PN-AAU-694

ENVIRONMENTAL BASELINE MONITORING SYSTEM & PROGRAM FOR THE LAKRA COAL MINING AND POWER SYSTEM PROJECT

FOR THE

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT IN ISLAMABAD
(USAID/ISLAMABAD)

THE PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY (WAPDA) OF THE GOVERNMENT OF PAKISTAN

AUGUST, 1984

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LAKHRA COAL PROJECT

ENVIRONMENTAL BASELINE MONITORING SYSTEM & PROGRAM

USAID/Islamabad

TAMS

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I. OBJECTIVES & GOALS (PHASE I)

A. Objectives

The objectives of this project was to design an environmental baseline monitoring system for a 300 megawatt lignite fired power plant and associated mine. This program would:

1. Provide an adequate air, water and meteorological baseline of the potential project site areas for future impact assessment;

2. Satisfy the needs of the sponsoring agencies and the recipient country - Pakistan; and

3. Be workable for the locale in which it is to be installed.

B. Goals

The goals of this Phase I study are:

1. To assess the environmental surroundings of the proposed power plant and mine sites including:

(a) Identification of any other noise, air and water point sources within a 16-kilometer (10-mile) radius of the proposed plant site;

(b) Identification of any topographical features having a potential influence on atmospheric dispersion of air and noise emissions from the proposed power plant;

(c) Identification of potential sensitive receptors (humans, flora and fauna) around the proposed plant and mine sites, i.e. population centers, hospitals, crops, schools; and

(d) Identification of electric power source availability to adequately run the monitoring equipment.

2. To determine and acquire any existing environmental baseline data concerning:

(a) Meteorology (wind speed, wind direction, temperature, rainfall, inversion height, stability and solar radiation);

(b) Air quality (SO_2, CO, TSP AND NO_x);

(c) Water quality (BOD DO, COD, turbidity, sulfates, TSS, total coliform, heavy metals, TOC, temperature, pH and alkalinity.

(d) Surface and subsurface hydrology (water flow, availability); and

(e) Land use characteristics

3. To review the relevant air, noise and water quality standards and guidelines with respect to:

(a) Pakistan Environmental Ordinance;

(b) World Bank; and

(c) USEPA.

4. To evaluate the potential capabilities and interest of Pakistani personnel to set-up, operate and maintain the monitoring equipment inclusive of:

(a) Other research entities within Pakistan i.e. PCSIR;

(b) Universities;

(c) WAPDA; and

(d) Local employment.

5. To establish a mechanism to procure, ship, set-up and maintain the monitoring systems.

6. To prepare a monitoring program that can be implemented in view of the data obtained in the aforementioned evaluations and specific to the capabilities of the available environs.

II. BACKGROUND

The Pakistan Water and Power Development Authority (WAPDA) of the Government of Pakistan is planning the development of the Lakhra lignite field and construction of a 300 MW, lignite-fired power plant. The Project is to be funded by the World Bank and the Asian Development Bank.

Although the Asian Development Bank (ADB) does not have environmental standards, the World Bank, as a condition of project funding, requires that a proposed facility demonstrate compliance with certain emission and ambient guidelines, and that an environmental impact assessment be prepared. To this end, the U.S. Agency for International Development in Islamabad (USAID/Islamabad) is assisting WAPDA in the preparation of this impact assessment and in the development of mitigative measures. As part of this assistance, USAID sent a team of environmental specialists to Pakistan to define what data would be needed to carry out an impact assessment, to assess what data is available, and to provide an environmental monitoring program for needed data that may not be available. This report is the result of the initial (data gathering) trip which took place in August, 1984.

Many data sources have been utilized in the preparation of this document. The major sources were the "Lakhra Coal and Power Project Review", by Stone & Webster Engineering dated April 1983, "The Lakhra Coal Mining and Power Station Project", by Japan International Corporation Agency dated February 1981, and "A Review of Agencies Involved in Environmental Management in Pakistan and Recommendations for Revision of Pakistan's draft Environmental Profile" by Jacqueline K. Hewett.

III. PLAN OF ACTION

A. Project Team

USAID

Mr. M. Charles Moseley, Chief, Office of Energy and Environment - USAID/PAKISTAN.

Dr. Kenneth P. Lue Phang, Deputy Chief, Office of Energy and Environment - USAID/PAKISTAN

Mr. Mian Shahid Ahmad, Project Engineer - USAID

Mr. Robert Lappi, Coal Advisor - USAID

Mr. Mohammad Anwar, Liaison Officer - USAID

TAMS Environmental Team

Dr. John H. Roebig - Team Leader

Mr. Irving D. Cohen - Monitoring Equipment Specialist

Dr. Nathan M. Reiss - Meteorologist

B. Planned Activity Schedule

		DATES
1.	Orientation W/USAID	8/01/84
2.	Meeeting with PCSIR to determine information availability	8/01/84
3.	Regroup and plan future activities based upon (1) and (2) above	8/01/84
4.	Arrange to obtain information found from PCSIR upon return to Karachi (Mr. Anwar)	8/02/84
5.	Travel to Hyderabad to meet with WAPDA personnel and evaluate environs	8/02/84
6.	Visit Jamshoro plant site and environs	8/02/84-8/03/84
7.	Visit Lakhra coal area	8/03/84-8/04/84

8.	Return to Karachi	8/05/84
9.	Visit information sources and obtain data	8/05/84
10.	Travel to Lahore	8/05/84
11.	Meet with WAPDA	8/06/84
12.	Meet with RCSIR in Lahore	8/06/84
13.	Determine any potential sources of information in Lahore	8/06/84
14.	Arrange to obtain data from Lahore sources	8/07/84
15.	Travel to Islamabad	8/07/84
16.	Meet USAID personnel and present work plan	8/08/84
17.	Dr. Reiss returns to Karachi	8/11/84
18.	Prepare a draft final report	8/08/84-8/13/84
19.	AID Review of draft report	8/14/84-8/15/84
20.	Incorporation of USAID comments and draft report submission.	8/17/84
21.	Mr. Cohen & Dr. Roebig return to Karachi	8/18/84
22.	Mr. Cohen & Dr. Roebig return to New York	8/19/84
23.	Meeting with AID/Washington and World Bank/Washington	9/13/84
24.	Final review, editing and printing of report in New York - TAMS.	

IV. ENVIRONMENTAL SETTING

A. Air Quality

Because of the lack of available existing air quality information, we felt the need to apprise ourselves of existing conditions. We performed a survey of the potentially affected area to determine the existing ambient air quality as well as the possibility of other local polution sources so that the impacts of the proposed facility could be addressed. The city of Hyderabad was surveyed by automobile in a search for point sources of sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO), total suspended particulates (TSP) and lead (Pb). Visible sources were noted. The most obvious, and probably the most serious point source in Hyderabad is a large cement plant (TSP source) located south of the center of Hyderabad and about 18 kilometers from Jamshoro. Three of the six stacks found were associated with factories that had been abandoned for 4,14, and 14 years, respectively. If this is indicative of the state of industry in Hyderabad, then the number of stacks that are seen in the city's skyline greatly overestimates the number of actual point sources. The contribution to air pollution by existing large point sources in Hyderabad is probably insignificant.

B. Meteorology

Table 1 shows relevant surface-level meteorological information for Hyderabad. These figures should apply, without major modification, to the entire river plain from Hyderabad to Khanot. No data is available for the upland areas west of the river. It seems likely that the main variation caused by the difference in elevation of approximately 300 feet will be that daily temperature ranges will be somewhat higher in the upland areas, with higher afternoon temperatures and lower early morning temperatures than exist along the river plain. Wind speeds and directions may also differ somewhat, being influenced by the temperature differences.

C. Water Quality and Hydrology

The Indus river is the only perennial water course near the project. It is about 20 km east of the mine site and 400 meters from the Jamshoro power Plant site project boundary.

Most of the Indus River is controlled by a series of barrages that have been built for irrigation purposes. Jamshoro is upstream from the Kotri Barrage (Ghulam Muhammad Barrage) and downstream from Lloyd Barrage (Sakhar Barrage). The water flow is artificially controlled by these barrages. Figure 1 shows flow data for 1979. The low and high month flows are February and August, respectively. The lowest measurement taken in February was 5,260 cubic feet per second (cfs).

The Indus River is used for both irrigation and drinking water in Hyderabad. Other water courses are intermittent in nature. However, these can be significant from a water quality perspective since they can flush pollutants that have accumulated during dry periods. There is a dam built south of Lakhra for the temporary impoundment of water during the monsoon season. It appears to have been built for the retention of storm water which would then recharge ground water for the seasonal growing of wheat by nomads in the area. This area needs to be examined in the routing of the railroad. In this area the flood plain is against the bedrock of the mountain wall to the west so that the flood plain is constructed to a narrow meander.

D. Land Use

The area around Lakhra is a very harsh environment. It is mostly barren and consists of sparsly/vegetated areas. A few settlements and mosques are permanent structures, but otherwise the area is devoid of settlements. The area around the proposed power plant site at Jamshoro has a few small villages, a secondary road, and some very small and primitive commercial enterprises along the road. East of the road is a large area of agricultural land. It is well irrigated by a series of canals (Rohri Canal, Hyderabad Branch, Nasir Branch, Jamrao Canal, and Mithrao Canal). This area is very productive agriculturally and must be closely examined for potential damage from air pollution. Farmed fruits, vegetables, "kharif" crops (millet and cotton),and "rabi" crops (wheat), are grown here. The areas to the north and west of the power plant are desert fringe areas having sparse vegetation that provides some forage for camels, sheep, and goats.

E. Noise

Noise sources on or near the site are very minimal. The Lakhra site is devoid of noise sources other than the existing private mines and one PMDC mine. These are all deep mines. There are no improved roads and the only existing traffic services the mines with supplies and water. Tanker trucks are used for this and are the main existing noise source.

At Jamshoro, there is a secondary route with a high percentage of medium and heavy trucks. There are no nearby industrial plants and very few aircraft flyovers.

TABLE 1

Meteorological conditions measured at Hyderabad during 1964 (from Lower Indus Report - The Atlas published by Sir M. McDonald and Associates (1966), P.4)

Mean Daily Percent Possible Sunshine (%)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
70	80	75	85	85	80	70	75	80	80	80	70

Wind Direction (Mean of Directions at 0700 and 1800 Hours)

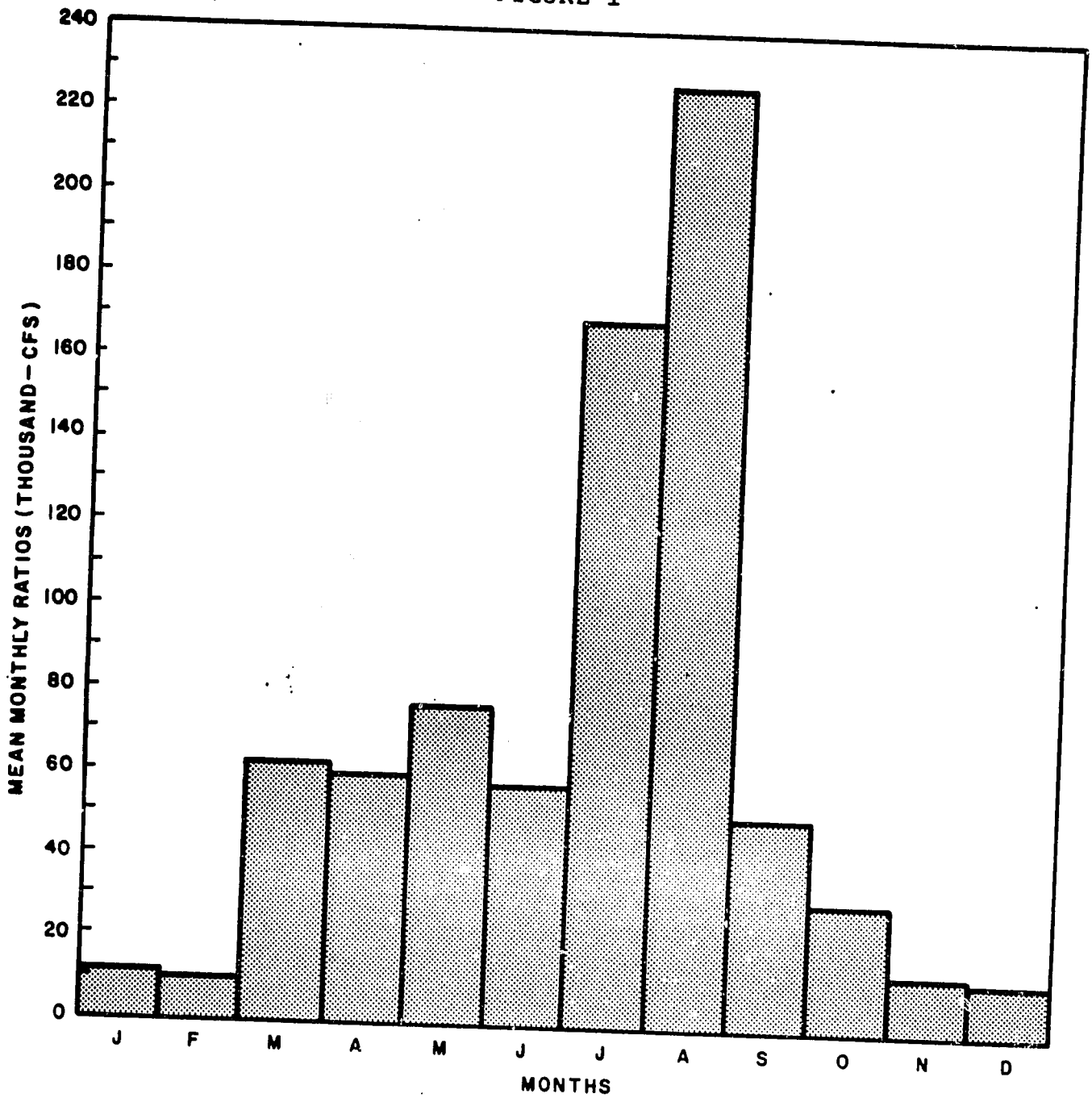
(Wind from the south = 18, west = 27, north = 36, etc.)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
34	36	Light+ variable	24	2[illegible]	21	21	21	20	Light+ variable	36	36

Cloud Cover (% of Sky Covered)

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
25	10	20	25	10	25	50	40	35	10	10	20

FIGURE 1



INDUS RIVER WATER FLOW
Figure 1

V. PROPOSED PROJECT

The Lakhra Project has two primary components: A 300 megawatt (MW) power plant, and a coal supply from Lakhra coal field sufficient to meet the requirements of the power plant.

