treatment wastes will be neutralized and then discharged to the evaporation pond. Plant drains will be treated for removal of and grease then discharged to the evaporation pond. Wastewater from air preheater washing and boiler chemical cleaning will be neutralized and then discharged to the evaporation pond. Sanitary wastes from the plant building will drain to septic tanks. Contents of septic tanks will be transferred to the evaporation ponds. All streams containing suspended solids are sent to the evaporation ponds. It is not known if ponds are to be lined. Possible ground water impact if not.	All wastewater streams except metal cleaning waste will comply with USEPA effluent guidelines so as to be suitable for reuse in irrigation. Individual streams are are treated as follows: Cooling tower blowdown will be discharged continously for irrigation except when chlorine residual exceeds 0.2 mg/l. Steam generator blowdown will be recycled to the cooling tower. Water treatment wastes will be neutralized and then discharged to the evaporation pond. Plant drains will be treated for removal of oil, grease, and suspended solids and then neutralized for use in irrigation. Metal cleaning wastes from steam generator chemical cleaning and non-chemical cleaning of the steam generator and air preheater will be neutralized and discharged to a lined evaporation pond. Sanitary wastes will receive secondary treatment and then be discharged to the lined evaporation pond. No anticipated harmful impacts from Phase II disposal of wastewater. Suspended solids concentration in the cooling tower blowdown will meet USEPA effluent guidelines and therefore this stream will not produce any solid waste. Streams from the water treatment systems that contain suspended solids will be recycled to the retention basins. Periodic dredging of the retention basins will be required to remove the settled solids. Since this material consists of silt from the river water and nonpolluting treatment chemicals, it will be placed in a landfill	Possible ground water contamination if Phase I evaporation ponds are unlined. Otherwise, no harmful impacts. Benefit gained from availability of irrigation water and presence of landscape vegetation.

Table 5-18

COMPARISON OF PHASE I AND PHASE II
ESTIMATED ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

CATEGORY	PHASE I PLAN AND IMPACT	PHASE II PLAN AND IMPACT	CUMULATIVE IMPACT
WASTEWATER (continued)			
		Solids from the plant drains will be placed in a landfill. Oil and grease will be disposed of off-site or recycled in the plant.	(See above)
		Solids from metal cleaning wastes will remain in the evaporation pond.	
		Solids from sanitary treatment will be placed in a landfill.	
STORMWATER MANAGEMENT			
	Plan for stormwater management is unknown. Contaminated water could reach the Indus River if there is no oil and gas separation.	Stormwater runoff will be directed to the raw water retention basins for suspended solids removal. Stormwater contaminated with oil and grease will be treated for oil and grease removal prior to release to the raw water retention basins. Overflow from the basins will go to the existing natural site drainage.	No net impact unless Phase I site runoff is not segregated to prevent oil and grease from reaching natural drainage channels. This could result in contaminated water reaching Indus River although probably of little amount and significance.
		No impact anticipated.	
NOISE	Maximum noise level at the site boundary will be 70 dBA.	Maximum noise level at the site boundary will be 70 dBA.	Noise level at boundaries of sites not to exceed 70 dBA.
AIR QUALITY			
Emissions	Emissions of SO_2, NO_2 and particulate emissions for Phase I alone estimated to be less than World Bank guideline maximum No adverse impact.	Emissions of SO_2, NO_2 and particulate emissions for Phase I alone estimated to be less than World II Bank guideline maximum.	Combined emissions of SO_2 and NO_2 from Phase I and Phase II are less than the World Bank criteria.
			SO_2, NO_2, and particulated emissions are less than pre-1990 Pakistan standards but exceed post-1990 standards for NO_2 and particulates.
Ambient Concentrations			Combined concentration of 24-hour and annual SO_2, 24-hour particulate and annual NO_2 are less than EPA and World Bank standards. The annual particulate concentration exceeds the World Bank and EPA standards due to high background.

Table 5-18

COMPARISON OF PHASE I AND PHASE II
ESTIMATED ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

CATEGORY	PHASE I PLAN AND IMPACT	PHASE II PLAN AND IMPACT	CUMULATIVE IMPACT
FUEL OIL PIPELINE			
	No fuel oil pipe for Phase I alone; fuel oil transport by rail via existing rail line and new spur. New railroad construction of little impact. Locomotive exhaust would result in local minor reduction of air quality.	Pipeline to transport fuel oil from Karachi to to the site. Significant net environmental impact.	The fuel oil pipeline is common to Phase I and Phase II. The piping will include seismic criteria to prevent failure of the piping during an earthquake. Leakage from pump shafts, flanges, and valve stems will be contained in the pump and heater stations and oil storage areas to prevent release of fuel oil to the environment. No locomotive use would result in net improvement of air quality for combined I and II over I alone.
CULTURAL RESOURCES			
	Cultural resource protection program not known. However Pakistan regulations require protection of resources, so major damage is not likely if Dept. of Archaeology is consulted during construction and operation.	Chance-find procedures and continued liaison with Dept. of Archaeology recommended. Pre-construction surveys also recommended. No significant impact likely.	Little or no impact to cultural resources likely if existing procedures are followed.
SOCIAL/INSTITUTIONAL CONCERNS:			
Population Increase	Construction: Contractors responsible for housing workers. Potential adverse impact if housing and facilities are inadequate. Coordination by local governments and WAPDA is required to plan for secondary population increases. Operations: WAPDA to provide housing for 1450, plus appropriate facilities including school to 12th grade, 16-bed hospital, mosque, recreation center, shops, playgrounds, and parks. Local governments and WAPDA must plan for secondary population increases. Training: Local training and hire programs planned by WAPDA during operations. No significant sociological problems anticipated.	Construction: Contractors responsible for housing. Potential adverse impact if housing and facilities are inadequate. Local governments and WAPDA must plan for secondary population increases. Operations: WAPDA to provide approximately 60% of housing and related facilities with facilities similar to Phase I. Local governments and WAPDA must plan for secondary population increases. Training: Local training and hire programs planned by WAPDA during operations. No significant sociological problems anticipated.	Effect of operations workers housed in Hyderabad expected to be minimal. Construction worker influx could be disruptive to Jamshoro area if adequate housing and facilities are not provided. A land use plan and clearly designed program to house construction personnel and dependents has been recommended to reduce impacts. Adequate support facilities such as medical, recreational, and educational will relieve effect of increased population. Training and hire of local residents important as well.

Table 5-18

COMPARISON OF PHASE I AND PHASE II
ESTIMATED ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS

CATEGORY	PHASE I PLAN AND IMPACT	PHASE II PLAN AND IMPACT	CUMULATIVE IMPACT
Transportation	Construction: Increased truck and worker commute traffic should contribute noticeably to already heavy traffic between Karachi, Hyderabad, and site. Operations: Relatively light traffic north of Hyderabad to site should not be significantly affected by project. Impact during construction could be noticeable, but of short duration. Little impact during operations.	Construction: Traffic will be further increased over Phase I level. Operations: Traffic north of Hyderabad towards site would be increased, but probably not significantly. Impact during construction more than Phase I alone. Little impact during operations.	A noticeable short-term increase in local traffic will occur during construction. Long-term traffic near site should be modest. In both cases, impacts can be mitigated by staggered work-shifts, busing of workers, and on-site residential community.
Occupational Safety and Health Hazards	acility construction and operations planned o be in accordance with WAPDA policies and rocedures. Impacts to safety and health elieved to be minimal.	As with Phase I, facility construction and operations are planned to be in accordance with WAPDA policies and procedures. In addition, Phase II activities reflect USISHA, and World Bank/USAID/USEPA environmental protection guidelines and standards. No significant impacts to worker health and safety are anticipated.	No significant impacts to worker health and safety are anticipated if WAPDA, World Bank, USAID and other standards and guidelines are followed as planned.

6.0 MONITORING AND MITIGATION

A summary of recommended environmental and socioeconomic monitoring and mitigation is presented in Table 6-1 on page 6-45. Along with specific monitoring programs and mitigation measures, a program is recommended for coordinated management of Phase I and II activities which affect the environment. This overall management program would include standardization of relevant procedures and equipment (such as emergency equipment) for Phases I and II.

6.1 ENVIRONMENT

The potential impacts to the natural and socioeconomic environment of the Jamshoro area resulting from the proposed construction and operation of Phase II of the Jamshoro power generation complex was discussed in the previous section. In this section, methods to reduce eliminate, or compensate for these consequences are presented. Monitoring programs to ensure continued success of these corrective measures are also presented. Subsequently, Section 7 will present costs for the various recommended monitoring and mitigation programs.

6.1.1 VEGETATION

The design basis for Phase II of the Jamshoro power generation complex incorporates many features which mitigate potential impacts on vegetation while at the same time reflecting good engineering

288x

practice. These project design features include minimizing the width of the pipeline right-of-way (ROW), direct routing of pipeline alternatives, using existing infrastructure, careful plant site location, containment of liquid effluents, and erosion control measures.

Acreages of natural vegetation disturbed by the pipeline are reduced through minimizing ROW width and pipeline length, and using existing infrastructure wherever possible. The ROW width is limited to 30 meters, which in turn limits the amount of vegetation disturbed by the fuel oil pipeline. The lengths of the proposed routes of Alternatives I and II have been minimized to the extent possible which also results in minimizing lost acreage. Existing infrastructure (e.g., highways, site access road) is used wherever possible, which prevents the loss of additional acreage of vegetation to construction of new facilities.

The location of the Jamshoro plant also will reduce potential direct impacts on vegetation as a result of construction activities. The proposed site is located in an area of low vegetative diversity and with vegetative cover ranging from 1 to 15 percent. Loss of 70 acres of tropical scrub forest vegetation for Phase II facilities is a minimal impact compared to the potential loss that would be incurred by siting the plant in the extensive stands of acacia and mesquite along dry streambeds to the west of the site, or in the riverain areas to the east along the Indus River which include remnant areas of natural riverain forest.

The workers colony may require as much as 150 acres of land with the same scrub forest vegetation as for the plant itself. Again, this is considered minimal impact considering the extent of this vegetation type in the province. In addition, landscaping of the workers' colony with project irrigation water would offset the loss of natural vegetation.

The extent of impacts of the Phase II facilities to vegetation downwind and at some distance from Jamshoro is minimal. World Bank guidelines and USEPA standards are being met for airborne substances of most concern to local species of natural and cultivated plants. The more stringent USEPA standards have been chosen because of specific consideration of health of children and the elderly. As was discussed in Section 5.1.1, this will minimize any potential damage to specific crops which may occur downwind under particular conditions. Although damage is unlikely owing to the intermittent exposure of plants to relatively modest pollutant levels, on-site monitoring of farmlands should be carried out to assure that vegetation is protected.

The plant design includes the use of curbing around facility components to contain spilled or leaked hazardous materials. For example, each lube oil storage tank area is encircled by a 6-inch curb which encloses the storage tanks, a lube oil transfer pump, a sump, and a drum dispensing area. Use of curbed containment design features minimizes the chance for spilled or leaked toxic materials to contact vegetation in the surrounding area. Tank areas should be inspected at regular

intervals to spot leaks before they become a problem, and enclosed in security fences. Tank layouts are in accordance with API standards.

The design basis for the plant also minimizes potential effects on vegetation at the Jamshoro site through containment of wastewaters in clay- or plastic-lined evaporation ponds. Certain liquid effluents which have been treated will be available for use as irrigation water.

Water from cooling tower blowdown averaging approximately 20.76 million liters per day will be treated to USEPA standards for release to surface waters and made available for irrigation. Sewage treatment effluent (345,040 LPD) and boiler cleaning wastewater (approximately 2 million LPD) will be ponded for evaporation in lined ponds.

Although much of the route traversed by either of the pipeline alternatives is flat or rolling terrain with low erosion potential, some localized areas will have higher erosion potential (e.g., steeper slopes, wash crossings). Where appropriate, the pipeline design will incorporate slope protection on banks to control erosion of ditch backfill during periods when wadis are carrying storm runoff. Erosion control measures also will be employed where appropriate to minimize slope erosion along the ROW. Incorporation of effective erosion control measures will reduce effects on vegetation in surrounding areas.

Spill prevention detection and clean-up procedures should be placed in force by WAPDA. These procedures are well established internationally. The contractor for the pipeline should review current

WAPDA procedures for pipeline safety and clean-up, and propose any changes in existing policy and practice which may be necessary for this specific project. Particular attention should be given to stream bed crossing whereby spilled oil could make its way to the Indus River. Strict adherence to state-of-the-art pipeline construction for crossing of streambeds should be ensured in the design of these crossings.

6.1.2 WILDLIFE

A number of potential impacts on wildlife are mitigated by the design basis for Phase II of the Jamshoro power generation complex. Project design features which avoid or reduce potential impacts on wildlife include: the screened water intake and fish return, the plant site location, routing of the pipeline alternatives, and containment of liquid effluents.

Impacts of the water withdrawal system on fish in the Indus River will be minimized by designing the intake structure to exclude fish. The current design basis provides for an intake of the wet pit type with traveling water screens (Bechtel, 1986). In addition, intake velocities of 0.12 m/sec (0.4 ft/sec) reduce intake sufficiently to minimize entrainment of fishes and fish larvae. Currently, a maximum velocity of one (1) foot-per-second is used as a guideline in the U.S.

The location of the plant site and routing of pipeline alternatives also reduce potential project impacts on wildlife. The proposed plant site is located in an area of relatively low quality wildlife habitat

292

(tropical scrub forest vegetation) which supports a relatively low diversity of wildlife species compared to that of the wetter areas east and west of the Jamshoro site. Clearing of the extensive stands of acacia and mesquite along dry streambeds to the west and the riverain areas to the east along the Indus River (including remaining areas of natural riverain forest) is avoided by locating the plant site as proposed in this semi-arid habitat. The plant location also minimizes potential effects on species considered to be endangered or vulnerable by the governments of Pakistan and the United States.

The effect of habitat removal by the workers' colony is estimated to be minimal, again owing both to the great extent of vegetation of this type in this region of the province, and to its minimal value as habitat. No formal surveys of the region have been made. Although it is possible that the threatened and endangered desert monitor and chinkara may be found in this area it is considered unlikely. A site survey, probably on a seasonal basis, could reduce these concerns, and has been recommended.

The facility has been designed to minimize off-site impacts through adherence to World Bank guidelines and USEPA standards for air emissions. Owing to the high natural background levels of suspended particulates in this portion of Sind, the modest increase of particulate matter from the Complex (<1%) is not believed to pose a threat to local wildlife.

Evaporation ponds can be an attractive nuisance for water birds. It is recommended that their use by birds be monitored to determine if exclosure netting is necessary. Also, the ponds should be securely fenced to prevent access by animals and people. Warning signs should be clearly posted to further deter human consumption.

Proposed routing of the pipeline alternatives also reduces potential impacts on wildlife by paralleling existing ROWs for most of either route. Some disturbance and adjustment of wildlife populations along these existing ROWs has occurred previously. Routing the fuel oil pipeline parallel and in close proximity to an existing ROW avoids disturbance and displacement of wildlife populations in a less accessible, currently undisturbed area. Neither alternative route crosses the Indus River which greatly reduces the chance of an oil spill reaching the Indus and affecting aquatic biota.

The use of curbing around facility components minimizes the chance for spilled or leaked toxic or hazardous materials to contact wildlife in the surrounding area. The design for the plant also minimizes potential effects on wildlife through the containment of wastewaters in clay-lined evaporation ponds.

Although much of the route traversed by either of the pipeline alternatives is flat or rolling terrain with low erosion potential, some localized areas will have higher erosion potential (e.g., steeper slopes, wash crossings). Where appropriate, the pipeline design will

294

incorporate slope protection on banks to control erosion of ditch backfill during periods when wadis are carrying storm runoff. Erosion control measures also will be employed where appropriate to minimize slope erosion along the ROW. These measures will minimize siltation of waterbodies into which stormwater runoff discharges and resultant effects on aquatic wildlife.

6.1.3 WATER RESOURCES

6.1.3.1 Monitoring

No return discharge to the Indus from Phase II operations is planned, and thus no Indus monitoring is recommended. As an integral part of the project operations, key wastewater streams and effluent from Phase II will be monitored. The monitoring program will consist of data sampling, data analysis, laboratory analysis,and training of staff. The monitoring will ensure efficient plant operation and would further verify the quality of water released from the project for irrigation purposes.

It is further recommended that ground water monitoring wells be placed to verify the integrity of the lined evaporation ponds. Local ground water, although reportedly brackish and of little domestic or agricultural use, if contaminated could eventually affect the quality of Indus River water. The responsibility for monitoring would be that of WAPDA and, or the local health organization. If contamination

likely to be associated with ponded effluents was detected, inspection and repair of pond lining might be necessary.

6.1.3.2 Mitigation

Plant Wastewater Management

The plant wastewater management system is designed to produce an effluent either suitable for release as agricultural irrigation wate or for ponding and evaporation. Thus, water will not be returned directly to the Indus River. Irrigation water will meet the United States Environmental Protection Agency (USEPA) effluent limitations for new electric power plants, USEPA 40 CFR 433.

All wastewater streams except those generated from the metal cleaning operations and the cooling tower blowdown will first be stored in a retention basin. The effluent from the retention basin after passing through the pH adjustment tank will then be treated to USEPA standards and then be transferred through a site drainage pipe to a holding pond for eventual release to irrigation canals. The effluent of the cooling tower blowdown and a portion of the steam generator blowdown, will also be treated for irrigation. The effluent streams of the metal cleaning operations - air preheater washdown drains, boiler drain header, boiler washdown drain - will be directed to a precipitation-evaporation pond, after lime treatment in a boiler drains storage tank.

976

Chemicals will be introduced to the circulating cooling tower water for a number of purposes. These chemical additives will be for pH adjustment, biofouling control to inhibit corrosion, and to control scale formation ($CaCO_3$ precipitation). The chemicals will be limited to those receiving prior approval by the Pakistan regulatory agencies. Generally, they will be drawn from a list of chemicals approved by internationally recognized authorities on environmental safety of these types of materials, such as the USEPA.

The retention basin will provide a common collection point for the various waste streams, equalization of the intermittent waste flows, passive homogenization of the various waste qualities, and an open area for further surface oil skimming.

The effluent streams directed to the retention basin are as follows. The demineralized water makeup system low TDS waste will be pumped from the low TDS waste sump directly to the retention basin, the effluents from the condensate polisher sump and the high TDS waste sump will be led to the retention basin after passing through a neutralization tank. The effluents from the turbine area sump and the boiler area sump will be directed to the retention basin after they are passed through an oil/water separator.

The turbine area sump will collect waste streams from the condenser pit sump, condenser waterbox drains, lubricating oil equipment and floor drains, and the turbine area equipment and floor drains. The boiler

area sump will collect waste streams from the boiler pit sump, air preheater drains, and boiler area floor and equipment drains. The condensate polisher sump will collect waste streams from the condensate polisher system, condensate polisher regeneration system, chemical control system drains, and the chemical storage area drains. The high TDS waste sump will collect waste streams from the water treatment area floor drains, chemical mix and day tank trains, and the demineralized water makeup system.

The pH of the water in the pH adjustment tanks will be continuously monitored prior to the release of the effluent into the site drainage pipe. The precipitation-evaporation pond will be provided with an impervious lining to prevent seepage of wastewater.

In summary, the following chemicals will be used in plant operations:

- o River water and wastewater treatment
  - Alum, ferric chloride or ferric sulfate
  - Polylectrolyte
  - Sodium hypochlorite

- o Make-up demineralizer and condensate polisher
  - Sulfuric acid
  - Sodium hydroxide

298

Feedwater treatment

- Ammonium hydroxide
- Hydrazine
- Trisodium phosphate

Circulating water treatment

- Sodium hypochlorite
- Sulfuric acid

A variety of chemicals are used in the chemical laboratory for testing water, solid waste and fuels.

All chemicals are stored and used in areas where they can be reclaimed and treated in the event of an accidental spill. A limestone-filled pit will be provided under the acid storage tank to neutralize potentially large spills in the event of tank rupture.

The floor area surrounding the demineralizer trains will be curbed to contain spills, and each train will be provided with an acid-resistant brick-lined trench to transport spills and regeneration wastes to the wastewater treatment system for neutralization.

Although not specified explicitly in the design criteria, in compliance with the USAID guidelines, all facilities will be located above the 100-year flood plain elevation Likewise, the retention basin and the evaporation pond will be designed to accommodate all stormwater with

sufficient freeboard, approximately 3 feet (1 meter) to prevent overtopping.

River Water Intake

It is recommended that WAPDA assure that development of the Phase I and Phase II intake facilities be coordinated, not only to avoid unnecessary duplication of effort and equipment, but to reduce by use of a single screened intake, environmental impact at the Indus.

Sanitary Wastewater Management

A sewage collection system and a sewage treatment plant will be built to handle the sanitary wastewater from the plant and the workers colony. Sanitary waste stream constituents of environmental concern include decomposable organics, suspended solids, plant nutrients, and pathogenic organisms. Although the detailed design of the system has not been completed at this time, the waste stream will receive secondary treatment followed by chlorination. Sanitary effluent from the plant may be recycled; the final disposal of the effluent will be to lined evaporation ponds. It will not be made available for irrigation water unless higher level of treatment is warranted in the future.

Stormwater Management

Two main divisions of drainage are considered. They are (1) surface drainage of runoff water from undeveloped areas, pavements and roofs, and (2) surface drainage of runoff water from developed areas with potential for contamination by pollutants such as oil and chemicals.

Surface Drainage of Undeveloped Areas

The design criteria for the drainage system are based on the flow generated from each runoff source by a 10-year storm. The water runoff generated is conveyed by open ditches and culverts to the raw water retention basin to remove suspended solids and this is discharged via an overflow structure to existing surface drainage.

Surface Drainage of Developed Areas

The major runoff sources in this category are the fuel oil pump areas and the plant equipment drainage area. The water runoff generated by the design storm is conveyed by perimeter ditches to collection basins and/or pumps that serve also for oil removal and settling to remove suspended solids from the runoff. The effluent is pumped to the raw water retention basin and discharged to existing surface drainage.

Solid Waste Management

A recommended solid waste management plan is presented in Appendix G. A plan similar to this should be formulated and initiated by WAPDA to minimize the potential for contamination of surface waters and groundwater. It is critical that Phase I and Phase II solid waste handling be coordinated within this complex.

Hazardous and Toxic Waste Management

It is recommended that plans for the handling of accidental, uncontrolled discharge of hazardous or toxic substances used in the plant be developed before construction and operation of the Jamshoro Complex. Substances of concern include lubricating oil, fuel oil, gasoline, chlorination chemicals, caustics, acids, solvents, chemicals for control of health and disease vectors, and pesticides. Control measures need to be formulated to minimize the potential for contamination of water resources. This is the responsibility of WAPDA, although it could be prepared by a contractor as part of development for the Phase II facilities. Hazardous and toxic waste management plans for both Phases I and II should be fully integrated and administered centrally.

Uncontrolled release of hazardous or toxic substances is prevented by containment measures such as curbing, retention walls, retention basins and specially designed storage and handling areas.

Emergency Planning

WAPDA should be certain that an effective Emergency Oil Spill Cleanup Plan is in place before construction and operation begin at Jamshoro, along the pipeline and at the Port of Karachi. If such plan does not exist within WAPDA or the Port,

WAPDA can have a suitable program prepared under contract, possibly by the firm designing and constructing the Phase II power generation and oil supply facilities. This plan should be integrated with Phase I activities to ensure that equipment used and procedures followed are standardized throughout the complex.

Health and Safety

WAPDA should also ensure that a suitable Health and Safety Plan is prepared for both construction and operation of Phase II, again integrated with Phase I operations. Existing WAPDA plans can be adapted, or a new plan prepared. Port of Karachi health and safety procedures should be reviewed for adequacy.

