Punjab Thermal Power (Pvt.) Limited

Date: July 26, 2017

THE REGISTRAR
National Electric Power Regulatory Authority
NEPRA Tower
Ataturk Avenue (East), G-5/1
Islamabad

Subject: **APPLICATION FOR A GENERATION LICENSE**

I, Ahad Khan Cheema, Chief Executive Officer, being the duly authorized representative of **Punjab Thermal Power (Private) Limited** by virtue of board resolution dated June 9th, 2017 hereby apply to the National Electric Power Regulatory Authority for the grant of a **Generation Licence** to **Punjab Thermal Power (Private) Limited** pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

A bank draft in the sum of Rupees 747,880/- (Rupees Seven Hundred Forty Seven Thousand Eight Hundred Eighty only) bearing no. **03767508** dated July 24, 2017 being the non-refundable licence application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

for & on behalf of
PUNJAB THERMAL POWER (PVT.) LIMITED

(AHAD KHAN CHEEMA)
Chief Executive Officer

First Floor 7 C-1 Gulberg III, Lahore, Tel:+92-42-35750936-8, Fax: +92-42-35750939

PUNJAB THERMAL POWER (PRIVATE) LIMITED

7-C1, Gulberg-III, Lahore

Extracts of the Resolutions passed by the Board of Directors of Punjab Thermal Power (Private) Limited at its 1st meeting of the held on 09th day of June, 2017

WHEREAS, there are numerous regulatory approval/consents/licenses etc. those are required for the project including Generation License (GL) from NEPRA. The Board agreed on the matter and passed the following resolutions:

RESOLUTIONS:

RESOLVED THAT, "approval of the Board of Directors be and is hereby accorded to authorize the Chief Executive Officer of the Company in respect of the following:"

i. *To obtain all requisite regulatory approvals, consents, licenses and permissions etc., including but not limited to those listed above (including generation license from NEPRA), required under relevant laws and policies applicable in Pakistan in connection with new Power Project and to make payments of all fees, expenses, charges and such other payments as may be required for the said purpose; and*

ii. *To sign, execute & file, either by himself or person(s) authorized by him, all necessary documents/ instruments, issue guarantees etc, to do all incidental and ancillary acts, deeds and things, take any or all necessary actions, complete all legal formalities, pertaining to the above, as may be required from time to time."*

CERTIFIED TO BE TRUE COPY

Company Secretary

A030137

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE,
LAHORE

CERTIFICATE OF INCORPORATION

[Under section 16 of the Companies Act, 2017 (XIX of 2017)]

Corporate Universal Identification No. **0109152**

I hereby certify that **PUNJAB THERMAL POWER (PRIVATE) LIMITED** is this day incorporated under the Companies Act, 2017 (XIX of 2017) and that the company is **limited by shares.**

Given under my hand at **Lahore** this **Eighth** day of **June,** Two Thousand and **Seventeen**.

Incorporation fee Rs. **101000.0/=** only

(SABOOHI ISRAR)
Deputy Registrar
Lahore

14/6/17

No. ARL/314159. dt 8/6/2017

THE COMPANIES ACT, 2017

10|3924
8|1|2017

(PRIVATE COMPANY LIMITED BY SHARES)

Memorandum of Association
of
PUNJAB THERMAL POWER (PRIVATE) LIMITED

1. The name of the Company is "**PUNJAB THERMAL POWER (PRIVATE) LIMITED**".
2. The Registered Office of the Company will be situated in the Province of Punjab.

3. (i) The principal line of business of the company shall be to establish, procure, construct, equip, operate, use, manage and maintain 1200 MW RLNG based power plant near load centers in Punjab.

   (ii) Except for the businesses mentioned in sub-clause (iii) hereunder, the company shall engage in all the lawful businesses and shall be authorized to take all necessary steps and actions in connection therewith and ancillary thereto.

   (iii) Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual Fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust management company, Housing Finance Company, Venture Capital Company, Discounting Services, Microfinance or Microcredit business), Insurance Business, Modaraba management company, Stock Brokerage business, forex, real estate business, managing agency, business of providing the services of security guards or any other business restricted under any law for the time being in force or as may be specified by the Commission.

(iv) It is hereby undertaken that the company shall not:

(a) engage in any of the business mentioned in sub-clause (iii) above or any unlawful operation;

(b) launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business;

(c) engage in any of the permissible business unless the requisite approval, permission, consent or licence is obtained from competent authority as may be required under any law for the time being in force.

4. The liability of the members is limited.

5. The Authorised Capital of the Company is Rs. 10,000,000/- (Rupees Ten Million Only) divided into 100,000 (Hundred Thousand) equity shares of Rs. 100/- (Rupees One Hundred only) each.

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a Company, in pursuance of this Memorandum of Association, and we respectively agree to take the number of shares in the Capital of the Company as set opposite to our respective names.

S No	Name and Surname (present & former) in full (in Block Letters)	CNIC No. (in case of foreigner Passport No)	Father's/ Husband' Name in full	Nationality (ies) with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signatures
1	**Government of Punjab, Energy Department through Mr. Asad Rehman Gilani**	35201-0254196-5	Ghafoor-ur- Rehman Gilani	Pakistani	Secretary, Energy Department	125 E, Model Town, Lahore	99, 998	
2	**Mr. Mohammad Jehanzeb Khan**	173018-276764-5	Mr. Muhammad Aurangzeb Khan	Pakistani	Chairman, P&D Department	8 - Danepur Lane, GOR-I, Lahore.	1	
3	**Hamed Yaqoob Sheikh**	35202-2994923-9	Muhammad Yaqoob	Pakistani	Secretary Finance Department	House No. 6, Danepur	1	

					Lane, GOR-1, Lahore		

Dated this 8th day of June, 2017

Witness =

Name: ZOHAIB AHMAD
Father's name: MUHAMMAD RAFI
NIC = 35301 - 1921753 - 5
Address: 12-A, MUHAFIZ TOWN, PHASE (II) LAHORE
OCCUPATION: ASSISTANT MANAGER CORPORATE
Signature:

The Companies Act, 2017

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

PUNJAB THERMAL POWER (PRIVATE) LIMITED

1. The Regulations contained in Table 'A' to the First Schedule to the Companies Act, 2017 shall be the regulations of **PUNJAB THERMAL POWER (Private) Limited** (the "Company") so far as these are applicable to a private company.

PRIVATE COMPANY

2. The Company is a "Private Company" within the meaning of Section Clause (49) of Section 2(1) of the Ordinance and accordingly:

   (1) No invitation shall be made to the public to subscribe for the shares or debentures of the Company.

   (2) The number of the members of the Company (exclusive of persons in the employment of the Company), shall be limited to fifty, provided that for the purpose of this provision, where two or more persons hold one or more shares in the company jointly, they shall be treated as single member; and

   (3) The right to transfer shares of the Company is restricted in the manner and to the extent herein appearing.

TRANSFER OF SHARES

3. A member desirous to transfer any of his shares shall first offer such shares for sale or gift to the existing members and in case of their refusal to accept the offer, such shares may be transferred to any other person, as proposed by the transferor member, with the approval of the Board of Directors.

DIRECTORS

4. The number of directors shall not be less than two or a higher number as fixed under the provisions of Section 154 of the Ordinance. The following persons shall be the first directors of the Company and shall hold the office upto the date of First Annual General Meeting:

   1. Mohammad Jehanzeb Khan – ACS (Energy)
   2. Asad Rehman Gilani – Secretary Energy
   3. Hamed Yaqoob Sheikh – Secretary Finance

We, the several persons whose names and addresses are subscribed, are desirous of being formed into a company, in pursuance of these articles of association, and we respectively agree to take the number of shares in the capital of the company set opposite our respective names.