USAID has commissioned feasibility studies for the power plant and coal supply which will address several economic, financial and technical issues relating to the project. Among these are the rationalization of coal supply (mining plans, degree of project coal production verses coal purchases from private or public sector producers already at Lakhra, coal transportation, etc.), power plant location, and power plant and boiler design.

Previous studies, primarily the SWEC and JICA studies, have reached a definitive conclusion relating to these issues. Several of these conclusions are being reexamined by other donor agencies. This re-examinations is the reason for the USAID financial feasibility studies referred to above.

Logistically, it is necessary for the environmental baseline monitoring system to be in place and in operation prior to the outcome of the new feasibility studies: both are necessary components of the environmental assessment.

To provide an appropriate baseline monitoring system, the monitoring equipment must be located so that the data would be valid for all of the proposed power plant siting alternatives. The importance of this determination relates primarily to site-specific meteorological conditions which will influence the estimated impacts associated with the emissions from the plant.

The SWEC and JICA studies concluded that Jamshoro is the preferred power plant location. Alternative sites include Khanot and a mine-mouth plant at Lakhra. The environmental baseline monitoring team has designed and located the monitoring system to be most applicable to Jamshoro as a plant site, but it will be sufficient to conduct environmental assessment for either of the alternative sites.

A. Coal Extraction

The Lakhra mining site is located approximately 45 km northwest of Hyderabad and 20 km west of the Indus River on a 52 square kilometer lease controlled by PMDC (Figure 2). The lease occupies part of the Lakhra coal field, the ultimate extent of which is undefined, but consists of more than 500 square kilometers.

The SWEC and JICA studies considered proven resources to total approximately 64 million tons within 26 square kilome-

ters of the lease based on JICA drilling. There are indications that further coal reserves will be found to the south and efforts are underway to enhance these assessments. Mining options on the site include both surface and underground mines.

B. Coal Characteristics

Lakhra coal is ranked as lignite A, bordering on sub-bituminous C. It is high-sulfur (4-to 8% from JICA analyses), evidently highly variable with respect to quality (Table 2), and is known to be susceptible to spontaneous combustion. The SWEC and JICA studies concluded that Lakhra coal is not amenable to washing because of high product losses due to the significant amount of rear gravity material associated with the coal. Both studies limited coal preparation to hand picking of visible rock material. However, the feasibility study will address the issue of coal preparation more thoroughly.

C. Coal Transport

The SWEC and JICA studies both proposed rail transport from Lakhra to Jamshoro. SWEC's railway route is a 50 km railroad which leads due south from the mine site and turns east opposite Jamshoro.

D. Coal Utilization

1. Site

The preferred site in both the JICA and SWEC reports is Jamshoro. Table-I from the SWEC report illustrates the economic factors used in making this determination. The environmental team visited the other potential power plant sites in order to accommodate them in the selection of locations for the monitoring stations. Other alternative sites evaluated were a mine-mouth site at Lakhra and an alternative site at Khanot.

The main issues raised were:

(a) Cost of transporting cooling water to the power plant and mine.

(b) Cost of transporting coal from the mine to the power plant.

(c) Availability of personnel and services at the mine and the power plant.

(d) Cost of transmission from the power plant to the 500 KV sub-station.

2. Power Plant

The power plant is designed for a 300 MW generating capacity. The net station heat rate is estimated to be 11,510 kj/kwh (10,900 Btu/Kwh) and the power plant will have a closed-system evaporative cooling tower. A river intake water system will be needed for make-up water of about 11 cubic feet per second. The SWEC reports that there will be effluent discharges from the power plant; however, details on this will be developed as part of the feasibility report.

E. Storage

Coal receiving, storage, and handling facilities for the power plant are presently proposed for the east side of the road adjacent to the power plant site. This is approximately 400m from the Indus river.

F. Support Facility

A colony will be required for both the miners at Lakhra and support personnel for power plant construction, preparation and maintenance.

A transmission line, along with switching and connection facilities, will be constructed to connect the power station to WAPDA's existing 500 KV substation in order to tie the power plant to the Pakistan Power Grid.

G. Proposed Additional Power Plants

There are a total of four power plants proposed for the project area. The first unit is an oil fired 250 MW Japanese Plant to be on-line in 1988. The second unit is also an oil fired 210 MW Chinese power plant that may be on-line by 1990. The third unit, 300 MW, is the focus of this report and is

expected to be on-line by 1991; it will have the capability of burning both oil & lignite. A fourth unit is anticipated to be the same as the third unit but will require additional coal reserves to be proven. Stack heights on Units 1 & 2 have not been specified but most likely will be less than 100 meters. It is possible that a fifth and sixth unit may be constructed should sufficient coal be found.

TABLE 2

	Expected Range	JICA	SWEC	5 Samples PCSIR GUDDU	1983 PSIR (AD)
Carbahatoxics Material (Total Fixco Carbon)	70.0-90.0%	26.90% 25% by WT		14.95-31.55	42.00-58.00%
Water (% Moisture)	.0-07.0%			10.80-20.30	11.00-41.00%
Volatile Water		28.8%		34.30-38.95	39.00-59.00%
Hydrogen					4.20-05.50%
Nitrogen	1.0-02.0%				0.50-01.00%
Total Surphur	.5-02.5%	5.95%	3.3-09.8%	3.1-04.38%	3.30-06.00%
Non-combustible Surphur					.11-00.43
Combustible Surphur					2.85-05.69
Inorganic Surphur					
Sulphate Sulphur					.23-00.69
Pypitic Sulphur					.60-02.70
Organic Sulphur					.97-02.70
Oxygen					18.20-25.40%
Other Inorganics (Trance metals)	5.0-20.0%				
Ash		19.30%		14.80-35.30	6.30-28.30
Iron Oxides			17.0-71.0%		
Colorific Values					
Kv/Kg			15,890 Ks/Kg		
Kcal/kg				4,731- 5,945	
B-TU/lb				8,516-10,701	7,980-11,400

Commission of European Community, 1982

TABLE 3

ECONOMIC COMPARISON OF POWER PLANT SITES

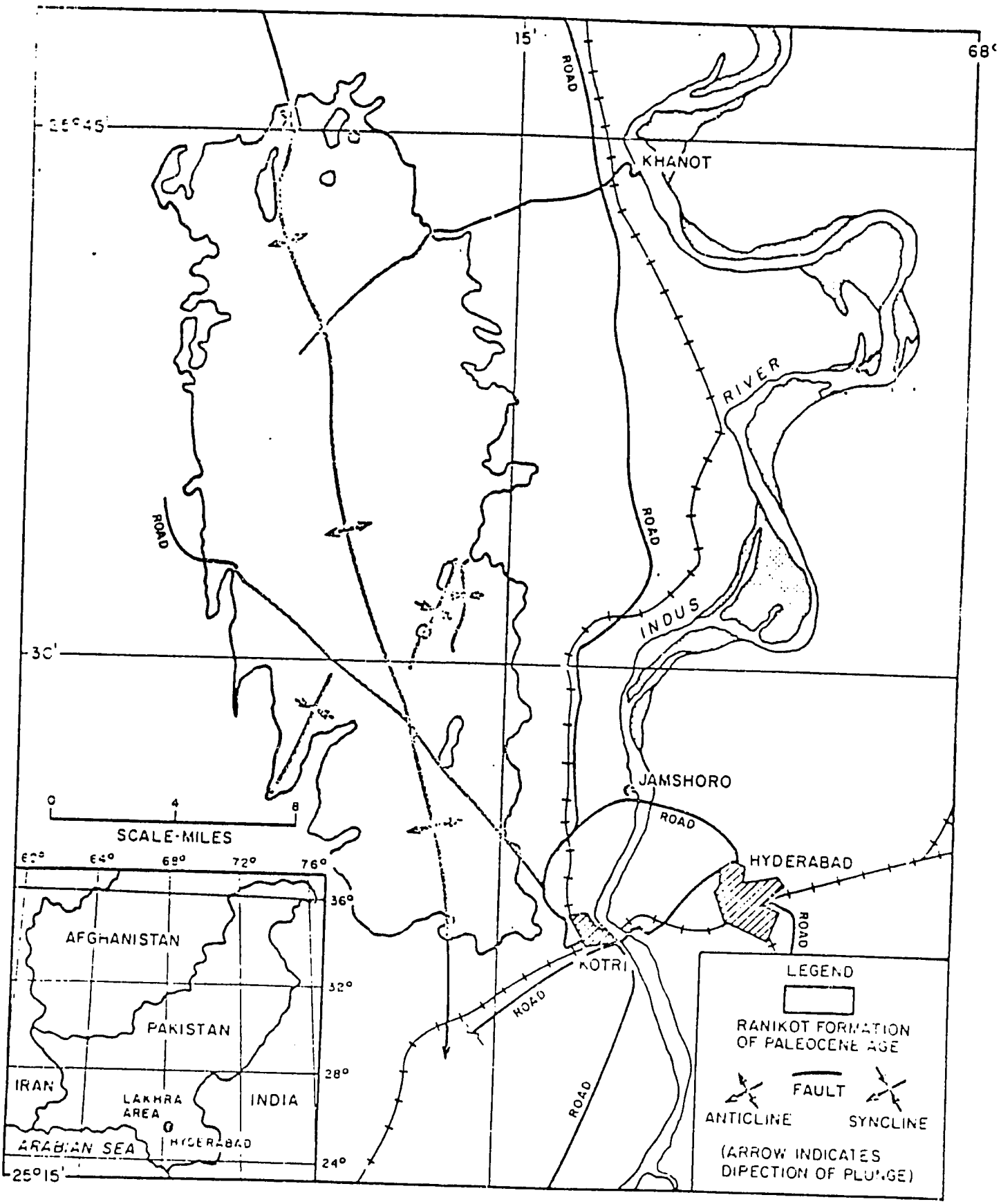
All costs are expressed in millions of January 1983 dollars as of January 1983. Dollar escalation, accrual of interest during construction, and import duties are not included.

Evaluated Capital Costs	Alternative 1 Once-Through/ Jamshoro	Alternative 2 Cooling Tower/ Jamshoro	Alternative 3 CoolingTower/ Minemouth	Alternative 4 Air-Cooled/ Minemouth
Condenser	3.0	3.0	3.0	25.3
Cooling Towers	NA	4.0	4.0	NA
Circulating Water Piping & Pumps	36.0	2.0	2.0	NA
Cooling Tower Makeup System	NA	13.0	67.0	NA
Railway & Cars	11.0	11.0	NA	NA
Transmission Line	NA	NA	6.3	6.3
Total Evaluated Capital Cost	50.0	33.0	82.3	31.6
Evaluated Lifetime Operating Costs				
Coal Transportation	3.0	3.0	NA	NA
Auxiliary Power Penalty	6.1	9.1	11.6	17.4
Back Pressure Penalty	Base	9.3	9.3	55.8
Total Evaluated Lifetime Operating Costs	9.1	21.4	20.9	73.2
Total Evaluated Lifetime Costs	59.1	54.4	103.2	104.8
Difference	4.7	Base	48.8	50.4

FIGURE 2

REGIONAL LOCATIONAL MAP

LAKHRA AREA



VI. EXISTING DATA

A. Meteorology

1. Surface Observations

A variety of surface observation data exists for the region under investigation. The most important sources of data is the routine observations or Aviation Current Weather Reports (ACWR) made by the Pakistan Meteorological Service at Karachi, Hyderabad, and Nawabshah. These observations are taken every three hours, around the clock and include temperature, wind speed, wind direction, cloud amount and type, and precipitation. The raw information consists of one sheet per day for each station, but is summarized for each month on two 11"x17" sheets. Both the raw observations and the monthly summaries are available at the office of the Director General of the Meteorological Service in Karachi.

Arrangements were made with Mr. A.A Rahmatullah, Director General of the Pakistan Meteorological Service and Mr. Mohammad Anwar, USAID Liaison in Karachi, to obtain copies of ACWR Monthly Summaries for Karachi, Hyderabad, and Nawabshah for the five-year period 1978-82.

Another source of surface observation data is the Annual Report of River and Climatological Data of Pakistan, which was prepared annually by the Surface Water Hydrological Project of WAPDA from 1960 through 1979. These reports, which are available in the basement WAPDA library at WAPDA House in Lahore, contain monthly mean values of precipitation, evaporation, temperature, relative humidity, solar radiation, and wind speed (but not wind direction).

2. Upper-Air Observations

Upper wind data for Hyderabad taken at 0000 and 1200 GMT are available at the WAPDA House in Lahore.

Combination upper wind and upper temperature observations taken at 0000 and 1200 GMT are available for Karachi and for Jacobabad in tabulated form (values given for every 1000 feet of elevation) or in their original graphic form as recorder plots of temperature versus pressure level. We were informed by the Meteorological Service that these plots have been analyzed for inversion height, but from their description it appears that they have focused on low-level inversions occurring near the ground.

Our interest in the upper-air observations will be primarily to obtain information about heights of any elevated inversions that may exist. Since this height will often lie in the 1000-3000 foot range, the tabulated observations are

probably not appropriate for our purposes. It would be preferable to extract inversion heights directly from the temperature-pressure graphs. The combination upper wind and upper temperature observations are not available at the Director General's office, but are housed at the other Meteorological Service building located near Karachi University. We attempted to obtain copies of these observations for the years 1978-82, and were referred by the Director General to Mr. Siddiqi at the latter's office, but he was not available when we were in Karachi.

3. Adequacy of Existing Data

The existing data are similar in style to routine meteorological observations made by the National Weather Service in the United States, though probably not subject to the same quality control. To be used in any air quality modeling, the data will have to be transferred from the tables and graphs to a computer.

B. Air Quality

A search for existing air quality data was conducted. WAPDA has not been involved in any air quality work. Visits were made to the Directors of the Pakistan Council for Scientific and Industrial Research (PCSIR) Offices in Karachi (Dr. M.A.A. Beg) and in Lahore (Dr. Muhammad Khurshid Bhatty). No environmental work is being done at the Karachi branch, but there has been some activity at Lahore under the leadership of Dr. Muhammad Hanif. In one study, Dr. Hanif and his colleagues collected air samples in some industrial environments and analyzed them. Another study involved a very general and qualitative survey of air quality problems in Pakistan. It appears that the technology and expertise needed to carry out air quality measurements of the type needed to satisfy environmental assessment requirements do not now exist in Pakistan.

On the other hand, as any visitor to Hyderabad will readily observe, the air there is highly polluted. The main sources evidently are automobiles, trucks, and buses whose engines usually do not appear to be well-tuned. The pollutants likely to be emitted in large amounts by these automotive sources are TSP, lead, carbon monoxide, and nitrogen oxides.

To summarize, our preliminary estimate of conditions existing in Hyderabad would indicate that although there are virtually no industrial point sources present, there are significant contributions made by automotive sources that are dispersed throughout the city.