Erosion and Sediment Control Measures

During the project construction, control measures will be employed to minimize soil erosion and to avoid release of sediment rich stormwater runoff into surface waters, primarily the Indus River. By proper

scheduling of the construction activities, the smallest possible exposed area will be left unstabilized for the shortest duration of time to avoid excessive soil erosion. Mulching, as a temporary measure, followed by natural re-vegetation should be used to stabilize exposed critical areas to reduce erosion rates.

Temporary structural measures such as diversion dikes, interceptor dikes will be used to isolate exposed construction sites. Sediment traps or sediment basins will be used to contain stormwater runoff, thus reducing sediment transport into the surface waters downstream.

Pipeline Route

Both of the routes for the pipeline cross several streams and dry wadis of large widths. Along the Alternative I route, the major crossings (over 200 meters wide) are at Ghagr Nala, Lat Nala, Ran Pethani, Kalu Nadi and Baran Nadi; and the minor crossings are at Khal Pani, Mulla Nadi, Chakri Nadi, and Rod Nadi. Along the Alternative II route, Baran Nadi is a major crossing; the minor crossings are at Kuni Nadi, Ajigar Nadi, Koras Nadi, Mera Nadi, and Choriko Nadi.

Soil conditions along both routes are fine grain silts and clay with subsurface conglomerate in some areas extending down to pipeline depth. Surface indications are that the conglomerate is weak and stratified and if these conditions exist below the surface, this type of rock should be rippable and would not present a problem to a properly equipped pipeline contractor.

There does not appear to be groundwater near the surface along the Alternative II route (Super Highway). Along the Alternative I route (Sui Gas), there are several surface indications of groundwater. Some are in the form of salt bogs and the others are shallow pools of standing water in some wadis. These wet areas may require weights to anchor the pipeline in the ditch.

Without the benefit of a more detailed route investigation, the areas requiring special construction techniques are difficult to define. Based on the information available, it would appear that the large wadis and the Baran River would be the main areas of special construction. If these areas can be crossed during the dry part of the year, much of the difficulty of these crossings would be removed. The wadi crossings would have concrete weight coating or river weights spaced as required to maintain negative buoyancy when the pipeline is empty. Slope protection may be required on the banks to control erosion of the ditch backfill during periods when the wadis are carrying storm runoff. In addition, the pipeline will be buried below the maximum storm depth expected during the design flood conditions to ensure that the pipeline would not be exposed, leading to subsequent damage and oil spills.

The most conservative construction and inspection techniques do not guarantee that a pipe break will never occur. Nor can malicious action be prevented with complete certainty. The fact that most of these wadis terminate at the Indus River makes it imperative that spill

prevention, detection, and clean-up procedures be prepared in advance of transfer of oil through the pipeline. These procedures should be an element of either the Hazardous and Toxic Waste Management or the Emergency Planning documents, prepared by WAPDA or its contractor.

6.1.4 AIR QUALITY

The Jamshoro Phase II facilities have been designed to reduce air pollution emissions generally below levels which are considered harmful to humans by the World Bank and the USEPA. To ensure that these ground level concentration standards are met, WAPDA should establish continuous monitoring stations at points projected by air quality modeling to have the highest pollution levels during the summer and winter prevailing winds. In addition, sensitive receptors such as hospitals and prime agricultural areas should be considered for continuous monitoring programs as well.

In the event that design criteria limits of ground level concentrations or stack emissions are exceeded, WAPDA has several optional measures available to them. These could include actions, e.g., reducing power output temporarily, changing fuel to a reduced sulfur content, or the addition of pollution control equipment.

A stack gas monitoring program should also be developed to assure that air pollutant emissions from the power plant stack also comply with the World Bank guidelines and World Health Organization criteria. This monitoring is performed and results displayed continuously.

The proposed air quality monitoring program is summarized in Table 6-2. The air pollutants being measured will include SO_2, NO, NO_x, O_3 and particulate matter (PM). Measurements of SO_2, NO, NO_x and O_3 would be continuous. Sampling of PM will be for 24-h average periods. Precise site locations would be selected in the field, and would consider security, terrain, and accessibility, power availability, proximity to maximum impact areas and sensitive areas.

Meteorological monitoring should cover the entire spectrum of data required for air quality modeling. Such data include wind speed and direction near the surface and aloft at stack exit elevation, ambient temperature and relative humidity, atmospheric stability and mixing height. A meteorological tower near the plant site would provide wind speed and direction at 3 levels, temperature at 2 levels and dew point temperature at 1 level. Relative humidity can be deduced from temperature and dew point temperature. Atmospheric stability would be deduced from the vertical temperature gradient and measure of horizontal turbulence (sigma theta). Mixing height would be monitored continuously by an acoustic sounder.

A quality assurance program would be carried out to assess the reliability, accuracy and precision of the collected data. Annual reports summarizing the ambient air quality, meteorological and air pollutant emission monitoring program results should be prepared. Air quality modeling should also be carried out to assure that the air quality, meteorological and pollutant emission measurements are

Table 6-2

Proposed Air Quality Monitoring Programs

Type of Monitoring	Parameters Measured	Frequency of Measurement	Number of Monitoring Stations	Location of Monitoring Stations
Ambient air quality	SO_2 NO, NO_x O_3 PM	Continuous Continuous Continuous 24-h avg.	3	1 near Petaro 1 near Liaqat Hospital and Sind University 1 near Hyderabad 1 north of Hyderabad in sensitive agricultural area
Meteorology	Wind speed and direction, at 3 levels, temperature at two levels, sigma theta and dew point temperature at one level, mixing height	Continuous	1	near plant site
Stack gas monitoring	SO_2, NO_2, PM	Continuous	1/unit	

308

consistent and that the design of the monitoring network is appropriate to determine the air quality impacts of the power plant.

Based on the air quality analysis presented in Section 5.1.5, it appears unlikely that there would be any significant adverse environmental impacts due to air pollutant emissions from the Jamshoro project. However, if unacceptable impacts were to occur, appropriate mitigation measures focusing on management and operation techniques will be employed by WAPDA in consultation with government agencies.

6.1.5 NOISE

6.1.5.1 Construction

The Phase II facilities are designed to meet World Bank guidelines for noise control, as well as U.S. Occupational Safety and Health Administration (OSHA) guidelines for worker safety. Furthermore, most of the construction activity will occur during daylight hours reducing the potential for interfering with sleep. The mitigating measures which will be implemented include:

- Ensure that all engines are properly equipped with mufflers
- Limit higher noise operations to daytime hours
- Equip stationary equipment with enclosures and silencers

Limit construction equipment to those which meet the European Economic Community 80 dBA limit.

6.1.5.2 Operation

In order to limit noise impact to the workers' colony, the following mitigating measures will be implemented:

- Design forced draft fans with intake silencers
- Acoustically lag the recirculation fan breeching and ducts
- Limit cooling tower fan blade tip speeds to less than 10,000 fpm
- Equip the electromatic steam vent with a silencer
- Set design limits on noise from rotating equipment, control valves and transformers

  Large rotating equipment such as pumps, motors, and turbines will be located in buildings

The ISO recommendation estimates the response from the community by comparing the intruding noise with the appropriate criterion value. If the intruding sound exceeds the criterion value, a response from the

310x

community is likely. An estimate of the public reaction which may be normally is expected is presented in Table 4-12.

The World Bank has adopted the recommendation of the USEPA for protecting the public personal comfort and well-being as well as from noise induced hearing damage (USEPA, 1974; The World Bank, 1983). These limitations are L_{dn} = 55 dBA for residential areas including hospitals and schools, and $L_{eq}(24)$ = 70 dBA for commercial, industrial, farmland and unpopulated areas. These USEPA recommended noise limitations will be used as guidelines for project design.

6.2 SOCIAL AND INSTITUTIONAL CONSIDERATIONS

This section presents recommendations for a strategy to enhance the benefits and reduce the social costs of the project. The recommendations discussed here include:

Development and implementation of adequate land use plans and controls for secondary development

A public information program to communicate project information to the local population and to local officials and landowners

A program to hire locally and to train the local workforce for project jobs

Provision of adequate community services and infrastructure to service anticipated population growth during construction and operation

Safe, sanitary housing and facilities for workers during construction, and workers' colony during operation for employees and their dependents

Road improvements, busing of workers, staggered workshifts, truck convoys for night travel, and implementation of good driving and vehicle maintenance practices

Implementation of archaeological chance find procedures

A program for overall management and scheduling for Phases I and II

These recommendations are discussed below.

6.2.1 ADEQUATE LAND USE PLANNING

Adequate land use planning is essential for secondary growth related to project development. The Government of Pakistan and the Government of Sind should ensure that land use plans have been developed and are in place before project development, and that plans are implemented by local governments in order to prevent uncontrolled growth. The

312

preferred location of business and residential development resulting from secondary growth should be determined before project construction begins

6.2.2 PUBLIC INFORMATION PROGRAM

A publ information program should be established to communicate project information to the local population. Community resistance is a common risk encountered by any industry seeking to site a facility. Without community acceptance, construction and operation can be delayed or prevented.

The attitude of the Sindhis will have a significant effect on the successful construction and operation of the project. If the local population does not perceive that the project is benefiting them, a lack of local cooperation, or even active resistance, could result in project delays. In order to establish good relations with the people in the Hyderabad and Jamshoro area, and to establish a positive public perception of the project, a public information program should be established early in the planning phase.

The goal of the public information program will be to convey information on the benefits of the project, such as the provision of electricity and increased economic activity including employment; and the potential adverse impacts of the project, such as economic recession at the end of construction and operation. The communication

program would include one specialist in mass communications to develop and direct the program, and at least one local person who has been trained in public communication and is fluent in Sindhi, to help implement the program. The program would include:

Identifying within WAPDA an easily accessible source of accurate and timely project information, to avoid problems resulting from lack of information, or from incorrect or conflicting information.

Identifying community leaders, including village, union, district, and provincial representations, as well as group and individuals, who are concerned about the project, or w may be affected by the project.

Surveying possible methods of communicating with groups and individuals, both educated and uneducated, and determining those most appropriate. Methods will include presentations at public meetings, such as those held after Friday afternoon prayers, and use of the local radio and newspapers. Care will be taken to use suitable terminology and language for the intended audience.

Developing a schedule for meetings and presentations

Developing a program to maintain contact with the public and the media, and to anticipate and respond to questions.

6.2.3 PROGRAM FOR HIRING AND TRAINING LOCAL WORKFORCE

A program to train and hire the local labor force will create a positive climate for the project. It is WAPDA policy to hire locally for positions up to Grade 16. Qualified local Sindhis will be hired whenever possible to encourage good community relations. The utilization of the local labor force will also mean increased economic growth for the project area, and a reduction in impacts associated with the influx of workers from outside the area. As discussed in Section 5.3.1, both skilled and unskilled labor are available in the project area. Training programs will further enhance the skills of the local labor pool, and ensure that workers have the necessary expertise to perform effectively.

The objectives of training programs will be: (1) to develop and expand a program for local employees in specific craft, supervisory, and management occupational skills, utilizing resources available in the project's geographic area, (2) to educate employees to become training supervisors, (3) to enhance the region's economic climate, and (4) to establish a permanent endemic construction workforce of proven technical excellence.

The following steps will be taken to implement the training program:

Survey and evaluate local resources (technical schools and training centers, instructors, curricula, training aids, teaching materials)

Identify areas where additional resources and training are required

Select and train local instructors

Develop recruitment, screening and testing procedures

Design culturally oriented classroom and on-the-job curricula utilizing a program guide tailored to meet the individual participant's needs based upon the levels of responsibility and disciplines which will be required.

Programs will also be established at local technical training schools in the Hyderabad and Dadu Districts, and at engineering universities in the area, such as Mehran Engineering University. In addition, WAPDA currently has a working relationship with the Electric Generating Authority of Thailand in Bangkok, which provides training programs for power plant employees.

Training programs must begin early in the project so that local workers have the necessary expertise to fill construction and operation workforce requirements.

6.2.4 PROVISIONS OF ADEQUATE COMMUNITY SERVICES AND INFRASTRUCTURE

Deficiencies in the supply of housing and community services can degrade the quality of life. This can lead to increase in worker

316

turnover and delays in construction schedules, thereby adding substantially to project costs. Unless growth is managed in a coordinated program, economic opportunities evaporate, and the social costs may exceed the benefits of a proposed project.

The Government of Sind and Dadu and Hyderabad District Governments should coordinate with WAPDA to discuss projected increases in population and to review the types of demands for infrastructure ar public services. This process should include determining financial responsibility for the provision of services, and the preparation of a plan for the timely development of the infrastructure and provision of services. The plan should include budget estimates for capital costs, operation and maintenance costs, and personnel costs. The construction contractor can assist WAPDA in this effort.

6.2.5 ADEQUATE HOUSING FOR CONSTRUCTION WORKERS AND PROVISION OF A WORKER'S COLONY DURING OPERATION

During construction, contractors should provide safe, sanitary living conditions for their employees. The provision of adequate housing and facilities for workers should be a contract requirement for contractors selected for construction.

During operation, a workers' colony will provide housing and community services for workers and their dependents. A workers' colony will reduce the likelihood of a squatters' settlement near the site (which

should be discouraged), and will reduce secondary population associated with the project by reducing the need for services in the project area. The colony will include amenities, such as recreation facilities, to maintain worker morale, and to reduce worker turnover.

WAPDA is currently supporting a program whereby housing for construction workers will be provided jointly by construction contractors and the private sector, and for operation workers by a WAPDA colony and local private effort. This is likely to be successful only with close coordination between the project and local development interests and authorities. It is estimated that an influx of 4,000 to 7,000 people will be associated with Phases I and II. Opinions on the availability of adequate local housing for outside workers ranged from plentiful to virtually non-existent. Given the importance of housing to project workers, the reliability of local private facilities should be verified soon if WAPDA intends to rely on this resource. It is recommended that WAPDA consider 100 percent worker housing unless plentiful accommodations, supporting and transportation facilities can be provided.

Housing should be comparable and adequate for workers of both Phase I and Phase II.

6.2.6 TRANSPORTATION IMPACT MITIGATION MEASURES

A number of mitigation measures may be employed to lessen the expected traffic-related impacts. Potential mitigation measures include:

offset work schedules to reduce traffic peaks, use of buses to transport workers, use of truck convoys at night, development of a proper intersection at the entrance to the site on the Indus Highway, driver training, and good driving and vehicle inspection and maintenance practices.

Traffic congestion related to transportation of workers (both Phase I and Phase II) to and from the Jamshoro site may be reduced by implementation of staggered workshifts. Staggering of reporting and quitting times may reduce the number of vehicles concurrently using local roads, and in particular, the intersection of the Indus Highway and the site access road at peak traffic hours. Concomitantly, the length of traffic delays at the intersection should decrease. The overall site manager would be responsible to reconciling changing schedules and workforces of overlapping construction and operational activities for the total of 7 units to be developed as part of Phases I and II.

The development of an onsite residential colony for Phase II operational workers similar to that planned for Phase I, will reduce transportation impacts. Although local-hires may commute from existing personal residences, workers hired outside the area may reside onsite in the residential colony. This would reduce the number of vehicles commuting to and from the site daily, and result in less traffic in the area and fewer delays at the intersection of the Indus Highway and the site access road. The number of vehicles transporting workers who live

in the surrounding area to and from the site each day could be further reduced by using buses.

Transportation of equipment and materials by truck convoys at night could be employed to alleviate project-related congestion and delays on the Indus or National Super Highway. Although the existing highways are capable of accommodating increased traffic volumes resulting from material transport, this measure could be considered to avoid adding to existing daytime traffic volumes.

Potential delays at the intersection of the Indus Highway and the site access road could be alleviated by development of a proper intersection. Such improvements could include creating turn lanes, widening the highway in this area, constructing a pedestrian bridge, o constructing an overpass to avert traffic congestion from the intersection.

Implementation of good driving and vehicle maintenance practices may also reduce transportation impacts. It is recommended that WAPDA require a vehicle inspection program for individuals or companies contracted to deliver materials and equipment to the site. Implementation of safe driving practices should be made a contract requirement of the contractor selected for transportation of project-related materials.

Ongoing improvements to the National Super Highway and planned improvements to the Indus Highway also may ameliorate transportation impacts. For example, widening the Indus Highway to a full width could reduce the potential for accidents.

6.2.7 CHANCE FIND PROCEDURES FOR CULTURAL RESOURCES

If chance finds are encountered at the plant site or along the pipeline route, Pakistan law requires notification of the Director of Archaeology within seven days. Failure to do so can result in imprisonment for up to three years and/or fines. A detailed discussion of archaeological chance find procedures are presented in Appendix J.

Because no preconstruction surveys have been conducted and the area has a high probability for containing archaeological remains; incidental discoveries of antiquities are likely particularly along the pipeline routes. These antiquities include, but are not limited to, flaked stone tools, ground stone tools, pottery, modified bone, and structural remains. To avoid unnecessary project delays and possible legal actions, the following procedures are recommended:

> Prior to ground disturbance at the site or along the pipeline, the Pakistan Department of Archaeology will be informed of this procedure and invited to comment on it.

A supervisory field representative for the contractor will be designated. This individual is responsible for ensuring compliance with this procedure. He may, if necessary, delegate responsibility for compliance to subordinates.

The contractor's field representative will establish a contact individual within the Department of Archaeology. This Department archaeologist will be called when antiquities are encountered.

The contractor's field representative and other responsible personnel will meet with the Department's representative for information exchange to include:

- Nature and extent of the proposed ground disturbing activity

- Instruction on cultural resource (antiquity) identification

Project personnel shall be instructed in cultural resource identification and reporting procedures at the job site and pipeline by a Department archaeologist. They will also be informed of the penalties for violation of antiquities laws.

- When antiquities are encountered the work will cease in the immediate area of the find and the contractor's field representative will be informed immediately. Work will not resume until permission to proceed is received from the Department through the field representative.

- The Department archaeologist will be informed of the find as soon as possible, but within seven days under all circumstances.

- If the Department determines that excavations are necessary to recover or protect the artifacts, then provisions for this work must be made and facilitated, if possible.

It is recommended that the Department of Archaeology conduct field surveys prior to construction and have an archaeologist present during major earth-moving operations or in particularly sensitive areas. These measures could avoid much of the down time that would be encountered following chance find procedures alone.

6.2.8 PROGRAM FOR COORDINATED MANAGEMENT OF ENVIRONMENTAL AND SOCIOECONOMIC ACTIVITIES OF PHASE I AND PHASE II

In accordance with scope of work for this contract, this report has concentrated on environmental and socioeconomic concerns of Phase II of the Jamshoro Project. In practice, however, it will be essential that

environmental protection measures for both phases at Jamshoro be integrated in a single program, managed by a single office. If separate programs are designed and administered for each of Phase Phase II, it will be much more difficult and expensive to implemer comprehensive complex-wide program of environmental protection anc scoioeconomic benefit.

Benefits resulting from coordinated activities of two phases are myriad. Responsibilities of the Jamshoro Complex environmental coordination office would include:

- Standardization of emergency plans and training of personnel
- Standardization of personnel work practices (breaks, holidays, work habits, behavior)
- Standardization and centralization of equipment (e.g. fire-fighting, safety, inspection, and monitoring)
- Standardization and centralization of data collection, analysis and preparation of statistics
- Minimized number of administrative personnel and facilities
- Complex-wide authority and responsibility for protection and correction activities

Objectivity in identifying problem areas in activities of Phase I, Phase II, or both

6.3 ECONOMIC CONSIDERATIONS

Recommended economic mitigation measures include:

A program to hire locally and to train the local workforce for project jobs

A program for overall management of Phases I and II of the Jamshoro Complex in order to optimize workforce requirements

Planning for economic recession at the end of construction

The establishment of a program to hire locally and to train the local workforce is discussed in Section 6.2, and a program for overall management of Phases I and II is also discussed in that section. These two measures will mitigate economic as well as social impacts. Planning for a recession in the economy at the end of construction, and generation pay allowances for power plant workers are discussed below.

6.3.1 PLANNING FOR LOCAL ECONOMIC RECESSION

A recession in the local economy will occur at the end of construction due to a reduction in work force requirements and a decline in the need for secondary support services. Representatives of the parties

responsible for the design and implementation of the Project should meet with the Government of Sind, and Dadu and Hyderabad District Governments to discuss the impacts and timing of the decline in project work force requirements. This process should include the preparation of a plan to address this issue.

6.4 PUBLIC HEALTH AND OCCUPATIONAL SAFETY

No significant changes to the health of project workers and colony residents are anticipated as a result of the air or water emissions at the Jamshoro power facility. This will be achieved through use of a facility design which minimizes impacts to worker health and safety as described in Section 5.4, implementation of an accident prevention program, monitoring of potential health hazards, and implementation of appropriate mitigation measures.

Potential health-related impacts resulting from exposure to solid waste that may be of a hazardous nature will be mitigated through the proper handling and disposal of such wastes. Wastes will be recycled when feasible, reused, or containerized and packaged for disposal to prevent uncontrolled exposure to the environment. All efforts will be employed to ensure that non-reuseable wastes are disposed in such a manner as to prevent contamination with the surface and groundwater.

Fence and warning signs identifying the potential danger of transmission lines and towers will be placed in areas around the

386

transmission cables. In addition, high voltage towers will be grounded to reduce accidental shocking.

To minimize the potential impacts to worker health and safety where engineered controls are inadequate or not feasible, both during construction and operation, a comprehensive worker accident prevention program will be developed. Formal procedures which detail the methods to be used for the safe completion of both routine and non-routine operating and maintenance activities are necessary. The program must also be designed to educate workers regarding plant hazards and the methods to be employed to control them. The health and safety program must address issues such as:

- o Provision and use of personal protective devices

  - Footwear, respirators, protective eyewear, and coveralls for boiler cleaning or other hazardous maintenance activities

  - Issue and use of hearing protection devices in hazardous noise areas where noise levels equal or exceed 90 dBA

- Provision of emergency equipment such as eyewashers, showers, and escape equipment

Establishment of procedures regarding confined spaces which address - breathing apparatus, detection of explosive hazards, ventilation, use of low voltage equipment, and entry and rescue procedures

Establishment of procedures for deenergizing equipment prior to maintenance, or for working on energized equipment

Establishment of an effective employee health and safety training program

Establishment of a clinic with a well-qualified nurse

The establishment of good housekeeping practices

Routine monitoring of health hazards will be required for a number of chemical and physical hazards. The agents to be monitored included toxic gases arising from the combustion process, heat stress in high temperature areas, noise at high noise work stations, and toxic and nuisance dusts particularly associated with the coal-fired option. In addition to the routine monitoring, special monitoring will be require for maintenance activities or other non-routine operations.

Routine monitoring of combustion gases such as nitrogen oxides, carbon monoxide, and sulphur dioxide will be necessary in the boiler facility areas. Normal operations should not create concentrations of combustion gases in excess of recognized acceptable levels. Monitoring

328x

results which show increases in toxic combustion gas levels are indicative of improper servicing and maintenance, deterioration of seals, or failure of control equipment. Mitigation would involve servicing or replacing equipment, or installation of additional control equipment. If measured exposure levels exceed healthful concentrations, workers will be required to wear respirators as a temporary protective measure until other appropriate mitigation measures can be implemented.

The monitoring of heat stress will be necessary when work is perf(in high temperature areas of the facility. Heat stress will be of particular concern when ambient temperatures and humidity are high. Mitigation measures which can be employed when heat stress measurements indicate excessive heat loads include controlling the work-rest regimen, provision of cool resting areas, installation of radiant heat barriers, and increased air flow.