S No	Name and Surname (present & former) in full (in Block Letters)	CNIC No. (in case of foreigner Passport No)	Father's/ Husband' Name in full	Nationality (ies) with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signatures
1	**Government of Punjab, Energy Department through Asad Rehman Gilani**	35201-0254196-5	Ghafoor-ur- Rehman Gilani	Pakistani	Secretary, Energy Department	125 E, Model Town, Lahore	99, 998	
2	**Mohammad Jehanzeb Khan**	173018-276764-5	Mr. Muhammad Aurangzeb Khan	Pakistani	Chairman, P&D Department	8 - Danepur Lane, GOR-I, Lahore.	1	
3	**Hamed Yaqoob Sheikh**	35202-2994923-9	Muhammad Yaqoob	Pakistani	Secretary Finance Department	House No. 6, Danepur Lane, GOR-1, Lahore	1	

Total number of shares taken 100,000
(One Hundred Thousand)

Dated the 8th day of June, 2017

Witness:

Name: ZOHAIB AHMAD

Fathers name: MUHAMMAD RAFI

NIC: 35301-1921753-5

Address: 12-A, MUHAFIZ TOWN, PHASE II
LAHORE

OCCUPATION: ASSISTANT MANAGER CORPORATE

Signature:

14/6/17

1	Registration No.	0109152
2	Name of the Company	**PUNJAB THERMAL POWER (PVT.) LTD.**

		Day	Month	Year
3	Form A made upto (Day/Month/Year)	11	07	2017
4	Date of AGM (Day/Month/Year)	-	-	-

PART-A

5	Registered office address:	**7-C1, Gulberg-III, Lahore.**
6	Email Address:	**compsec@qathermal.com**
7	Office Tel. No.:	**042-35750936-8**
8	Office Fax No.:	**042-35750939**
9	Nature of Business:	**Power Generation**

10 **Authorized Share Capital**

Type of Shares	No. of Shares	Amount	Face Value
Ordinary Shares	**100,000**	**10,000,000**	**100 each**

11 **Paid up Share Capital**

Type of Shares	No. of Shares	Amount	Issue Price
Ordinary Shares	**100,000**	**10,000,000**	**100 each**

12 **Chief Executive**

Name	**Mr. Ahad Khan Cheema**	NIC	35202-0449427-1
Address	**7-C1, Gulberg-III, Lahore.**		

13 **Chief Accountant**

Name	**Mr. Shamsul Aziz**	NIC	61101-4709295-5
Address	**7-C1, Gulberg-III, Lahore.**		

14 **Company Secretary**

Name	**Syed Salman Hassan**	NIC	35200-1513320-7
Address	**7-C1, Gulberg-III, Lahore.**		

15 **Legal Adviser**

Name	**M/s. CSJ & Co. Advocates & Corporate Counsels**
Address	**Basement S.M. Tower, 9-Fane Road, Lahore**

16 **List of Directors on the date**

Name of Director	Address	Nationality	NIC (Passport No. if foreigner)												
1. Mr. Mohammad Jehanzeb Khan	16- Golf Road, GOR-I, Lahore	**Pakistani**	1	7	3	0	1	8	2	7	6	7	6	4	5
2. Mr. Asad Rehman Gilani	8th Floor, EFU House, 6-D- Main Gulberg, Jail Road, Lahore.	**Pakistani**	3	5	2	0	1	0	2	5	4	1	9	6	5
3. Mr. Hamed Yaqoob Sheikh	Civil Secretariat, Lahore	**Pakistani**	3	5	2	0	2	2	9	9	4	9	2	3	9
4. Mr. Abdul Basit	2-A, Ahmad Block	**Pakistani**	3	5	2	0	2	9	5	6	8	7	7	9	7

	New Garden Town Lahore.														
5. Mr. Anjum Butt	152-B, DHA, Phase 1, Lahore.	Pakistani	3	5	2	0	1	6	8	3	9	9	0	2	5
6. Mr. Javed Iqbal Bhatti	78-A, Izmir Town, Lahore.	Pakistani	3	5	2	0	2	5	7	4	1	1	5	5	3
7. Khawaja Ahmed Hassan	426, 4th Floor, Alfalah Building, Shahrah-e-Quaid-e-Azam, Lahore.	Pakistani	3	5	2	0	2	3	0	2	2	2	0	6	1
8. Mr. Najam Ahmed Shah	Civil Secretariat, Lahore.	Pakistani	4	2	1	0	1	9	7	7	9	2	9	2	5
9. Mr. Rehman Naseem	59-3, Abdali Road, Multan.	Pakistani	3	6	2	0	2	5	3	4	8	7	9	6	1

PART-B

17. List of members & debenture holders on the date																	
Folio	Name	Address	Nation-ality	No. of shares	NIC (Passport No. if foreigner)												
	Members																
1	Government of the Punjab, Energy Department through Mr. Asad Rehman Gilani	8th Floor, EFU House, 6D1- Main Gulberg, Jail Road, Lahore	Pakistani	99,998						N	/	A					
2	Mr. Mohammad Jehanzeb Khan	16- Golf Road, GOR-I, Lahore	Pakistani	1	1	7	3	0	1	8	2	7	6	7	6	4	5
3	Mr. Hamed Yaqoob Sheikh	Civil Secretariat, Lahore	Pakistani	1	3	5	2	0	2	2	9	9	4	9	2	3	9
			Total	100,000													

PROFILES OF THE CHIEF EXECUTIVE OFFICER AND SENIOR MANAGEMENT OF PUNJAB THERMAL (PVT.) LIMITED

MR. AHAD KHAN CHEEMA
Chief Executive Officer

Mr. Ahad Khan Cheema is a Civil Servant belonging to Pakistan Administrative Service (PAS). He earned the degree in MSc. Social Policy and Planning from London School of Economics and Political Science. He has more than 16 years of experience of working in different leading positions including Chief Executive Officer, Quaid-e-Azam Thermal Power Pvt. Limited (1180MW CCPP Bhikki Power Plant), Secretary to Government of the Punjab, District Coordination Officer (DCO) Lahore and Director General, Lahore Development Authority (LDA).

During his service career, he has accomplished high level assignments. Under his leadership, many engineering masterpieces were constructed in Lahore including Lahore Metro Bus Project, Kalma Underpass, Azadi Chowk and Qainchi Flyovers. Lahore Metro Bus Project is first of its kind in Pakistan which was completed in mere eight months.

Mr. Ahad Khan Cheema has been bestowed with Tamgha-e-Imtiaz by the Government of Pakistan in recognition of his public service.

MR. SHAMSUL AZIZ
Chief Financial Officer

Mr. Shamsul Aziz is a seasoned professional with proven success in financial and operations management to achieve the organizational mission. He developed leadership qualities with a solid record of contributions leading to improved financial and technical performance and enhanced internal controls.

He has successful track record and in-depth experience of independently planning and handling projects from planning, development of feasibility studies to execution including dealing with project lenders, regulators and other Government agencies for their successful execution.

He has solid background and expertise in managing the financial and operational affairs of a corporate entity of substantial size.

He is well versed with the dynamics of energy sector of Pakistan. He has worked in Siemens for 8 years, in PPIB for one and a half years, in Southern Electric Power Company Limited on top position for 15 years and Quaid-e-Azam Thermal Power (Pvt.) Limited since 2015.

MR. KHALID PARVAIZ
General Manager (Admin & HR)

Mr. Khalid Parvaiz is a Civil Servant belonging to Provincial Management Service (PMS). He has more than 14 years' experience of working in different capacities ranging from project management, strategic planning, policy making and managerial positions including General Manager, Quaid-e-Azam Thermal Power (Pvt.) Limited, Deputy Secretary to Government of the Punjab and Director Administration, Lahore Development Authority (LDA). He has also worked as a Consultant with UNICEF and the World Bank.

Apart from his practical experience, he has degree in Social Research Methods from London School of Economics and Public Administration from Columbia University's School of International and Public Affairs (SIPA).

ENGR. SYED WASIM-UR-REHMAN
General Manager (Technical)

Engr. Syed Wasim-ur-Rehman has more than 25 years of experience in power industry by serving at senior level positions like General Manager (Technical), Quaid-e-Azam Thermal Power Pvt. Limited (1180MW CCPP Bhikki Power Plant) , Engineering Manager, Project Manager, General Manager Plant and General Manager Technical in Pakistan and Saudi Arabia. He has diversified exposure of operating, planning, procurement, performance, maintenance, erection, testing and commissioning and development of power plants/projects.

****

Annex-IX

National Transmission and Despatch Company Limited (NTDC)

Grid Interconnection Study Report for Evacuation of Power from 1230 MW RLNG Power Plant near Trimmu, Jhang to the National Grid

Power System Planning Department
4th Floor, PIA Tower, Egerton Road, Lahore.