Outside of Hyderabad, even automotive contributions to air pollution levels appear to be fairly small. The city itself is considered as having by far the highest air pollution

concentrations in the Hyderabad-Jamshoro-Lakhra-Khanot area, with the exception of dust in and around the Lakhra coal field.

The only other air pollution source of concern here is the coal mining operation at the Lakhra coal field. At Lakhra, no special effort is made to control fugitive dust, so TSP is expected to be a potential problem in that area. No other significant pollutant sources are present at Lakhra or elsewhere in the upland area. Because of the arid conditions in this area, fugitive dust conditions will be virtually impossible to control and should be considered part of the environment.

C. Water Quality

1. Existing Conditions

Coal Production

There are apparently no data available for the proposed surface and subsurface coal mines. However, the mining area is located in a desert region and water discharge from the site is not expected to be significant.

Power Generation

The primary source of water for steam generation at the Jamshoro Site will be Indus River. The Institute of Public Health Engineering and Research in Lahore, as part of its GEMS - Water Quality Project, maintains a monitoring station on the Indus River upstream of the Kotri Barrage, within 10 km of the Jamshoro site

Table 4 provides a summary of water quality during low and high flow periods between 1981 and 1984. The data indicate that water at the Kotri Barrage station is of generally good quality. The most striking water quality difference between low and high flow periods is in the level of total suspended solids (TSS). However, the elevated TSS levels during high flow are expected.

D. Hydrology

Flow data is taken on a weekly basis at Sehwan (50 miles north of Khanot) by WAPDA and on a monthly basis at the Kotri Barrage by the Irrigation Department. These data need to be supplemented during the impact assessment phase to provide accurate site-specific flow data.

E. Land Use

Aerial photographs (1"=40,000'), taken in 1954 would be too old to be useful in assessing land use patterns, due to the many changes that have occurred since that time.

A master plan report is available at the Karachi Development Authority which can give some idea of expected future land use patterns.

TABLE 4
AMBIENT WATER QUALITY
UPSTREAM OF KOTRI BARRAGE (a), INDUS RIVER

	HIGH FLOW				LOW FLOW			
Date	8/19/81	9/4/82	9/19/83	7/19/84	12/19/81	12/4/82	12/4/83	1/19/84
Time	9:30	11:00	10:00	10:00	10:00	10:00	10:00	11:00
Temperature(°C)	20.0	27.0	28.0	35.0	18.0	18.0	22.0	18.0
pH	7.5	7.4	7.5	7.5	7.4	7.2	7.4	7.4
Electrical Conductivity (uM hos/cm)	0.320	0.250	0.380	0.330	0.330	0.270	0.325	0.290
Dissolved Oxygen(b)	6.0	6.5	14	7.5	8.7	12	22	12
BOD	3.0	4.5	10.0	5.5	3.5	4.5	12.5	8.0
COD	4.0	10.0	28.0	20.0	5.0	28.0	30.0	30.0
Fecal Coliform Bacteria (MPN/100 ml)	110.0	79.0	109.0	94.0	110.0	170.0	110.0	109.0
Chloride	52.0	36.0	52.0	60.0	50.0	36.0	56.0	56.0
Alkalinity	120.0	96.0	104.0	120.0	140.0	100.0	120.0	120.0
Suspended Solids	2000.0	2600.0	2000.0	2000.0	60.0	25.0	30.0	20.0
Nitrogen, Ammonia	0.0	0.27	0.25	0.25	1.1	3.1	0.22	0.25
Nitrogen, NO_2+,NO_3	1.8	1.8	2.0	2.5	2.5	2.2	3.0	3.0
Fluoride	0.4	0.25	0.5	0.4	0.5	2.5	0.45	0.5
Phosphate (Ortho)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Chromium (Hexavalent)	0.0	0.0	0.0	-	0.5	0.0	0.0	-
Iron	0.0	0.1	0.1	1.0	1.0	0.1	0.1	0.1
Sodium	2.4	8.0	24.0	32.0	4.0	12.0	24.0	20.0
Sulfate	84.0	64.0	100.0	100.0	100.0	90.0	124.0	96.0
Calcium	32.0	24.0	48.0	40.0	33.6	44.0	32.0	32.0
Magnesium	12.0	7.84	22.5	30.0	9.4	26.0	24.0	24.0

Notes: (a) All samples taken by the Institute of Public Health Engineering and Research; University of Engineering and Technology, Lahore, Pakistan for the GEMS - Water Quality Project

(b) All units in mg/l, unless otherwise noted.

VII. ENVIRONMENTAL STANDARDS

A. Air Quality

The standards for ambient air quality and for point source emission are presented in Table 5. By far the most stringent requirements are those of USEPA, but they were not designed for a developing country. Although it is desired from an environmental view point to minimize the emissions from a facility in a developing country where industrialization is in its infancy, this degree of control is not appropriate. However, as industrialization increases this concept must be reassessed.

As the World Bank is expected to finance the proposed project, World Bank Guidelines would apply. These Guidelines should be applied, however, they may be adjusted to each specific situation. Where these performance levels cannot be achieved, the appraisal and/or supervisory mission should fully document deviations and reasons for these deviations, be they technical, regulatory or other" [World Bank's Office of Environmental Affairs, July 1984].

B. Water Quality

Coal Production. Table 6 provides effluent limitation recommended by the World Bank for surface mining operations, underground coal mining and coal preparation facilities. Since the mining site is in a desert area, there are no know discharges from the site. Occasional discharges from the site may occur as a result of intermittent rain storms. This effluent is not likley to meet the World Bank effluent limitation. However, the quantity of these effluents is expected to be insignificant and the occurence of discharges is expected to be rare.

Power Generation. The World Bank's Office of Environmental Affairs (1984) provides general guidelines for the disposal of industrial effluents such as those resulting from power generating facilities. These guidelines state that the temperature of the diluted effluent should not be more than 3°C higher than that of the receiving waters except within a mixing zone defined on a case-by-case basis. However, if the receiving water temperatures are determined to be 28°C (82°F) or less, the guideline allows the diluted effluent temperature to be a maximum of 5°C above that of the receiving waters except within a mixing zone, also defined on a case-by-case basis. This guideline applies to use of water from the Indus River for steam generation. An alternative procedure for calculating permissible effluent temperature provided in the guidelines, whereby a maximum allowable stream temperature is calculated from the optimum and lethal temperatures for potentially affected species. However, absence of thermal tolerance data

for species in the Indus River inhabiting the Jamshoro Reach precludes the use of this option.

The United States Environmental Protection Policy (EPA, 1982) provides water quality effluent guidelines and standards for the steam electric power generation industry. These effluent limitations are shown in Table 7. All discharges, except for once through cooling water, are required to have a pH between 6.0 and 9.0. Furthermore, no discharge of polychlorinated biphenyl (PCBs) compounds is permitted. A list of 126 Priority Pollutants mentioned in Table 7 are provided in Attachment II.

Water Quality Monitoring

Coal Production. As discussed previously, no water quality data are available from the proposed surface and subsurface coal production area. However, since the mining area is located in a desert, water discharges are anticipated to be occasional and insignificant. As a result, no monitoring is recommended at this time.

Power Generation. Table 8 provides a selected list of water quality monitoring parameters which will reflect the quality of the effluents from the discharges. We have based our list on the previously discussed World Bank guidelines and U.S. EPA recommended parameters for power generating facilities. However, in developing our list, we have also considered availability and ease of analysis and replicability under field conditions likely to be encountered in Pakistan.

The list of parameters is divided into two groups, based on significance of the monitoring parameter and includes recommended effluent guidelines for the parameters, where applicable. These guidelines represent reasonable water quality criteria for the protection of ground, surface and drinking water supplies and aquatic life in the Indus River Basin. Should it be required, these effluents can be collected and treated by a variety of available methods prior to discharge.

List of parameters on Table 8 depending on Site Specific Conditions may be modified in the field.

TABLE 5

APPLICABLE AIR QUALITY REGULATIONS - USEPA AND WORLD BANK

AMBIENT LEVELS (ug/m3)

USEPA Standards(1)

(World Bank Guidelines)

Pollutant	Time Period				
	Annual	24 Hour	8 Hour	3 Hour	1 Hour
Total Suspended Particulates (TSP)	75 (100)	250 (500)	-	-	-
Sulfur Dioxide (SO_2)	80 (100)	365 (500)	-	-	-
Carbon Monoxide (CO)	-	-	10,000	40,000	-
Nitrogen Dioxide (NO_2)	100 (100)	- (500)	-	-	-
Ozone (O_3)	-	-	-	-	235
Lead (Pb)	1.5[2]	-	-	-	-

STACK EMISSION LIMITATIONS

Pollutant	USEPA Standards (LBS/MMBTU)	World Bank Guidelines Maximum Allowable Annual Emissions(3)	Increment
Total Suspended Particulates (TSP)	0.03	100 mg/m3	-
Sulfur Dioxide (SO_2)	1.20	500 tons/day	50 ug/m3
Carbon Monoxide (CO)	-	-	-
Nitrogen Dioxide (NO_2)	0.60	0.6 LBS/MMBTU	-
Ozone (O_3)	-	-	-
Lead (Pb)	-	-	-

Notes: (1) These are USEPA primary standards which are designated to protect human health. The USEPA also has more restrictive secondary standards which are designed to protect human welfare, vegetation, etc.

(2) Per calendar quarter

(3) Applies when background levels are high.

TABLE 6

WORLD BANK EFFLUENT LIMITS (a)

	Surface Mining Operations	Underground Mining Operations/Coal Preparation
Total Suspended Solids (mg/l)	30 - 100	70
pH	6 - 9	6 - 9
Total Iron (mg/l)	4 - 7	4
Total Magnesium (mg/l	-	4
Alkalinity (mg/l)	Greater than the Acidity	-
Soluble Toxicants	None	-

Notes: (a) Environmental Guidelines; The World Bank; Office of Environmental Affairs (July 1984); Washington, D.C.

TABLE 7
WATER QUALITY GUIDELINES
AND STANDARDS FOR
STEAM ELECTRIC POWER (1982)

Source(b)	Pollutant or Pollutant Property	NSPS EFFLUENT LIMITATIONS(a) Maximum Concentration	Average Concentration	Maximum For Any One Day	Average Daily Values for 30 Consecutive Days	Fc Ar Ti
Low Volume Waste Sources						
	TSS			100.0	30.0	
	Oil and Grease			20.0	15.0	
Chemical/Metal Cleaning Wastes						
	TSS			100.0	30.0	
	Oil and Grease			20.0	15.0	
	Copper, Total			1.0	1.0	
	Iron, Total			1.0	1.0	
Bottom Ash Transport Water						
	TSS			100.0	30.0	
	Oil and Grease			20.0	15.0	
Once Through Cooling Water (From each discharge point)						
	Total Residual Chloride	0.20				
	Free Available Chloride	0.50	0.20			
Cooling Tower Blowdown						
	Free Available Chloride	0.50	0.20			
The 126 Priority Pollutants (Attachment II) Contained in Chemicals Added for Cooling Tower Maintenance, except:				No Detectable Amount	No Detectable Amount	
	Chromium, Total			0.20	0.20	
	Zinc, Total			1.00	1.00	
ol Pile Runoff						
	TSS					Not to Exceed

Notes: (a) New Source Performance Standards.
(b) All Concentrations in mg/l. All numbers must be multiplied by the flow of the source.

TABLE 8

RECOMMENDED EFFLUENT GUIDELINES FOR THE PROPOSED JAMSHORO POWER PLANT

Primary Parameters	Limit
Temperature (°C)	(a)
pH (units)	6.0 - 9.0
Dissolved Oxygen(b)	5.0
Total Suspended Solids (TSS)	100
Total Residual Chlorine	0.2
Total Available Chlorine	0.5
Secondary Parameters	
Chromium	1.0 mg/l
Copper	1.0 mg/l
Iron	1.0 mg/l
Phosphate	(c)
Sulfate	(c)
Conductivity (uMhos / cm)	(c)
Alkalinity	Greater than the Acidity
Acidity	(c)

Notes: (a) Diluted effluent may not exceed by 3°C the receiving waters. However, if receiving waters are 28°C or less, diluted effluent may not exceed these waters by more than 5°C.

(b) All parameter units in mg/l, unless otherwise noted.

(c) Diluted effluent not to significantly exceed receiving waters.

ATTACHMENT II

PRIORITY POLLUTANTS

001 Acenaphthene
002 Acrulein
003 Acrylonitrile
004 Benzene
005 Benzidine
006 Carbon tetrachloride (tetrachloromethane)
007 Chlorobenzene
008 1.2.4-trichlorobenzene
009 Hexachlorobenzene
010 1.2-dichloroethane
011 1.1.1-trichloroethane
012 Hexachloroethane
013 1.1-dichloroethane
014 1.1.2-trichloroethane
015 1.1.2.2-tetrachloroethane
016 Chloroethane
018 Bis(2-chloroethyl) ether
019 2-chloroethyl vinyl ether (mixed)
020 2-chloronaphthalene
021 2.4. 6-trichlorophenol
022 Parachlorometa cresol
023 Chloroform (trichloromethane)
024 2-chlorophenol
025 1.2-dichlorobenzene
026 1.3-dichlorobenzene
027 1.4-dichlorobenzene
028 3.3-dichlorobenzidine
029 1.1-dichloroethylene
030 1.2-trans-dichloroethylene
031 2.4-dichlorophenol
032 1.2-dichloropropane
033 1.2-dichloropropylene (1.3-dichloropropene)
034 2.4-dimethylphenol
035 2.4-dinitrotoluene
036 2.6-dinitrotoluene
037 1.2-diphenylhydrazine
038 Ethylbenzene
039 Fluoranthene
040 4-chlorophenyl phenyl ether
041 4-bromophenyl phenyl ether
042 Bis(2-chloroisopropyl) ether
043 Bis(2-chloroethoxy) methane
044 Methylene chloride (dichloromethane)
045 Methyl chloride (dichloromethane)
046 Methyl bromide (bromomethane)
047 Bromoform (tribromomethane)
048 Dichlorobromomethane
051 Chlorodibromomethane
052 Hexachlorobutadiene
053 Hexachloromyclopentadiene
054 Isophorone
055 Naphthalene
056 Nitrobenzene
057 2-nitrophenol
058 4-nitrophenol
059 2.4-dinitrophenol
060 4.6-dinitro-o-cresol
061 N-nitrosodimethylamine
062 N-nitrosodiphenylamine
063 N-nitrosodi-n-propylamin
064 Pentachlorophenol
065 Phenol
066 Bis(2-ethylhexyl) phthalate
067 Butyl benzyl phthalate
068 Di-N-Butyl Phthalate
069 Di-n-octyl phthalate
070 Diethyl Phthalate
071 Dimethyl phthalate
072 1.2-benzanthracene (benzo(a) anthracene
073 Benzo(a)pyrene (3.4-benzo-pyrene)
074 3.4-Benzofluoranthene (benzo(b) fluoranthene)
075 11.12-benzofluoranthene (benzo(b) fluoranthene)
076 Chrysene
077 Acenaphthylene
078 Anthracene
079 1.12-benzoperylene (benzo(ghi) perylene)
080 Fluorene
081 Phenanthrene
082 1.2.5.6-dibenzanthracene (dibenzo(.h) anthracene)
083 Indeno (.1.2.3-cd) pyrene (2.3-o-pheynylene pyrene)
084 Pyrene
085 Tetrachloroethylene
086 Toluene
087 Trichloroethylene
088 Vinyl chloride (chloroethylene)
089 Aldrin
090 Dieldrin
091 Chlordane (technical mixture and metabolites)
092 4.4-DDT
093 4.4-DDE (p.p-DDX)
094 4.4-DDD (p.p-TDE)
095 Alpha-endosulfan
096 Beta-endosulfar
097 Endosulfan sulfate
098 Endrin
099 Endrin aldehyd
100 Heptachlor
101 Heptachlor epoxide (BHC-hexachlorocyclohexane)
102 Alpha-BHC
103 Beta-BHC
104 Gamma-BHC (lindane)
105 Delta-BHC (PCB-polychlorinated biphenyls)
106 PCB-1242 (Arochlor 1242)
107 PCB-1254 (Arochlor 1254)
108 PCB-1221 (Arochlor 1221)
109 PCB-1232 (Arochlor 1232)
110 PCB-1248 (Arochlor 1248)
111 PCB-1260 (Arochlor 1260)
112 PCB-1016 (Arochlor 1016)
113 Toxaphene
114 Antimony
115 Arsenic
116 Asbestos
117 Beryllium
118 Cadmium
119 Chromium
120 Copper
121 Cyanide. Total
122 Lead
123 Mercury
124 Nickel
125 Selenium
126 Silver
127 Thallium
128 Silver
128 Zinc
129 2.3.7.8-tetrachloro-dibenzo-p-dioxin (TCDD)