Although routine workstation locations should not have noise exposures which exceed 90 dBA on a 8-hour time-weighted-average basis, workstations or job activities with the potential for high noise exposures will be monitored to determine acceptability. At work stations where acceptable noise levels are exceeded, a variety of mitigation options may be employed. Mitigation includes modification of equipment to reduce noise generation and enclosure of equipment or workstation with acoustic attenuation material to reduce noise transmission. In the case of non-routine exposures to high noise

levels, mitigation involves the use of personal hearing protectors or control of the length of employee exposures.

Routine operations in a thermal power plant do not normally present the potential for excessive exposures to dusts. However, where the potential for high dust exposures exist they should be monitored. Nusiance dust exposures should be maintained below 10 mg/m^3. More toxic dusts such as free silica associated with coal dust ash, or vanadium oxides associated with fuel oil ash which may be encountered by workers during boiler cleaning operations should be maintained at recognized acceptable levels, for instance according to US OSHA guidelines. Where monitoring results indicate the exceedence of these levels, mitigation options include use of a wet process to reduce dust generation, use of local exhaust ventilation or dust collection equipment, and use of respirators.

The handling and use of hazardous materials can often create a health hazard. Employees who are involved in activities associated with these compounds will receive instruction and training on the correct procedures associated with their use. Included in this training will be the proper use of protective equipment and clothing as well as use of emergency equipment, health-related information on the hazard of the material, emergency first aid treatment and spill contingency

330X

Health of regional residents away from the Jamshoro site is protected by World Bank guidelines and USEPA standards to which the plant is designed. In addition, it is recommended that pollutant monitoring stations be placed at locations likely to receive the highest ground-level concentrations, or which could be sensitive even to levels within these guidelines and standards. Consequently, if predicted levels are exceeded, or if receptors appear particularly sensitive, the cause can more easily be identified, and correction actions taken.

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Vegetation and Wildlife:				
Reduce land disturbed by site preparation and pipeline	Disturbance of land, removal from use; erosion.	MINIMIZE AREA DISTURBED, RE-CONTOUR, REVEGETATE. SELECT PIPELINE ALTERNATIVE WITH LEAST POTENTIAL IMPACT.	C.	WAPDA
Pipeline Spill Prevention and Safety Program	Oil spills.	Spill prevention plan; design proper maintenance; leak detection and alarms; clean up equipment; personnel training.	A.	WAPDA, with assistance by MH (site), Port of Karachi.
Hazardous Substances Spill Protection Plan	Environmental damage from uncontrolled spills. Safety and Health.	Prepare hazardous substances control and clean-up plan. PROVIDE CONTAINMENT BERMS WHERE APPROPRIATE.	A.	WAPDA, with assistance from MH, PEPA[3]
Location and design of plant	Damage to sensitive plants, animals, and habitats.	LOCATE PLANT IN AREA OF LOW ENVIRONMENTAL SENSITIVITY. DESIGN PLANT TO INTERNATIONAL STANDARDS.	B.	WAPDA, with verification by PEPA[3], MH and using AAQS
Environmental Monitoring Program	Detection of potentially hazardous emissions of environmental impacts.	INITIATE POLLUTANT MONITORING PROGRAM	A.	WAPDA, with assistance from PEPA[3], PCSIR, MH, local universities and hospitals.
Compensation for vegetation and habitat unavoidably lost	Unavoidable construction damage to vegetation or habitat of ecological importance.	PROVIDE IRRIGATION WATER FOR AGRICULTURE AND LANDSCAPING.	B.	WAPDA, with cooperation of PEPA[3]
Avoidance of contaminated surface or ground waters "Zero Discharge" to Indus River	Degradation of surface and ground waters and reduction of beneficial uses.	EVAPORATION OF CERTAIN HAZARDOUS LIQUIDS IN LINED PONDS.	A.	WAPDA, in consultation with GSP
		TREATMENT OF WATER SUITABLE FOR AGRICULTURE. Primary treatment sewage to evaporation ponds.	B.	WAPDA, with cooperation by MH, PEPA[3]

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Table 6-1

mmary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	:iority	Implementation Organization
Screened river water intake	Entrainment and kills of fish and larvae.	PROVIDE TRAVELING SCREENS WITH FISH RETURN SYSTEM.	B.	WAPDA
Reduced intake velocities	High intake velocities can draw fish in intake, and impinge on travelling screens.	Intake velocities of 1 foot/sec allows escape of most species.	B.	WAPDA
Faunal survey of site	Possible effects of development on habitat of desert monitor or chinkara (threatened and endangered species).	Conduct habitat and faunal survey of affected areas at Jamshoro to determine likelihood of impact an recommend mitigation.	C.	ZSP, with assistance from Sind University staff, U.S. Fish & Wildlife Services; cooperation by WAPDA
Protection of humans and of wildlife likely to use water in evaporation and holding ponds	Use of evaporation or holding ponds by waterfowl, with adverse affects to these species.	Monitor use of ponds by waterfowl Minimize vegetation as attractive nuisance. Cover with netting if necessary.	C.	ZSP, with assistance from Sind University staff; cooperation b WAPDA
	Use of ponds as source of drinking water for wildlife and humans.	Fence ponds to prevent access. Post warning signs.	B.	WAPDA
Pipeline routing to minimize wildlife impacts	Potential long-term impacts to wildlife habitat and population from unneeded right of way clearing.	ROUTE PIPELINES ALONG EXISTING CORRIDORS AND AWAY FROM SENSITIVE WILDLIFE AREAS WHERE FEASIBLE.	C.	WAPDA; support from ZSP
Plant design to avoid potential contamination of wildlife habitat	Discharges or accidental spill of lube oils, wastewater or other toxic materials could impact wildlife habitat.	ENCLOSE LUBE STORAGE TANK, LUBE O TRANSFER PUMP, SUMPS AND DRUM DISPENSING AREA WITH 6" PROTECTIV CURBING. CONTAIN AND DISPOSE OF WASTEWATERS IN LINED EVAPORATION PONDS.	A.	WAPDA

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA sc pe of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Pipeline design to control effects of erosion on fish and wildlife	Erosion of stream banks and slopes crossed by the pipeline can impact terrestrial and aquatic wildlife habitats.	BANK PROTECTION AT DRAINAGE CROSSINGS AND EROSION CONTROL STRUCTURES/MEASURES TO MINIMIZE EROSION ALONG RIGHT OF WAY SLOPES.	B.	WAPDA
Water Resources Protection:				
Monitoring of key wastewater streams	Ensure efficient plant operation and quality of water for use in irrigation.	DEVELOP MONITORING PROGRAM INCLUDING DATA SAMPLING, DATA ANALYSIS, LABORATORY ANALYSIS AND STAFF TRAINING	A.	WAPDA, with assistance from PEPA[3]
Monitor groundwater to identify potential contamination	Potential effects on groundwater use and on connected surface water use from evaporation pond leakage.	Develop shallow groundwater monitoring well system.	B.	WAPDA, with assistance from MH
Wastewater handling and treatment	Maximum re-use of wastewater and minimum cost of disposal.	SEPARATE AND TREAT WASTEWATER STREAMS TO ALLOW EVAPORATION OF METAL CLEANING OPERATIONS WASTEWATER AND RECYCLING OF OTHER WASTEWATERS FOR IRRIGATION USE IN ACCORDANCE WITH U.S. EPA STANDARDS.	A.	WAPDA, with cooperation o PEPA[3]
Plant design to avoid water quality degradation from toxic spills and erosion	Discharges or accidental spills of toxic materials could cause water quality degradation.	ENCLOSE LUBE STORAGE TANK, LUBE OIL TRANSFER PUMP, SUMPS AND DRUM DISPENSING AREA WITH 6" PROTECTIVE CURBING. CONTAIN AND DISPOSE OF WASTEWATERS IN LINED EVAPORATION PONDS.	A.	WAPDA
Storm and flood design considerations	Avoid surface water contamination due to flooding and retention or evaporation pond overflowing	FACILITY LOCATED ABOVE 100-YEAR FLOOD PLAIN ELEVATION; WASTEWATER PONDS DESIGNED WITH 3 FEET (1 METER) FREEBOARD	A.	WAPDA, in consultation with GSP
Sanitary wastewater management	Protect human environment from decomposable organics, suspended solids, pathogenic organisms.	DEVELOP A SEWAGE COLLECTION SYSTEM AND TREATMENT PLANT, INCLUDING PRIMARY AND SECONDARY (BIOLOGICAL TREATMENT AND CHLORINATION) TREATMENT.	A.	WAPDA, with verification of PEPA[3], MH

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

3348

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Solid waste management	Potential contamination of surface and groundwater	Formulate and implement a solid waste management plan	B.	WAPDA, with support of PEPA[3], MH
Water Resources:				
Hazardous and toxic waste management	Potential contamination of surface and groundwater	Prepare hazardous and toxic waste plans. Develop control measures to prevent and cleanup accidental discharges of hazardous and toxic substances.	A.	WAPDA, with support from PEPA[3]
Emergency planning	To standardize procedures during emergency responses to major toxic spills, fires and earthquakes	Develop Emergency Planning and Management Plan prior to construction and operation of all major facilities	A.	WAPDA, with support from PEPA[3], MH
Pipeline erosion control and revegetation	Minimize erosion and release of sediment-rich stormwaters into surface waters	Develop plans with control measures and temporary structures for use during pipeline and facility construction; scheduling techniques, mulching and revegetation of exposed critical areas, sediment traps and diversion dikes.	C.	WAPDA, with assistance from PEPA[3]
Pipeline design and operation to avoid severe oil spill impacts	Accidental oil spills from pipeline rupture at sensitive stream crossings	EFFECTIVE BANK STABILIZATION AT STREAM CROSSINGS; BURY PIPELINE IN STREAM CHANNELS BELOW MAXIMUM PREDICTED SCOUR DEPTH; DEVELOP AND IMPLEMENT SPILL PREVENTION, DETECTION AND CLEANUP PROCEDURES	A.	WAPDA, in consultation with GSP

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Air Quality:				
Ambient air monitoring program	To ensure ground levels of various contaminants are within accepted limits.	Develop system of continuous air monitoring stations downwind of plant and at sensitive receptors; place one meterological station near the plant site.	A.	WAPDA, with cooperation of PEPA[3] and using AAOS
Stack emissions source testing	To ensure stack emissions from each unit are within World Bank guidelines and WHO criteria.	Test each unit of the facility annually and sequentially for SO_2, NO_2 and PM emission levels; if SO_2 levels are too high, use low sulphur oil.	A.	WAPDA, with cooperation of PEPA[3], MH
Nois				
Construction noise abatement	Noise impacts on nearby communities or worker health and safety	INSTALL ENGINE MUFFLERS; MINIMIZE NIGHT TIME NOISY WORK; ENCLOSE OR SILENCE STATIONARY EQUIPMENT; LIMIT CONSTRUCTION EQUIPMENT TO E.E.C. 80 dBA LIMIT.	B.	WAPDA, with verification by MH
Operational noise abatement	Noise impacts on nearby communities or worker health and safety	EQUIP FORCED DRAFT FANS, STEAM VENTS, AND VENTILATION FANS WITH SILENCERS; ENCLOSE PUMPS, MOTORS AND TURBINE IN ACOUSTICALLY DESIGNED ENCLOSURES/ BUILDINGS; SET DESIGN LIMITS ON NOISE FROM ROTATING EQUIPMENT, CONTROL VALVES AND TRANSFORMERS	B.	WAPDA, MH
Cultural Resources:				
Archeological artifact notification and handling	Compliance with Pakistan law, avoidance of unnecessary project ys, protection of cultural urces.	Implement recommended chance-find procedures for cultural resources, including close liaison with Pakistan Dept. of Archeology and notification of any finds within seven days; pre-construction field surveys.	A.	PDA, with cooperation of WAPDA

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Developm...
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Social/Institutional Concerns				
Land use planning	Control secondary growth of residential and business development resulting from project development	Develop land use plans for implementation by local governments; provide guidance for selection of preferred locations for secondary growth; plan for timely development of supporting infrastructure and community services.	B.	MPD, with cooperation of WAPDA
Public Information Program	Seek public acceptance of the proposed project; minimize public concerns and issues; establish good relations with local populus	Establish a public information and communication program in the project community; determine information to be released; develop methods for communication; identify target groups and officials to meet with; schedule presentations and meetings.	B.	WAPDA in cooperation with Sind Universityand representatives of local groups
Train and hire local workforce	Provide economic benefits to project area; encourage good community relation; reduce influx of people from outside area	ESTABLISH PROGRAM TO TRAIN LOCAL WORKFORCE FOR PROJECT JOBS; HIRE QUALIFIED LOCAL SINDHIS WHENEVER POSSIBLE.	B.	ML, MPD, with support of WAPDA
Worker housing plan	Provide safe sanitary living conditions and adequate housing for project work force; minimize high worker turnover and low productivity.	Require construction contractors to provide adequate worker housing; develop housing and services plan based on evaluation of local availability; PROVIDE WORKERS' COLONY DURING OPERATION.	B.	WAPDA with assistance from local universities and technical training schools
Transportation Planning	Traffic-related impacts	Stagger work schedules, on-site housing for workers, bus transport for workers, use of night truck convoys, highway improvements, driver training, load limitations.	C.	WAPDA, ML

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

Table 6-1

Summary of Recommended Environmental and Socioeconomic Mitigation Activities

Mitigation Description	Need or Impact	Recommended Activity[1]	Priority	Implementation Organization
Environmental and Socioeconmic Program, Phase I & II	Standardization of emergency plans and personnel training; standardization and centralization of equipment and data collection and analysis; complex-wide authority and responsibility for protection/correction activities.	DEVELOPMENT OF A SINGLE INTEGRATED PROGRAM FOR IMPLEMENTATION FROM A SINGLE OFFICE FOR BOTH PHASES.	B.	WAPDA, with cooperation of appropriate ministries
Planning for local recession	Local recession following construction.	Project representatives meet with local governments to discuss potential impacts and prepare a plan to address the issue.	C.	WAPDA, with assistance from ML, MPD, local groups
Public Health/Occupation Safety				
Solid and hazardous waste handling	Protect workers and public from exposure health risks	RECYCLE OR CONTAINERIZE AND PACKAGE FOR DISPOSAL IN APPROVED DISPOSAL SITE; TRAIN WORKERS ON PROPER HANDLING.	A.	WAPDA, with assistance from PEPA[3], MH
High voltage safety	Avoid accidental shocking	FENCE AND POST WITH WARNING SIGNS IN AREA CONTAINING TRANSMISSION CABLES; GROUND HIGH VOLTAGE TOWERS.	A.	WAPDA
Worker accident prevention	To minimize worker health and safety risks where design controls are inadequate or not feasible	Develop formal safety procedures and training program for operating and maintenance activities; educate workers on plant hazards.	A.	WAPDA, with assistance from ML, MH
Monitoring of chemical and physical hazards	Potential impacts to worker health and safety from specific work-related hazards	ROUTINE MONITORING OF TOXIC GASES, NOISE LEVELS, HEAT STRESS, TOXIC AND NUISANCE DUSTS; SPECIAL MONITORING OF MAINTENANCE AND NON-ROUTINE ACTIVITIES	B.	WAPDA, with verification of MH

1. Upper case: already incorporated or in existence
   Lower case: recommended only
2. Priorities: A. Essential go-no go for project for environmental and/or statutory reasons
   B. Highly recommended
   C. Recommended
3. As PEPA scope of authority is prepared and the agency acquires adequate staff, it will be requested to participate more

GSP = Geological Survey of Pakistan.
MH = Ministry of Health.
ML = Ministry of Labor.
MPD - Ministry of Planning and Development.
PCSIR = Pakistan Council for Scientific and Industrial Research.
PDA = Pakistan Department of Archeology.
PEPA = Pakistan Environmental Protection Agency.
AAQS = Ambient Air Quality Standards.
ZSP = Zoological Survey of Pakistan.

7.0 COSTS FOR RECOMMENDED MITIGATION AND MONITORING

This section provides an order of magnitude estimated cost for recommended mitigation and monitoring activities (see Table 7-1). Costs for activities of environmental benefit which are included as normal good engineering practice in project design have already been included in the project estimate. For example, noise suppression with enclosures or insulation will mitigate harmful environmental impacts; however, these measure will be part of the engineering design and were not priced separately. It should also be noted that some of the environmentally related costs such as training and housing of workers are already included in the capital costs.

Labor costs were difficult to estimate, as it was not always known if a service would originate in Pakistan or outside the country. When the source of a service was not obvious, an assumption was made and stated.

Costs will also depend on the degree of participation by GOP agencies. For example, a regional development plan could be prepared entirely by a consultant, or with the assistance of the Ministry of Planning. The net cos to WAPDA would vary considerably.

Most monitoring and mitigation measures in Table 7-1 have been costed as if conducted separately. Costs will be reduced considerably if various activities are combined in a comprehensive service contract. For instance, hazardous waste handling, clean-up, and emergency preparedness and response plans could be combined.

Finally, the scope of work performed under each mitigation and monitoring activity can vary widely, affecting costs directly. WAPDA should be certain that these tasks are carefully designed and well-defined before contracting any work.

Table 7-1

Capital and Recurrent Costs (U.S. $) of Recommended Additional Monitoring and Mitigation Measures
(Not included in current feasibility design)

Monitoring and Mitigation Measures	Initial or Capital Cost (1 U.S. Dollar = 17 Rupees)	Recurrent Costs	Reliability Under Pakistan Conditions	Training Requirements
Vegetation and Wildlife:				
Intake velocities of 1 foot/sec	No added costs			
Habitat and faunal survey of affected areas at Jamshoro to determine likelihood of impact and recommend mitigation	$20,000	0	Excellent	None
Monitor use of ponds by waterfowl	$4,000	$2,000/yr	Excellent	None (use University staff
Minimize vegetation as attractive nuisance	$2,000	$2,000/yr	Excellent	None
Cover with netting if necessary	$50,000/ surface acre	$5,000/surface acre	Moderate	None
Water Resources:				
Develop shallow groundwater monitoring well system	$25,000	$10,000/yr	Excellent	None (use project lab staff)
Prepare and implement hazardous and toxic waste management plans. Develop control measures to prevent and cleanup accidental discharges of hazardous and toxic substances.	$150,00(	$15,000/yr (Administration)	Good	Special Staff required: 4 weel course, at $1500 for each staff member. Continued employee education
Develop erosion control measures for use during pipeline and facility construction; use of seasonal scheduling techniques, mulching and revegetation of critical areas, sediment traps and diversion dikes.	$40,000	$12,000 (second year only)	Very Good	Employee orientation
Air Quality:				
Develop system of continuous air monitoring stations down wind of plant and at sensitive receptors; place one meterological station near the plant site	$1,000,000 (based on 3 AQ stations and 1 met station)	$100,000/yr (based on 1 full-time local technician and 1 part-time consultant @ 50-75% and local maintenance)	Excellent	$7,000 to train 1 technician in U.S. for one month

Table 7-1 (cont'd)

Capital and Recurrent Costs (U.S. $) of Recommended Additional Monitoring and Mitigation Measures
(Not included in current feasibility design)

Monitoring and Mitigation Measures	Initial or Capital Cost (1 U.S. Dollar = 17 Rupees)	Recurrent Costs	Reliability Under Pakistan Conditions	Training Requirements
Test each unit of the facility annually and sequentially for SO_2, NO_2 and PM emission levels; if SO_2 levels are too high, use low sulphur oil	$25,000, if testing equipment as purchased	$3,000/yr if testing equipment is rented; $6,000 per year (for 200 hrs @ $30/hr)	Excellent	$10,000 (160 hrs @ $60/hr)
Cultural Resources:				
Implement recommended chance-find procedures for cultural resources, including close liaison with Pakistan Dept. of Archeology and notification of any finds within seven days; preconstruction field surveys should be considered	To be conducted by Pakistan Department of Archaeology	None	Excellent	$1,200 per year for supervisor training and orientation
Land Use:				
Develop land use plans for implementation by local governments; provide guidance for selection of preferred locations for secondary growth; plan for timely development of supporting infrastructure and community services	To be prepared by Pakistan Ministry of Planning		Very Good	None
Social and Institutional:				
Establish a public information and communication program in the project community; determine information to be released; develop methods for communication; identify target groups and officials to meet with; schedule presentations and meetings.	$120,000 (1 part-time consultant @ 50% and 1 full-time national; materials @ $5000)	$120,000	Good	$3,000 to train one national in Pakistan for 1 month
Require construction contractors to provide adequate worker housing. Develop housing and services plan based on evaluation of local availability.	$350,000 for housing and services plan (3 consultants @ 100%)	None	Excellent	None

Table 7-1 (cont'd)

Capital and Recurrent Costs (U.S. $) of Recommended Additional Monitoring and Mitigation Measures
(Not included in current feasibility design)

Monitoring and Mitigation Measures	Initial or Capital Cost (1 U.S. Dollar = 17 Rupees)	Recurrent Costs	Reliability Under Pakistan Conditions	Training Requirements
Transportation:				
Stagger work schedules, on-site housing for workers, bus transport for workers, use of night truck convoys, highway improvements, driver training.	$600,000 (6-45 passenger buses)	$250,000/yr (4 supv. and 15 drivers; maintenance and equipment @ $15,000)	Good	$15,000/yr (1 part-time trainer @ $30/hr @ 25%)
Economic:				
Project representatives meet with local governments to discuss potential impacts and prepare a plan to address impacts.	$115,000 (one full-time consultant for one year)	$30,000/yr (on part-time consultant @ 25%)	Good	
Public Health and Occupational Safety:				
Develop formal safety procedures and training program for operating and maintenance activities; educate workers on plant hazards	$50,000	$10,000 (employee education)	Excellen	nued employee education

AR:7135d tg:Rev.2

343

Appendix A

LIST OF PREPARERS

Listed below are persons who directly participated in the preparation of the Environmental and Social Soundness Assessment for Phase II of the Jamshoro Power Generation Complex.

David A. Cobb, B.A.	Bechtel National, Inc. Environmental Coordinator
Catherine L. DaMassa, B.S.	Bechtel National, Inc. Social Sciences
Peter C. Carr, B.S.	Bechtel Power Corporation Air Quality
Asem M. Elgawhary, Ph.D., P.E.	Bechtel Power Corporation Environmental Engineering
Eugene M. Hattori, Ph.D.	Bechtel National, Inc. Anthropology
Susan A. Kubanis, M.S.	Bechtel National, Inc. Ecology
John J. Meersman, M.S.	Bechtel National, Inc. Environmental Engineering
Tim Morgan, B.S.	Bechtel Power Corporation Meteorology
Ramon E. Nugent, B.S., P.E.	Bechtel National, Inc. Noise
Stephen R. Ripple, M.P.H	Bechtel National, Inc. Environmental Health Science
Jessica B. Romm, Ph.D.	Bechtel Power Corp. Labor Relations
Luis J. Saguinsin, Ph.D.	Bechtel National, Inc. Environmental Science and Engineering
Christian Seigneur, Ph.D	Bechtel National, Inc. Air Quality

344

Christopher M. Valentino, M.S.	Bechtel National, Inc. Community Health Sciences
Vefa Yucel. M.S.	Bechtel Civil, Inc. Hydrology and Water Resources
Kennard F. Kosky, M.S., P.E.	KBN Engineering and Applied Sciences, Inc. Environmental Setting
James R. Newman, Ph.D.	KBN Engineering and Applied Sciences, Inc. Environmental Setting

Appendix B

REFERENCES

Agriculture Research Institute. 1986. Personal Communication. Sind University, Tandojam.

Agriculture Extension Service. 1986. Personal Communication. Sind University, Hyderabad.

Ahmad, M. F. and Ghalib, S. A. 1975. A Checklist of Mammals of Pakistan. Records, Zoological Survey of Pakistan, Vol. VII (1 and 2):1-34.