July 2017

Table of Contents

Executive Summary

1. M/s Punjab Thermal Power (Pvt.) Ltd. is planning to set up a thermal RLNG based Combined Cycle Power Project (CCPP) with a total gross capacity of 1230 MW near Trimmu at Jhang which is adjacent to the site of the existing H.B.Shah RLNG power project. The expected COD of two gas turbines (simple cycle operation) is November 2018, whereas, the expected COD of the steam turbine (combined cycle operation) is November 2019.

2. M/s Punjab Thermal Power (Pvt.) Ltd. has engaged Planning Power NTDC to carry out interconnection studies for power evacuation from 1230 MW RLNG based CCPP at Jhang.

3. This is the interconnection study report in which the results of load flow and short circuit studies have been presented for the connectivity of 1230 MW RLNG CCPP at Jhang with the National Grid. The interconnection studies have been carried out to propose and evaluate the adequacy of the proposed interconnection scheme for power evacuation from said power project to the National Grid in the light of NEPRA Grid Code.

4. Considering the capacity, location, expected CODs of gas & steam turbines and existing/planned transmission network in the vicinity of the RLNG based power project at Jhang, the following interconnection schemes for its power evacuation to the National Grid have been proposed:

<u>With Two Gas Turbines (Simple Cycle Mode)</u>

(i) Two 220 kV Double Circuit (D/C) transmission lines, approx. 35 km each on twin-bundled Rail Conductor, RLNG power project at Jhang to T.T.Singh.

(ii) 1x250 MVA, 220/132 kV T/F at T.T.Singh

(iii) 132 kV D/C line, approx. 15 km on Rail conductor, from T.T.Singh to T.T.Singh (Old)

It is to be noted that scope mentioned at (i) is required by Nov. 2018 and at (ii) & (iii) is required in summer 2019.

<u>With One Steam Turbine (Combined Cycle Mode)</u>

220 kV D/C transmission line, approx. 125 km on twin-bundled Rail conductor, from Lalian for looping in-out of one 220 kV circuit of Jhang RLNG power project to T.T. Singh (near Jhang RLNG power project).

It is added that the 220 kV D/C line from T.T.Singh/Jhang RLNG power project to Lalian will be looped in-out at Faisalabad West 500/220/132 kV substation after its commissioning.

5. The latest system network data available with Planning (Power) NTDC has been used in the studies. The necessary data for the generators of 1230 MW RLNG power plant at Jhang has been used same as of the under-construction 1230 MW RLNG power plant at H.B.Shah after consultation with M/s Punjab Thermal Power (Pvt.) Ltd. However, the assumption of generator step-up transformer has been made by Planning Power NTDC as the proposed interconnection voltage is 220 kV for the subject RLNG power project at Jhang.

6. The load flow studies have been carried out for various operating scenarios of winter and summer. It is found that with the proposed interconnection scheme, the power from 1230 MW RLNG power plant at Jhang can be dispersed to the National Grid in a reliable manner during normal and N-1 contingency conditions.

7. Short circuit studies have been carried out to compute maximum three phase and single phase short circuit levels with the induction of 1230 MW RLNG power plant at Jhang. The results of short circuit studies indicate that the maximum three phase and single-phase short circuit levels at the 220 kV switchyard of 1230 MW RLNG power project at Jhang would be 43.5 kA and 43.2 kA respectively in year 2022. The short circuit rating of 50 kA has been proposed for the 220 kV switchgear equipment of 1230 MW RLNG power project at Jhang in view of future expansions in NTDC and FESCO transmission networks. Moreover, the short circuit levels at the existing and planned 220 kV substations in the vicinity of the proposed power plant would remain within their switchgear equipment rating.

8. On the basis of detailed study results presented in this report, it is concluded that the proposed interconnection scheme for the 1230 MW RLNG power plant at Jhang is reliable for its power dispersal to the National Grid.

1. Introduction

M/s Punjab Thermal Power (Pvt.) Ltd. is planning to set up a RLNG based Combined Cycle Power Project (CCPP) with a total gross capacity of 1230 MW at Jhang. The subject Jhang RLNG power project is adjacent to the existing H.B.Shah RLNG power project. The expected COD of two gas turbines (simple cycle) is November 2018, whereas, the expected COD of the steam turbine (combined cycle) is November 2019.

M/s Punjab Thermal Power (Pvt.) Ltd. has engaged Planning Power NTDC to carry out interconnection studies for power evacuation from 1230 MW RLNG based CCPP at Jhang.

This is the interconnection study report in which the results of load flow and short circuit studies have been presented for the connectivity of 1230 MW RLNG based CCPP at Jhang with the National Grid. The interconnection studies have been carried out to propose and evaluate the adequacy of the proposed interconnection scheme for power evacuation from 1230 MW RLNG based CCPP to the National Grid in the light of NEPRA Grid Code.

2. Proposed Interconnection Scheme

The objective of the interconnection study is to propose the interconnection scheme for reliable dispersal of power from the 1230 MW RLNG based power project at Jhang to the National Grid System under normal and N-1 contingency conditions.

The following interconnection scheme has been proposed for the above 1230 MW RLNG based power plant at Jhang keeping in view its generation capacity, location, expected CODs of gas & steam turbines and the existing/planned system network in its vicinity:

<u>Two Gas Turbines (Simple Cycle Mode)</u>

(i) Two 220 kV Double Circuit (D/C) transmission lines, approx. 35 km each on twin-bundled Rail Conductor, RLNG power project at Jhang to T.T.Singh.

(ii) 1x250 MVA, 220/132 kV T/F at T.T.Singh

(iii) 132 kV D/C line, approx. 15 km on Rail conductor, from T.T.Singh to T.T.Singh (Old)

It is to be noted that scope mentioned at (i) is required by Nov. 2018 and at (ii) & (iii) is required in summer 2019.

<u>One Steam Turbine (Combined Cycle Mode)</u>

220 kV D/C transmission line, approx. 125 km on twin-bundled Rail conductor, from Lalian for looping in-out of one 220 kV circuit of Jhang RLNG power project to T.T. Singh (near Jhang RLNG power project).

It is added that the 220 kV D/C line from T.T.Singh/Jhang RLNG power project to Lalian will be looped in-out at Faisalabad West 500/220/132 kV substation after its commissioning.

The geographical diagram showing the above interconnection schemes is attached as Figure #1, 2 & 3.

3. Study Assumptions and Criterion

3.1 Study Assumptions

The load flow studies are based on the following assumptions:

- Latest load forecast.
- Latest generation expansion plan.
- Latest transmission expansion plans of NTDC and DISCOs.
- Mostly interconnected transmission system has been assumed whereas some line openings at 132 kV voltage levels have been carried out as per system requirements.
- Maximum net generation capacities of the existing/under construction three RLNG power plants (Bhikki, Balloki & H.B.Shah).
- The total net output capacity for the subject 1230 MW RLNG based CCPP at Jhang is assumed as 1208 MW after subtracting auxiliary consumption.
- The necessary data for the generators of 1230 MW RLNG power plant at Jhang has been used same as of the under-construction1230 MW RLNG power plant at H.B.Shah after consultation with M/s Punjab Thermal Power (Pvt.) Ltd. However, the assumption of generator step-up transformer has been made by Planning Power NTDC as the interconnection voltage is 220kV for the subject RLNG power project at Jhang.

3.2 Study Criterion

The load flow studies have been carried out keeping in view of the following system operating criteria/limits in accordance with NEPRA Grid Code:

Voltage Limits:	±5% under normal and ±10% under contingency conditions. However, voltages at generation and/or substations may be kept upto +8% under normal operating conditions as per network configuration and/or system requirements.

Transmission Line Loading Limits:	100% of rating under normal and N-1 contingency conditions.
Transformer Loading Limits:	100% of rating under normal and 110% under N-1 contingency conditions.

4. Load Flow Studies

The load flow analysis has been carried out with the proposed interconnection scheme for various operating scenarios for the months of January and July-to-Sept corresponding to the typical winter (low hydro) and summer (high hydro) scenarios respectively. In this regard, the peak load scenarios of January 2019, January 2020 and Aug/Sep. 2021 have been simulated in accordance with the expected CODs of gas and steam turbines to analyze the impact of the proposed 1230 MW RLNG based CCPP at Jhang on the system network under normal and N-1 contingency conditions.