VIII. TECHNICAL CAPABILITIES OF ON-SITE PERSONNEL

The availability of technical personnel both to maintain and operate air quality and meteorological monitoring systems exists within the WAPDA organization. Discussions have indicated their desire to provide such personnel for this program. As a back-up, PCSIR staff can also be trained to operate and maintain the monitoring system.

Minor field repairs can be accomplished by these personnel, however, major "breadboard" repairs should be provided through the equipment manufacturer.

The availability of personnel for water quality monitoring exists within the Irrigation Department, Kotri Barrage, Government of Sind.

IX. MONITORING PROGRAM

A. Air Quality Monitoring

1. Purpose

The purposes of air quality monitoring are as follows:

(a) Before a facility is constructed, air quality monitoring is used to provide "baseline" information about existing air quality conditions and their variation with time of day, season of the year, and meteorological conditions. This information is needed to provide data which can be used to determine whether operation of the facility would result in a significant deterioration of air quality or whether air pollution concentrations from the proposed facility, when added to pre-existing levels, would result in unacceptable air quality levels.

(b) After a facility is constructed, air quality monitoring data is used to determine whether air pollution modeling was correct, and to provide a means of assessing whether the facility's operation continues to be in compliance with applicable air quality regulations.

Although this study is concerned only with the first of these two purposes, it would be advantageous for any monitoring system that is selected to satisfy both considerations.

The objective in monitoring for a baseline study is to obtain a general picture of existing pollutant concentrations in the area to be impacted by the proposed facility. Thus, the monitor should be located away from any major point sources that would render the readings unrepresentative of the overall area. Air quality monitoring after construction of the facility should be concentrated in the area in which the greatest air quality impact is predicted, particularly if high levels are possible and/or if there are sensitive receptors (e.g. hospitals, schools, population centers, etc.), nearby. Monitoring may be called for at sensitive receptors regardless of their proximity to the site.

2. Parameters to be monitored

The air quality parameters to be monitored are those generally accepted as being associated with coal combustion in power plants, and for which ambient air quality standard exist in the U.S. These are:

(a) Nitrogen oxides

(b) Sulfur dioxide

(c) Carbon monoxide

(d) Total suspended particulates

B. Meteorological Monitoring

1. Purpose:

Meteorological factors are the most important influences in determining the day-to-day fluctuations in air pollution levels. Pollutants are carried by the wind and spread horizontally and vertically by the turbulent (random) motions of the air. Pollutants are washed out of the air by precipitation. Thus, meteorological measurements are needed for the interpretation of air quality monitoring data and for estimating the dispersion of air pollution from existing or proposed pollution sources.

2. Parameters to be monitored:

(a) Wind Speed.

Wind speed at the height at which a pollutant is emitted determines the amount of air that is mixed with each unit of pollutant that enters the atmosphere, and is a factor in determining how rapidly plumes spread as they travel. Because it is often impractical to measure winds precisely at the source elevation, and because emission often takes place at several heights, a standard height of ten meters is used for wind spread measurements. Computer models that estimate pollutant dispersion adjust this to reflect its approximate value at the height of emission.

Anemometers used in air pollution work must meet specifications that are different from those that are used in routine meteorological monitoring as is done at airports and for climatological purposes. The latter monitoring is usually concerned primarily with occurrences of high winds that are a threat to safety, and such anemometers are designed primarily to survive the occasional occurrences of hurricane-force winds. Their large mass, however, prevents them from responding to the light winds that are of critical importance to air pollution work. Anemometers used in air pollution work typically are able to record wind speeds as low as 1 mph, whereas a well-maintained airport anemometer has a lower limit of about 2 mph, or even higher.

(b) Wind Direction and Sigma-theta

Since pollutants are carried by the wind, the wind direction determines the direction that pollutants travel after

they leave the source. The variability of the wind direction on a very short time scale, known as sigma-theta, has been found to be an excellent indicator of the degree of turbulence that is present in the atmosphere, and so-called sigma-theta computers are often connected to wind direction monitors that are used in air pollution work. In fact, the USEPA now considers sigma-theta as the preferred method of measuring the stability or turbulence characteristics of the atmosphere.

The same sensitivity and siting requirements that apply to anemometers also apply to wind vanes.

(c) Inversion Height

Temperatures in the atmosphere ordinarily decrease with increasing altitude. This situation, where cold air overlies warm air near the ground, provides a certain amount of instability or turbulent overturning of the air which helps to disperse air pollutants. At times, however, temperatures increase with height (temperature inversions) producing conditions that may trap pollutants near the ground, thereby causing high ground-level concentrations. These same inversions also inhibit the vertical development of rain-producing clouds. It is these inversions which are largely responsible for the desert climate that characterizes much of southwestern Pakistan. Since it is expected that temperature inversions will play an important role in pollutant dispersion in southern Pakistan, it appears advisable to measure inversion heights in addition to the parameters measured near the ground.

A convenient method for measuring inversion heights makes use of an acoustic sounder. The sounder operates essentially by emitting acoustic pulses vertically and by measuring the time needed for a reflected pulse to arrive. The sharp temperature discontinuity that usually characterizes temperature inversions provides the interface at which the reflection occurs.

The effect of rain on air pollutant dispersion is not directly incorporated into an air quality modeling analysis. This is not because rainfall is not an important factor, but because its effects are too complex. Rainfall provides one of the primary mechanisms through which pollutants are remove from the atmosphere, and concentrations typically decrease during and after rain. Knowledge of when these events actually occur is important in the interpretation of background monitoring results.

3. Considerations in Siting of Equipment

Ideally, meteorological (and air quality) equipment should be sited at the locations for which background monitoring and/or dispersion modeling is to be done. In the presence of complicating factors, such as complex terrain, sea breezes,

etc., there should be a sufficient number of monitoring sites to adequately define the existing conditions. There are several sites which we are of concern. These are:

Jamshoro (site)	Proposed primary power plant site
Khanot	Proposed alternate power plant site
Lakhra	Proposed alternative power plant site and proposed initial mining area
Hyderabad	High population impact area
Jamshoro (town)	Impact on Liagat Medical College and Hospital, and on Sind University.

Geographically, the Jamshoro-Lakhra-Khanot area can be described in terms of the fertile Indus River plain which is in an essentially north-south direction for the 32 kilometers separating Khanot and Jamshoro, characterized by a rapid desertification and slow rise in elevation as one proceeds westward from the plain. The area's agriculture and population are heavily concentrated on the river plain, essentially between the 30 and 45 meter height contours. A small population of nomads inhabits the upland areas. The city of Hyderabad lies about 14 kilometers southeast of Jamshoro.

C. Equipment Location

Two sites have been chosen for the meteorological and air quality monitoring equipment, one at the proposed power plant site in Jamshoro and one at the proposed mine site in Lakhra.

The Jamshoro site is on the lower of two small isolated hillocks, about 600 meters due south of the existing Jamshoro switching station and 1.5 kilometers north of Liagat Medical College and Hospital. This site will represent conditions in what will probably be the most critically affected areas along the river plain, as well as meteorological conditions at the source, whether it is located at Jamshoro or at Khanot. The hillock, which rises about 18 meters above the surrounding terrain, represents a small deviation from the ideal site that would be located on the prevailing flat terrain. The hillock was chosen over the flat site for the following reasons:

1. Extensive construction operations at Jamshoro during the coming months could interfere with the measurements and/may result in a need for the site to be moved during the monitoring program.

2. WAPDA is planning to construct a one-story, 750 square meter guest house for Jamshoro visitors atop the second, slightly higher hillock. Having the two facilities adjacent to each other will facilitate installation of power.

3. Visitors to the guest house will be able to see the environmental monitoring station and thereby become more sensitive to the need for environmental monitoring in conjunction with projects of this sort. The guest house could even include a placard or other literature that describes the operation of the environmental monitors.

4. A site located near the guest house will derive a certain amount of protection from vandalism and theft, as there will usually be some activity there.

The second meteorological monitor, together with a monitor for total suspended particulate matter, are to be sited at the Lakhra coal mining area. Mr. Memon of WAPDA suggested locating it near marker JT-19, also near the projected site of a WAPDA guest house. However, we have suggested that the site and the guest house be moved westward from JT-19 until they are at least 400 meters west of all the site activity. This would make the suspended particulate readings taken at the site more representative of background conditions because the monitor would not often be downwind of the coal mining activities. The same logic applies to moving the guest house.

D. Power Supply Equipment

Because data acquisition on this project will be done through use of a computer and a data logger, steady electric power is a necessity. Power surges can destroy delicate electronic equipment, and extended power outages can result in the loss of valuable data.

An attempt was made to evaluate the steadiness and reliability of electric power in the areas where the equipment is to be sited. During conversations with various individuals, conflicting information about the reliability of WAPDA's power was received. On one occasion, we were told that eight-hour electric outages were not uncommon. However, Mr. A.S. Memon, Director (Mining and Geology) and Project Director (DUKI) has assured us that at the sites we have selected, power outages will be no more than a few minutes in length; power surges do, however, occur.

As a result of this and other information it was decided to isolate all electronic equipment from the power lines by operating it from a bank of batteries. The batteries will operate inverters that will produce smooth, surge-free 110 volt alternating current. The batteries will be charge from the power lines. Irregularities and/or disruptions in the charging current will be of minor consequence, and the disruption will not be transmitted to the instruments.

E. Personnel Requirements

Personnel required for the efficient operation of the air quality monitoring network will consist of one person for one (1) hour every day at each monitoring station. It will be his responsibility to check that:

1. All equipment is functioning properly;
2. All equipment is within the appropriate control ranges outlined in the manual;
3. All filters are weighed and stored;
4. All maintenance routines are undertaken;
5. All calibrations are completed as required; and
6. All logs are properly filled out.

To accomplish the above functions the individual must have a technical training and be able to repair rotational motors and instrumentation. He must be conversant with electrical semi-conductor technology and be able to troubleshoot transistorized circuitry. This individual must be capable of understanding electrical schematics as well as being fastidious in keeping proper instrument logs. The technician must be fluent in the English language to understand the technical manuals supplied with the instrument. He should have demonstrated job stability, an eagerness to learn, as well as self-motivation.

Personnel required for the water quality monitoring program will require experience in taking a water sample and using chemicals as per "cookbook" direction. This individual should be available for one (1) full day per week at both the Jamshoro and Khanot sites during the two (2) month low flow period (January-February) and the two (2) month high-flow period (July-August); for the remaining period this person will have to sample the aforementioned sites on a routine monthly basis as per recommended standard operating procedures.

F. Equipment Lists and Specifications

See Tables 9 through 14.