American Conference of Governmental Industrial Hygienists (ACGIH) 1985. Threshold Limit Values and Biological Exposure Indices for 1985-86.

American Public Health Association (APHA). 1980. Standard Methods for the Examination of Water and Wastewater. 15th ed. New York, N.Y..

Ansari, T. A. Chief Conservator of Forests. 1986. Personal Communication.

American National Standards Institute (ANSI). 1971. Method for Physical Measurement of Sound, ANSI Standard S1.2-1962 (R1971), American National Standards Institute, New York, NY.

Arid Lands Information Center. 1981. Draft Environmental Profile, The Islamic Republic of Pakistan. Bureau of Science and Technology, Office of Forestry, Environment and Natural Resources. USAID, Washington, D.C.

Bastein, George, 1987. Memorandum from Bastein, Project Engineer. January, Gaithersburg, Maryland.

Bechtel National, Inc. 1986a. Pre-feasibility Study of the Jamshoro Power Generation Complex, Final Report (Revision 1) February.

Bechtel National, Inc. 1986b. Jamshoro Power Generation Complex - Phase II Feasibility Study. Draft. Prepared for Pakistan Water and Power Development Authority, Lahore, Pakistan.

Beg, A. R. 1975. Wildlife Habitats of Pakistan. Biological Sciences Research Division. Pakistan Forest Institute, Peshawar. Bulletin No. 5 (Botany Branch).

Bowers, J. F., R. Bjorklund J. and Cheney C. S. 1979. "Industrial Source Complex (ISC) Dispersion Model User's Guide." Report EPA-450/4-79-030, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

EEC Directive 90998/85 (Draft), October, 1985. Council of European Communities, Brussels, Belgium.

Eldred, K. M., 1974. "Assessment of Community Noise," Noise Control Engineering, Vol. 3, No. 2, pp. 88-95.

Environmental Science and Engineering, Inc. 1986. Air Quality and Land and Water Data and Analyses. Gainesville, Florida.

Environmental Science and Engineering, Inc. (ESE) 1986. Environmental and Social Soundness Assessment. Lakhra Coal Mine and Power Generation Project, August, Gainesville, Florida.

Federal Register. Vol. 50, No. 207, Friday October 25, 1985.

Ferenbaugh, R. W. 1978. Effects of Prolonged Exposure of Oryzopsis hymenoides to SO_2. Water Air and Soil Pollution, 10:27-31.

Gilbert/Commonwealth International, Inc. (GCII). 1986. Lakhra Coal Mine and Power Generation Feasibility Study: Power Plant Feasibility. Vols. I-IX. Submitted to U.S. Agency for International Development and Pakistan Water and Power Development Authority. Jackson, Michigan.

Government of Pakistan. 1983. Control of Pollution and Protection of the Living Environment. Government of Pakistan Ordinance XXXVII of 1983.

Helweg, A. W., 1985. Social Soundness Assessment of the Lakhra Coal Mine and Power Generation Project. USAID, Islamabad.

Hill, C. A., Hill, S., Lamb, C., and Barrett, T. W. 1974. Sensitivity of Native Desert Vegetation to SO_2 and to SO_2 and NO_2 Combined. J. Air Pollution Control Association, 24:154-157.

Holzworth, G. C., 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States. Publication No. AP-101. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.

Hunting Survey Corporating, Ltd., 1960. Reconnaissance Geology of Part of West Pakistan. Published for the Government of Pakistan by the Government of Canada. Toronto, Canada.

Institute of Public Health Engineering and Research, University of Engineering and Technology, Hyderabad, 1985.

Irving, P. M. and S. W. Ballou. 1980. SO_2 Dose-Response Sensitivity Classification Data for Crops and Natural Vegetation Species. Technical Memo ANL/EES-TM-112. 26 p. Argonne National Laboratory, Argonne, Illinois.

ISO/R 1996-1971. Acoustics - Assessment of Noise with Respect to Community Response, International Organization for Standardization, Geneva, Switzerland.

Japan International Cooperation Agency (JICA), 1981. Feasibility Report for Lakhra Coal Mining and Power Station Project.

KBN Engineering and Applied Sciences, Inc., 1986. Air Quality, Noise, Biological and Socioeconomic Data and Analyses Pakistan: Lakhra Coal Mine and Power Generation Project. Gainesville, Florida.

Kuresky, K. U., 1978. A Geography of Pakistan. Oxford University Press, Oxford.

Jensen, K. F. and Dochinger, L. S. 1979. Growth Responses of Woody Species to Long- and Short-Term Fumigation with Sulfur Dioxide. Northeastern Forest Experiment Station, Broomall, Pennsylvania.

Marshall, P. E. and Furnier, G. R., 1981. Growth Responses of *Ailanthus altissima* Seedlings to SO_2. Environmental Pollution 25:149-153.

Meersman, John J., Seigneur C., and Cobb D. A. 1986d. Review of Draft Air and Water Emission Standards Proposed by the Pakistan Environmental Protection Agency. Bechtel National, Inc., San Francisco, California, 52 pp.

Minton, S. A., 1966. A contribution to the Herpetology of West Pakistan. Bull. American Museum of Natural History, 134:27-184.

Newman, J. R., 1979. Effects of Industrial Air Pollution on Wildlife. Biol. Conserv., 15:181-190.

Newman, J. R., 1980. Effects of Air Emission on Wildlife Resources. U.S. Fish and Wildlife Service, Biological Service Program, National Power Plant Team. FWS/OBS-80/401.

Newman, J. R., Novakova, E., and McClave, J. T., 1985. The Influence of Industrial Air Emissions on the Nestin Ecology of the House Martin (*Delrichon urbica*) in Czechoslovakia. Biological Conservation, 31:229-248.

Nieuwolt, 1977.

348

Norby, R. J. and Kozlowski, T. T. 1983. Flooding and SO_2 Stress Interaction in Betula papyrifera and B. nigra Seedlings. Forest Science, 29:739-750.

Pakistan Meteorological Service. 1985. Summary of Climatological Data Observed in Hyderabad, Pakistan, from 1931 to 1960.

Pakistan Population Census Organisation, Statistics Division. 1983a. 1981 District Census Report of Hyderabad. District Census Report No. 37. Islamabad.

Pakistan Population Census Organisation, Statistics Division, 1983b. 1981 District Census Report of Dadu. Islamabad.

Peterson, A. P. G., 1980. Handbook of Noise Measurement, General Radio Company, West Concord, MA, p. 4.

Preston, E. M., and Gullet, T. L. (eds.), 1979. The Bioenvironmental Impacts of a Coal Fired Power Plant. 4th Interim Report, December 1978, Colstrip, MT. Corvallis Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Corvallis, OR, EPA-600/3-79-044.

Reich, P. B. et al. 1985. Effects of O_3, SO_2, and Acidic Rain on Mycorrhizal Infection in Northern Red Oak Seedlings. Canadian J. Botany, 63:2049-2055.

Seigneur, C., Saxena P. and Roth P. M. 1985. "Chemistry of Sulfate and Nitrate Formation" in Air Pollution Modeling and Its Application, Vol. 4, C. de Wispelaere, ed., pp. 129-154, Plenum Press, New York, New York, U.S.A.

Seigneur, C., Saxena P. and Roth P. M. 1984. "Computer Simulations of the Atmospheric Chemistry of Sulfate and Nitrate Formation" Science, Vol. 225, pp. 1028-1030.

Shaukat, S. S., Khairi, M. A., Khan, D., and Qureshi, J. A. 1980. Multivariate Approaches to the Analysis of Vegetation of Gadap Area, Southern Sind, Pakistan. Tropical Ecology, 21(1):81-102.

Shaukat, S. S., Khan, D., and Qadir, S. A., 1981. On the Vegetational Dynamics of Calcarious Hills Around Karachi. Pak. J. Bot., 13(1):17-37.

Sind Bureau of Statistics. 1984. Development Statistics, Sind. Bureau of Statistics, Planning and Development Department, Government of Sind, Karachi.

Sind Wildlife Protection Ordinance, 1972.

Suwannapinunt, W. and Kozlowski, T. T., 1980. Effect of SO_2 on Transpiration, Chlorophyll Growth, and Injury in Young Seedlings of Woody Angiosperms. Canadian Journal of Forest Research, 10:78-81.

Thompson, C. R., Kats, G., and Lennox, R. W., 1980. Effects of SO_2 and/or NO_2 on Native Plants of the Mojave Desert and Eastern Mojave-Colorado Desert. J. Air Pollution Control Association, 30:1304-1309.

Tippets-Abbett-McCarthy-Stratton (TAMS). 1985. Environmental Baseline Monitoring System and Program for the Lakhra Coal Mining and Power System Project. Prepared for USAID and WAPDA.

United Nations Centre for Regional Development. 1981. Present Situation, Regional Development in Sind. A Comprehensive Planning Report. Volume 1(2).

U.S. Agency for International Development (USAID). 1982. AID Handbook 3. Appendix 3F, Social Soundness Analysis.

U.S. Environmental Protection Agency (USEPA). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA/ONAC 550/9-74-004, pp. A-16 to A-18, B-2. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1982. Air Quality Criteria for Particulate Matter and Sulfur Oxides Volume III - Final Report. Environmental Criteria and Assessment Office, U.S. Environmental Protection Agency, Research Triangle Park, N.C. EPA 600/8-82-029cf.

U.S. Environmental Protection Agency (USEPA). 1982. Development Document for Final Effluent Limitations Guidelines, New Source Performance Standards, and Pretreatment Standards for the Steam Electric Point Source Category. EPA 400/1-82/029. Effluent Guidelines Division, Office of Water and Waste Management, USEPA, Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1986. "Guidelines on Air Quality Models (Revised)" EPA-450/2-78-027R, U.S., Environmental Protection Agency, Research Triangle Park, North Carolina.

Winner, W. E., and Mooney, H. A., 1980. Ecology of SO_2 Resistance: III Metabolic Changes of C3 and C4 Atriplex Species Due to SO_2 Fumigation. Oecologia 46:49-54.

Water and Power Development Authority (WAPDA). 1983. Surface Water Hydrological Report. Government of Pakistan.

Water and Power Development Authority (WAPDA). 1985. Reports on Total Suspended Particulate Matter Concentrations Collected at the Jamshoro and Lakhra Monitoring Stations from May 30 to August 13, 1985. Government of Pakistan.

Water and Power Development Authority (WAPDA). Water Quality Monitoring Data for May 1985 through August 1986 taken at stations along the Indus River.

Water and Power Development Authority (WAPDA), September 1986a. Meeting with Syed Abid Alc, Jamshoro Project Director, Units I, II and III. Hyderabad. Wentzel and Ohnesorge, 1961.

Water and Power Development Authority (WAPDA), October 1986b. Meeting with Syed Abid Alc, Jamshoro Project Director, Units I, III and III. San Francisco.

Wentzel and Ohnesorge, 1961. Fortsarchiv 32:177-186.

World Bank, Office of Environmental Affairs. 1984. Environmental Guidelines. Washington, D.C.

World Health Organization. 1985. Drinking Water Guidelines.

World Health Organization. 1977. Environmental Health Criteria No. 4 4 for Oxides of Nitrogen. Geneva, 79 pp.

World Health Organization. 1979. Environmental Health Criteria No. 8 for Surfur Oxides and Suspended Particulate Matter. Geneva, 107 pp.

RS1

Appendix C

PERSONAL CONTACTS

Robert Archer
U.S. AID Energy Office
Washington, D.C.

Bernard Baratz
Chemical Engineer
Office of Environmental and Scientific Affairs
The World Bank
Washington, D.C. 20433

Stephen F. Lintner, Ph.D.
Environmental Coordinator
Bureau for Asia and the Near East
USAID-Washington, D.C.

Saskia Vleer
International Labor Organization, United Nations
Islamabad, Pakistan

M. Glenn Rutaner-Whaley, M.S.
Environmental Advisor
USAID-Islamabad Mission

David A. Ferguson
U.S. Department of the Interior
Office of International Affairs
Fish and Wildlife Service
Washington, D.C.

Syed Abid Ali
Project Director
Jamshoro Oil Fired Power Station
Water and Power Development Authority
Hyderabad, Pakistan

Mohammad Jamil Arain
Senior Engineer Mechanical
Gas Turbine Power Station
Water and Power Development Authority
Kotri, Pakistan

352

Abdul Aziz Chandio
Executive Engineer
Jamshoro Oil Fired Power Station
Water and Power Development Authority
Hyderabad, Pakistan

Ghulam Hyder Essani
Deputy Director
Agricultural Extension
Hyderabad, Pakistan

M. Zafar Ullah Khan
Executive Engineer
Jamshoro Oil Fired Power Station
Water and Power Development Authority
Hyderabad, Pakistan

A. K. Makhdoom
Executive Engineer
Coal Fired Power Station Lakhra Project
Water and Power Development Authority
Hyderabad, Pakistan

Niaz Rasool
Director, Southern Circle
Department of Archeology and Museums
Hyderabad, Pakistan

Nazim Husain Siddiqui
Chief Engineer, Design
Water and Power Development Authority
Lahore, Pakistan

Syed Anis Abbas Zaidi
Chief Engineer (Thermal) Jamshoro
Water and Power Development Authority
Hyderabad, Pakistan

Ayaz Ali Shah
Joint Secretary of Environmental and Urban Affairs
Government of Pakistan
Islamabad, Pakistan

Khurshid Hasan
Director General
Department of Archeology
Government of Pakistan
Karachi, Pakistan

Dr. Ahmed
Department of Geology
Sind University
Hyderabad, Pakistan

Har Bagash
Mass Communications Department
Sind University
Hyderabad, Pakistan

Ghulam Haider Balochi
Social Work Department
Sind University
Hyderabad, Pakistan

M. A. Chinnar
Assistant Professor, Bota
Sind University
Hyderabad, Pakistan

Ghulam Rasool Dahri
Social Work Department
Sind University
Hyderabad, Pakistan

K. M. Khan
Chairman, Botany Department
Sind University
Hyderabad, Pakistan

Fouzia Jafferi
Department of Mass Communications
Sind University
Hyderabad, Pakistan

Ghulam Khokhar
Sociology Department
Sind University
Hyderabad, Pakistan

G. M. Mastoi
Social Work Department
Sind University
Hyderabad, Pakistan

Ghulam Sarwar Memon
Sociology Department
Sind University
Hyderabad, Pakistan

354

Ghulam Nizamuddin
Sociology Department
Sind University
Hyderabad, Pakistan

Ibadullah Rashdi
Mass Communications Department
Sind University
Hyderabad, Pakistan

Mahtab Rashdi
Director, Institute of Sindiology
Sind University
Hyderabad, Pakistan

Ghulam Rasool Shah
Social Work Department
Sind University
Hyderabad, Pakistan

Badaraddin Soomro
Mass Communications Department
Sind University
Hyderabad, Pakistan

APPENDIX D

RECORD OF THE SCOPING SESSION FOR THE LAKHRA COAL MINE AND POWER GENERATION PROJECT ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT AND JAMSHORO THERMAL POWER COMPLEX (PHASE II) ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT

I. INTRODUCTION

This attachment is intended to serve as a formal record of the scoping session for the Environmental and Social Soundness Assessments of the Lakhra Coal Mine and Power Generation Project, and the Jamshoro Thermal Power Complex (Phase II). This scoping session was held by the Water and Power Development Authority of Pakistan (WAPDA) From 9:00 to 13:00 on 6 October 1986 at the Fataz Hotel in Hyderabad, Sind Province, Islamic Republic of Pakistan. The scoping session was conducted in English at the request of the Government of Pakistan.

II. SUMMARY OF THE SCOPING SESSION

A. Agenda

1.	Seating of guests		0900
2.	Recitation from the Holy Quran.	Qari Sahib.	0900-0910
3.	Welcome Address	Engr. A.A. Zaidi Chief Engineer Jamshoro	0910-0915
4.	Opening Remarks	Engr. Nazim Hussain Siddiqui, C.E. (Design) Thermal, Lahore	0915-0930
5.	Overview of Lakhra and Jamshoro Projects	Engr. A.A. Zaidi Chief Engineer Jamshoro	0930-0945
6.	Description of USAID Environmental Procedures	Dr. Stephen F. Lintner Environmental Coordinator USAID, Washington D.C., USA	0945-1000
7.	USAID involvement in Lakhra and Jamshoro Projects	Mr. John Morgan Mission Environmental Officer, USAID, Islamabad	0955-1000
8.	Brief description of Lakhra Power Station Project	Engr. M. Qasim Sheikh Project Engineer, Lakhra Power Station Project	1000-1015
9.	Brief description of Lakhra Coal Mining Project	Engr. Tariq Zamir, Project Engineer, Lakhra Coal Mining Project	1015-1030

3526+

10.	Teabreak	----------	1030-1100
11.	Environmental Study & Impact of Lakhra Power Station	Kennard F. Kosky, P.E. ESE/KBN, Gainesville, Florida, USA	1100-1130
12.	Environmental Study & Impact of Jamshoro Power Station Project	David A. Cobb, Catherine L. Damassa Bechtel National, Inc., San Francisco, California USA	1130-1200
13.	Questions, Comments, proposals from the floor		1200-1300

B. Synopsis of the Formal Presentations

1. Lakhra Coal Mine and Power Generation Project

An overview of the draft Environmental and Social Soundness Assessment was presented by Mr. Kosky. This presentation consisted of the following topics which were supported by visual aids (figures and tables for the overhead projector):

a. Purpose of Scope of Environmental Assessment (EA)
b. Applicable Regulations
c. EA structure
d. Analysis of Alternatives including those related to management, type of technology and social-infrastructure
e. Environmental impacts, including short and long term impacts to the physical, ecological and social environments
f. Mitigation Plan - overview of proposed plan which includes provisions for environmental management and monitoring, mine reclamation, occupational safety and health, emergency prevention planning and management, solid waste management, infrastructure (primary and secondary) and archeological/historical preservation.

2. Jamshoro Thermal Power Complex (Phase II)

Mr. David A. Cobb of Bechtel National, Inc. presented an overview of information, analyses and considerations that will be part of the Environmental and Social Soundness Assessment. At the time of the presentation, the assessment was not completed. Mr. Cobb's presentation was supported by visual aids (charts) and included discussion of potential major areas of significant environmental impact on the physical and ecological environment of the Jamshoro area. Ms. Damassa presented information related to the impacts to the social environment and considerations that must be included for the projects' development.

2cn

III. Question and Answer Session

A. Introduction

Professor K.M. Khan, Chairman, Department of Botany, Sind University, proposed that for clarity the question and answer session be divided into two portions, one for Lakhra, one for Jamshoro. In this manner, each project could be discussed separately.

This proposal was adopted by the moderator of the meeting, Engineer Nazim Siddiqui.

B. Lakhra Coal Mine and Power Generation Project

Professor M.R. Shabayo, Professor of Metallurgical Engineering, Mehran Engineering University, inquired about potential secondary impacts of air emissions of power plants, particularly with regard to corrosion. He asked if this had been taken into account in the Environmental Assessment. Mr. Kosky, representing ESE/KBN, replied that the power plant design incorporated an appropriate selection of materials for plant equipment to address anticipated abrasion problems. Corrosion, due to flue gases, is not anticipated to be a problem due to the low humidity and high dispersion in the area. He also noted that flue gases will be well above the dew point, reducing the amount of acid precipitation.

2. Professor K.M. Khan raised the following questions:

   (a) Why was WAPDA considering the use of high sulfur coal when in other parts of the world this is not being done? This can result in harm to the natural environment and to wildlife.

   (b) Have the potential impacts of fugitive dust from surface mining operations been considered in the Environmental Assessment? For example, will it have an impact on migratory ducks which pass through the area each year?

   (c) Have the seasonal variation in winds, and downwind impacts been considered in the Environmental Assessment?

Question (a) was answered by Engineer Siddiqui of WAPDA. He noted that WAPDA must use the coal which it has available within Pakistan to improve balance of payments. The most abundant Pakistani coal is in the Lakhra field. He observed that high sulfur coals are in use elsewhere in the world. He also assured the audience that WAPDA planned to use locally available coal in such a way as to minimize potentially adverse environmental impacts.

Question (b) was addressed as follows:

Engineer Siddiqui noted that dust emissions from surface mining had been reviewed in the design process.

3584

Mr. Kosky made the following points:

The proposed Lakhra plant and mine site are located on a plateau, approximately 100 meters above the level of the Indus River, which will enhance dispersion of any fugitive dust. He also said that most of the fugitive dust particles which result from the mining operation are larger than 10 microns in diameter, which is above the respirable size fraction, thus posing little risk to human health. Due to their density, these materials will settle close to the point of release. He also observed that the vegetation in the vicinity of the plant and mine site is of a hardy type and should not be significantly affected by potential particle emissions. Mr. Kosky stated that from a health viewpoint the dust (fly ash) from the flue gas represented a greater health hazard and that Gilbert-Commonwealth, the power plant feasibility consultant, has included an electro-static precipitator (ESP) for flue gas particulate removal in their design.

Dr. Lintner, AID/Washington, noted that there is a significant level of experience in surface coal mining in the United States and that water suppression is the most commonly used control technique for dust. In addition, the proposed mining plan includes the reclamation of mined areas to reduce long term dust generation.

Question (c) was answered by Mr. Kosky, who noted that from the beginning of the Environmental Assessment the quantity and quality of meteorological data was a serious concern. Available data from the Pakistan Meteorological Department station at Hyderabad, because of its urban setting, did not accurately reflect the wind regime at Lakhra. Consequently, a meteorological station was set up at the proposed Lakhra site to collect the necessary data beginning in May 1985. This station has reported wind data as high as 30 knots. This on-site data was taken into account in the air pollutant analyses used in the Environmental Assessment.

3. Dr. M. Yakoob Soomro, Chairman, Department of Chemical Engineering, Mehran University, related that he was conducting research into flue gas desulfurization (FGD) processes and would be interested in any data or information relative to this technology which has been developed in the course of the Lakhra feasibility studies. He also wanted to receive some samples of coal from the Lakhra field.

Engr. Siddiqui directed Engr. Qasim Sheikh, Project Engineer, Lakhra Power Station, to provide available data and coal samples to Dr. Soomro, as well as the results of some recent WAPDA flue gas desulfurization studies.

4. Dr. Shabayo asked if WAPDA has considered gasification, and if the coal exploration data have been computerized.

Engr. Siddiqui noted that large-scale gasification technology for power generation is still in the development stage in the United States and Western Europe. He observed that once such technology was proven it would be given consideration by WAPDA.

Mr. Morgan, USAID/Islamabad, explained that data being collected from the joint USAID/Geological Survey of Pakistan Coal Resource Assessment will be computerized for analysis. He noted that these data will not be detailed enough for development of site specific mine plans.

The audience posed no additional questions on the proposed Lakhra Coal Mine and Power Generation Project.

C. Jamshoro Thermal Power Complex (Phase II) Project

1. Dr. Hussainy, Chairman, Department of Zoology, Sind University, observed that the winter wind directions would cause direct impacts on the students and academic community from the operation of oil-fired power plants at Jamshoro, and asked if these effects had been studied.

Engr. Siddiqui responded that this is being considered in the study and that the findings and results will be shared with representatives of the university.

2. Dr. Khan stated that due to the location of university campuses immediately to the south of the proposed power complex, the Jamshoro site is not suitable for the power plant. He expressed concerns about the plans for storing fuel oil at the site. He expressed concerns that the nearby hospitals would also be affected by the air emissions of sulfur from the power plant.

He noted that since oil can be transported easily, unlike coal, it would be much better to move the plant to an alternate site.

Engr. Siddiqui stated that WAPDA would protect the environment and health of the people. He noted that the siting decision will be based on analysis of a number of factors. He promised to provide copies of reports and to have additional meetings with representatives of the university.