The load flow study exhibits for power dispersal of 1230 MW Jhang RLNG based CCPP with the proposed Interconnection scheme are attached in Appendix-1.

4.1 Peak Load Winter 2019 Scenario

Load flow study for the peak load scenario of winter (January) 2019 has been carried out with only two gas turbines at Jhang RLNG power project operating at full capacities and is attached as Exhibit #1-0. As per load flow study, the power flows on the circuits emanating from the subject Jhang RLNG power plant and in its vicinity are as under:

Transmission Line	Power Flow (MW)
Jhang RLNG-PP to T.T Singh (Two 220 kV D/C lines = 4 Circuits)	4 x 202
T.T.Singh to Samundari Road 220 kV Circuit#1	145
T.T.Singh to Samundari Road 220 kV Circuit#2	162
T.T.Singh to Gojra 132 kV D/C	2 x 99
T.T.Singh to T.T.Singh (old) 132 kV S/C	53

Transmission Line	Power Flow (MW)
T.T.Singh to Pir Mehal 132 kV S/C	45

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Condition

As per load flow study, the power flows on transmission lines and transformers in the vicinity of Jhang RLNG power project are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed power plants to the system under normal operating condition.

N-1 Contingency conditions

The load flow studies have also been carried out for single line contingency (N-1) conditions in the vicinity of Jhang RLNG power project and are attached as Exhibit # 1-1 to 1-5. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
1-1	Jhang RLNG-PP to T.T.Singh 220kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
1-2	T.T.Singh to Summundri Road 220kV S/C out	-do-
1-3	T.T.Singh to Gojra 132 kV S/C out	-do-
1-4	T.T.Singh to Pir Mehal 132 kV S/C out	-do-

Exhibit #	Contingency Conditions	Remarks
1-5	1x 250 MVA, 220/132 kV transformer at T.T.Singh out	-do-

4.2 Peak Load Winter 2020 Scenario

Load flow study for the peak load condition of winter (January) 2020 has been carried out with two gas turbines and one steam turbine at Jhang RLNG power project operating at full capacities and is attached as Exhibit #2-0. In this scenario, the 220 kV link from Jhang RLNG power project to Lalian has also been assumed. As per load flow study, the power flows on the circuits emanating from the subject Jhang RLNG power project and in its vicinity are as under:

Transmission Line	Power Flow (MW)
Jhang RLNG-PP to T.T Singh (Three 220 kV circuits)	3 x 308
Jhang RLNG-PP to Lalian New 220 kV S/C	284
T.T Singh New to Samundari Road 220 kV Circuit#1	142
T.T. Singh New to Samundari Road 220 kV Circuit#2	158
T.T.Singh New to Gojra 132 kV D/C	2 x 89
T.T.Singh to T.T.Singh (old) 132 kV S/C	13
T.T. Singh to T.T. Singh (old) 132 kV D/C	2 x 32
T.T. Singh to Pir Mehal 132 kV S/C	32

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Condition

As per load flow study, the power flows on transmission lines and transformers in the vicinity of Jhang RLNG power project are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed power plants to the system under normal operating condition.

N-1 Contingency conditions

The load flow studies have also been carried out for single line contingency (N-1) conditions in the vicinity of Jhang RLNG power project and are attached as Exhibit # 2-1 to 2-6. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
2-1	Jhang RLNG-PP to Lalian New 220kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
2-2	Jhang RLNG-PP to T.T Singh 220kV S/C out	-do-
2-3	T.T.Singh to Summundri Road 220kV S/C out	-do-
2-4	T.T.Singh to Gojra 132 kV S/C out	-do-
2-5	T.T. Singh to Pir Mehal 132 kV S/C out	-do-
2-6	1x 250 MVA, 220/132 kV transformer at T.T.Singh out	-do-

4.3 Peak Load Summer 2020 Scenario

Load flow study for the peak load condition of summer (July to Sept.) 2020 has been carried out with two gas turbines and one steam turbine at Jhang RLNG power project operating at full capacities and is attached as Exhibit #3-0. In this scenario, Faisalabad West 500/220/132 kV substation with its associated scope, especially, looping in-out of 220 kV D/C line from T.T.Singh/Jhang RLNG power project to Lalian at Faisalabad West, has been assumed in the analysis. As per load flow study, the power flows on the circuits emanating from subject Jhang RLNG power project and in their vicinity are as under:

Transmission Line	Power Flow (MW)
Jhang RLNG-PP to T.T Singh (Three 220 kV circuits)	3 x 256
Jhang RLNG-PP to Faisalabad West 220 kV S/C	440
T.T.Singh to Samundari Road 220 kV Circuit#1	43
T.T.Singh to Samundari Road 220 kV Circuit#2	48
T.T.Singh to Gojra 132 kV D/C	2 x 79
T.T. Singh to T.T. Singh (old) 132 kV S/C	22
T.T. Singh to T.T. Singh (old) 132 kV D/C	2 x 52
T.T. Singh to Pir Mehal 132 kV S/C	54

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Condition

As per load flow study, the power flows on transmission lines and transformers in the vicinity of Jhang RLNG power project are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed power plants to the system under normal operating condition.

N-1 Contingency Conditions

The load flow studies have also been carried out for single line contingency (N-1) conditions in the vicinity of Jhang RLNG power project and are attached as Exhibit # 3-1 to 3-6. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
3-1	Jhang RLNG-PP to Faisalabad West 220 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
3-2	Jhang RLNG-PP to T.T Singh 220kV S/C out	-do-
3-3	T.T.Singh to Summundri Road 220kV S/C out	-do-
3-4	T.T.Singh to Gojra 132 kV S/C out	-do-
3-5	T.T.Singh to Pir Mehal 132 kV S/C out	-do-
3-6	1x 250 MVA, 220/132 kV transformer at T.T.Singh out	-do-

4.4 Findings of Load Flow Analysis

As per load flow study results, the proposed interconnection scheme has been found as a reliable transmission arrangement for power dispersal of the 1200 MW RLNG based combined cycled power project to the National Grid System under normal and single line contingency conditions.

5. Short Circuit Studies

5.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analysis for which provision is available in the PSS/E software used for such studies. The maximum short circuit currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to Zero
- Set shunt to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 p.u.

Since the detailed plant data for Jhang RLNG gas based CCPP is not presently available, therefore, for the purpose of the short circuit analysis, the necessary data for the generators of 1230 MW RLNG power plant at Jhang has been used same as of the under-construction1230 MW RLNG power plant at H.B.Shah. However, the assumption of generator step-up transformer has been made by Planning Power NTDC as the interconnection voltage is 220 kV for the subject RLNG power project at Jhang. The assumed data for generators and step-up transformers of Jhang RLNG based CCPP is as under:

A. Generator Data:

<u>Gas Turbine</u>:

- Rating = 535 MVA
- Sub-transient reactance (sat.) = 0.18 p.u.
- Negative sequence reactance (sat.) = 0.18 p.u.
- Zero Sequence Reactance = 0.125 p.u.

Steam Turbine:

- Rating = 530 MVA
- Sub-transient reactance (sat.) = 0.22 p.u.
- Negative sequence reactance (sat.) = 0.22 p.u.
- Zero Sequence Reactance = 0.092 p.u.

B. Generator Step-up Transformer:

- Rating = 550 MVA
- Impedance (X_{HL})= 16% (Assumed)

Moreover, one and half beaker scheme at the 220 kV switchyard of 1230 MW RLNG power project has been assumed.

5.2 Findings and Recommendations of Short Circuit Analysis

The short circuit studies have been carried out with proposed Interconnection scope of work to compute the maximum three phase and single phase short circuit levels after induction of 1230 MW RLNG power project at Jhang. The studies have been carried out with all the existing and planned generation in operation and with interconnected transmission system.

The results of short circuit studies indicate that the maximum three phase and single-phase short circuit levels at the 220 kV switchyard of 1230 MW RLNG power project at Jhang would be 43.5 kA and 43.2 kA respectively in year 2022. The short circuit rating of 50 kA has been proposed for the 220 kV switchgear equipment of 1230 MW RLNG power project at Jhang in view of future expansions in NTDC and FESCO transmission networks. Moreover, the short circuit levels at the existing and planned 220 kV substations in the vicinity of the proposed power plant will remain within their switchgear equipment rating.