TABLE 9

EQUIPMENT LIST
AMBIENT AIR QUALITY MONITORING

No. Reqd.	Annex No.	Analyzer Type	Type of Equipment	EPA Designation	Manufacturer	Est. Cost	S
1.	A	Nitrogen Oxides Ambient Analyzer	Chemiluminescent	RFNA-0677-021	Monitor Labs ML8440	$8000	A
1.	B	Sulfur Dioxide Ambient Analyzer	Pulsed Fluorecent	EQSA-0779-039	Monitor Labs ML8850	8000	A
1.	C	Carbon Monoxide Ambient Analyzer	Non-dispersive Infrared	RFCA-1278-033	Horiba APMA-300	5000	A
2.	D	Total Suspended Particulates Monitors	Hi Volume Sampler with programmed timing capabilities and Elapse running Clock		Kurz Instruments KRZ 1000 W/310 T Option	3000	A
2.	D	Total Suspended Particulates Monitors	"		" W/Battery Options	5000	A

TABLE 10

EQUIPMENT LIST
METEOROLOGICAL EQUIPMENT

No. Reqd.	Annex No.	Equipment Type	Description	Manufacturer	Est. Cost	Shi By
1.	I	Met Set 3D Wind speed Wind direction Temperature Solar radiation Rain fall SIGMA Data logger	Meterological equipment Self-Contained W/SIGMA & Solar Power Panel Option	Met-One		
1.	S	Translator Chassis	5 Slot	Met-One	$ 500	AIR
2. (1 Spare)	K	Wind Speed Sensors & Translator Card	Anemometer 0-100 MPH Start Threshold 1MPH Accuracy + 0.25 MPH	Met One 014A Translator Card - 1680	1,500	AIR
2. (1 Spare)	L	Wind Direction Sensors and Translator Card	Wire Wound Potentiometer type 0°-540° Threshold 1 MPH Accuracy +5°	Met One 024A	1,500	AIR
2.	M	Temperature Sensor & Translator Card	Vane Aspirated Shielded, Platinum Resistance Temp. Sensor Temp. Range - 50°F to 150°F Accuracy = 0.1°C	Met One 071-066-3		
1.	N	Solar Radiation Sensor	Pyranometer Accuracy +5%	Met One 096	1,800	AIR
1.	O	Rain Gauge	Tipping Bucket Accuracy 0.5% Orifice 20 CM Calibration 0.25MM	Met One 099	1,250	AIR
1.	P	Inversion Hight Detector	Acoustic Sounder	Radian Corp Echosonde III	25,000	AIR

TABLE 11

EQUIPMENT LIST
DATA ACQUISITION EQUIPMENT

No. Reqd.	Annex No.	Equipment Type	Description	Manufacturer	Est. Cost	Shi By
1.	G	Personal Computer	256K RAM W/ Dual 5-1/4" FD Drives DD Monochrome Display Graphics Board W/ RS-232, Printer Port and Asynchronous Communication Port	Computer -IBM PC	$2600	AIR
1.	G	Keithley Das Data Acquisition System	Data Acquisition System 20 Channel input	Keithley/Das Model 510	3300	AIR
1.	H	Data Logger (For Data Acquisition Backup)	Micro Processor ML 9300 Series	Monitor Labs	3500	AIR
1.	H	Power Supply Back-up Unit	On-line power Back-up 120 min reserve supply 5 KVA	Lorain Products WDA 502B	8000	AIR
1.	G	Printer	Dot Matrix 130 Column, Bi-Directional	EPSON FX 100	800	AIR

TABLE 12

EQUIPMENT LIST
CALIBRATION EQUIPMENT

No. Reqd.	Annex No.	Equipment Type	Description	Manufacturer	Est. Cost	Sh: By
1.	E	Calibration Controller	To automatically Activate Solenoid Values & Calibrator To zero and span Instruments at preset times	Monitor Labs ML 8350	$2000	AIF
2.	F	Calibration	3 Channel w/ SO_2 & NO_2 Permeation Tube Ovens	Monitor Labs ML 8500 W/SO_2 & NO_2 and Zero Air Channel	7000	AIR
4.		No_2 Permeation Tubes	To Generate NO_2 In Concentrations from 0.05 - 0.45 PPM When Diluted with zero air	Monitor Labs	800	SEA
4.		SO_2 Permeation	To Generate NO_2 In Concentrations from 0.05 - 0.45 PPM When Diluted with zero air	Monitor Labs	800	SEA
12.		Co protocol I Cylinders 8 PPM in N_2	Certified protocol I Gases Aluminum Cylinders	Scott Envri. Technology	3500	SEA
6.		Nitrogen Cylinders	+ 2% Aluminum Cylinders	"	1200	SEA
6.		No protocol I Cylinders 100 PPM in N_2	Certified protocol I Gases Aluminum, Cylinders	"	3500	SEA

TABLE 13

EQUIPMENT LIST
REQUIRED SUPPLIES & SPARE PARTS

Number Required	DESCRIPTION	COST
2	NO_2 regulator	$ 300
2	CO regulator	300
2	N_2 regulator	300
30	1/2" Stainless Steel Swagelok or equal tubing unions	75
30	1/4" x 1/8" stainless Swagelok or equal reducing tubing unions	100
30	1/4 Stainless Steel Swagelok or equal tubing unions	75
30	1/8" Stainless Steel Swagelok or equal tubing unions	75
50	1/4" Stainless Steel Nuts (NPT)	50
50	1/8" Stainless Steel Nuts (NPT)	50
50	Compression Ferrules (Stainless Steel)	40
30	1/4" Stainless Steel Swagelok or equal Tees	
2 Box	1/4" Tygon tubing 100 Ft	
2 Box	1/8" Teflon tubing 100 Ft	Approx. 150
2 Box	1/4" Teflon tubing 100 Ft	
1 roll	1/4" Stainless Steel tubing 100'	
1 roll	1/8" Stainless steel tubing 100'	Approx. 300
5	Multi-Plug Adapters	25
10	Heavy Duty Power Cords 200 FT	300
10	Miniature 3-port Solenoid Valves	2000
5 rolls	100' electrical wire-solid core Different colors	

TABLE 14

EQUIPMENT LIST
REQUIRED SUPPLIES & SPARE PARTS

Number Required	DESCRIPTION	COST
1	Instrument Tool Box w/Multimeter	$ 150
1	Nitrogen Oxide Analyzer Expendables kit	350
1	Sulfur Dioxide Analyzer Expendables kit	350
1	Carbon Monoxide Analyzer Expendables kit	200
20 sets	Hi Vol_2 Motor Brushes	600
1	Ozone Generator	000
2	Chopper Motors (NO_x)	1000
5	Chopper Motor Drive Belts (NO_x)	100
5	SO_2 Analyzer Belts	100

TABLE 15

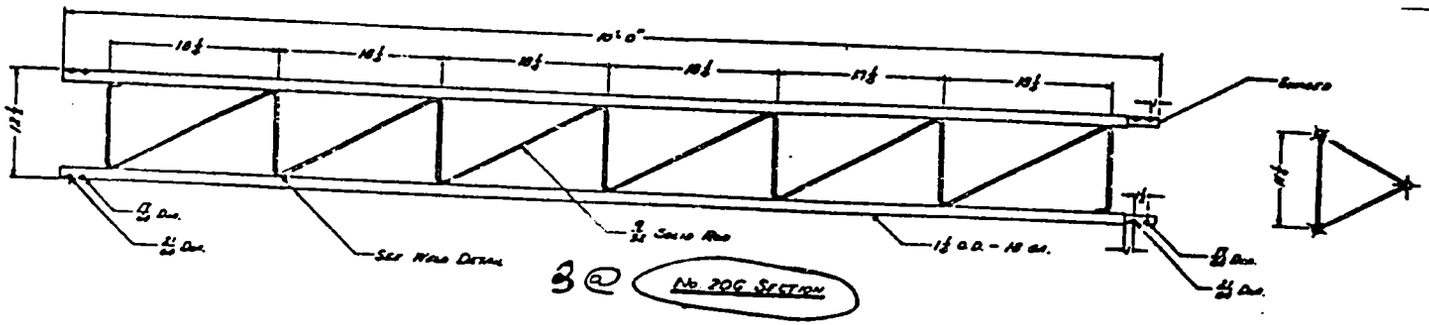
EQUIPMENT LIST
WATER QUALITY MONITORING

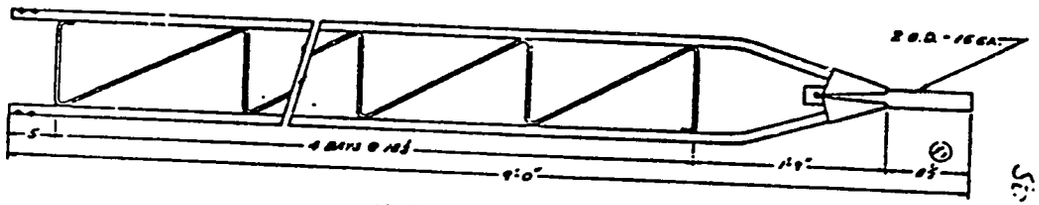
Number Required	Equipment Type	Manufacturers	Estimated Cost
1.	In-Situ Monitoring System Dissolved Oxygen Conductivity pH Temperature	Hydrolab	$ 6000
1.	Portable Water Quality Laboratory DREL/5 Parameters as attached	Hach Chemical	2000

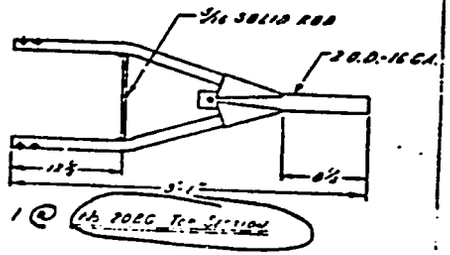
TABLE 16

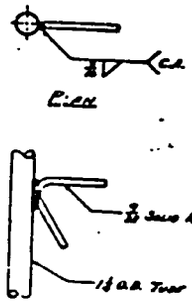
EQUIPMENT TO BE FURNISHED BY WAPDA

2	10 Meter Towers	As per attached specifications
2	8' x 8' enclosure w/ air conditioner	As attached









Tower Specifications	
Distance between side rails (center to center)	18½"
Overall length of section	10'-0"
Weight per section	32 lbs.
Size pipe diameter and gauge	1½ O.D. - 18 Ga.
Cross sectional area of one leg	.1849 sq. in.
Gross allowable vertical load on the bottom tower section	11,700 lbs.
Maximum allowable axial compression of the cross section of one side rail	2,900 lbs.
Measured tensile strength of one side rail	12,810 lbs.
Measured tensile strength of one bolted leg joint	11,010 lbs.
Maximum allowable tension in each bolted leg joint	4,400 lbs.
Safe moment of resistance	3,170 ft.-lbs.
L = unbraced length of side rail (distance between crossbracing)	10½"
R = radius of gyration of side rail	.37"
L/R	43.9
Wind load per linear foot of tower at the indicated wind pressures (based upon flat surfaces) noted below:	
[illegible]	7.37
[illegible]	9.85
[illegible]	[illegible]

Supplied with end section:
3 - 5/16 dia. x 1½" NF Bolts
3 - 5/16 dia. x 1½" NF Bolts

Note: All dimensions in inches except as noted

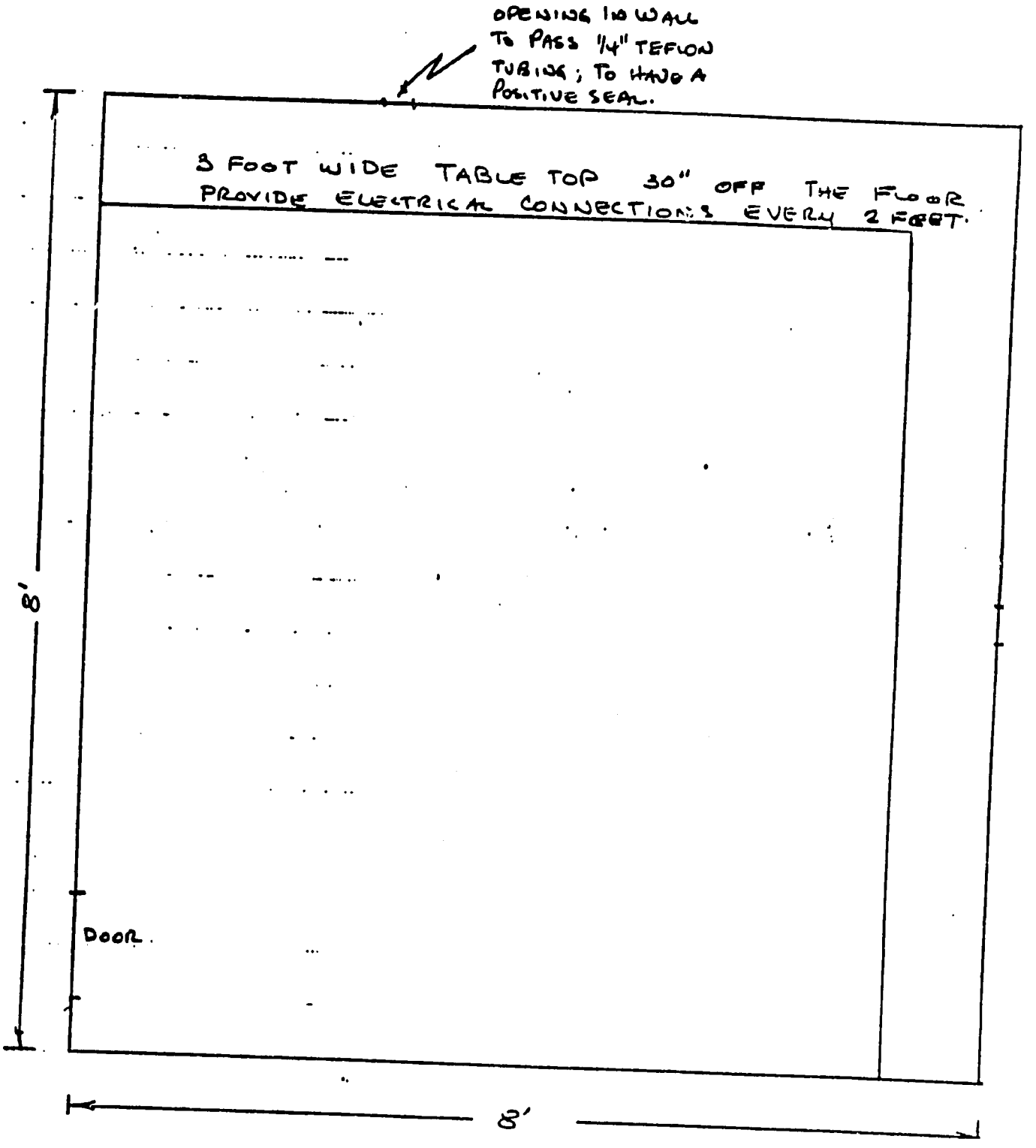
Rev.	Add section 20BC & was 2
Rev.	Removed scale