Engr. Siddiqui reviewed with Dr. Khan the proposed site drawings (posted behind the stage) for oil storage facilities at Jamshoro. Dr. Khan noted the acceptability of the proposed oil storage site.

3. Dr. Nazim al Din, Chairman, Department of Sociology, University of Sind, observed that the job opportunities were the most important aspects of the project. He said that from his viewpoint there were no objections to the project.

Engr. Siddiqui reiterated the policy position of WAPDA to maximize local employment at their facilities.

4. Mrs. Fouzia Jaffari, In-Charge, Mass Communications, Sind University, observed that the educated people had a great deal of questions about this project and inquired if WAPDA had any specific plans to answer the questions of the "common people" and to communicate the importance of this project to them.

360

Engr. Siddiqui requested that those in the audience, and particularly the mass communications faculty at Sind University, assist WAPDA in explaining the project to the "common people." He noted that this will be a long-term process and WAPDA will have press releases, statements from the Government of Pakistan, and informational articles. He noted that copies of relevant reports will be made available to the representatives of the University as they are completed.

5. Dr. Khan thanked WAPDA, USAID, and the consultants for their presentations, and observed that it was refreshing to see that someone was actually thinking about the environment.

The audience posed no further questions concerning the proposed Jamshoro Thermal Power Complex (Phase II).

Also included as part of Attachment B are the following:

1. Text of opening remarks by Engr. Nazim Hussain Siddiqui, C.E. (Design), Thermal, Water, and Power Development Authority of Pakistan (WAPDA), Lahore, Pakistan, and

2. List of persons invited and in attendance at the scoping session.

"THE ENVIRONMENTAL SCOPING SESSIO
ON
LAKHRA PROJECT
ON 06-10-1986 AT HYDERABAD

***

" OPENING REMARKS"
BY

ENGR.NAZIM HUSAIN SIDDIQUI
CHIEF ENGINEER DESIGN(THERMAL)

RECEIVED 20 OCT 1986 3811

FBE Action To: Margam
Date Date:
Action Taken:
Sign:
Date

Distinguished guests, ladies & gentlemen

Assalam-o-Alaikum

Today, the importance of electrical energy in a developing country like Pakistan, needs no emphasis. All of our industrial development, agricultural growth, economical uplift and social soundness is dependent upon the electric power. In fact the per capita consumption of electrical energy in any country is an index of standard of living and prosperity.

Most of us present here are well aware, that there is a remarkable gap between the growing demand of electrical energy and its supply. The undesired phenomenon of load shedding is well known in the country for the last two-three years. Load shedding besides causing inconvenience and discomfort to the people, also has ill effect, on productivity in the country almost in all sectors. The gap between power demand and supply, therefore, has to be eliminated with all the means at our disposal.

Elimination of load shedding by 1990 is also included in the five points programme of Prime Minister. In order to bridge the gap between the power demand and supply, a number of power generation schemes have been planned. All efforts are being made to comply with the directive of the Prime Minist for eliminating the menace of the load shedding by 1990. Emphasis have been laid on the maximum utilisation of hydel potential available in the country. The capability of hydel stations, however, does not remain uniform during t year, due to which thermal support has to be provided when the output of hy stations goes down in the lean water months.

Contd.P-2

On the hydroelectric development, a scheme for installing four unit No.11, 12, 13 & 14 of 432 MW each at Tarbela has been prepared work on this project has already been started. Further extension o Tarbela by adding units 15, 16 & 17 is also envisaged. Addition o unit No.9 & 10 each of 100 MW at Mangla has also been planned.

WAPDA is working untiringly for expansion of thermal generation almost day and night. Recently a 210 MW steam unit No.4 and 300 MW gas Turbin projects have rendered a remarkable relief in load shedding. Yet we have to go a long way to achieve the objective of total eradication of load shedding. A 400 MW Gas Turbine Project at Kot Addu is nearing completio A large Power complex of about 1,700 MW based on oil firing has also bee planned at Jamshoro and for this purpose preliminary works are already i hand.

Gentlemen' WAPDA is also carrying out studies for thermal power generatic programme based on coal firing. Presently the Lakhra Coal Fired Power Statio Project at Lakhra and Imported Coal Fired Power Station Project near Karachi are under study. We have very little experience in firing coal for thermal power generation. In the entire country, there are only two tiny units in WAPDA system each of 7.5 MW capacity at Quetta firing indigenous coal from sore-range mines in Baluchistan. Lakhra coal is comparatively poor in qual having a calorfic value of 5740 BTU/lb, with high sulfur, high ash and high moisture contents. The tentative size of the Lakhra coal fired power plant b studied will be 500 MW in its first phase. Keeping in view our little experienc in coal firing technology, poor quality of Lakhra lignite and large size plant, we are carefully steping forward in connection with the Lakhra Project.

As stated eaelier, following two thermal power station projects in this area in the near future:-

i) Jamshoro Oil Fired Thermal Power Station with a capacity of about 1,700 MW.

ii) 500 MW Lakhra lignite fired Power Station at Lakhra

Contd.P-3

Installation of following units is planned at Jamshoro site:-

1X250 MW
3X210 MW.
3X300 MW

This Power Station will operate on furnace oil which will pump from Keamari through a pipe line to meet the entire requiremen of fuel oil.

The above two power stations besides providing thermal support to the system will have a pronounced effect on the prosperity of the area. The two Power plants and mining will provide direct employment to about 7000 people. The indirect employment figures may b as high as 40000. The majority of directly employed personnel an almost all the indirectly employed persons will be from the local area. According to laid down policy, all new technicians and non skilled staff have to be recruited from local area. A large numb of people will also be provided training facilities.

The proposed thermal power expansion in this area will enable us t cope up with our rapidly rising power requirements besides bringin prosperity to the area but the environmental pollution aspects hav to be analyzed very carefully. WAPDA is aware of this problem and control technology. Considering the world as one family, the donor agencies like the World Bank, the USAID, the Asian Development Bank etc are also concerned about the associated problem of environmental pollu tion and its control.

Contd. P-4

364

The environmental pollution, resulting from thermal generation, particularly due to burning of sulfur, if left un-controlled, may have ill effects on the vegetation and living beings in the area. The unchecked flow of flue gases and other industrial wastes will adversely affect the human life, crops, biological life, civil structures etc. in the vicinit of these thermal units.

Being conscious of the importance of clean environment for healthy vegitation and biological life, WAPDA with the assistance of United States Agency for International Development has given a very careful consideration to the problem of environmental pollution. We have engaged consultants of International repute for both Lakhra and Jamshoro Power Plants with the assistance of USAID. M/s. ESE of United States of America have carried ou the environmental studies for determining the impact of Lakhra project of this surrounding area. M/s. BECHTEL of USA have been engaged for carryir out the similar study for Jamshoro Thermal Power Station. I will request the representatives of these two Companies to explain to the participants of this scoping session about the studies, they are carrying out and the guidelines being used for control of environmental pollution. Your assistance in this regard is requested. Please advise us with your proposals, if any, which you may wish to be taken care during the studies, being car out by our Consultants. I assure you sir that both WAPDA & our Consultar will give most careful consideration to such proposals.

In the end, ladies & gentlemen, I will thankyou all for sparing your valuable time for this scoping session despite your extremely busy programmes.

ENVIRONMENTAL SCOPING SESSION-LAKHRA & JAMSHORO PROJECTS

Held at Hotel Fatty, Hyderabad

DATE	NAME	ADDRESS	TELEPHONE RES.	TELEPHONE OFF.	REMARKS/signature
6-10-86	Nazim Husain Siddiqui	WAPDA House LAHORE	882770	56207	
"	Anis Abbas Zaidi	WAPDA 38-A G.O.R. HYDERABAD	26824	41590	
6-10-86	Stephen F. Lintner, Environmental Coordinator	Bureau for Asia and Near East, USAID, Washington, DC 20523, USA	(202) 647-8226		
6-10-86	Farrukh Mahmood, Project Manager	USAID/ISD	841677	824071	
6-10-86	Syed Anwarul Hassan, Project Manager, Lakhra	USAID/ISD		824071	
6.10.86	TARIQ ZAMIR	WAPDA 38/A G.O.R Hyderabad	25481	84634	
6-10.86	A.K. MAKHDOOM	WAPDA 38/A GOR Colony Hyd.	25481		
6.10.86	A.R. Chanar	WAPDA 38/A GOR Colony Hyd.	25481		
6-10-86	Abu Adil	GTPS WAPDA KOTRI	Wapda Colony Kotri	51062	
6.10.86	M. Yousuf Eida	Director (CPP) WAPDA, Lahore		303702	
6.10.86	LOREN M. CHRISTIAN	BECHTEL Los Angeles, USA	213-807-2133		
6.10.86	Maqsood Butt	Senior Chemist, WAPDA, Lakhra Coal Mine Project Hyd			
—	S. Habeebullah Husaini	Sr. Budget & Accts. Officer, WAPDA			
"	MOHAMMAD HAQ DCK	329-W. House Lhr.		302623	
6-10-86	Major Azhar N. Shah	Dy. Director Security (Sou-K) Hyderabad			

364

ENVIRONMENTAL SCOPING SESSION-LAKHRA & JAMSHORO PROJECTS

DATE	NAME	ADDRESS	TELEPHONE RES.	TELEPHONE OFF.	REMARKS
6.10.86	IRSHAD HUSAIN	DIRECTOR (GEOLOGY) 329, Wapda Flats Lhr.		202623	
6.10.86	KH. ASIFULLAH	DIRECTOR (TECHNICAL) PMDC Islamabad		855364	
6-10-1986	MUHAMMAD MEMON	Senior Geologist 38 A G.O.R. Colony Hyd.		25481	
	Nizamuddin Harapete	Head Deptt. of Soil Sci. S.U.			
6-10-1986	Sahabzada Noor Rasuli	Sr. Geologist L.C.A.R. Hyderabad. 38-A, G.O.R. Colony		25481	
6.10.1986	Major (Retd) Nasseem Ahmed Khan	Dy Director (T/S) CAEB Hyd			
6-10-1986	Maj (Retd) Ihtisham Ahmed	Dy Director Transhead (S)			
6/X/86	A. H. Khan	Chief Engineer GSC Hyderabad			
	Dr. K. M. Khan	Dean Faculty of Nat. Sciences S.U.			
6-10-1986	Abdul Waliqane Bhatti	P.R.O Wapda			
6-10-1986	Mohammad Akram	Sr. XEN (Mech) OFJ Jamshoro			
6-10-1986	Abdul Rashid Qureshi	XEN-II OFJ Jamshoro			
6-10-1986	Dr. Faizullah Abbasi	Chairman Mining MUET.			
6-10-1986	Prof. Dr. M. R. Sabay	Director, Industrial Liaison Jamshoro			

ENVIRONMENTAL SCOPING SESSION - LAKHRA & JAMSHORO PROJECTS

DATE	NAME	ADDRESS	TELEPHONE RES.	TELEPHONE OFF.	REMARKS
6-10-86	A.R.A TUNIA	PAKMET DEPTT		- 25905 -	
6-10-86.	Catherine DaMassa, Social Scientist	Bechtel, San Francisco			
6-10-86	Kennard Kosky	ESE, Gainesville Florida			
"	David A. Cobb, Biologist	Bechtel, San Francisco, USA			
6-10-86	M. GLENN RUTANEN-WHALEY	USAID / ISLAMABAD			
6.10.86	Fouzia Jaffari	Deptt of Mass Communication Mawem			
6.10.86	Don Sroom	British Council, Karachi			/ Bio
6-10-86	John Morgan	USAID Islamabad			
6-10-86	DR MUHAMMED YAKOOB SOOMRO	Associate Professor Mehran University Jamshoro		71242	
6-10-86	Abdus Sami Soomro	Resident Engineer Tha Thermal Power Station Kotri			
6-10-86	M. P. FAROOQUI	BECHTEL			
	Moosa Shah Hussing	Sr. Engg. L.P.S.	82340(R)	25481(O)	
6.10.86	Ghulam Rasool Akhund	Sr. Engineer L.P.S			
6.10.86	TARIQ JAWAID MEMON.	Jr. Engineer LCMP			
6-10-86	MUKHTAR AHMED CHANDIO	Jr. Engineer CIVIL			
6-10-86	~~Mr A K MAKHDOOM~~	~~Sr. Engineer~~ Civil			
6-10-86	ZAKA FAROOQ SHEIKH	Dy. Secretary Environment & Urban affairs Division M/o Housing			Please supply me the relevant Papers.

2484

ENVIRONMENTAL SCOPING SESSION-LAKHRA & JAMSHORO PROJECTS

DATE	NAME		ADDRESS	TELEPHONE RES.	TELEPHONE OFF.	REMARKS
06-10-86	Imam Illahi Khan		38A G.O.R. Colony, Hyderabad.			
6-10-86	Ijaz Ahmed Ijaz Geologist.	Wapda.	38/A, G.O.R colony Hyd.			
6. 10. 86	Engr. Niamat Ali	L.C.M.P. WAPDA	38/A G.O.R colony Hyd.			
6. 10-86	Muhammad Shafique	jr. Eng. (Environment Scientist)	38-A G.O.R colony Hyderabad.			
6. 10-86	M. Qasim Shaikh	Project Engineer	38A G.O.R. colony Hyderabad 26327-51062/52			

Few names are missing

Telephone: 26624/25481/26327

Telegrams :

No. CEJ/

OFFICE OF THE
CHIEF ENGINEER (THERMAL)
JAMSHORO AT 38/A, G.O.R.
COLONY, HYDERABAD.

Date

NAMES & ADDRESSES OF INVITEES FOR ENVIRONMENTAL SCOPING SESSION LAKHRA & JAMSHORO PROJECTS TO BE HELD AT HYDERABAD.

Sr. No.	Name & Address.	Telephone No.
1-	Mr. Sadaqat Hasan Mir, Managing Director ENERPLAN, Ministry of Planning & Development House No;2, street-74, G-6/4, I S L A M A B A D.	
2-	Syed Aijaz Ali Shah, Joint Secretary, Ministry of Housing, Works, Environment & Urban Affairs Govt. of Pakistan I S L A M A B A D.	051/822757
3-	Mr. Masood Nabi Noor, Chief Secretary, Govt. of Sind, Sind Secretariat, KARACHI.	
4-	Mr. Allah Bux Soomro, Additional Chief Secretary (Development), Govt. of Sind, Sind Secretariat, KARACHI.	
5-	Qazi Mazharul Haq Siddiqui, Vice Chancellor, University of Sind, JAMSHORO.	0221/71563
6-	Dr. Tahir Rajput, Professor Botany Department, Unviersity of Sind, JAMSHORO.	0221/71291
7-	Dr. S.H. Qureshi, Vice Chancellor, Mehran University of Engg: & Technology, JAMSHORO.	022/71197 71236
8-	Dr. Abdur Rehman Memon, 'Dean' Faculty of Engg. Mehran University of Engg: & Technology, JAMSHORO.	221/71255
9-	Dr. A.A. Ansari, Vice Chancellor, Sind Agriculture University, TANDO JAM.	)221/27043
10-	Dr. Ahmed Mustafa Khan, Director Agriculture Research (Sind Agriculture Research Institute, TANDO JAM.	)221/41606
11-	Dr. Irshad Ahmed Morani, Principal & Medical Superintendent, Liaquat Medical College & Civil Hosp. JAMSHORO / HYDERABAD.	)221/30505

Contd: ----- P/

370

Director (South) Archaeology Department, Govt. of Pakistan, Pacca Fort, HYDERABAD. 0221/27257

Mr. Qadir Bux Memon, Chief Engineer, Irrigation Kotri Barrage, Irrigation Department, G.O.S. HYDERABAD. 0221/30238

Mr. Arz Mohammad Talpur, Chief Engineer, Irrigation Development, Shahbaz Building, HYDERABAD 0221/26748

Mr. Aftab Ahmed Khan, Director General, Agriculture Extension Sind, Shahbaz Building Block-A, Thandi Sarak, HYDERABAD. 0221/24115 23894

16- Mr. A.K. Qazi, Chief Engineer, Public Health Engg. Behind Zubaida College, Near Central Jail HYDERABAD. 0221/32966

17- Mr. T.A. ANSARI? Chief Conservator Forest of Sind, Shahbaz Building, Block-A, HYDERABAD. 0221/23994

18- Mr. Khan Mohammad Khan, Chief Conservator, (Wild Life), G.O.S. Stretchen Road, KARACHI. 021/523176

19- Mr. N.K. Afghan, Additional Director, Mineral Development, Pakistan Secretariat, Block-6, Shahrae Liqquat, Saddar, KARACHI. 21/

20- Mr. Bashir Ahmed Ansari, Chief Inspector Mines, Block 87/Room No.1&2, Pakistan Secretariat, Shahrae Liaquat, Saddar, KARACHI. 021/513479

21- Khawaja Asifullah, Director Technical, P.N.D.C, 13, H-9, Post Office Shaigan, ISLAMABAD.

22- Mr. Masood Hussain Project Manager, P.M.D.C, Bungalow No.9, Block-B, Unit No.7, Latifabad, HYDERABAD. 0221/82707

23- Mr. Ali Mohammad G.Shaikh, Commissioner, Hyderabad Division, Shahbaz Building, Block-A, HYDERABAD. 0221/26092

24- Mr. Shakeel Haider, Dy.Commissioner, Hyderabad District, Darbar Hall/D.C House, HYDERABAD. 0221/25167

25- Mr. Ashiq Hussain Memon, Dy.Commissioner, Dadu District D.C House, Dadu.

26- Syed Shahbuddin Shah, Member National Assembly of Pakistan Taluka Hala, HYDERABAD.

Contd; ----- P/2...

27- Mr. Pir B[illegible] Khokhail,
Member National Assembly of Pakistan,
DADU.

28- Mr. Wasi Mazhar Nadvi,
Member National Assembly of Pakistan,
HYDERABAD.

29- Malik Asad Sikandar,
Member Provincial Assembly Sind,
KOTRI DADU.

30- Pir Khalid Jan Sarhadi,
Chairman, District Council Hyderabad,
Local Bodies, Thandi Sarak,
HYDERABAD. 0221/25706

31- Pir Ghulam Rasool Shah,
Chairman, District Council Dadu,
DADU camp at KOTRI. 0221/51129

32- Mr. Shahid Ali Baig,
General Secretary, Mine Owner Association
(Sind), C/o. National Mines, Noor Building,
Risala Road, HYDERABAD. 0221/25438

33- Factory Manager,
M/s. Sandoz, Sandoz Nagar,
JAMSHORO. 221/50181
26779

34- Syed Amir Haider Shah,
Agriculturist, P.O.Sunn,
District Dadu, DADU.

35- Syed Amjad Ali Shah Jamot,
Agriculturist, Taluka Hala,
Distt:HYDERABAD.

36- Mr. Ahad Yusuf,
Mayor, HYDERABAD.

37- Director (MST), Near Airport,
Shahrae Faisal, KARACHI.

38- Mr. G.M. Taharani,
President Mines Owners Association.

39- Mr. Khan Muhammad Panhwar,
Research Officer & Advisor to
Sind University, JAMSHORO.

40- Mr. Ghulam Sarwar Shah,
Principal, Mehran University Engg.
College, Sakrand Road,
NAWABSHAH.

Water And Power Development Authority

Telephones: _____

Telegrams: _____

No. _____ Date _____

OPTIONAL LIST.

NAME & ADDRESSES OF THE INVITEES FOR ENVIRONMENTAL SCOPING SESSION LAKHRA & JAMSHORO PROJECTS TO BE HELD AT HYDERABAD.

1- Prof. Shamim Ahmed Khan,
Head of the Department Zoology,
University of Sind, JAMSHORO.

2- Mr. Mohammad Sajjan Memon.
Director Health Services,
Govt. of Sind, Shahbaz Building,
Block-A, Thandi Sarak,
HYDERABAD.

3- Syed Arif Ali Shah,
Chief Engineer, Highways, G.O.S.
Shahbaz Building, Thandi Sarak,
Block-A, HYDERABAD.

4- Mr. Ayaz Ali Memon,
Director Agriculture Extension,
Hyderabad. Division, Shahbaz Building
Block-B, Thandi Sarak,
HYDERABAD.

5- Mr. Fazal Siddique Shaikh,
Dy.Director, Bungalow No.638, Block-B
Unit No.2, Latifabad, Hyderabad.
(Industrial & Mineral Department).

6- Mr. Irshad,
Director (Geology
WAPDA, LAHORE.

7- Mr. Subuhat Noor,
Senior Geologist,
Lakhra Coal Mines Project,
Jamshoro at HYDERABAD.

8- Mr. A. Rashid Qureshi,
Executive Engineer, 250 MW
Oil Fired Power Station,
Jamshoro at HYDERABAD.

9- Mr. Tariq Javed Memon,
Assistant Engineer (Mech:),
Lakhra Coal Mines Project,
Jamshoro at HYDERABAD.

1.	Khawaja Daood	General Manager(Thermal).
2.	Mr. Nazim Siddiqui	Chief Engineer (Design).
3.	Mr. G.M Ilias	Chief Engineer (CPP).
4.	Mr. Yusuf Eida	Director (Power Plant)
5.	Mr. Moin-ul-Haq	Director (Mining).

WAPDA OFFICIALS HYDERABAD.

6.	Mr. Anis Abbas Zaidi	Chief Engineer Jamshoro.
7.	Syed Abid Ali	Project Director (OFJ).
8.	Mr. M. Qasim Shaikh	Project Engineer (LPS).
9.	Mr. Tariq Zamir	Project Engineer (LCMP).
10.	Mr. A.K Makhdoom	Sr. Engineer (Civil) LPS.
11.	Mr. Moosa Shah Hussainy	Sr. Engineer (Env:) LPS.
12.	Mr. Mohammad Memon	Sr. Geologist LCMP.
13.	Mr. A.A Chandio	Sr. Engineer (OFJ).
14.	Mr. Zafarulla Khan	Sr. Engineer (Civil), OFJ.
15.	Mr. Maqsood Butt	Sr. Chemist (LCMP).
16.	Mr. Ghulam Rasool Akhund	Jr. Engineer (Env:) LPS.
17.	Mr. Muhammad Shafique.	Environment Scientist LPS.
18.	Mr. Mohsin Shaikh	General Manager (South) Water Wing.
19.	Mr. Ghulam Farid	Chairman Area Electricity Board,Hyd.
20.	Mr. Mehmood Wahid	Chief Engineer G.S.O.
21.	Mr.Abdul Hafiz Khan	Chief Engineer G.S.C
22.	Mr. Rafi Farooqui	Chief Engineer 500 Kv.
23.	Mr. Abdus Sami Soomro	Resident Engineer, G.T.P.S, Kotri.

Appendix E

ROFORMA FOR ENVIRONMENTAL IMPACT ASSESSMENT JAMSHORO PHASE II

DRAFT

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
1.	General	
1.1	Name of the Project:	Jamshoro Oil-Fired Power Generation Station: Phase II
1.2	Official address at which correspondence can be made:	Water and Power Development Authority Lahore, Pakistan
1.3	Name and address of consultant appointed, if any:	Bechtel National, Inc. P.O. Box 3965 San Francisco, California, USA, 94119
1.4	Name, designation, and address of official authorized to deal with this Questionnaire/ Proforma:	Nazim Siddiqui Chief Engineer, Design 106 WAPDA House Lahore, Pakistan
1.5	Date on which letter of intent was issued:	August 1986
2.	Process Details	
2.1	Production Schedule:	See Section .
2.1.1	List of main products proposed to be produced with designed daily production or capacity:	Electrical power; 1,050 MW rated capacity.
2.1.2	List of by-products produced with designed daily product capacity:	Irrigation water; approximately 20.78×10^6 L/day.