6. Overall Conclusions and Recommendations

a) The following interconnection schemes for its power evacuation to the National Grid have been proposed:

<u>With Two Gas Turbines (Simple Cycle Mode)</u>

(i) Two 220 kV Double Circuit (D/C) transmission lines, approx. 35 km each, on twin-bundled Rail Conductor from RLNG power project at Jhang to T.T.Singh.

(ii) 1x250 MVA, 220/132 kV T/F at T.T.Singh

(iii) 132 kV D/C line, approx. 15 km on Rail conductor, from T.T.Singh to T.T.Singh (Old)

It is to be noted that scope mentioned at (i) is required by Nov. 2018 and at (ii) & (iii) is required in summer 2019.

<u>With One Steam Turbine (Combined Cycle Mode)</u>

220 kV D/C transmission line, approx. 125 km on twin-bundled Rail conductor, from Lalian for looping in-out of one 220 kV circuit of Jhang RLNG power project to T.T. Singh (near Jhang RLNG power project).

It is added that the 220 kV D/C line from T.T.Singh/Jhang RLNG power project to Lalian will be looped in-out at Faisalabad West 500/220/132 kV substation after its commissioning.

b) It is proposed to employ one and half beaker scheme at the 220 kV switchyard of 1230 MW RLNG power project.

c) The results of the load flow studies for various operating scenarios of winter and summer reveal that with the proposed interconnection scheme, the power from 1230 MW RLNG power project at Jhang can be dispersed to the National Grid in a reliable manner during normal and N-1 contingency conditions.

d) Short circuit studies have been carried out to compute maximum three phase and single phase short circuit levels with the induction of 1230 MW RLNG power plant at Jhang. It is found that the short circuit levels at the existing and planned 220 kV substations in the vicinity of RLNG power project at Jhang would remain within their switchgear equipment rating.

e) The maximum three phase and single-phase short circuit levels at the 220 kV switchyard of 1230MW RLNG power plant at Jhang would be 43.5 kA and 43.2 kA respectively in year 2022. The short circuit rating of 50 kA has been proposed for the 220 kV switchgear equipment of 1230 MW Jhang RLNG power project in view of future expansions in NTDC and FESCO transmission networks.

f) On the basis of detailed study results presented in this report, it is concluded that the proposed interconnection scheme for the 1230 MW RLNG power plant at Jhang is reliable for its power dispersal to the National Grid.

g) The comments of M/s Punjab Thermal Power (Pvt.) Ltd. and NESPAK on this report are welcome. These comments will be incorporated in the next report which will also include the results of transient stability studies.

FIGURE # 1: **Interconnection Scheme for Power Dispersal of Jhang RLNG (with 2 Gas Turbines) Power Plant**

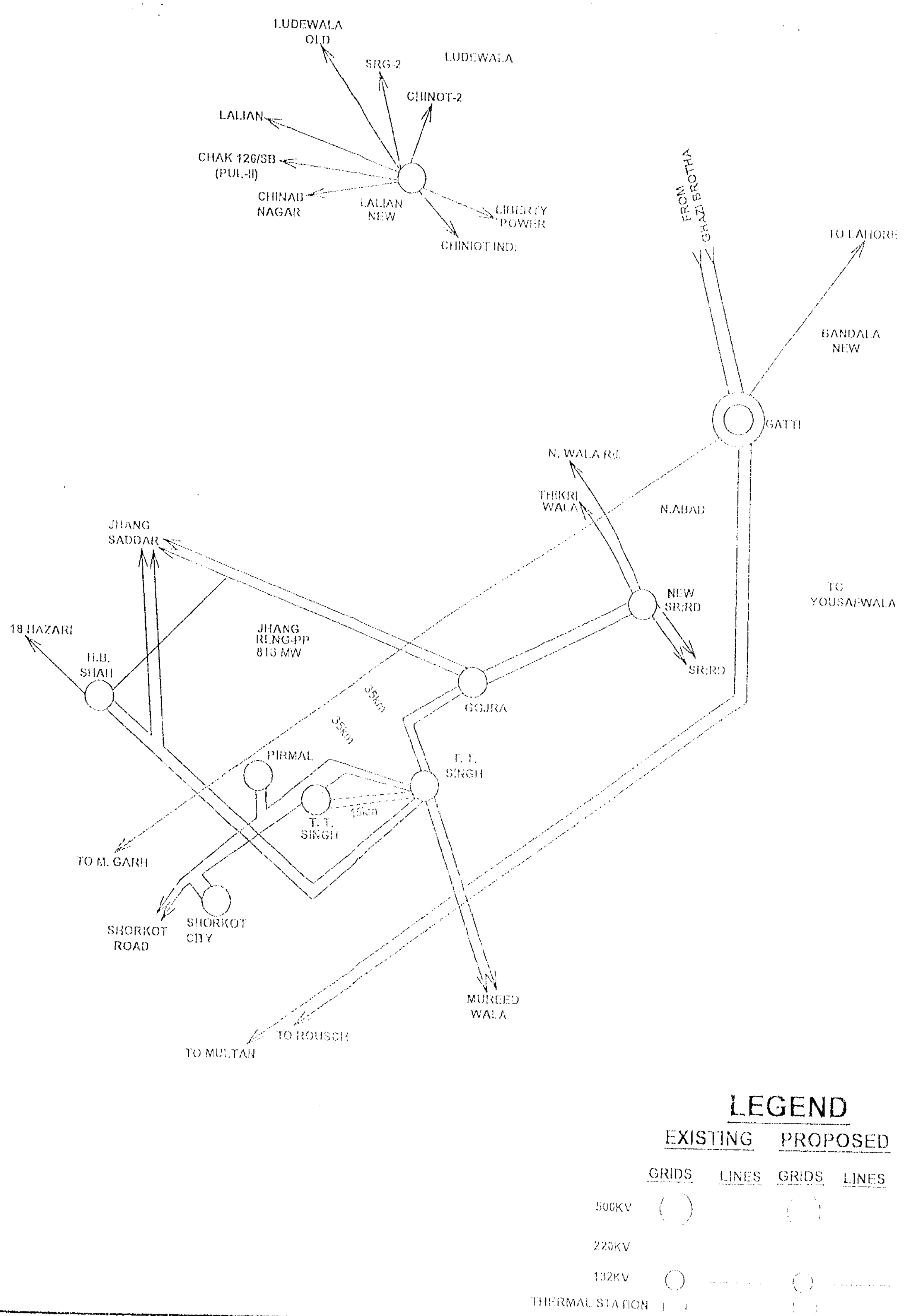


FIGURE # 2: **Interconnection Scheme for Power Dispersal of Jhang RNLG (2 Gas Turbines & 1 Steam Turbine) Power Plant**