Unarco-Rohn

Model 20 Tower Section

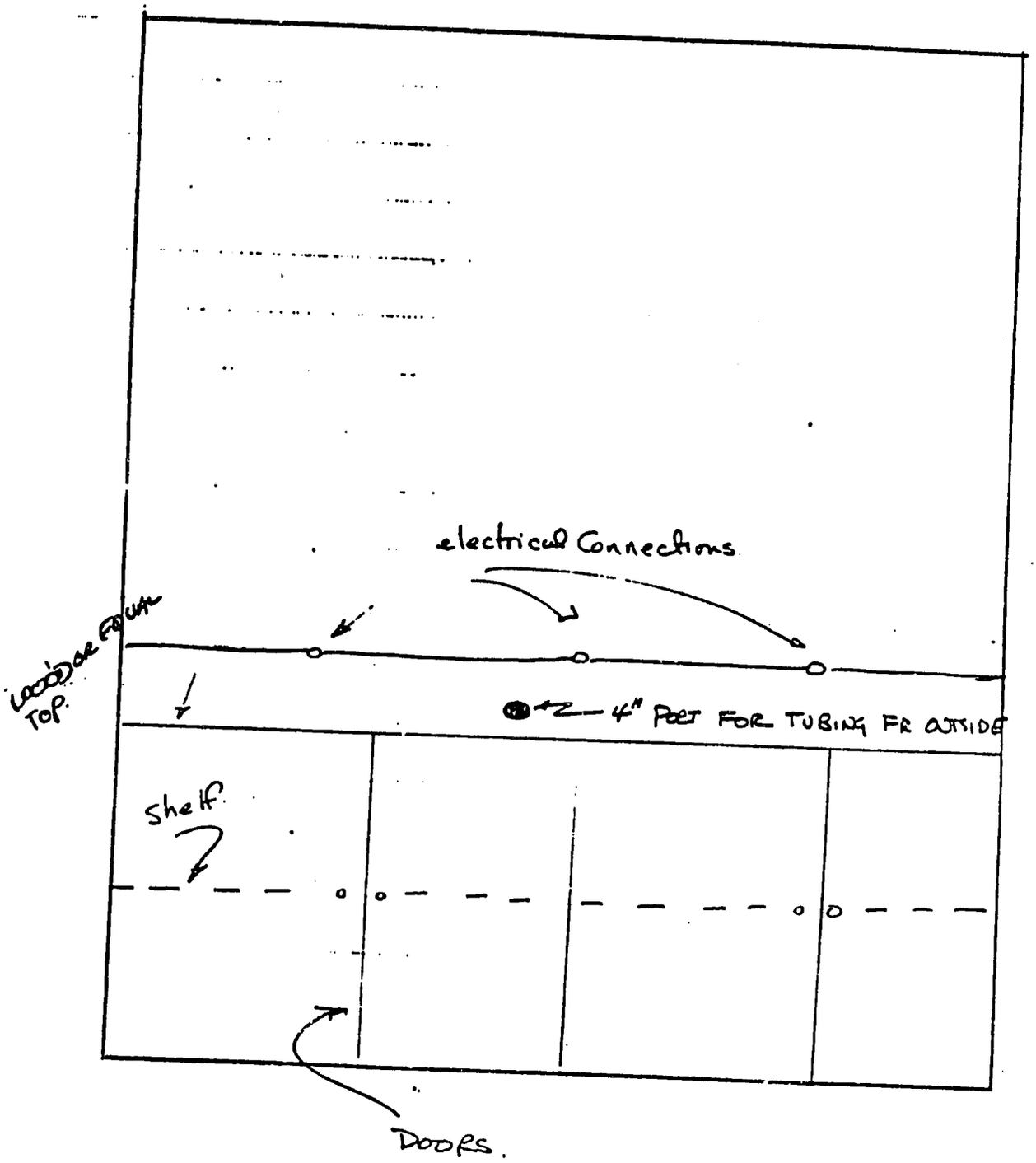
FIGURE 3

FIGURE 4



PLAN VIEW

FIGURE 5



ELEVATION VIEW

X. EQUIPMENT INSTALLATION

Equipment installation will be accomplished as outlined in the attached document. Following equipment purchase and receipt it will be initially checked out in our U.S. Offices and after satisfactory testing will be packed for air freight shipment. This quality assurance step is necessary to insure that the equipment which arrives in Pakistan in good operating order. Calibration gases will be ordered for shipment by sea as soon as we return to the U.S.; it is envisioned that these gases should be ready for transport two weeks after the purchase authorization is given.

After all equipment is received in Pakistan we will return to assist the Pakistani personnel with the installation of the equipment at both sites (Jamshoro and Lakhra). In order to meet the schedule with the World Bank, it is imperative that USAID procure the equipment immediately. Based upon that scenario, the equipment should arrive mid October.

XI. PERSONNEL TRAINING

A personnel training program will be undertaken under separate work order of the assigned Pakistani personnel. It is advised that not only should the individual selected for this assignment to be trained but also one upper management person be trained should the first individual leave. Training will be provided by our staff for each piece of equipment for its installation, operation and maintenance.

A manual and video-taping (VHS) will be prepared prior to our arriving in Pakistan for review, retraining and reference of all USAID, WAPDA and other interested personnel. Personnel should be available for a 2-week in-country training program.

XII. ENVIRONMENTAL ASSESSMENT

An environmental impact assessment report will have to be prepared for the proposed coal fired plant and coal mine in accordance with USNEPA requirements, World Bank requirements and Pakistan Ordinance XXXVII, December 31, 1983, Chapter 8. This impact assessment should address the following: all noise, water and air pollution control activities to minimize these emissions, positive and negative impacts caused by the construction and operations of the proposed upon the terrestrial, atmosphere and aquatic biological and human ecosystems, unavoidable adverse effects, and alternative processes and alternative sites.

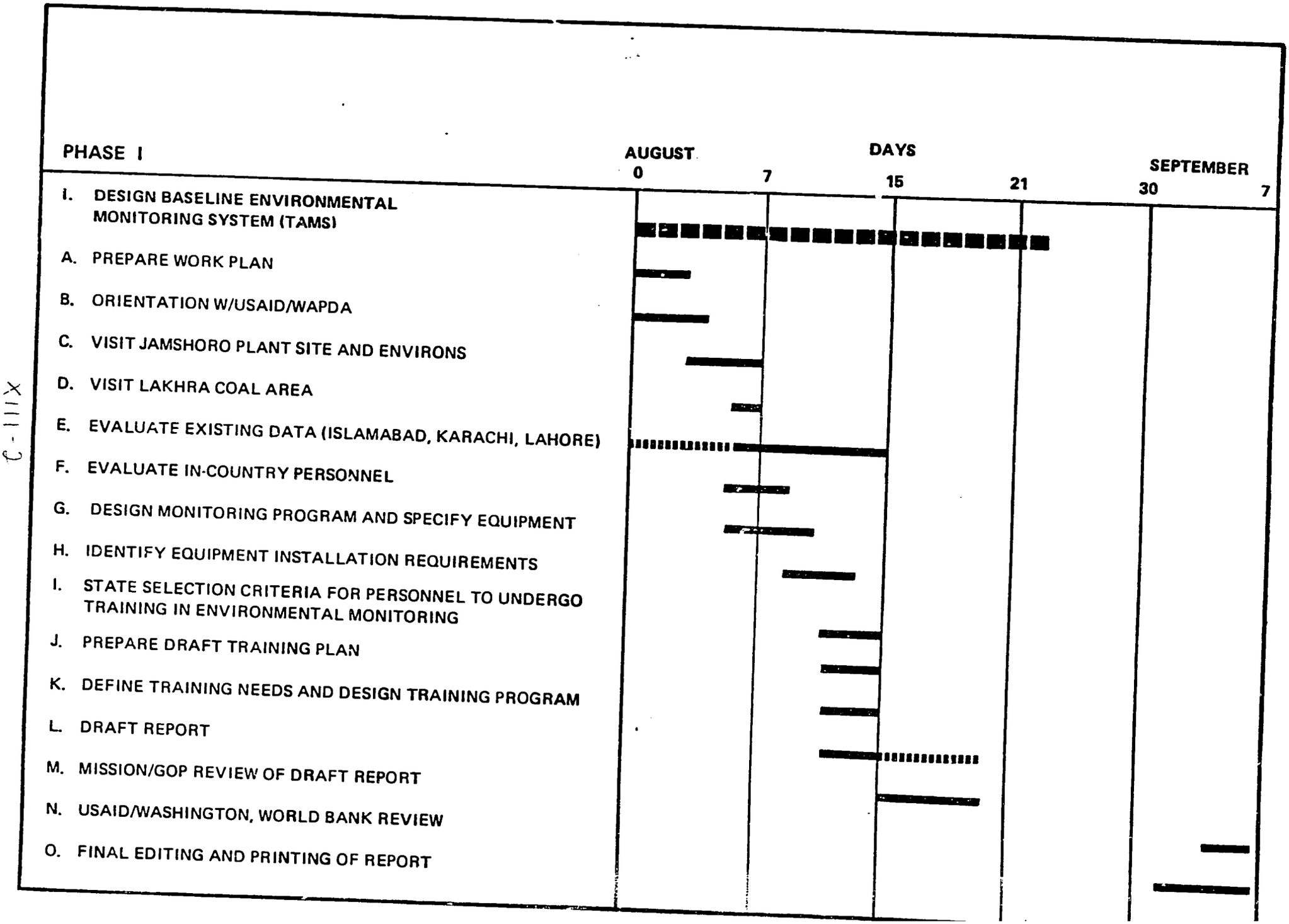
The implementation of the monitoring program presented herein will fill the data gaps to complete this environmental assessment. The environmental team will utilize this as well as the data gathered by that team to project the associated impacts of the proposed facilities. Mitigative measures as well as an appropriate action plan to implement these measures should be developed by the environmental team.

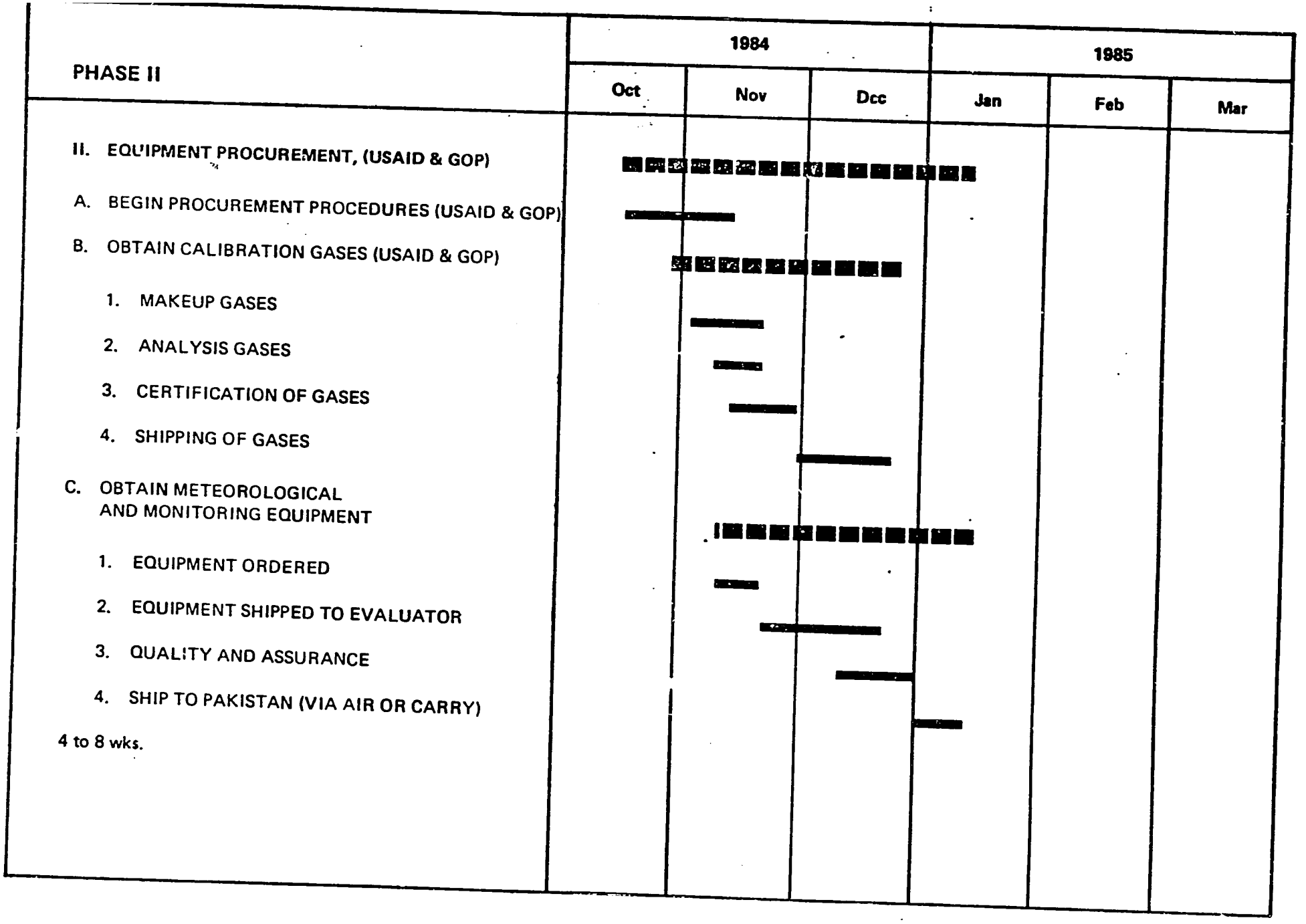
It should be noted that the project site alternatives are all in locations that have little or no environmental pressures and hence the air quality monitoring program is not expected to reveal any data above the lowest limit of sensitivity of the instrument. Hence, utilizing the existing data in Karachi and Hyderabad combined with a minimum of 4 months of on-site data will be sufficient to perform the necessary evaluations of atmospheric impact.

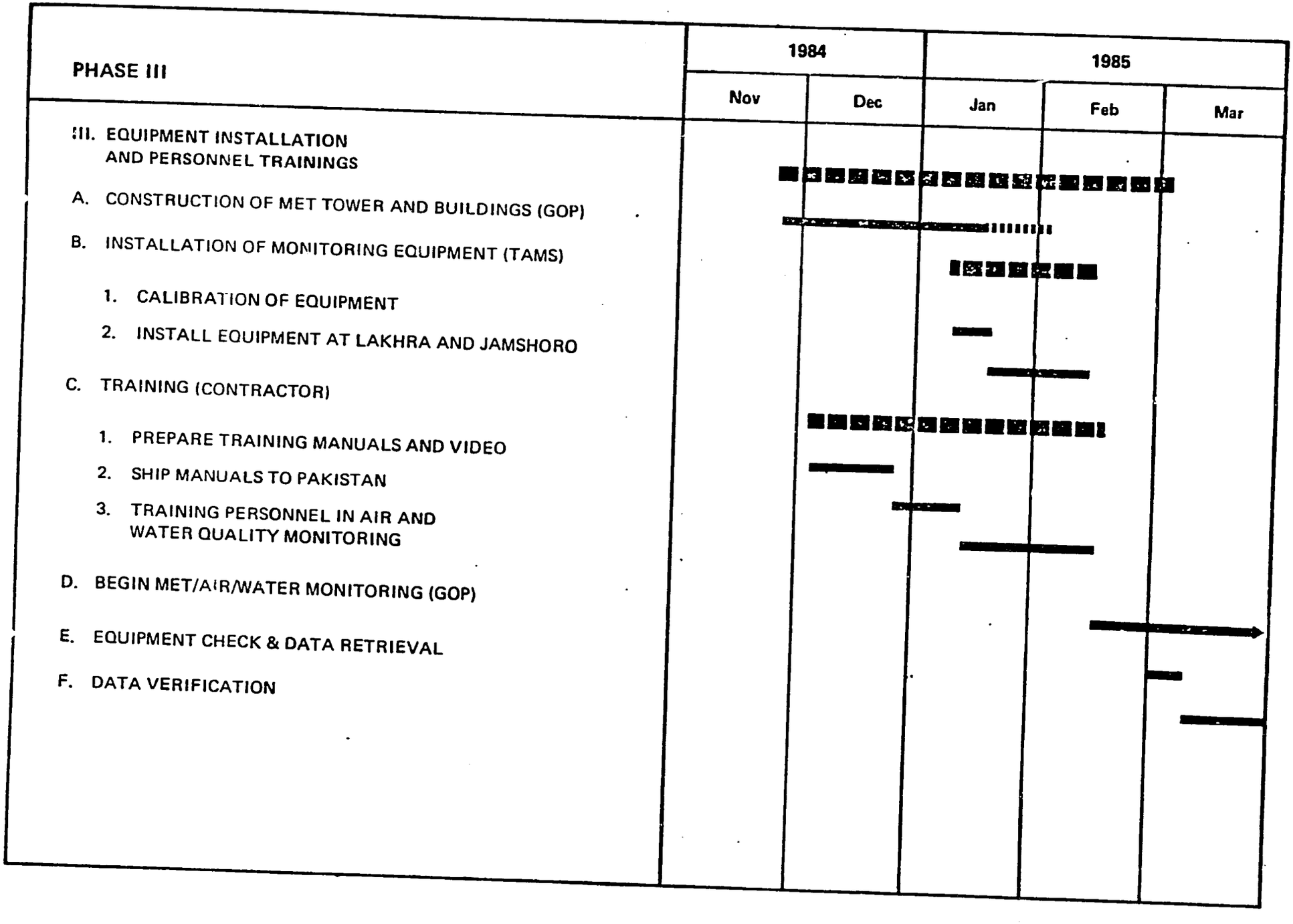
The results of the environmental analyses will provide the necessary input for the final engineering aspects of the power plant and mining facilities with respect to providing the Best Available Control Technology (BACT) for both atmospheric and aquatic emissions.