3758

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
2.1.3	Time phase for achieving full production capacity:	Approximately 4 years.
2.2	Raw Materials Consumption	
2.2.1	List all raw materials with daily consumption at full production capacity:	Fuel oil (No. 6): 52200 Tonnes/day. Water from Indus: 65.84 x 10^6 L/day.
2.2.2	List all process chemicals/ materials consumed with approximate quantities:	Chemicals used for plant operation: a) River water and wastewater treatment Alum, ferric chloride, or ferric sulfate Polyelectrolyte Sodium hypochlorite b) Make-up demineralizer and condensate polisher Sulfuric acid Sodium hydroxide c) Feedwater treatment Ammonium hydroxide Hydrazine Trisodium phosphate c) Circulating water treatment Sodium hypochlorite Sulfuric acid e) A variety of chemicals are used in the chemical laboratory for testing water, solid waste and fuels.
2.2.3	Is any recycled material from the waste of your project or any other project used in the process? If so, please specify quantities and source.	Wastewater treated for reuse as process water. Approximately 10,866 L/day.
2.2.4	Is any material salvaged from your waste stream re-usable economically for any other?	Wastewater suitable for irrigation. Approximately 20.78 x 10^6 L/day.
2.3	Manufacturing Process	
2.3.1	Source of process know-how:	WAPDA/Bechtel National, Inc.

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
2.3.2	Give a brief description of the process technology utilized with a flow-chart. (Flow-chart of the process should be attached).	Oil-fired steam electrical generation facility. 1050 MW rated capacity. Figure 3-6.
2.3.3	Have you any foreign collaboration?	Development funding to be requested of World Bank and other donor agencies.
2.4	Energy Consumption	
2.4.1	Source of energy:	
	a) In-plant generation.	Approximately 5% of plant capacity will be required for internal auxillary power (53 MW).
	b) Public supply.	Only for start-up. Estimated to be 30 MW.
2.4.2	If energy is generated in plant, type and quantity of fuel daily consumed:	This oil-fired facility produces 1050 MW. Approximately 52200 tonnes/day of fuel oil will be required.
3.	General Environment (Site climate settlement)	
3.1	Site	
3.1.1	Where is the plant proposed to be sited?	Dadu District, Sind Province, near town of Jamshoro approximately 12 km west of Indus River
	Attach map showing topographical features of the area.	Figure 4-2.
3.1.2	Elevation above mean se level:	Approximately 40 m (132 feet).
3.1.3	Area of land proposed t be acquired:	Approximately 70 acres. See Section 3.3
3.1.4	Area proposed to be built up or developed:	Approximately 70 acres.
3.1.5	Present use of the land: agriculture/forest/grazing/ settlement/fallow	Some seasonal grazing; disturbed. See Section 4.2.2.

377

Types of Information		Information or Sections of Environmental and Social Soundness Assessment
3.1.6	Indicate the nature of topography near the site: plains/valley/hilly	Open, scrub vegetation, low hills. See Section 4.1
3.1.7	Specify site character: river basin/coastal/ estaurine/land-locked	Semi-arid, open. See Section 4.1
3.1.8	Is the land situated within any municipal or corporation jurisdiction?	Dadu District. See Section 4.1
3.1.9	Is the land situated in an approved industrial zone or estate? If so, please specify.	No
3.1.10	What, of the following features, exist within 30 km of the site?	
	i) Human settlements: specify population.	See Section 4.2.1
	ii) Agricultural land: specify crops.	See Section 4.1.2
	iii) Grazing land:	See Section 4.1.3
	iv) Fisheries:	See Section 4.1.4
	v) Forest/sanctuary/ natural park:	See Section 4.2.2
	vi) Nullahs/streams/ rivers:	See Section 4.1.4
	vii) Ponds/lakes/dams:	See Section 4.1.4
	viii) Estuary/sea:	NA
	ix) Hills/mountains	See Section 4.1.1
	x) Archaelogical/ Historic/Cultural/ Scenic sites/ Scientific Institutions/Hospitals/ Sanatoria/Religious importance:	See Sections 4.2.6, 4.2.2
	xi) Industries, specify:	See Section 4.3.3
3.1.11	Type of flora and fauna, especially wildlife, endangered species:	See Sections 4.1.2, 4.1.3
3.1.12	Present employment or occupational pattern in the area:	See Section 4.3.1

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
3.1.13	Prominent Endemic Disease (Fluorosis, Malaria, Filaria, Malnutrition, etc.):	See Section 4.4
3.1.14	Mortality rates: (Crude, Infant, Material):	Not available.
3.1.15	Any other observation regarding state of the environment?	See Section 4.0
3.2	Climate	
3.2.1	Indicate the climatic conditions at the site (e.g., arid, semi-arid, etc.).	Semi-arid. See Section 4.1.6
3.2.2	Rainfall yearly average. Range:	See Section 4.1.6
3.2.3	Temperature seasonal. Ranges:	See Section 4.1.6
3.2.4	Provide information on speed and direction of wind.	See Section 4.1.6
3.3	Settlement	
3.3.1	Total number of persons proposed to be employed: (a) During construction: (b) After completion:	See Section 5.2.1
3.3.2	Do you propose to build a township/housing quarters for your employees?	WAPDA will build workers' colony. See Section 5.2.3
3.3.3	Area allocated for above:	72 hectares (178 acres).
3.3.4	Population to be accommodated:	See Section 5.2.3
3.3.5	Distance from township to plant site:	0.5 km. See Section 5.2.3

379X

	Types of Information	nformation or Sections of Environmental and Social Soundness Assessment
3.3.6	Services provided in township:	nformation to be provided by WAPDA.
	i) Water - daily consumption	
	ii) Sewer system:	
	ii) Sewage treatment:	
	iv) Garbage disposal:	
	v) Drainage:	
	vi) Any other:	
4.	Water Requirements:	
4.1	What treatment is given before use, if any?	See Section 5.1.3
4.2	Average daily quantities and characteristics of water consumed:	
	i) Process and wash:	0.84×10^6 L/day
	ii) Cooling:	61.29×10^6 L/day
	iii) Sanitary:	3.82×10^6 L/day
	iv) Total:	68.8×10^6 L/day.
4.3	Are adequate quantities of water available?	See Section 5.1.3
	i) At present:	Yes.
	ii) For future expansion:	Yes.
5.	Wastewater Discharges:	
5.1	Total quantity of wastewater discharged from the project per day:	See Section 5.1.3
5.2	Wastewater discharges per day from:	See Section 5.1.3
	i) Process and wash (with break up, where possible):	
	ii) Cooling:	
	iii) Sanitary:	
	iv) Total:	

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
5.3	How do you propose to discharge the wastewater? i) Separate streams/ combined: ii) Continuous/ intermittent:	Ponded for evaporation and treated for irrigation. No discharge back to Indus River.
5.4	Type of treatment proposed to be adopted: Give details and flow chart:	See Sections 5.1.3 and 6.1.3
5.5	What standards for treatment effluent do you propose to adopt?	Primary for ponded sanitary wastes. USEPA standards for irrigation water. See Sections 5.1.3 and 6.1.3
	Does it conform to standards prescribed by State/Central Water Pollution Board, Local Authority, or other statutory authority?	Yes. See Section 5.1.3
5.6	Mode of final discharge: (open channel/pipeline/ covered drains)	Evaporation ponds and pipes to irrigation canals. See Sections 5.1.3 and 6.1.3
5.7	Point of final discharge: fallow land/agricultural land/sewer/river/lake bay/estuary/sea. Give details of outfall design.	Evaporation ponds and irrigation canals. See Sections 5.1.3 and 6.1.3
5.8	Is any portion of the wastewater proposed to be recycled? If so, give details.	Steam generator blowdown, 108,660 L/day per steam generator.
5.9	What methods do you propose to adopt for handling and disposal of sludge from treatment plants?	Salts remain in lined evaporation pond for life of plant. Sludge to landfill.

3814

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
5.10	Indicate available information on wastewater characteristics before treatment as below. a) Physical Parameters: Temperature, pH, color, turbidity, odor, total solids, total suspended solids, and total volatile solids. b) Chemical Parameters: Acidity, total, and pH; Alkalanity, total and pH; Hardness, total; BOD; COD; Oil and Grease; total N; Phosphates, total; Chlorides; Sulphates; Sodium; Potassium; Calcium; and Magnesium.	See Section 5.1.3
5.11	What other specific toxic substances are discharged? Please specify nature and concentration: (inorganics, organics, including pesticides and organic chlorine compounds, phenols, lignin, mercaptans, heavy metals, and radioactive substances).	See Section 5.1.3
6.	Solid Wastes: Process and Treatment Plants	Refer to Appendix G for proposed solid waste management plan.
6.1	Total quantity of solid wastes in tonnes per day:	The retention basin will produce 26 tonnes/day, the evaporation pond will produce 0.27 tonnes/day.
6.2	Nature of Wastes: Lumps/ Granules/Dust/Slurry/ Sludge	Sludge, evaporation salts, and silt from Indus River.
6.3	Type of waste (organic inorganic, ash, glass, natal, etc.)	Oil ash, iron oxide, iron, copper, and silt from Indus River.

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
6.4	Method proposed for disposal, including treatment plant: landfill/dumping/sea/ lagoon/marsh/composting/ incineration/solid	Evaporation ponds (salts); landfill (sewage sludge).
6.4.1	If landfill, possibility of leaching of toxic compounds into soil, ground water, or surface water:	An impervious liner will be installed.
6.4.2	If incinerated, details of incineration plant and procedures:	None in Phase II generation facilities; may be limited incineration in WAPDA community.
6.6	Do you anticipate any problems regarding collection, handling, and transport of solid wastes?	No.
6.7	Are there any problems of subsequent pollution of air, water, or soil likely at the place of disposal of solid wastes?	No.
7.	Atmospheric Emissions	
7.1	Emission from fuel burning:	See Section 5.1.4
7.1.1	Anticipated quantity of stack emissions:	See Section 5.1.4
7.1.2	Temperature of emission:	See Section 5.1.4
7.1.3	Composition of emission:	See Section 5.1.4
	(a) Particulates and smoke nature and quantity:	
	(b) Gases: Sulphur dioxide Nitrogen oxides Hydrocarbons Carbon monoxide Moisture Other, specify.	

2834

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
7.2	Emissions from process:	See Section 5.1.4
7.2.1	Anticipated emissions, quantity:	See Section 5.1.4
7.2.2	Temperature:	See Section 5.1.4
7.2.3	Composition of emissions a) Particulates, nature and quantity: b) Gases: i) Sulphur dioxide ii) Nitrogen oxides iii) Carbon monoxide iv) Ammonia v) Acide Mists vi) Halogens vii) Hydrocarbons viii) Mercaptans ix) Others, specify:	See Section 5.1.4
7.3	Height of stack(s), for atmospheric emissions for 150 meters:	See Section 5.1.4
7.4	Proposed air pollution control system:	None. See Section 5.1.4
7.5	Proposed method of handling and disposal of wastes trapped by pollution arresting equipment:	None. See Section 5.1.4
7.6	Are any standards of emission prescribed for or adopted by your industry?	See Sections 4.1.7, 5.1.4
8.	Other Types of Pollution	
8.1	Is your project industry likely to cause noise pollution?	See Section 5.1.5

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
8.2	Is your project industry likely to cause any odor pollution?	No.
	If yes, what measures are proposed to be taken?	-
8.3	Is your project industry likely to cause any thermal pollution?	130°C out stacks only; no discharge of heated water to Indus River.
	If yes, what measures are proposed to be taken?	
8.4	Is your project industry likely to cause radio-active pollution?	No
	If yes, what measures are proposed to be taken?	-
8.5	Describe the nature and extent of pollution nuisance caused during construction phases and measures taken to contain the same.	See Sections 5 and 6.
8.6	Work Environment Hygiene and Housekeeping:	
8.6.1	What major health/safety hazards are likely in the working environment in your factors?	See Section 5.4
8.6.2	What provision have you made to conform to health and safety requirements as per Factories Act?	See Sections 5.4 and 6.4

385X

	Types of Information	Information or Sections of Environmental and Social Soundness Assessment
9.	Management of Pollution Control	
9.1	Give details of the organizational set-up you propose to have for pollution control.	A coordinated program linking Phases and II under the responsibility of WAPDA has been recommended.
9.2	What is the level of expertise of the person in charge of pollution control?	Registered Sanitary Engineers
9.3	Do you propose to monitor the pollution from your industry?	Yes
	If yes, give details.	See Section 6.0
9.4	What laboratory facilities do you propose to have for the above?	Appropriate to support secondary treatment facilities.
9.5	Give details of operation and maintenance of facilities you propose to have for treatment plants and pollution monitoring and control equipment.	Water treatment plants will be operated in accordance with US EPA standards. Conductivity and pH will be monitored and TSS, Fe, Cu, Oil and Gas will be sampled regularly.
10.	Cost of Pollution Control	
10.1	Total expenditure proposed for pollution monitoring and control:	See Section 7.0.

Type of expenditure	Amount (Rs)	Percentage of total capital investment/operating expenditure of the industry
Capital		$US 12.33 x 10^6 for water treatment; approximately 50 % for pollution control and 50 % for in-process control. Section 7.0.
Recurring (including monitoring)		

386

Types of Information	Information or Sections of Environmental and Social Soundness Assessment
11.1 Climate and Air Quality	
i) Will the project modify the local wind behavior?	No
ii) Will the project have an impact upon the local precipitation/ humidity pattern?	No
iii) Will the project have an impact upon the local temperature pattern?	No
iv) Will the project generate and disperse atmospheric pollutants?	See Section 5.0.
v) Will the project generate any intense odors?	No.
11.2 Water	
i) Will the project alter the hydrological balance?	No.
ii) Will the project affect the ground water in terms of quality/quantity, depth, and direction of flow?	No.
iii) Will dewatering methods be necessary to undertake excavation?	No.
iv) Will the project induce a major sediment influx into area water bodies?	No.
v) Will the project impede the natural drainage pattern and/or induce alteration of channel form?	No.

Types of Information	Information or Sections of Environmental and Social Soundness Assessment
vi) Will the project impair existing surface waters through filling, dredging, water extraction, or other detrimental practices?	No.
vii) Will recreation or aesthetic values be endangered?	No. See Section 5.2
11.3 Geotechnical	
i) Is there risk of damage or loss resulting from tectonic/seismic activity and/or volcanic activity?	See Section 4.1.5
ii) Are there mineral resources of potential value close to the project?	NO
iii) Will there an an increase in rock deposition/degradation as a result of the project?	No
iv) Are there potential dangers related to slow failure or falling rock?	No
v) Is there risk of major ground subsidence associated with the project?	No
11.4 Soil	
i) Will there be a substantial loss of soil due to construction or operational practices?	No

Types of Information	Information or Sections of Environmental and Social Soundness Assessment
ii) Will there be a risk of losses due to instability?	Designed to prevent settlement.
iii) Will project cause or be exposed to liquefaction of soils in slopes or foundations?	No.
iv) In case of settlement/ heave, will there be a risk of damage of structure or services?	Designed to prevent settlement.
v) Will the project modify the property of impacted soil?	No. Specially prepared backfill will be used if load bearing capacity of excavated soil is insufficient.
11.5 Ecology	
i) Are there rare/ endangered species which require protection?	See Sections 4.1.3.2, 5.1.2, 6.1.2.
ii) Are there species which are particularly susceptible to human activities?	See Sections 4.1 and 5.1.
iii) Would the loss of certain plants species deny food or habitat to wildlife species?	See Section 5.1.1.
iv) Are there any unusual population communities of plants that may be of scientific value?	See Section 4.1.2.
v) Will project activities impair natural productivity?	See Section 5.1.1.
11.6 Land Use and Land Capability	
i) Will the project conflict with existing or proposed land use?	See Sections 5.2.2, 6.2.

Types of Information	Information or Sections of Environmental and Social Soundness Assessment
··) Will the project degrade land capability types?	No. See Section 5.2.2.
11.7 Noise and Vibration	
i) Will the internal noise level present a potential risk to the hearing of workers?	No. Controlled in accordance with US OSHA standards.
ii) Will the safe operation of the project be affected?	No.
iii) Will the project create noise levels which will cause annoyance or discomfort to nearby properties?	Infrequent noise disturbance expected during construction. None during operation. See Section 5.1.5.
iv) Will the project cause damage to structures, both natural and manmade, due to vibration?	
v) Will the vibration levels within the plant be such that there is a risk to employees safety?	No. Plan incorporates many safety features to protect workers. US OSHA standards for worker protection will be followed with repect to noise, machinery walkways, etc.
11.8 Visual Quality	
i) Will the content of the scene perceived by the residents of the surrounding area be adversely affected by the project?	Phase I and II will change view of area. However, there is currently a sub-statio at the site and many transmission towers
ii) Will the coherence of the surrounding area be impaired by the project?	It will be changed and the appearance will be less natural.

Appendix F

SUMMARY OF REGULATIONS AND PERMIT PROCEDURES

Resource	Authority	Administering Agency	Requirements
Comprehensive Environmental Protection	Ordinance No. XXVII of 1983	Ministry of Housing and Works; Environmental and Urban Affairs Div.	Environmental pro forma
Protection of Antiquities	Act No. VI of 1977	Ministry of Culture, Archaeology, Sports, and Tourism; Dept. of Archaeology	Provides protection and preservation of historically and archaeologically important sites
Water Resources	West Pakistan Act of 1958	WAPDA	Management of water resources
	Sind Irrigation Act of 1879	Government of Sind, Irrigation and Power Department	Granting of water use from Indus River
Wildlife	West Pakistan Wildlife Protection Ordinance of 1959	Ministry of Food, Agriculture, and Cooperatives; Zoological Survey; National Council for Conservation of Wildlife	Promote conservation and establish limits on hunting
Wildlife	Sind Wildlife Protection Ordinance	Government of Sind, Ministry of Forest, Wildlife, and Forestry	Promote conservation and limit hunting
Forests	Forest Act of 1927 No. XVI	Ministry of Food, Agriculture, and Cooperatives; Pakistan Forest Institute; Government of Sind, Ministry of Forest, Wildlife, and Forestry	Protection; regulation of exploitation of forests

Sources: ESE, 1986; KBN, 1986.

Appendix G

RECOMMENDED SOLID WASTE MANAGEMENT PLAN
JAMSHORO PROJECT

1. IDENTIFICATION OF SOLID WASTES

Solid wastes generated by oil-fired steam electric power plants result from a number of processes and subsystems at the site. Major sources of solid wastes include the following:

- Metal cleaning wastes
- Boiler blowdown
- Make-up water treatment
- Condenser cooling system
- Sanitary waste system

Other miscellaneous wastes that will be generated during plant operation include floor and yard drainage, maintenance wastes and sampling wastes.

Wastes from the cooling water system and boiler blowdown are discharged more or less continuously during plant operation. Water treatment operations that utilize a cleaning or a regenerative step in the cycle (ion exchange, filtration, and clarification) generate wastes

397

intermittently, but on a regular basis, during plant operation. Maintenance cleaning wastes are produced less frequently since maintenance cleaning typically occurs during scheduled shutdowns. Finally, floor and yard drainage depends on meteorological and other factors that are unrelated to the production of electricity.

The flow diagram shown in Figure G-1 (Figure No. 9M71-001, Plant Water Use Diagram) schematically illustrates the various sources of solid waste that will be generated at the Jamshoro steam electric power plant. These wastes are primarily aqueous in nature and will be treated prior to discharge for agricultural purposes. Since a number of the sludges and solids resulting from treatment of the various waste streams are of environmental concern, a solid waste management plan must be developed early in the project schedule.

The following paragraphs briefly describe each of the waste streams identified for the Jamshoro project.

Boiler Cleaning Wastes

Often, as in the case of Jamshoro, no flyash collection system is necessary because of the low ash content of the oil used. Bottom ash production at oil-fired plants is usually so insignificant that most plants rely on periodic fireside (furnace and a preheater) washing. In addition, periodic chemical cleaning of the boiler tubes will occur.

Figure G-1

Plant Water Use Diagram

394

Iron, copper, nickel, zinc, and chromium are typically pollutants of the maintenance cleaning waste stream.

Boiler Blowdown

To control the buildup of dissolved solids in the boiler water, a controlled amount of boiler water is bled off (boiler blowdown). Boiler blowdown is a source of soluable salts, iron and copper.

Water Treatment

The quality of the boiler make-up water is dependent upon both the raw water quality and the boiler operating pressure. Since modern high pressure, high temperature boilers require a controlled stream of high quality water, significant pretreatment including clarification, ion exchange, and filtration is often required. The Jamshoro project water treatment system includes clarification, ion exchange, filtration, chlorination, and polishing. The principal chemical additives include chlorine, sulfuric acid, sodium hydroxide, ammonium hydroxide, hydrazine, and perhaps lime. These additives or their compounds may appear in the water treatment sludges.

Condenser Cooling System

A closed cycle cooling system has been selected for the Jamshoro project. To remove heat from the recirculated cooling water, cooling towers will be used. To control the build-up of dissolved solids within the system, bleed streams (cooling tower blowdown) must be continuously drained from the system.

The chemical additives to the Jamshoro cooling water system are expected to be chlorine and sulfuric acid

Sanitary Wastes

Sewage from the Jamshoro project excluding the sanitary waste from the associated workers' colony will be directed to a sewage treatment system. After secondary treatment, it is recommended that effluent be discharged to evaporation ponds for final disposal.

2. SOLID WASTE MANAGEMENT PLAN

The Jamshoro project recognizes the need for a comprehensive solid waste management plan in order to protect the environment from pollutants. The proposed plan is comprised of specific treatment procedures for the individual solid waste sources identified above. These treatment procedures are described in the following paragraphs.

396X

Boiler Cleaning Wastes

Fireside boiler cleaning is expected to occur twice a year. Waste: from the cleaning process will be stored for treatment with lime for pH adjustment prior to being sent to a lined precipitation/evaporation pond. Supernatant from this pond will evaporate to atmosphere

Boiler tube-side cleaning waste will be disposed of offsite.

Boiler Blowdown

Boiler blowdown is expected to be of high quality and will be r within the plant as cooling tower make-up.

Make-up Water Treatment System Effluents

All effluents from the Water Treatment System will be treated to comply with U.S. EPA effluent guidelines prior to discharge.

Clarifier Blowdown

Clarifier blowdown and filter backwash will be directed to the raw water retention basin for settlement.

Make-up Demineralizer Regeneration Waste

Regeneration wastewater that is low in total dissolved solids (TDS) will be routed to a wastewater retention basin for settlement prior to being sent to the pH adjustment tank. After pH adjustment, this effluent will be discharged.

Regeneration wastewater that is high in TDS will be neutralized prior to being sent to the wastewater retention basin. After pH adjustment, this wastewater will be discharged.

Condensate Polisher Regeneration Wastewater

Wastewater from the condensate polisher will be neutralized prior to being sent to the wastewater retention basin. After pH adjustment, this wastewater will be discharged.

Condenser Cooling System

Since cooling tower blowdown will be in compliance with U.S. EPA effluent guidelines, no additional treatment will be required prior to discharge.

24XX

During periods of chlorination, cooling tower blowdown will be terminated and will not be discharged again until chlorine levels are within guidelines.

Sanitary Waste Treatment

Treated solids from the sanitary waste treatment system will be landfilled and will present no hazard to the environment.

Miscellaneous Plant Drains

Intermittent effluent from the plant drains will be sent to an oil/water separator prior to being routed to the wastewater retention basin and ultimately to the pH adjustment tank prior to discharge. These drains will not contain chromates.

Separated oil will be disposed of offsite or be recirculated to the fuel oil storage system for use in the plant.