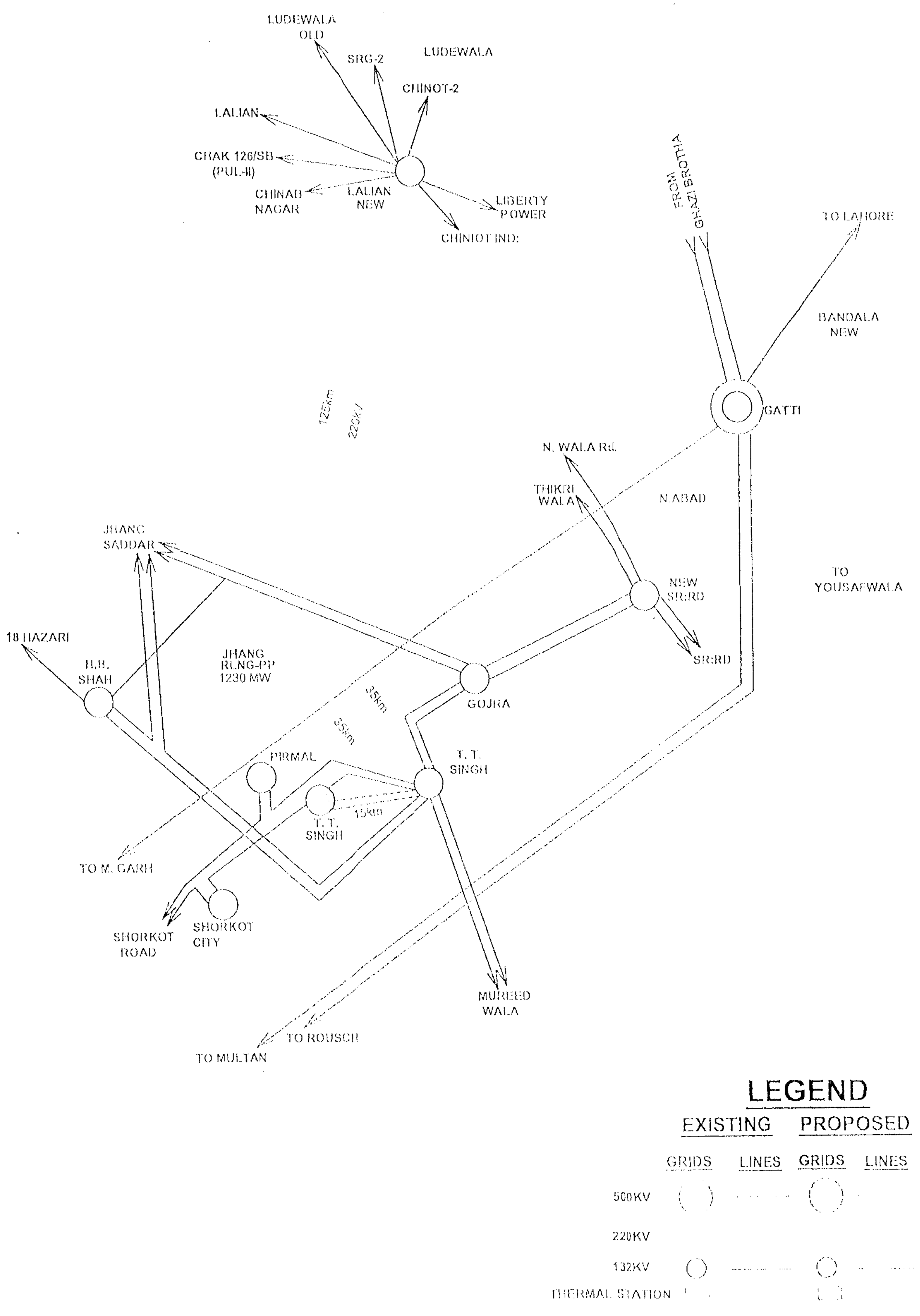
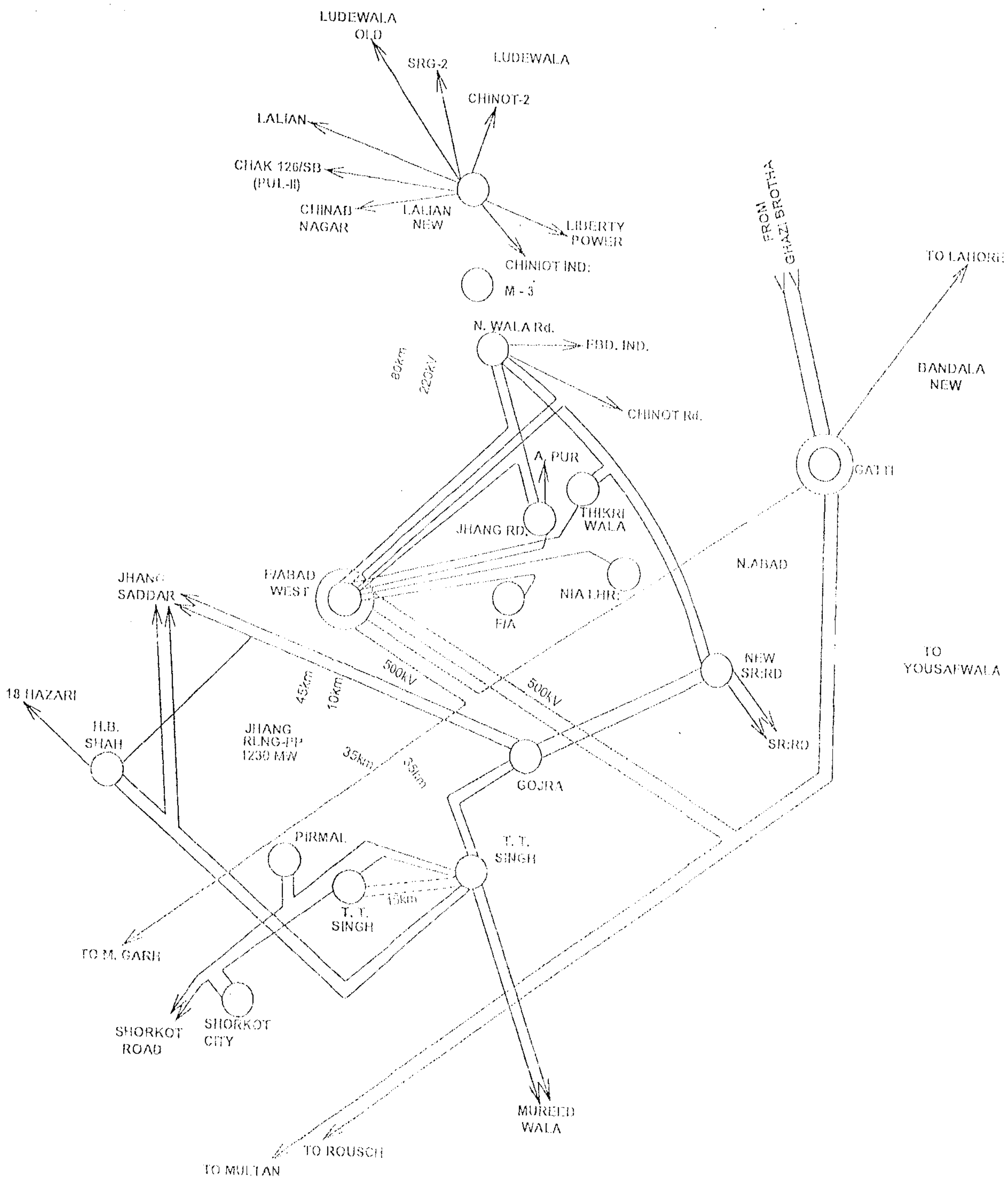


FIGURE # 3: **Interconnection Scheme for Power Dispersal of Jhang RLNG (2 Gas Turbines & 1 Steam Turbine) Power Plant (and with Faisalabad West 500/220/132kV SubStation)**



LEGEND

	EXISTING GRIDS	EXISTING LINES	PROPOSED GRIDS	PROPOSED LINES
500KV				
220KV				
132KV				
THERMAL STATION				

PROSPECTUS

(AS REQUIRED UNDER REGULATION 3(I) OF THE NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1998)

(i) A BRIEF INTRODUCTION OF THE APPLICANT;

The Applicant is a Government of the Punjab (GoPb) owned company incorporated under the Companies Act, 2017 mandated to establish around 1100-1400MW RLNG Combined Cycle Power Plant at Jhang District, Punjab. (*Certificate of Incorporation, Memorandum and Articles of Association attached with the application for grant of generation license*)

(II) THE SALIENT FEATURES OF THE FACILITY OR THE SYSTEM IN RESPECT OF WHICH THE LICENCE IS SOUGHT;

The project is based on Combined Cycle technology to ensure higher level of efficiency, which is to be more than 60% (Net @ ISO). It is expected that the finished facility will generate between 1100-1400MW (Net @ ISO). The primary fuel is RLNG and the backup fuel will be HSD. The plant is located close to load centers of the country and the power will be evacuated from a 220kV transmission line. For cooling purposes, water will be taken form the adjacent canal during 10-11 months of the year, and for the remainder deep well pumps will be utilized.

(III) THE PROPOSED INVESTMENT;

Government of the Punjab, being the sponsor of the project, has committed 25% equity for the project. The 75% debt is being arranged from a consortium of local financial institutions.

(IV) THE SOCIAL AND ENVIRONMENTAL IMPACT OF THE PROPOSED FACILITY OR SYSTEM IN A NON-TECHNICAL AND COMMONLY UNDERSTOOD LANGUAGE

To be provided accordingly.