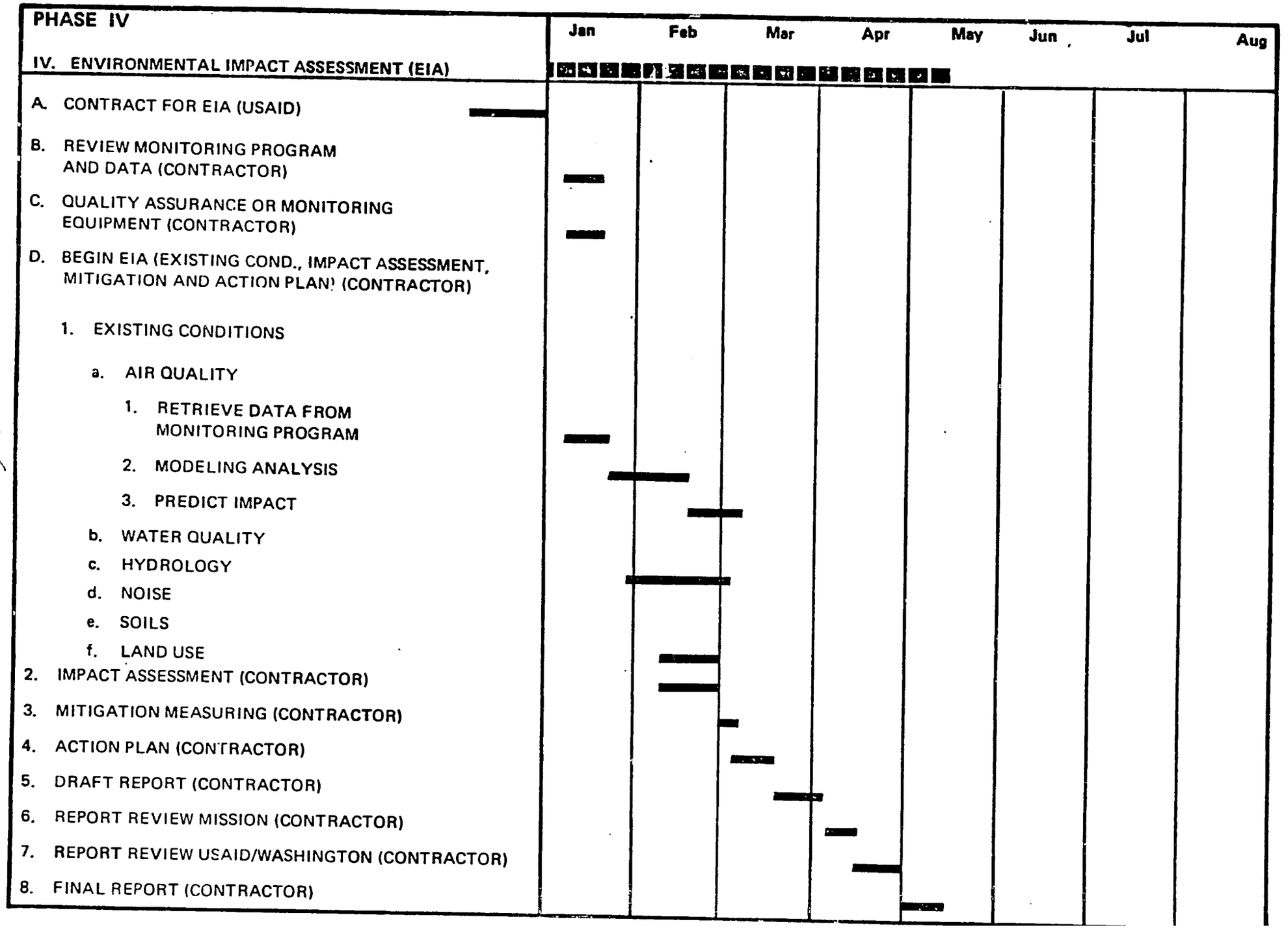
XIII. ENVIRONMENTAL PROGRAM SCHEDULE

The following schedule has been prepared to identify the necessary steps and associated time frames in order to meet the overall Project Schedule.


PHASE I
AUGUST
DAYS
SEPTEMBER
0
7
15
21
30
7
I. DESIGN BASELINE ENVIRONMENTAL MONITORING SYSTEM (TAMS)
A. PREPARE WORK PLAN
B. ORIENTATION W/USAID/WAPDA
C. VISIT JAMSHORO PLANT SITE AND ENVIRONS
D. VISIT LAKHRA COAL AREA
E. EVALUATE EXISTING DATA (ISLAMABAD, KARACHI, LAHORE)
F. EVALUATE IN-COUNTRY PERSONNEL
G. DESIGN MONITORING PROGRAM AND SPECIFY EQUIPMENT
H. IDENTIFY EQUIPMENT INSTALLATION REQUIREMENTS
I. STATE SELECTION CRITERIA FOR PERSONNEL TO UNDERGO TRAINING IN ENVIRONMENTAL MONITORING
J. PREPARE DRAFT TRAINING PLAN
K. DEFINE TRAINING NEEDS AND DESIGN TRAINING PROGRAM
L. DRAFT REPORT
M. MISSION/GOP REVIEW OF DRAFT REPORT
N. USAID/WASHINGTON, WORLD BANK REVIEW
O. FINAL EDITING AND PRINTING OF REPORT


PHASE II
1984
1985
Oct
Nov
Dec
Jan
Feb
Mar
II. EQUIPMENT PROCUREMENT, (USAID & GOP)
A. BEGIN PROCUREMENT PROCEDURES (USAID & GOP)
B. OBTAIN CALIBRATION GASES (USAID & GOP)
1. MAKEUP GASES
2. ANALYSIS GASES
3. CERTIFICATION OF GASES
4. SHIPPING OF GASES
C. OBTAIN METEOROLOGICAL AND MONITORING EQUIPMENT
1. EQUIPMENT ORDERED
2. EQUIPMENT SHIPPED TO EVALUATOR
3. QUALITY AND ASSURANCE
4. SHIP TO PAKISTAN (VIA AIR OR CARRY)
4 to 8 wks.


PHASE III
1984
1985
Nov
Dec
Jan
Feb
Mar
III. EQUIPMENT INSTALLATION AND PERSONNEL TRAININGS
A. CONSTRUCTION OF MET TOWER AND BUILDINGS (GOP)
B. INSTALLATION OF MONITORING EQUIPMENT (TAMS)
1. CALIBRATION OF EQUIPMENT
2. INSTALL EQUIPMENT AT LAKHRA AND JAMSHORO
C. TRAINING (CONTRACTOR)
1. PREPARE TRAINING MANUALS AND VIDEO
2. SHIP MANUALS TO PAKISTAN
3. TRAINING PERSONNEL IN AIR AND WATER QUALITY MONITORING
D. BEGIN MET/AIR/WATER MONITORING (GOP)
E. EQUIPMENT CHECK & DATA RETRIEVAL
F. DATA VERIFICATION


PHASE IV
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
IV. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
A. CONTRACT FOR EIA (USAID)
B. REVIEW MONITORING PROGRAM AND DATA (CONTRACTOR)
C. QUALITY ASSURANCE OR MONITORING EQUIPMENT (CONTRACTOR)
D. BEGIN EIA (EXISTING COND., IMPACT ASSESSMENT, MITIGATION AND ACTION PLAN) (CONTRACTOR)
1. EXISTING CONDITIONS
a. AIR QUALITY
1. RETRIEVE DATA FROM MONITORING PROGRAM
2. MODELING ANALYSIS
3. PREDICT IMPACT
b. WATER QUALITY
c. HYDROLOGY
d. NOISE
e. SOILS
f. LAND USE
2. IMPACT ASSESSMENT (CONTRACTOR)
3. MITIGATION MEASURING (CONTRACTOR)
4. ACTION PLAN (CONTRACTOR)
5. DRAFT REPORT (CONTRACTOR)
6. REPORT REVIEW MISSION (CONTRACTOR)
7. REPORT REVIEW USAID/WASHINGTON (CONTRACTOR)
8. FINAL REPORT (CONTRACTOR)

XIII-5

XIV. GENERAL COMMENTS

A. Environmental Awareness in Pakistan.

The Environmental awareness among the Pakistani Public and Government organization in Pakistan is increasing. Developments that are taking place will require an increased level of environmental awareness on all sides. U.S. and World Bank policies require that environmental assessments be carried out. Increasing industrialization and use of motorized transportation have caused a great and rapid deterioration in air quality. The public obviously recognizes this, but probably does not realize that massive environmental degradation is not a necessary part of the development process. Dr. Muhammad Bhatty of PCSIR, Lahore, noted for instance, that his scientists' surveys indicated farmers were blaming the rapid increase in air pollution for damage to their crops.

The scientific and engineering facilities in Pakistan are, in general, not up to modern standards. The scientists and engineers on the other hand, were extremely enthusiastic and eager to bring their knowledge up to date. While it is certainly important for some key scientists and engineers to be sent abroad for their education, we feel it is even more important for the scientists and engineers to be exposed, on a day-to-day basis, to what their colleagues elsewhere in the world are doing. To this end, we suggest that more of an investment be made by WAPDA, PCSIR, USAID, etc., in the purchase of technical books and subscriptions to technical journals. Subscriptions to many trade journals may be obtained free of charge. On a somewhat more costly level, scientists and engineers should be able to occasionally attend conferences and workshops abroad. An incentive sometimes used in the U.S. to foster productivity is for organizations to pay for their members to attend meetings if they are presenting papers.

B. Air Quality Aspects of Power Plant Siting.

Siting of the power plant at the presently selected Jamshoro location will certainly have a very adverse air quality impact unless effective emission control measures are employed. It may also affect the necessity to install these costly control measures (scrubbers).

Northerly winds that prevail for 4-6 months of the year will carry the plume in the direction of the Liaqat Medial College and Hospital, Sind University, and the City of Hyderabad. In fact, on sunny days with light winds, during those months, the plume's maximum impact on the ground is expected to occur near the hospital and the university. During the remaining 4-6 months winds are from the south-southwest and will transport the plume directly up to the populous Indus

River Valley, possibly causing damage to human health and crops. The proposed site at Khanot would not be near a hospital, a university, or an urban center. However, plume transport up and down the populated Indus River would still be a problem. If the plant were sited at Lakhra, environmental damage due to air pollution would be confined primarily to effects on desert crops and other vegetation. However, the Lakhra site appears less desirable for other reasons.

A suggestion which should be considered is to locate the plant about two miles west of its currently planned Jamshoro location. This would greatly reduce air pollution problems because the plume would usually remain over the sparsely populated upland areas, and yet retain the positive aspects of siting the plant at Jamshoro. According to WAPDA officials, the existing Jamshoro switching station could be used in conjunction with a power plant that is two miles away. As the Lakhra coal field expands southward in the years to come, this facility could eventually become a "mine-mouth" operation.

C. Non-Environmental Aspects of Power Plant Siting

During contacts with WAPDA and USAID personnel, a number of non-envrionmental issues associated with siting of the plant became apparent. They are list here for the record:

1. Cost of constructing a railroad and transporting coal from the mine-mouth to the power plant;

2. Cost of transporting cooling water to the power plant;

3. Difficulty of finding qualified personnel who would be willing to work at Lakhra, where there are few amenities. WAPDA estimates that a 50% bonus would have to be paid to employees who will be willing to work at Lakhra; and

4. Cost of transmission lines needed to connect the power plant to the switching station at Jamshoro.

D. General Environmental Training Program

Because there appeared to be a general lack of awareness in Pakistan of environmental issues, we recommend that a general environmental training course be given upper and middle members of the GOP. A new environmental ordinance is being proposed in Pakistan and the course could be coordinated with the timing of that ordinance.

We recommend a three week course be given to cover the general topics of economy, air and water quality, pollution and impact assessment. The first few days could be a forum of top

GOP officials, followed by environmental training of middle level government officials. We would suggest that work hours be organized as part of the course to cover issues and projects relevant to Pakistan.