Appendix H

METEOROLOGICAL DATA

Meteorological data taken from the WAPDA-operated meteorological stations located at the Jamshoro and Lakhra sites were used to describe the dispersion meteorology. These stations were installed with U.S. AID assistance in May 1985 and provide an annual data base for analysis.

Meteorological data from the Jamshoro site are expected to be representative of the proposed plant's location because it is the closest meteorological station to the proposed site, and the necessary parameters to describe the dispersion meteorology were developed. However, because a full year of meteorological data was not available, data from the Lakhra site were used to supplement the Jamshoro data base to make a complete set of hourly data. The Lakhra data from May 1985 through February 7, 1986, and the Jamshoro data from February 8, 1986, through April 30, 1986, were used.

A comparison of the air dispersion model and meteorological preprocessor input requirements to the parameters available from the

400X

stations in Lakhra and Jamshoro is presented in Table H-1. Because the meteorological program was based on processing data in specific formats from NWS stations in the United States, the preprocessor program was modified to convert parameters into proper units, calculate stability and mixing heights by assuming values of cloud cover and ceilings, and assigning an indicator for hours of missing data. Prior to processing the data through the preprocessor, however, the Lakhra and Jamshoro data were reviewed to compare and determine consistency of reported values between the sites (i.e., wind direction, wind speed, and temperature) and ensure that the reported values were reasonable and generally typical for the time of year, time of day, and location. Based on the results of that review, the Lakhra data were adjusted in the following manner:

1. Wind speed - The wind speeds at Lakhra were reduced by 25 percent to account for values that were unrealistically high on hourly and monthly average bases (e.g., winds were in excess of 32 kph 50 percent of the time). This adjustment resulted in wind speeds that appeared more typical throughout the day and seasons than those observed for Jamshoro.

2. Temperature - The temperatures for Lakhra were adjusted using the same temperature scale used at the Jamshoro site.

Table H-1

Comparison of Air Dispersion Model and Meteorological Preprocessor Input Requirements to Parameters Available from Meteorological Stations at Lakhra and Jamshoro

Parameter	Lakhra and Jamshoro Meteorological Stations	Model and Preprocessor Requirements
Wind Direction		
Frequency	Every hour	Every hour
Reported Units	Nearest 10 degrees; up to 36 directions	Nearest degree but can be ra ized over sector width for reported direction
Wind Speed		
Frequency	Every hour	Every hour
Reported Units	mph	Units converted to m/s
Minimum Value	3 mph	3 knots or 1.0 m/s
Temperature		
Frequency	Every hour	Every hour
Reported Units	°C	Units converted to K
Stability(1)		
Based on:		
Cloud Cover		
Frequency	Not available	Every hour
Reported Units		Units coded from 0-10, which, when multiplied by 10, indicate amount of cloud cover in percent
Cloud Height		
Frequency	Not available	Every hour
Reported Units		Actual height in ft
Wind Speed	See above	See above
Mixing Height(2)		
Based on:		
Radiosonde Data		
Frequency	Not available in format for model	Twice daily
Reported Values, Units		Sufficient height to compute mixing height
Temperature	See above	See above
Stability	See above	See above

(1) Not measured directly but inferred using Turner method (USEPA, 1964) and specified parameters.
(2) Not measured directly but inferred using Holzworth method (USEPA, 1982) and specified parameters.
Source: ESE, 1986.

402X

The frequencies of wind directions and wind speeds for the combined data set using the Lakhra and Jamshoro data are shown in Figures 4-8 and 4.9, for the May to September and the October to April periods, respectively. These figures are based on observations from both sites. The data indicate the influence of the monsoon seasons, which produce a predominant west-southwest wind direction occurring approximately 21 percent of the time, primarily during the summer months (i.e., June to September) and secondary prevailing north-northeast wind direction occurring approximately 15 percent of the time, primarily during the winter months.

A summary, based on the processed meteorological data, of the frequency of prevailing wind directions and atmospheric stability for the combined Lakhra and Jamshoro data is presented in Table H-2. Using actual observations, no calm conditions occurred throughout the period of observation. The most frequent atmospheric stability is neutral stability (i.e., Class D), which occurred approximately 65 percent of the time, and during day or nighttime hours. By comparison, unstable stability (i.e., Classes A, B, and C), which is daytime stability, had a frequency of 17 percent. Stable stability (i.e., Classes E and F) occurring during the night had a frequency of approximately 18 percent. The low frequency for very and moderately unstable stability is related to the high wind speeds observed. Higher wind speeds during the day and night increase the occurrence of neutral conditions and decrease the potential for other stabilities to occur

Table H-2

Frequency of Prevailing Wind Directions and Atmospheric Stability for the Combined Lakhra and Jamshoro Data

Case	Number of Values	Atmospheric Stability Occurrence (Percent)* A (Very Unstable)	B (Moderately Unstable)	C (Slightly Unstable)	D (Neutral)	E (Slightly Stable)	F (Moderately Stable)
Processed Data for Model Input*	6,522	0.2	3.3	13.5	65.3	14.8	2.9

Case	Wind Statistics (Percent) Most Frequent Wind Directions West-Southwest	West	North-Northeast	North-East
Processed Data for Model Input*	21.0	18.0	15.0	10.7

*Based on temporal interpolation scheme and not allowing stability to vary by more than one class per hour.

Source: ESE, 1986.

Appendix I

WATER RESOURCES DATA

405'x

Table I-1. Maximum and Minimum Discharges (m^3/sec) of the Indus River, 1981-1983, Sample Station Kotri Barrage

YEAR/LOCATION	JANUARY		FEBUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		YEAR	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1981																										
UPSTREAM OF BARRAGE	32,473	3,657	30,831	11,954	11,640	2,830	44,261	8,075	171,510	13,410	169,224	12,742	180,401	26,650	316,246	152,110	185,369	21,501	20,100	8,055	9,910	3,412	6,952	2,138	316,246	0
DOWNSTREAM OF BARRAGE	12,107	3,657	12,021	0,431	4,390	0	39,382	1,575	147,863	7,200	137,757	0	165,575	0	302,172	136,130	127,301	6,432	8,100	0	0	0	6,952	0	302,172	0
WITHDRAWAL FROM BARRAGE	20,366	0	18,810	7,523	7,242	2,830	4,879	6,500	23,647	6,210	31,467	20,742	22,826	26,650	14,074	15,976	18,068	15,069	12,000	8,055	9,910	3,412	0	2,138	31,467	0
1982																										
UPSTREAM OF BARRAGE	17,540	3,000	16,090	1,247	9,153	1,273	24,043	2,711	76,516	12,819	45,115	14,660	47,218	35,069	250,054	33,191	162,245	5,904	30,709	13,695	15,191	1,332	25,782	1,013	259,054	0
DOWNSTREAM OF BARRAGE	0	3,000	1,105	0	0	0	20,000	0	58,385	6,150	12,300	0	10,400	1,496	219,661	2,751	131,899	70	2,600	2,903	2,899	0	1,981	0	219,661	0
WITHDRAWAL FROM BARRAGE	13,586	0	15,785	1,247	9,153	1,273	4,043	2,711	18,131	7,969	32,815	17,960	28,818	34,286	30,393	28,440	30,746	6,824	23,109	10,792	12,292	1,332	17,801	1,313	34,286	0
1983																										
UPSTREAM OF BARRAGE	22,571	1,651	9,496	1,646	5,347	799	126,138	931	114,868	30,582	123,693	51,544	170,620	62,819	344,790	111,680	193,163	46,920	38,084	11,278	12,594	8,959	717,032	4,835	717,032	0
DOWNSTREAM OF BARRAGE	3,279	0	0	0	0	0	114,526	0	90,726	9,052	88,932	20,252	149,300	32,305	358,179	85,488	474,311	33,500	23,000	2,231	2,213	482	17,032	432	474,311	0
WITHDRAWAL FROM BARRAGE	19,292	1,651	9,496	1,646	5,347	1,099	11,612	931	24,142	21,536	34,761	31,292	25,320	30,514	6,619	26,192	18,852	13,420	15,084	9,047	10,381	9,627	0	9,303	34,761	0

SOURCES: Institute of Public Health Engineering and Research, 1983.

ESE, 1985.

Table I-2. Discharge Characteristics of Indus River at Sehwan for the Years 1972-75 and 1979*

Year	MONTHLY AVERAGE DISCHARGE (CUSECS)											
	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1972	6,010	2,350	1,520	5,370	20,000	82,400	224,000	136,000	62,000	7,640	2,740	2,490
1973	13,400	2,170	1,160	21,000	57,600	159,000	396,000	497,000	305,000	51,900	11,800	7,120
1974	18,200	6,440	2,330	73,200	9,230	34,200	70,300	93,400	12,000	7,230	2,760	1,820
1975	9,220	1,950	1,250	2,060	12,600	54,600	135,000	249,000	312,000	31,800	4,990	3,870
1979	13,000	11,200	63,500	68,600	77,500	50,400	170,000	229,000	51,900	30,100	13,000	—†
AVG	11,966	4,822	13,952	34,046	35,386	76,120	199,060	240,880	148,580	25,734	7,058	3,825

*Minimum daily discharge for period of record as follows:

Extreme Daily Minimum: 895 cusecs (for 7 consecutive days in April 1975).
Average of Extreme Daily Minimums for Period: 1,363 cusecs.

† Data not available.

Source: WAPDA Surface Water Hydrological Report, 1960-1979.

Table I-3. Mean Monthly Water Quality Data, 1980-1984, Sample Station Upstream of the Vetri Barrage near the Left Divide Wa.

	O-PHOSPHATE mg/l	F-COLIFORM MPN/100 ml	AMMONIUM IRON TOTAL mg/l	SODIUM mg/l	SULFATE mg/l	CHLORIDE mg/l	MAGNESIUM mg/l	FLUORIDE mg/l	C.O.D. mg/l	IRON TOTAL
JANUARY	0.01	118	0	15.6	103	39	18.4	0.3	76.2	0.2
FEBRUARY	0.01	112	0	15.4	104	41	16.6	0.3	18.2	0.2
MARCH	0.02	109	0	13.2	105	45	19.1	0.4	16.3	0.1
APRIL	0.02	107	0	12.9	96	41	17.0	0.4	19.4	0.1
MAY	0.02	112	0	14.2	101	40	16.1	0.4	12.0	0.1
JUNE	0.02	104	0	13.4	100	36	13.3	0.4	10.1	0.1
JULY	0.00	92	0	13.9	102	31	14.3	0.3	0.9	0.1
AUGUST	0.00	92	0	13.0	90	37	19.4	0.3	10.0	0.1
SEPTEMBER	0.00	95	0	14.6	91	39	16.2	0.3	14.1	0.1
OCTOBER	0.00	100	0	14.7	96	40	17.3	0.3	13.3	0.1
NOVEMBER	0.00	100	0	14.0	97	41	19.8	0.3	14.9	0.1
DECEMBER	0.01	115	0	13.1	97	39	19.4	0.3	17.7	0.1

	TEMP IN DEGREES C	pH	COND mmho/cm	D.O. mg/l	CHLORIDE mg/l	ALKALINITY TOTAL mg/l	SUSPENDED SOLIDS mg/l	N-NH3 mg/l	NO2 +NO3	B.O.D. mg/l
JANUARY	18	7.4	310	10.0	50	106	110	0.30	2.2	7.0
FEBUARY	19	7.4	346	10.6	55	105	60	0.30	2.2	6.9
MARCH	24	7.4	395	11.2	63	109	46	0.22	2.3	6.5
APRIL	30	7.5	367	10.6	57	100	30	0.16	1.9	6.1
MAY	32	7.5	360	9.1	56	100	160	0.27	1.9	5.7
JUNE	34	7.5	332	0.2	51	100	403	0.20	1.0	4.0
JULY	31	7.5	309	7.2	46	90	1213	0.16	1.0	4.7
AUGUST	30	7.5	303	7.0	43	93	2078	0.16	1.9	5.9
SEPTEMBER	29	7.5	322	0.0	46	90	1440	0.16	1.9	6.0
OCTOBER	20	7.5	327	0.9	49	102	270	0.16	2.0	6.5
NOVEMBER	23	7.4	333	10.0	54	96	50	0.10	2.0	7.0
DECEMBER	21	7.4	320	12.3	49	109	50	0.24	2.3	7.5

SOURCE: Public Health Engineering Research Laboratory, Hyderabad; ESE, 1985

Table I-4. Water Quality Monitoring Data

Temperature (DEG C)

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY		30.4					30.40	30.40	30.40	0.00	30.40	30.40	30.40	0.00
JUNE	27.9	28.6	29.0	28.0	30.0	30.0	28.92	30.00	27.90	0.85	29.12	30.00	28.00	0.79
JULY	26.0	25.6	25.5	26.1	25.8	26.0	25.83	26.10	25.50	0.22	25.80	26.10	25.50	0.23
AUGUST	30.6	30.0	30.0	28.0	30.0		29.72	30.60	28.00	0.89	29.50	30.00	28.00	0.87
SEPTEMBER	29.7	32.6	29.8	30.3	30.0	30.3	30.45	32.60	29.70	0.99	30.60	32.60	29.80	1.02
OCTOBER														
NOVEMBER	24.0	24.0	24.0	24.0	24.0	24.0	24.00	24.00	24.00	0.00	24.00	24.00	24.00	0.00
DECEMBER	21.3	19.2	19.2	19.2	19.2	19.2	19.55	21.30	19.20	0.78	19.20	19.20	19.20	0.00
1986														
JANUARY	16.1			18.0	18.0	18.0	14.02	18.00	0.00	7.05	13.50	18.00	0.00	7.79
FEBRUARY	22.0	22.0	21.6	22.0	21.5	21.6	21.78	22.00	21.50	0.22	21.74	22.00	21.50	0.22
MARCH	22.0	21.0	21.0	21.3	21.5	21.7	21.42	22.00	21.00	0.36	21.30	21.70	21.00	0.28
APRIL	21.0	20.0	21.0	19.0	22.0	22.0	20.85	22.00	19.00	1.07	20.80	22.00	19.00	1.17
MAY	25.0	24.0	25.0	24.0	24.0	25.0	24.50	25.00	24.00	0.50	24.40	25.00	24.00	0.49
JUNE	30.0	32.8	32.4	32.4	32.3	32.5	32.07	32.80	30.00	0.94	32.48	32.80	32.30	0.17
JULY	32.2	32.3	32.2		32.2	32.2	32.22	32.30	32.20	0.04	32.23	32.30	32.20	0.04
AUGUST	26.8	25.0	30.5	23.3	23.3	23.3	25.37	30.50	23.30	2.63	25.08	30.50	23.30	2.79
MEAN	25.33	26.25	24.37	24.28	25.27	25.06								
MAXIMUM	32.20	32.80	32.40	32.40	32.30	32.50								
MINIMUM	16.10	19.20	0.00	18.00	18.00	18.00								
STD. DEV.	4.39	4.65	8.01	4.31	4.64	4.64								

1094

Table I-4 (cont'd)

pH

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	8.34	7.20					7.77	8.34	7.20	0.57	7.20	7.20	7.20	0.00
JUNE	8.33	8.48	8.41	8.50	8.40	8.30	8.40	8.50	8.30	0.07	8.42	8.50	8.30	0.07
JULY	7.90	8.00	8.40	8.00	8.10	7.80	8.03	8.40	7.80	0.19	8.06	8.40	7.80	0.20
AUGUST	7.40	7.45	7.40	7.40	7.50		7.43	7.50	7.40	0.04	7.44	7.50	7.40	0.04
SEPTEMBER	7.80	8.00	7.80	8.10	7.50	7.70	7.82	8.10	7.50	0.20	7.82	8.10	7.50	0.21
OCTOBER														
NOVEMBER	8.08	8.05	8.10	8.19	8.06	8.27	8.13	8.27	8.05	0.08	8.13	8.27	8.05	0.08
DECEMBER	7.90	8.07	8.00	8.05	8.04	7.90	7.99	8.07	7.90	0.07	8.01	8.07	7.90	0.06
1986														
JANUARY	7.90		8.00	7.60	7.30	7.70	7.70	8.00	7.30	0.24	7.65	8.00	7.30	0.25
FEBRUARY	7.70	7.80	7.70	7.70	7.50	7.50	7.65	7.80	7.50	0.11	7.64	7.80	7.50	0.12
MARCH	7.76	7.66	7.80	7.70	7.70	7.65	7.71	7.80	7.65	0.05	7.70	7.80	7.65	0.05
APRIL	8.30	8.40	8.40	8.10	8.20	8.30	8.28	8.40	8.10	0.11	8.28	8.40	8.10	0.12
MAY	8.20	8.10	8.00	7.90	7.90	8.00	8.02	8.20	7.90	0.11	7.98	8.10	7.90	0.07
JUNE	8.70	7.60	7.60	7.60	7.60	7.60	7.78	8.70	7.60	0.41	7.60	7.60	7.60	0.00
JULY	7.40	7.24	7.60		7.40	7.30	7.39	7.60	7.24	0.12	7.39	7.60	7.24	0.14
AUGUST	7.30	7.20	7.20	7.10	7.50	7.10	7.23	7.50	7.10	0.14	7.22	7.50	7.10	0.15
MEAN	7.93	7.80	7.89	7.84	7.76	7.78								
MAXIMUM	8.70	8.48	8.41	8.50	8.40	8.30								
MINIMUM	7.30	7.20	7.20	7.10	7.30	7.10								
STD. DEV.	0.38	0.41	0.36	0.36	0.33	0.36								

Table I-4 (cont'd)

Alakalinity (mg/l)

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	118	74					32.00	118.00	0.00	47.00	14.80	74.00	0.00	29.60
JUNE	139	99	94	89	73	77	95.17	139.00	73.00	21.59	86.40	99.00	73.00	9.91
JULY	89	77	94	95	99	85	89.83	99.00	77.00	7.27	90.00	99.00	77.00	7.95
AUGUST	92	126	114	112	130		114.80	130.00	92.00	13.30	120.50	130.00	112.00	7.66
SEPTEMBER	93	79	83	105	70	98	88.00	105.00	70.00	11.86	87.00	105.00	70.00	12.76
OCTOBER														
NOVEMBER	99	100	111	108	92	95	100.83	111.00	92.00	6.72	101.20	111.00	92.00	7.30
DECEMBER	109	124	115	126	112	126	118.67	126.00	109.00	6.92	120.60	126.00	112.00	5.92
1986														
JANUARY	144	100	143	155	146	126	135.67	155.00	100.00	18.12	134.00	155.00	100.00	19.42
FEBRUARY	110	125	120	110	111	120	116.00	125.00	110.00	5.92	117.20	125.00	110.00	5.78
MARCH	168	112	95	115	117	123	121.67	168.00	95.00	22.43	112.40	123.00	95.00	9.41
APRIL	160	114	101	109	109	97	115.00	160.00	97.00	20.89	106.00	114.00	97.00	6.13
MAY	128	97	99	109	227	206	144.33	227.00	97.00	52.36	147.60	227.00	97.00	56.79
JUNE	90	86	93	103	207	215	132.33	215.00	86.00	55.91	140.80	215.00	86.00	57.63
JULY														
AUGUST	127	132	127	150	122	127	130.83	150.00	122.00	9.04	131.60	150.00	122.00	9.73
MEAN	119.00	103.21	99.21	106.14	115.36	115.00								
MAXIMUM	168.00	132.00	143.00	155.00	227.00	215.00								
MINIMUM	89.00	74.00	0.00	0.00	0.00	0.00								
STD. DEV.	25.33	18.80	31.56	34.38	53.52	52.14								

X114

Table I-4 (cont'd)

Conductivity (umho/cm)

	STATION NUMBER 1	2	3	5	6	7	ALL STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.	STATIONS 2 - 7 MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY														
JUNE	1700	200	100	1100	1100	1100	883.33	1700.00	100.00	561.00	720.00	1100.00	100.00	466.48
JULY	1100	220	260	700	700	400	563.33	1100.00	220.00	306.03	456.00	700.00	220.00	208.00
AUGUST	236	230	226	227	229		229.60	236.00	226.00	3.50	228.00	230.00	226.00	1.58
SEPTEMBER	222	225	223	220	222	220	222.00	225.00	220.00	1.73	222.00	225.00	220.00	1.90
OCTOBER														
NOVEMBER			260				260.00	260.00	260.00	0.00	260.00	260.00	260.00	0.00
DECEMBER	300	300	300	300	300	300	300.00	300.00	300.00	0.00	300.00	300.00	300.00	0.00
1986														
JANUARY	400		400	399	421	397	403.40	421.00	397.00	8.87	404.25	421.00	397.00	9.73
FEBRUARY	525	270	365	358	357	356	371.83	525.00	270.00	75.87	341.20	365.00	270.00	35.74
MARCH	950	320	380	300	300	310	426.67	950.00	300.00	235.63	322.00	380.00	300.00	29.93
APRIL	1550	370	310	300	320	410	543.33	1550.00	300.00	451.80	342.00	410.00	300.00	41.67
MAY	800	250	230	220	230	215	324.17	800.00	215.00	213.08	229.00	250.00	215.00	12.00
JUNE	180	170	160	175	175	190	175.00	190.00	160.00	9.13	174.00	190.00	160.00	9.70
JULY	280	300	270		260	270					275.00	300.00	260.00	15.00
AUGUST	290	290	180	220	250	190	236.67	290.00	180.00	43.84	226.00	290.00	180.00	40.30
MEAN	656.38	262.08	261.71	376.58	374.15	363.17								
MAXIMUM	1700.00	370.00	400.00	1100.00	1100.00	1100.00								
MINIMUM	180.00	170.00	100.00	175.00	175.00	190.00								
STD. DEV.	501.50	58.29	82.21	255.43	245.35	235.51								

-212-

Table I-4 (cont'd)

Suspended Solids (mg/l)

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	500	1					250.50	500.00	1.00	249.50	1.00	1.00	1.00	0.00
JUNE	60	52	80	100	180	75	91.17	180.00	52.00	42.55	97.40	180.00	52.00	44.03
JULY	130	220	225	230	310	200	219.17	310.00	130.00	52.79	237.00	310.00	200.00	37.89
AUGUST	900	950	800	800	850		860.00	950.00	800.00	58.31	850.00	950.00	800.00	61.24
SEPTEMBER	600	300	260	140	155	130	264.17	600.00	130.00	163.00	197.00	300.00	130.00	69.40
OCTOBER														
NOVEMBER	70	350	90	95	100	80	130.83	350.00	70.00	98.51	143.00	350.00	80.00	103.71
DECEMBER	135	190	120	300	220	100	177.50	300.00	100.00	68.42	186.00	300.00	100.00	72.00
1986														
JANUARY	465		740	230	250	125	362.00	740.00	125.00	218.92	336.25	740.00	125.00	237.89
FEBRUARY	600	120	280	290	580	180	341.67	600.00	120.00	184.97	290.00	580.00	120.00	158.24
MARCH	60	50	190	90	60	90	90.00	190.00	50.00	47.26	96.00	190.00	50.00	49.64
APRIL	920	260	350	600	1400	380	651.67	1400.00	260.00	398.51	598.00	1400.00	260.00	416.29
MAY	230	80	120	700	450	170	291.67	700.00	80.00	217.82	304.00	700.00	80.00	236.69
JUNE	120	450	840	400	1800	900	918.33	1800.00	120.00	558.64	1078.00	1800.00	450.00	470.68
JULY	180	350	350		700	300	376.00	700.00	180.00	173.51	425.00	700.00	300.00	160.08
AUGUST	1800	1000	1200	900	1100	1200	1200.00	1800.00	900.00	288.68	1080.00	1200.00	900.00	116.62
MEAN	451.33	312.36	403.21	451.92	582.30	302.31								
MAXIMUM	1800.00	1000.00	1200.00	1400.00	1800.00	1200.00								
MINIMUM	60.00	1.00	80.00	90.00	60.00	75.00								
STD. DEV.	460.00	299.07	335.74	385.46	513.26	335.16								