Punjab Thermal Power (Pvt.) Limited

Ref: PTPL\Leg\089\2017
Date: September 7, 2017

MR. IFTIKHAR ALI KHAN
Director
Registrar Office
National Electric Power Regulatory Authority
NEPRA Tower, Ataturk Avenue (East) G-5/1
Islamabad

Subject: **APPLICATION OF PUNJAB THERMAL POWER (PRIVATE) LIMITED (PTPL) FOR GRANT OF GENERATION LICENCE IN RESPECT OF THERMAL POWER PROJECT, DISTRICT JHANG, PUNJAB**

Dear Sir,

This has reference to your letter no. NEPRA/R/LAG-30/13223 dated July 31, 2017 (**"First Letter"**) and no. NEPRA/R/LAG-30/14925 dated August 30, 2017 (**"said Letters"**) in response to Punjab Thermal Power (Pvt.) Limited's (the **"Applicant"** or **"PTPL"**) Application for Grant of Generation Licence dated July 26, 2017 wherein certain information/documents were required in connection therewith.

2. It is recapitulated that PTPL in its letter no. PTPL/Leg/067/2017 dated August 11, 2017 (**Annex-A**), in response to your First Letter, submitted that PTPL was incorporated on June 8, 2017 by Government of the Punjab to establish the subject project on fact track basis. Accordingly the process of procuring EPC contractor through International Competitive Bidding (ICB) has been initiated, and almost concluded, in accordance with the applicable Punjab Procurement Rules, 2014. Hence, the information available at this stage is as under:

	REQUIRED DOCUMENT / INFORMATION	**RESPONSE**
1	Expression of Interest to provide credit or financing alongwith sources and details thereof as required pursuant to Regulation 3(5)(d)(ii) of the Regulations	Expression of Interest to provide financing in form of Summary of Indicative Term Sheet by the mandated lead arrangers / financiers dated August 17, 2017 is appended herewith as **Annex-B**
2	Latest financial statement of the Company as required pursuant to Regulation 3(5)(d)(iii) of the Regulations	The Company got incorporated on June 8, 2017. Hence, its first quarterly financial statement ending period September, 2017 will be available in October. Hence, can be made available accordingly.
3	Profile of sub-contractors, if any, alongwith expression of interest of such sub-contractors as required pursuant to Regulation 3(5)(d)(v) of the Regulations	Not applicable. The sub-contractor(s), if required, will be appointed by the EPC contractor in due course.
4	Verifiable references with reference to experience of the Applicant and its sub-contractors as	Not applicable. The Applicant is a company specifically incorporated by Government of the

First Floor 7 C-1 Gulberg III, Lahore, Tel:+92-42-35750936-8, Fax: +92-42-35750939

	required pursuant to Regulation 3(5)(d)(vi) of the Regulations	Punjab through Energy Department for establishing and executing the subject project.
5	The type, technology, model, technical details and design of the facilities proposed to be acquired, constructed, developed or installed as required pursuant to Regulation 3(5)(g)(a) of the Regulations	Gas Turbine based Combined Cycle Power Plant, H- Class (GT), Siemens SGT5-8000H, Net Power Output of 1242.7 (Gas) MW at RSC and Net Thermal Efficiency of 61.16% (Gas) at RSC. Preliminary General Layout plan is attached herewith as **Annex-C** and detail design of each module will be finalized at design stage and will be shared in due course of time.
6	Feasibility study of the project as required pursuant to Regulation 3(6)(A)(a)(16) of the Regulations	Attached herewith as **Annex-D**.
7	Technology, size of plant, number of units as required pursuant to Regulation 3(6)(A)(a)(2) of the Regulations	Technology: Gas Turbine based Combined Cycle Power Plant Size of Plant: 1263.2 MW (Gross- Gas) at Mean Site Condition. 1242.7 MW (Net – Gas) at Mean Site Condition. Number of Units: 2 X Gas Turbines + 1 X Steam Turbine
8	Project cost, information regarding sources and amounts of equity and debt as required pursuant to Regulation 3(6)(A)(a)(2) of the Regulations	The estimated project cost is around PKR 85-90 billion. Government of the Punjab has committed to fund the equity (as indicated to PPIB *vide* its letter dated July 5, 2017 i.e. Annex-H to the subject Application for Grant of Generation Licence) and the debt is to be provided by consortium of financial institutions / commercial banks (*Please see Annex-B hereof*).
9	Project commencement and completion schedule with milestones as required pursuant to Regulation 3(6)(A)(a)(9) of the Regulations	Project Commencement: End of September 2017 (approximately) Completion Schedule: Simple Cycle Operation – 14 - 15 months from notice to proceed (NTP) to the contractor (estimated) Combined Cycle Operation: 26 – 30 months from NTP (estimated)
10	ESSA (Environment and Social Soundness Assessment) as required pursuant to	Draft Environmental Impact Assessment Report is attached herewith as **Annex-E**

First Floor 7 C-1Gulberg III, Lahore, Tel:+92-42-35750936-8, Fax: +92-42-35750939

	3(6)(A)(a)(10) of the Regulations	
11	Safety plans, emergency plans as required pursuant to 3(6)(A)(a)(11) of the Regulations	Detailed safety and emergency plans are to be finalized after discussion and in agreement with the EPC contractor, before commencement of works at site. The same can be shared with the Authority in due course.
12	Control, metering, instrumentation and protection as required pursuant to 3(6)(A)(a)(14) of the Regulations	The EPC contractor will finalize the said information/document in its design after approval of Employer/Applicant, Employer's Technical Consultant and the Power Purchaser. The same will be shared with the Authority after finalization in due course of time.
13	Training and development as required pursuant to 3(6)(A)(a)(15) of the Regulations	The said information will be made available once finalized with the EPC contractor in due course.
14	Efficiency regarding following efficiency parameters as required under Regulation 3(6) Schedule-III Part (A)(a) serial no. 17: i. Designed Efficiency of Plant (%) ii. Gross Efficiency of Power Plant at Mean Site Conditions (%) iii. Net Efficiency of Plant at Mean Site Condition	Designed Efficiency of the Plant: At least 60% (Net) at ISO Gross Efficiency at Mean Site Condition: Not Available. Net Efficiency at Mean Site Condition: 61.16% (Net) at Mean Site Condition

3. Hope that the above suffices the relevant requirements. It is also submitted that the remaining information sought corresponds to that of the detailed design stage of the project, hence, will be provided accordingly.

4. Nevertheless, in light of the aforementioned and considering that the project is of public importance, it is requested that PTPL's subject application be further processed and any further information/documents if so required be allowed to provide accordingly.

Best Regards,

(HAMMAD ALTAF KHAN)
Chief Legal Officer

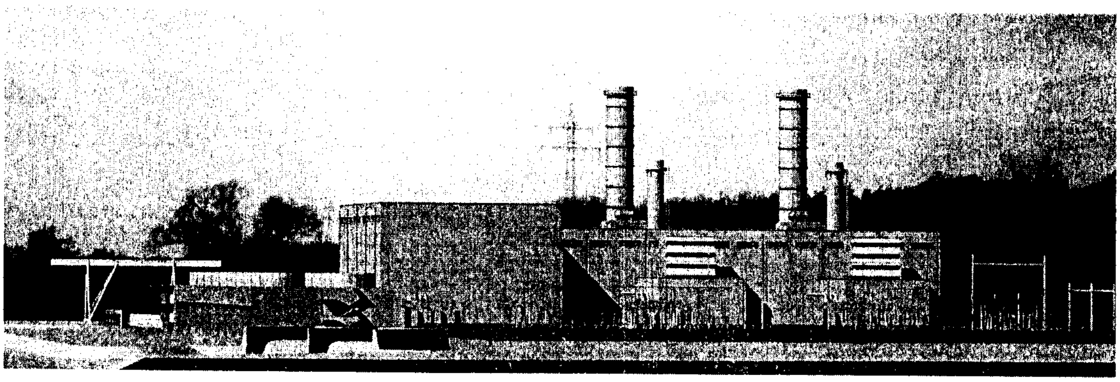
First Floor 7 C-1 Gulberg III, Lahore, Tel:+92-42-35750936-8, Fax: +92-42-35750939

NESPAK LAHMEYER INTERNATIONAL

BANKABLE FEASIBILITY STUDY

1100-1400 MW (NET) RE-GASIFIED LIQUEFIED NATURAL GAS (RLNG) BASED COMBINED CYCLE POWER PLANT AT JHANG, PUNJAB, PAKISTAN

20-23-00263



1100-1400 MW (NET) RE-GASIFIED LIQUEFIED NATURAL GAS (RLNG) BASED COMBINED CYCLE POWER PLANT ATJHANG, PUNJAB, PAKISTAN

Prepared for:

Punjab Thermal Power (Pvt.) Limited (PTPL) –

Government of Punjab, Pakistan

Prepared by

Lahmeyer International GmbH
Friedberger Str. 173
61118 Bad Vilbel
Germany

National Engineering Services Pakistan (NESPAK)
Power & Mechanical Division,
NESPAK House, 1-C, Block N,
Model Town Ext. Lahore, Pakistan

Ernst & Young (EY)
96-B/1 Pace Mall Building
4th Floor, M.M. Alam Road
Gulberg II, Lahore, Pakistan

Cornelius, Lane & Mufti (CLM)
Plot 4, Queens Road, Mozang
Lahore, Pakistan

Marsh Insurance
Oceanic House, 1st Floor, 6-E, Street 11,
Badar Commercial, Phase V Ext., D.H.A.,
Karachi - 75500, Pakistan.