XV. TRIP REPORT

Project: Energy Planning and Development Project: Environmental Baseline Monitoring System for Lakhra Project:

Tams Environmental Team: John H. Roebig - Team Leader
Irving D. Cohen - Monitoring Equipment Specialist
Nathan M. Reiss - Meteorologist

Arrived in Karachi 1140 hours July 31, 1984

A. USAID Orientation

Mian Shahid Ahmad, Project Engineer	USAID
Robert Lappi, Coal Advisor	USAID
Mohammad Anwar	USAID Liaison Officer in Karachi

Topics Covered

Work Plan - Itinerary
Project Review
Meeting Schedule

B. PCSIR Laboratories - Karachi, 1400-1600 - August 1, 1984

(Pakistan Council of Scientific and Industrial Research Laboratories)

Dr. M.A.A. Beg Director, PCSIR, Karachi

TOPICS DISCUSSED

Dr. Beg gave a briefing and answered questions concerning in-country data sources, the general environmental status of the country, and the technical and laboratory facilities available. A second branch of this organization is located in Lahore. The PCSIR Laboratories are engaged in mostly applied research in agricultural and industrial machinery, and systems specialized for Pakistani application. The facilities are very much out of date. Dr. Beg informed us that the Pakistan Meteorological Department is in Karachi, not Lahore, and that to obtain its data we should contact its Director, Mr. Rahmatullah. Mr. Anwar indicated he would try to arrange an appointment for us. He also said there is an Environmental Research Institute at Karachi University that has been looking at Karachi's air quality since 1982. We discussed the attitude

in Pakistan regarding the environment. He felt that government agencies are very apathetic, and that no laws should be passed unless they can be implemented. He felt that at present there is no will to pursue successful enforcement. He said that the Department of Urban Affairs (Islamabad) handles environmental matters, with Ayaz Ali Shah in charge. We learned they do not handle problems unless specifically asked to, but under new legislation, new sources would have to go through that office, which would also be responsible for enforcement. He felt that if pollution dangers can be spelled out, government leaders will listen. For example, a recent water pollution control experiment was characterized by non-cooperation. However, he said that if air pollution control equipment is considered an integral part of a facility, it will be accepted.

Dr. Beg also gave us a complete tour of the PCSIR Laboratories in Karachi. Our impression (conclusion) was that the Laboratories' analysis capabilities were mostly in wet chemistry analysis, with almost no spectroscopy capability.

C. Meeting with Pakistan Water and Power Development Authority (WAPDA) - Hyderabad August 2, 1984

Mr. Anis Zaidi, Chief Engineer, Lakhra

Mr. Abdus Sattar Memon, Director (Mining & Geology) and Project Director

Mr. Tariq Zameer, Project Engineer, Lakhra

and other WAPDA engineers

WAPDA officials seemed extremely willing to cooperate with us. They said that nothing about the plant is firm, including location, which is the pending consultants' recommendations.

1. Mr. Memon gave us a briefing on the status of the project and answered our questions.

2. The Asian Development Bank has suggested that the siting of the power plant at Jamshoro be reconsidered. Therefore, the siting of power plant needs should be addressed in the feasibility study.

3. From an engineering point of view siting the plant at Jamshoro would be easier for the Pakistanis and would be more convenient than putting it at, for instance, Lakhra, which is near the mine.

4. The diameter of the stack will be determined in the feasibility study.

5. The power at the site needs to be stable.

6. Aerial photos of the site are available at the scale of 1"=40,000'.

7. There is need for two independent and complete monitoring stations to cover both sites (Jamshoro and Lakhra).

8. TAMS must provide details of tower and room.

9. There would be no problem with providing the staff required. They would prefer to have their own people do the monitoring work.

a. 1 Person hour per day

b. Instrument Technician

(Check circuitry, replace brushes, perform basic mechanical repairs).

10. WAPDA said that there are no significant point sources of SO_2, TPS, NO_x in a 10-mile radius of the plant & that the plant would not have a significant impact. We suspect that they are glossing over the facts and plan to investigate these further.

D. <u>Jamshoro Power Plant Site Visit, 1500-1700 August 2, 1984</u>

Visited the power plant site to examine site layout, existing pollution point sources, and to see the project surroundings.

<u>Observations</u>:

1. The proposed power plant site is very desolate

2. The site for the meteorological station is on top of a hillock just south of the plant. A guest house for visitors is to be constructed on top of an adjacent hillock about 200 feet away.

3. The storage site for coal and ash.

4. Adjacent land uses (sensitive receptors), (the hospital, university and small villages are the main receptors).

5. Other point sources.

6. Water intake areas.

There are plans for a housing complex for plant workers to be located about 1/4 mile or less to the south of the plant. We were told the water intake flow rate was 50 cu ft/Sec. (SWEC claims 19,000 lpm or 11. cuft/Sec).

E. Site Visit - Lakhra Mine Site - 0630 - 1600 August 3, 1984.

Accompanied by A.S. Memon and T. Zameer of WAPDA.

The trip to Lakhra was interesting in that we spent a lot of time in the desert area and were able to see what kinds of things go on there. These included a wall for capturing rainfall runoff, nomadic herdsmen, private mining enterprises, agriculture that makes use of scant water supply, cotton, wheat, desert animal life, birds of prey, lizards, camels, cows and buffalo. The terrain was very rugged from Jamshoro up to the Lakhra plateau. The 10 million dollar projected cost in the SWEC Report appears very low owe conclusion is that it must be at least doubled.

Mr. Memon was asked where he would prefer the power plant to be located if it were decided to place it at Lakhra. He replied that the best place would be between the two projected mine pits, where no mining is planned. He showed us his suggested site for an air monitoring station, near marker JT-19, which is the same location where a guest house is planned. We suggested that the site be placed to the west of all site activity, so that background readings would be minimally affected. The guest house could be put there too. We then went to the area near the operating underground mine where we were received with great hospitality by the mine workers at the "Lakhra Hilton," their restaurant. We had tea there and took pictures. Many of the workers are from NWFP, where jobs are scarce. The Lakhra miners receive about 1000 Rupees per month.

Mr. Memon said that Pakistan's coal mine ventures are deemed by outside agencies as not economically viable. He said, and Bob Patti confirmed from his calculations, that the inexperienced labor force that is available in Pakistan makes such operations possible.

We stopped at the PMDC mine. We could smell the sulfur and see the pyrites in the coal. There is a lot of rock mixed in but it is all heavier (in weight) and lighter in color. It could be separated in a hand picking table fairly easily. The mining site is in a desert environment which is arid to semi-arid with sparse vegetation. There are almost no trees but a sparse covering of grasses and shrubs exist. There were quite a number of large lizards seen and evidence of some larger

rodents was present. The only people appeared to be nomads with goats or, in some cases, cattle. We later travelled eastward to the Indus River at Khanot, along the alternate railway path that has been proposed. This option would bring the coal to the north-south railroad line that runs along the Indus River. The path is much shorter, but the terrain is more rugged, its not clear which is the better option. Locating the power plant somewhere in the Khanot area was another option presented by Mr. Memon. From an air pollution standpoint, this site would not have much of an advantage over Jamshoro. There are numerous residential areas along the river, just as there are near Jamshoro. However, there are no hospitals or universities. On the negative side, the land rises west of the river much more rapidly at Khanot than at Jamshoro. Thus, areas of terrain - induced high concentrations of pollutions are likely to be more extensive at Khanot than at Jamshoro.

After returning from the Lakhra trip, we made an automobile survey of Hyderabad, looking for significant point sources of SO_2, NO_x, and CO. We sought out sites that were noted on a map of Hyderabad, as well as obvious stacks that were visible. The most obvious, and probably the most serious point source in Hyderabad is a cement plant located 11 miles from Jamshoro and south of the center Hyderabad. Half of the six stacks whose locations we searched out were associated with factories that had been abandoned for 4, 14 & 16 years respectively. If this is indicative of the state of industry in Hyderabad, then the number of stacks that are to be seen in the city's skyline greatly overestimates the number of actual point sources in Hyderabad. Contribution to air pollution by point sources in Hyderabad is probably insignificant.

F. <u>Meeting with WAPDA 0830 - 1130</u>

Mr. Abduc Sattar Memon

Mr. Tariq Zameer

USAID/TAMS Representatives

The meeting was extremely useful, in that all of us were by now fairly well informed about each other's issues and were able to discuss them. There was some discussion as to whether air quality monitoring should begin before a site is selected, in view of the fact that monitoring should be carried out at the projected location of the maximum ground-level concentration. Both the WAPDA people and Bob Lappi felt, however, that to achieve credibility with the World Bank and USAID, some information about background concentrations should be available during the site selection process. Given the fact that background concentrations of SO_2 and NO_x are expected to be very low, with the highest concentrations (between Jamshoro, Lakhra, & Khanot) to be at Jamshoro, it was decided to set out only one full air quality monitoring station at Jamshoro, and a TSP

monitor at Lakhra where mining emissions are anticipated to be a problem.

We also discussed the siting of meteorological monitoring stations. The same question applies here as with the air monitoring stations. Meteorological conditions at Lakhra are significantly different from those along the river at Khanot and Jamshoro. Two sites, one somewhere along the river and one at Lakhra, would provide adequate coverage. Because of the small incremental cost of providing three stations, it was decided to put one station at Lakhra, one at Jamshoro and one at Khanot.

Due to the high costs of monitoring equipment and low level of existing pollutants, we agreed that one full station at Jamshoro and 3 meteorological stations at Jamshoro, Lakhra and Khanot, would be more than sufficient to cover our data collection requirements.

In order to cover both water quality data at WAPDA and the meteorological data in Karachi, it was decided that the team should split up.

G. Meeting with Project Planning Organization (PPO) of WAPDA Water Wing, Hyderabad - August 5, 1984

Abdul Ghafoor Memon - Supt. Engineer - PPO

Allah Bux Soomro - Senior Geologist - PPO - WAPDA .

Shahi Ahmad - USAID

John Roebig - TAMS

Abdul Memon telephoned CMO, to see what data they had on hydrology or water quality.

Neither PPO nor CMO (Central Monitoring Organization) have any hydrology data in Hyderabad. There is, therfore, need to search the WAPDA House Library in Lahore.

H. Meeting with Public Health Engineering Department Government of Sind, Hyderabad - August 5, 1984

Gazi Abdul Khjum - Chief Engineer Public Health Engineering Department, Government of Sind

Mr. Satram Das - Research Officer

Shahid Ahmad - USAID

John Roebig - TAMS

Water quality samples are collectedon a monthly basis at Kotri Barrage. They gave TAMS a copy of the high flow (July)

and Low flow (Jan) months. This data wascopied by hand, so more data could not be obtained at the time. The Indus River provides drinking water to Hyderabad, the old section receiving only chlorinated water, the new section of the city receives a filtered and chlorinated water supply. The World Health Organization (WHO) standards for drinking water were adhered to. The personnel in the Lab are Chief Engineer, Research Officer, Assistant Researcher, Senior Lab. Technician, and Lab. Assistant. (They do chemical and bacteriological testing. No dissolved oxygen (D.O.) and no trace elements are tested.)

I. Meeting with Irrigation Department Government of Sind, Hyderabad on August 5, 1984

Muhammad Alam Baluch, Supt. Engineer, Irrigation Dept.

Shahid Ahmad - USAID

John Roebig - TAMS

J. Meeting with Director of the Pakistan Meteorological Service, Karachi, August 5, 1984

A.A. Rahmutullah, Director
Pakistan Meteorological Service

Mr. Kazmi, Pakistan Meteorological Service.

Mohamed Anwar - USAID

Nathan Reiss and Irving Cohen - TAMS

On a daily basis, three hourly weather observations are available for Karachi, Hyderabad, and Nawabshah and summarized for each month (ACWR - Aviation Current Weather, Report) on two 11" x 17" sheets. Detailed observation sheets are also available. These are located at the Director General's office building, and Mr. Anwar will get the 5 years spanning 1978-82, duplicated for each station. Mr. Kazmi is the contact person.

Upper-air data is also available, and upper wind for Hyderabad are available, but not temperatures. Radiosonde raw graphs for Karachi and Jacobabad are available at the Meteorological Service Office near Karachi University, but the person in charge was not in. These include both temperatures and winds. We will tray to get him on a return trip to Karachi, to include the 5-year period 1978-82, for both stations.

Left Karachi - 1830 8/5/84

Arrive Lahore - 2030 - Hilton Hotel 8/5/84

K. Team meeting with Kenneth P. Lue Phang, USAID, Lahore August 6, 1984

Mr. Lue Phang of USAID met us early in the morning for a breakfast meeting. He mentioned that Jamshoro was the only siting alternative being considered by USAID river flow at Khanot is inadequate in winter to support cooling water for the plant. The only way that water could be brought to Lakhra would be to pipe it up from the Kotri Barrage. The reason that water levels at Kotri Barrage stay higher than at Khanot is due to inflow & seepage from beneath the surface.

Ken also pointed out that the Lakhra coal field is much larger than we thought, egg-shaped, with the southern end actually south of Jamshoro. In future years, mining could be expected to extend there, eventually, turning a Jamshoro plant into a mine-mouth operation.

L. Meeting with WAPDA-0900 hours Lahore - August 6, 1984

Mr. Abdus Sattar Memon - WAPDA

Mr. Tariq Zameer and Mr. Siddiqi - WAPDA

Shahid Ahmad - USAID

Bob Lappi - USAID

TAMS Team

Discussion

We resummarized, and examined more data on hydrology and salinity. They have 1" = 40,000 - 1954 air photos.

Memon said that the reason the two southern sites were being considered was that the Asian Development Bank insisted on it. We were informed that the ADB wanted the issue of the power plant site left open and a mine mouth location to be considered.

We later received a letter indicating Jamshoro could be considered as a mine mouth location.

The World Bank's position was that it wanted Jamshoro as Power Plant site because of the availability of water and personnel.

Memon was asked if moving the plant westward would prove to be a great problem. He said it could be done and that no new switching station beyond the one already at Jamshoro would be needed. He asked that we take the matter up with Lakhra project member Siddiqi who was at the meeting. We consulted

this, they can easily find higher-paying jobs in the Middle East. The training program needs to consider the probable higher turnover of personnel. He suggested developing a video cassette training program that could be used as needed.

It was decided at this meeting that the Khanot site is not really under serious consideration. The meteorological data taken at Jamshoro will be duplicated to characterize the site at Khanot. Therefore, only two monitoring stations are required.

M. Meeting with PCSIB

Dr. Muhammad Khurshid Bhatty
Director PCSIR Lahore

Dr. Muhammad Hanif, Principal Scientific Officer
PCSIR Lahore

USAID/TAMS

The purpose of the meeting was to determine what assistance, if any, PCSIB could render if a quick start to the monitoring program were needed, and other sources were not available. Dr. Bhatty showed us some reports done by his scientists, indicating some air pollution work, but they clearly are not conversant with modern techniques. He indicated that meteorological equipment could be manufactured in Pakistan. (In our opinion the precision equipment needed could not readily be manufactured) Dr. Bhatty suggested sending some of his people for 2-3 weeks of training in the U.S. His Institute has done a study on agricultural pollution, as well as a general survey of air pollution conditions in Pakistan. Dr. Bhatty said that surveys by his people indicated that farmers were blaming Pakistan's rapidly increasing air pollution for damage to their crops.

G.C/Mass Spectroscopy are not acquiring any contiguous sampling equipment; they are mostly concerned with Wet-Chemistry, and are not interested unless they get the whole contract. They are funded like a university. In parting, Dr. Bhatty said that his main connection with WAPDA has been to curse them when the lights go out. In their groups, when a person turns eccentric he is said to be "WAPDA hogya" (under the spell of WAPDA).