413X

Table I-4 (cont'd)

Dissolved Oxygen (mg/l)

	STATION NUMBER 3		5		6	7	ALL STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.	STATIONS 2 - 7 MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	6.9	6.8					6.85	6.90	6.80	0.05	6.80	6.80	6.80	0.0
JUNE	6.9	7.6	7.7	7.7	6.6	6.6	7.18	7.70	6.60	0.49	7.24	7.70	6.60	0.4
JULY		7.9		7.4			7.65	7.90	7.40	0.25	7.65	7.90	7.40	0.2
AUGUST			7.0	7.2	7.1		7.10	7.20	7.00	0.08	7.10	7.20	7.00	0.0
SEPTEMBER	7.0	6.8	7.1	7.0	7.0	6.8	6.95	7.10	6.80	0.11	6.94	7.10	6.80	0.1
OCTOBER														
NOVEMBER					12.0		12.00	12.00	12.00	0.00	12.00	12.00	12.00	0.00
DECEMBER	7.8	9.2	9.1	9.0	8.4	7.5	8.50	9.20	7.50	0.66	8.64	9.20	7.50	[illegible]
1986														
JANUARY	8.7		8.2	10.1	9.3	9.3	9.12	10.10	8.20	0.64	9.23	10.10	8.20	0.64
FEBRUARY	9.7	9.6	8.5	9.6	9.4	7.7	9.08	9.70	7.70	0.74	8.96	9.60	7.70	0.74
MARCH	8.7	9.1	9.1	7.7	7.6	7.8	8.33	9.10	7.60	0.65	8.26	9.10	7.60	0.65
APRIL	7.5	8.7	8.2	7.5	8.5	6.5	7.82	8.70	6.50	0.74	7.88	8.70	6.50	0.74
MAY	8.8	8.7	8.7	9.1	8.7	9.0	8.83	9.10	8.70	0.16	8.84	9.10	8.70	0.16
JUNE	6.8	6.0	6.9	16.5	6.8	7.2	8.37	16.50	6.00	3.66	8.68	16.50	6.00	3.66
JULY	6.5	6.3	7.0		7.0	6.4	6.64	7.00	6.30	0.30	6.68	7.00	6.30	0.30
AUGUST	6.4	6.6	6.6	9.7	6.7	5.9	6.98	9.70	5.90	1.24	7.10	9.70	5.90	1.24
MEAN	7.64	7.77	7.84	9.04	8.08	7.34								
MAXIMUM	9.70	9.60	9.10	16.50	12.00	9.30								
MINIMUM	6.40	6.00	6.60	7.00	6.60	5.90								
STD. DEV.	1.04	1.21	0.87	2.48	1.48	1.02								

414

Table I-4 (cont'd)

Chloride (Cl^-) mg/l

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	S
1985														
MAY	110	40					75.00	110.00	40.00	35.00	40.00	40.00	40.00	0.00
JUNE	182	23	27	21	24	17	49.00	182.00	17.00	59.56	22.40	27.00	17.00	3.32
JULY	13	20	22	21	18	19	18.83	22.00	13.00	2.91	20.00	22.00	18.00	1.41
AUGUST	11	14	15	15	14		13.80	15.00	11.00	1.47	14.50	15.00	14.00	0.50
SEPTEMBER	13	14	18	9	14	23	15.17	23.00	9.00	4.37	15.60	23.00	9.00	4.67
OCTOBER														
NOVEMBER	20	12	17	20	15	16	16.67	20.00	12.00	2.81	16.00	20.00	12.00	2.61
DECEMBER	75	18	14	14	13	15	24.83	75.00	13.00	22.49	14.80	18.00	13.00	1.72
1986														
JANUARY	20		25	29	24	15	22.60	29.00	15.00	4.76	23.25	29.00	15.00	5.12
FEBRUARY	65	21	18	26	24	21	29.17	65.00	18.00	16.22	22.00	26.00	18.00	2.76
MARCH	170	25	20	13	23	21	45.33	170.00	13.00	55.88	20.40	25.00	13.00	4.08
APRIL	296	50	38	40	44	49	86.17	296.00	38.00	93.94	44.20	50.00	38.00	4.75
MAY	194	18	20	20	16	19	47.83	194.00	16.00	65.38	18.60	20.00	16.00	1.50
JUNE	15	14	12	10	15	15	13.50	15.00	10.00	1.89	13.20	15.00	10.00	1.94
JULY	8	8	6		7	15	8.80	15.00	6.00	3.19	9.00	15.00	6.00	3.54
AUGUST	30	15	12	7	16	15	15.83	30.00	7.00	7.01	13.00	16.00	7.00	3.29
MEAN	81.47	20.86	18.86	18.85	19.07	20.00								
MAXIMUM	296.00	50.00	38.00	40.00	44.00	49.00								
MINIMUM	8.00	8.00	6.00	7.00	7.00	15.00								
STD. DEV.	86.46	10.93	7.49	8.78	8.44	8.79								

A154

Table I-4 (cont'd)

SO_4 (mg/l)

	STATION NUMBER 1	2	3	5	6	7	ALL STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.	STATIONS 2 - 7 MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	65	50					57.50	65.00	50.00	7.50	50.00	50.00	50.00	0.00
JUNE	108	38	40	32	39	42	49.83	108.00	32.00	26.19	38.20	42.00	32.00	3.37
JULY	28	18	17	16	8	30	19.50	30.00	8.00	7.48	17.80	30.00	8.00	7.05
AUGUST	19	22	28	25	25		23.80	28.00	19.00	3.06	25.00	28.00	22.00	2.12
SEPTEMBER	9	8	16	19	17	15	14.00	19.00	8.00	4.08	15.00	19.00	8.00	3.74
OCTOBER														
NOVEMBER	30	29	27	25	26	30	27.83	30.00	25.00	1.95	27.40	30.00	25.00	1.85
DECEMBER	100	30	29	25	37	37	43.00	100.00	25.00	25.85	31.60	37.00	25.00	4.72
1986														
JANUARY	35		30	38	50	38	38.20	50.00	30.00	6.58	39.00	50.00	30.00	7.14
FEBRUARY	100	48	46	80	100	44	69.67	100.00	44.00	24.61	63.60	100.00	44.00	22.50
MARCH	200	22	35	115	42	31	74.17	200.00	22.00	64.10	49.00	115.00	22.00	33.63
APRIL	400	60	75	95	90	120	140.00	400.00	60.00	117.72	88.00	120.00	60.00	20.15
MAY	160	60	70	120	70	60	90.00	160.00	60.00	37.42	76.00	120.00	60.00	22.45
JUNE	17	26	30	28	24	22	24.50	30.00	17.00	4.23	26.00	30.00	22.00	2.83
JULY	24	18	12		18	12	16.80	24.00	12.00	4.49	15.00	18.00	12.00	3.00
AUGUST	55	44	44	48	52	55	49.67	55.00	44.00	4.64	48.60	55.00	44.00	4.36
MEAN	90.00	33.79	35.64	51.23	42.71	41.23								
MAXIMUM	400.00	60.00	75.00	120.00	100.00	120.00								
MINIMUM	9.00	8.00	12.00	16.00	8.00	12.00								
STD. DEV.	99.07	15.81	17.85	36.14	26.55	26.39								

Table I-4 (cont'd)

NO_3 (mg/l)

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY	1.00	0.20					0.60	1.00	0.20	0.40	0.20	0.20	0.20	0.00
JUNE	1.90	0.30		1.20	1.00	0.90	1.06	1.90	0.30	0.52	0.85	1.20	0.30	0.34
JULY	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AUGUST	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SEPTEMBER	0.31	0.30	0.19	0.28	0.23	0.34	0.28	0.34	0.19	0.05	0.27	0.34	0.19	0.05
OCTOBER														
NOVEMBER	0.00	0.20	0.00	0.00	0.10	0.20	0.08	0.20	0.00	0.09	0.10	0.20	0.00	0.09
DECEMBER	0.50	0.16	0.12	0.00	0.42	0.20	0.23	0.50	0.00	0.17	0.18	0.42	0.00	0.14
1986														
JANUARY	0.00		0.00	0.00	0.10	0.20	0.06	0.20	0.00	0.08	0.08	0.20	0.00	0.08
FEBRUARY	8.00	4.00	4.50	4.50	5.00	2.20	4.70	8.00	2.20	1.72	4.04	5.00	2.20	0.97
MARCH	3.50	4.00	6.00	2.00	0.20	1.80	2.92	6.00	0.20	1.85	2.80	6.00	0.20	2.00
APRIL	2.00	0.01	0.01	0.10	0.10	0.00	0.37	2.00	0.00	0.73	0.04	0.10	0.00	0.05
MAY	0.10	0.20	0.20	0.25	0.50		0.25	0.50	0.10	0.13	0.29	0.50	0.20	0.12
JUNE	0.10				0.10		0.10	0.10	0.10	0.00	0.10	0.10	0.10	0.00
JULY	0.10	0.01	0.10		0.16		0.09	0.16	0.01	0.05	0.09	0.16	0.01	0.06
AUGUST	0.10	0.15	0.20	0.40	0.26	0.15	0.21	0.40	0.10	0.10	0.23	0.40	0.15	0.09
MEAN	1.17	0.73	0.94	0.73	0.58	0.60								
MAXIMUM	8.00	4.00	6.00	4.50	5.00	2.20								
MINIMUM	0.00	0.00	0.00	0.00	0.00	0.00								
STD. DEV.	2.07	1.40	1.95	1.28	1.25	0.75								

XCIX

Table I-4 (cont'd)

Iron (mg/l)

	STATION NUMBER 1	2	3	5	6	7	ALL STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.	STATIONS 2 - 7 MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY														
JUNE	0.51	0.35		0.35	3.70	1.30	1.24	3.70	0.35	1.28	1.43	3.70	0.35	1.37
JULY	0.23	0.26	0.35	0.62	0.31	0.48	0.38	0.62	0.23	0.14	0.40	0.62	0.26	0.13
AUGUST	1.50	0.40	0.25	0.14	0.09	0.18	0.43	1.50	0.09	0.49	0.21	0.40	0.09	0.11
SEPTEMBER	2.00	0.21	0.08	1.10	0.80	2.10	1.05	2.10	0.08	0.79	0.86	2.10	0.08	0.73
OCTOBER														
NOVEMBER	0.15	0.22	0.08	0.09	0.22	0.18	0.16	0.22	0.08	0.06	0.16	0.22	0.08	0.06
DECEMBER	0.41	0.40	0.25	0.14	0.09	0.18	0.25	0.41	0.09	0.12	0.21	0.40	0.08	0.11
1986														
JANUARY	0.08		0.60	0.30	0.18	0.30	0.33	0.60	0.08	0.19	0.40	0.60	0.18	0.16
FEBRUARY	0.48	0.50	0.30	0.35	0.80	2.50	0.82	2.50	0.30	0.77	0.89	2.50	0.30	0.82
MARCH	0.80	1.10	1.10	0.45	0.30	0.80	0.76	1.10	0.30	0.30	0.75	1.10	0.30	0.33
APRIL	0.40	0.25	0.30	0.25	0.40	0.30	0.32	0.40	0.25	0.06	0.30	0.40	0.25	0.05
MAY	0.28	0.40	0.40	0.15	0.50	0.60	0.39	0.60	0.15	0.14	0.41	0.60	0.15	0.15
JUNE	0.28	0.15	0.50	1.90	0.70	0.50	0.67	1.90	0.15	0.58	0.75	1.90	0.15	0.60
JULY	0.40	0.50	0.20		0.30	0.26	0.33	0.50	0.20	0.11	0.32	0.50	0.20	0.11
AUGUST	0.030	0.020	0.015	0.012	0.010	0.010	0.02	0.03	0.01	0.01	0.01	0.02	0.01	0.00
MEAN	0.54	0.37	0.34	0.45	0.60	0.71								
MAXIMUM	2.00	1.10	1.10	1.90	3.70	2.50								
MINIMUM	0.03	0.02	0.02	0.01	0.01	0.01								
STD. DEV.	0.54	0.25	0.27	0.50	0.89	0.72								

8/17

Table I-4 (cont'd)

Total PO4 (mg/l)

	STATION NUMBER 1	2	3	5	6	7	ALL STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.	STATIONS MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY		0.15					0.15	0.15	0.15	0.00	0.15	0.15	0.15	0.00
JUNE	0.75	0.42		2.10	4.00	4.00	2.25	4.00	0.42	1.53	2.63	4.00	0.42	1.49
JULY	0.50	0.60	0.70	1.20	1.00	1.80	0.97	1.80	0.50	0.44	1.06	1.80	0.60	0.43
AUGUST	0.90	1.00	0.48	0.64	1.40		0.88	1.40	0.48	0.32	0.88	1.40	0.48	0.35
SEPTEMBER	1.60	1.25	0.95	1.20	1.60	1.20	1.30	1.60	0.95	0.23	1.24	1.60	0.95	0.21
OCTOBER														
NOVEMBER	0.49	1.10	0.40	0.38	0.52	0.60	0.58	1.10	0.38	0.24	0.60	1.10	0.38	0.26
DECEMBER	0.68	0.82	0.53	0.83	1.46	0.82	0.86	1.46	0.53	0.29	0.89	1.46	0.53	0.31
1986														
JANUARY	0.70		1.30	0.98	0.92	1.42	1.06	1.42	0.70	0.26	1.16	1.42	0.92	0.21
FEBRUARY	0.86	1.10	0.96	0.65	0.60	3.50	1.28	3.50	0.60	1.01	1.36	3.50	0.60	1.09
MARCH	1.50	1.50	2.00	2.10	2.00	2.20	1.88	2.20	1.50	0.28	1.96	2.20	1.50	0.24
APRIL	0.70	0.20	0.75	0.20	0.50	0.35	0.45	0.75	0.20	0.22	0.40	0.75	0.20	0.21
MAY	2.40	1.20	0.80	0.60	1.40	1.15	1.26	2.40	0.60	0.57	1.03	1.40	0.60	0.29
JUNE	0.80	0.60	0.40	0.45	0.60	0.85	0.62	0.85	0.40	0.16	0.58	0.85	0.40	0.16
JULY	0.60	0.70	0.43		0.51	0.80	0.61	0.80	0.43	0.13	0.61	0.80	0.43	0.15
AUGUST	0.80	0.60	0.52	0.43	0.52	0.42	0.55	0.80	0.42	0.13	0.50	0.60	0.42	0.07
MEAN	0.95	0.80	0.79	0.90	1.22	1.47								
MAXIMUM	2.40	1.50	2.00	2.10	4.00	4.00								
MINIMUM	0.49	0.15	0.40	0.20	0.50	0.35								
STD. DEV.	0.51	0.39	0.43	0.59	0.91	1.10								

419X

Table I-4 (cont'd)

Copper (mg/l)

	STATION NUMBER						ALL STATIONS				STATIONS 2 - 7			
	1	2	3	5	6	7	MEAN	MAXIMUM	MINIMUM	STD. DEV.	MEAN	MAXIMUM	MINIMUM	STD. DEV.
1985														
MAY														
JUNE	0.05	0.02		0.10	0.60	0.10	0.17	0.60	0.02	0.22	0.21	0.60	0.02	0.23
JULY	0.01	0.05	0.06	0.01	0.28	0.02	0.07	0.28	0.01	0.10	0.08	0.28	0.01	0.10
AUGUST	0.29	0.57	0.10	0.16	0.13		0.25	0.57	0.10	0.17	0.24	0.57	0.10	0.19
SEPTEMBER	0.20	0.18	0.12	0.39	0.21	0.19	0.22	0.39	0.12	0.08	0.22	0.39	0.12	0.09
OCTOBER														
NOVEMBER	0.02	0.20	0.00	0.00	0.01	0.09	0.05	0.20	0.00	0.07	0.06	0.20	0.00	0.08
DECEMBER	0.28	0.21	0.20	0.50	0.05	0.20	0.24	0.50	0.05	0.14	0.23	0.50	0.05	0.15
1986														
JANUARY	0.09		0.12	0.20	0.20	0.30	0.18	0.30	0.09	0.07	0.21	0.30	0.12	0.06
FEBRUARY	0.20	0.10	0.00	0.20	0.40	0.10	0.17	0.40	0.00	0.12	0.16	0.40	0.00	0.14
MARCH	0.10	0.30	1.10	0.00	0.00	0.00	0.25	1.10	0.00	0.39	0.28	1.10	0.00	0.43
APRIL	0.40	0.14	0.25	0.30	0.33	0.40	0.30	0.40	0.14	0.09	0.28	0.40	0.14	0.09
MAY	0.15	0.13	0.15	0.30	0.26	0.25	0.21	0.30	0.13	0.07	0.22	0.30	0.13	0.07
JUNE	0.05	0.10	0.10	0.01	0.10	0.10	0.08	0.10	0.01	0.03	0.08	0.10	0.01	0.04
JULY	0.15	0.10	0.10			0.10	0.11	0.15	0.10	0.02	0.10	0.10	0.10	0.00
AUGUST	0.010	0.015	0.012	0.010	0.012	0.010	0.01	0.02	0.01	0.00	0.01	0.02	0.01	0.00
MEAN	0.14	0.16	0.18	0.17	0.20	0.14								
MAXIMUM	0.40	0.57	1.10	0.50	0.60	0.40								
MINIMUM	0.01	0.02	0.00	0.00	0.00	0.00								
STD. DEV	0.12	0.14	0.28	0.16	0.17	0.11								

Appendix J

JAMSHORO POWER GENERATION COMPLEX - PHASE II
"ARCHAEOLOGICAL CHANCE FIND PROCEDURES"

1. INTRODUCTION

The following "Archaeological Chance Find Procedures" have bee endorsed by U.S.A.I.D./Washington, and are intended to support implementation of the provisions of the Antiquities (Amendment) Act, 1976 of the Islamic Republic of Pakistan. The development of power plants is often subject to surveys for archaeological and/or historical sites. It is recommended that surveys of a site be conducted prior to commencement of construction activities to determine the presence of sites of archaeological and/or historical significance.

However, sites that are buried or not located by the survey may be discovered during the course of project implementation. These sites are protected under the provisions of the Antiquities (Amendment) Act 1976. Archaeological clearance for the project for U.S.A.I.D. suppor will generally be contingent upon the development and implementation Archaeological Chance Find Procedures. These procedures address step that must be taken when archaeological and/or historical materials ar encountered in the course of construction or mining activities.

It should be noted that implementation of the Archaeological Chance Find Procedures is both legally required by the Government of Pakistan and consistent with the long-standing concerns for archaeological

421X

and/or historical sites of a number of international development organizations.

2. IMPLEMENTATION

Implementation of the Archaeological Chance Find Procedures will be the responsibility of the management and environmental staff of each organization responsible for a construction or operational activity. The Environmental, Safety, and Health Unit for the power plant has primary long-term responsibility to assure implementation of the procedures. Implementation of the procedures will be monitored periodically by the Department of Archaeology and representatives of international development organizations.

3. ARCHAEOLOGICAL CHANCE FIND PROCEDURES

Definition of an Archaeological Chance Find

An archaeological chance find is the unanticipated discovery of material remains of an archaeological and/or historical nature. Most frequently such finds are found with 0-3 meters of the present surface and often are characterized by concentrations of pottery, worked stone, human and animal bones, and in some cases the remains of mud-brick structures. These materials are often of no commercial value, but the may be of significant importance to archaeologists, historians, and others who are involved in studying the people, culture, and environment of ancient Pakistan.

Notification of the Department of Archaeology

When a discovery has been made of archaeological and/or historical materials, or it is believed that such material may exist in an area to be disturbed, the Department of Archaeology should be notified immediately and requested to send a representative to make a site inspection. The request should be made both in writing and by telephone to the appropriate local Department of Archaeology office. All work should immediately cease in the vicinity of the find and not be resumed until a Department of Archaeology representative has visited the site. The Department should be advised of any materials that have been observed and any support to assist in examination of the material that might be available from the contractor or operating organization.

Response Period for the Department of Archaeology

The Department of Archaeology has a maximum of 72 hours after being notified by telephone to provide a representative to inspect the chance find; to determine the significance of the material, and to make recommendations concerning what steps should be taken to salvage or formally excavate the material. If at the end of the 72-hour period the Department of Antiquities has not responded to the request for field assistance, any observed materials will be removed from their archaeological context and placed in storage for later collection by the Department.

4323K

Archaeological Salvage Procedures

The Department of Archaeology has the authority to conduct formal archaeological excavations and/or salvage of any materials discovered as the result of chance finds. It should be noted that all Pakistani rupee costs for the planning, management and conduct of such actions will be responsibility of the Government of Pakistan. Potential support from international development organizations participating in implementation of the project will be restricted to the provision of expert technical assistance to assist Government of Pakistan-funded personnel in the planning, excavation and evaluation of archaeological and/or historical materials located as the result of project implementation.

4. PENALTIES FOR VIOLATIONS OF THE PROCEDURES

It should be noted that Article 5A., (4) of the Antiquities Act of 1976 states that "If any person who discovers or finds any moveable antiquity contravenes the provisions of subsection (1) or subsection (2), he shall be punishable with imprisonment for a term which may extend to three years, or with fine, or with both, and the court shall direct that the antiquity in respect of which such contravention has taken place shall stand forfeited to the Federal Government."

5. OTHER ARCHAEOLOGICAL CONCERNS

It is important that all contractors and operators note and advise their personnel of the provisions of Article 26, of the Antiquities Act of 1976, Export of Antiquities, which prohibits the export of any antiquity except under a license granted by the Director of Antiquities, and Article 29, Prohibition of Archaeological Excavation or Exploration Without License, which prohibits the conduct of archaeological excavation or exploration without a license issued by the Director of Antiquities.

All contractor operator personnel should be strongly discouraged by their management from engaging in the illegal excavation, collection, and/or export of antiquities.

Appendix K

CONVERSION TABLE FOR WEIGHTS AND MEASURES

LENGTH		
1 inch (in)		= 2.54 centimeter (cm)
1 foot (ft)	= 12 inch	= 0.3048 meter (m)
1 yard (yd)	= 3 foot	= 0.9144 m
1 mile	= 1760 yard	= 1.6093 kilometer (km)
a int nautical mile	= 2025.4 yard	= 1.852 km
Area		
1 (in^2)		= 6.4516 cm^2
1 (yd^2)	= 9 ft^2	= 0.8361 m^2
1 acre	= 4840 yd^2	= 4046.9 m^2
1 sq mile ($mile^2$)	= 640 acres	= 2.59 km^2
Volume/Capacity		
1 cu inch (in^3)		= 16.387 cm^3
1 cu foot (ft^3)	= 1728 in^3	= 0.0283 m^3
1 fluid ounce (fl oz)		= 28.413 milliliter (ml)
1 pint (pt)	= 16 fl oz	= 0.5683 liter (l)
1 gallon (gal)	= 8 pt	= 4.5461 l
Mass (Weight)		
1 ounce (oz)	= 437.5 grains	= 28.35 g
1 pound (lb)	= 16 oz	= 0.4536 kg
1 hundredweight (cwt)	= 112 lb	= 50.802 kg
1 ton	= 20 cwt	= .909 mt
US MEASURES		
1 US dry pint	= 0.9689 UK pt	= 0.5506 l
1 US bushel	= 64 US pt	= 35.238 l
1 US liquid pint	= 0.8437 UK pt	= 0.4732 l
1 US gallon	= 8 US liq pt	= 3.7853 l
1 short cwt	= 100 lb	= 45.359 kg
a short ton	= 2000 lb	= 0.9072 t