Table of Contents

List of Figures

List of Tables

List of Annexes

Abbreviation &Definition

AC	Alternative Current
AIS	Air-Insulated Switchgear
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AVR	Automatic Voltage Regulator
BMS	Burner Management System
BOP	Balance of Plant
Capital spare	Capital spare is the parts within inventory that are purchased as spare parts for depreciable equipment (e.g., capital equipment).
CCPP	Combined Cycle Power Plant

CCR	Central Control Room
CCW	Closed Cooling Water (System)
CEMS	Continuous Emission Monitoring System
Client	The firm (entity) responsible for execution the Project
COD	Commercial Operation Date
Contractor	The firm (entity) responsible for execution the works according to the Contract.
CT	Current Transformer
DCS	Distributed Control System
DFR	Design Flow Rate
DIN	Deutsches Institut für Normung
EBH	Equivalent Base Hours
EDOC	Effective Date of Contract
Engineer	Engineer means Owner's Engineer who represents the Owner of a project during design, development, and construction to confirm that the work is done well and within legal standards
EOH	Equivalent of Operating Hours
EPC	Engineering Procurement Construction
EPC contract	Means the EPC Turnkey Contract between the Owner and contractor
EPC contractor	The firm (entity) responsible for execution the works described in EPC contract
ER	Electronic Room
FAC	Final Acceptance Certificate
FAT	Factory Acceptance Test
FFH	Factored Fired Hours
FS	Factored Starts
GIS	Gas Insulated Switchgear
GoPb	Government of Punjab (Pakistan)
GT	Gas turbine
GTG	Gas Turbine Generator
h/a	Hours/annum
HMI	Human Machine Interface
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HV	High Voltage
HVAC	Heating, Ventilation and Air Conditioning
HSD	High Speed Diesel
I&C	Instrumentation & Control
IEC	International Electro Technical Commission

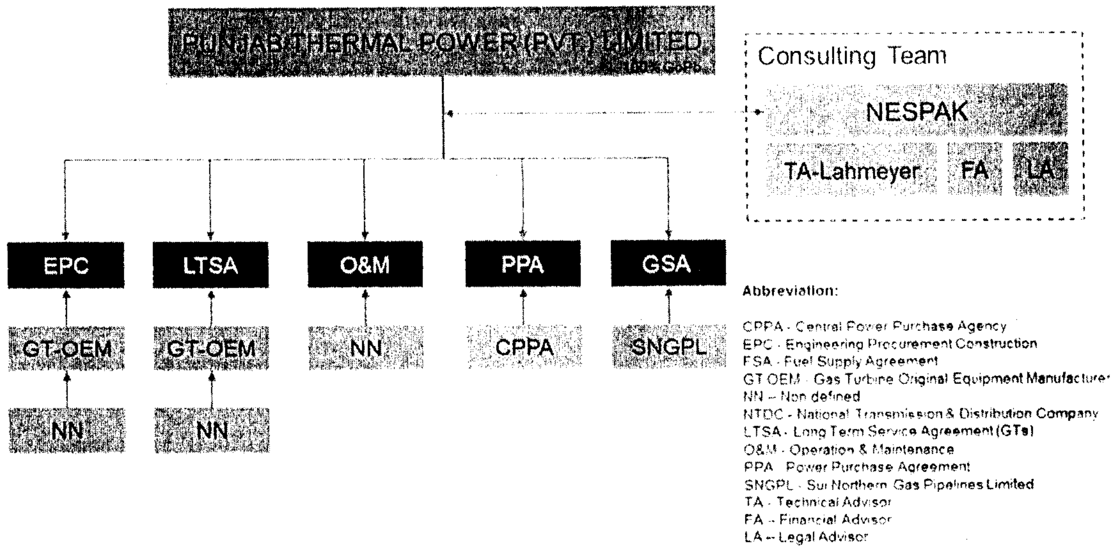
IFP	Invitation for Pre-Qualification
IPB	Isolated Phase Bus
ISO	International Organization for Standardization
KKS	Kraftwerk Kennzeichnungs System
LHV	Low heating value
LI	Lahmeyer International GmbH
LNG	Liquefied natural gas
LP	Low Pressure
LTSA	Long Term Service Agreement
LV	Low Voltage
MCC	Motor Central Control
MCR	Maximum Continuous Rating
MMCFD	Million cubic feet per day
MV	Medium Voltage
MVR	Manual Voltage Control
NESPAK	National Engineering Services Pakistan (Pvt.) Limited is state owned Pakistan's lead engineering consultancy organization
NG	Natural Gas
NLTC	No-Load Tap Changer
NTDC	National Transmission and Despatch Company - Operator of Transmission Lines in Pakistan
NTP	Notice to Proceed
O&M	Operation and Maintenance
ODAF	Oil Directed Air Forced
OEM	Original equipment manufacturer – means a company (entity) which manufactures a component or equipment that is used in Project as "end product" (steam turbine, boiler, pumps etc.)
OH	Operating hours
OHTL	Overhead Transmission Line
OLE	Object Linking and Embedding (software)
OLTC	On Load Tap Changer
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
OS	Operator Station
Owner	Punjab Thermal Power (Pvt) Limited - PTPL
PAC	Provisional Acceptance Certificate
PED	Pressure Equipment Directive 97/23/EC
PID	Piping and Instrumentation Diagrams

PLC	Programmable Logic Controller
Power Island	Gas turbine, Steam turbine, HRSG, generator, DCS system, potentially gas compressor system
Project Company	Punjab Thermal Power (Pvt.) Limited (PTPL)
RFP	Reinforced plastic
RLNG	Re-Gasified liquefied natural gas
Rs	Pakistani rupee
RSC	Reference Site Conditions
SAT	Site Acceptance Test
SC	Single cycle
SCADA	Supervisory Control & Data Acquisition
SES	Static Excitation System
SI	System International
SIL	Safety Integrity Level
Site	Site means the site on which the Project is finally located
SLD	Single Line Diagram
SNGPL	Sui Northern Gas Pipeline Limited - Operator of Gas Pipelines in Pakistan
ST	Steam turbine
STG	Steam Turbine Generator
SWG	Switchgear
TPS	Turbine Protection System
TÜV	Technischer Überwachungsverein
UPS	Un-Interruptible Power Supply
UV/Vis	Ultra Violet / Visible
VDE	Verband Deutscher Elektroniker e.V.
VDI	Verein Deutscher Ingenieure
VDU	Visual Display Unit
VT	Voltage Transformer
XLPE	Cross Linked Polyethylene
3 RLNG based CCPP projects	Projects being executed in Punjab province during period Q4 2015 – Present, Owner's Engineer – NESPAK with Lahmeyer support

1 EXECUTIVE SUMMARY

The Government of Punjab (Pakistan) intends to install a 1,100 - 1,400 MW RLNG based CCPP base-load power plant on a site near Trimmu Barrage / Haveli Bahadur Shah, Jhang, Punjab. For this reason, the company PUNJAB THERMAL POWER (PVT.) LIMITED has been established. The expected sequence of execution of the mentioned projects is presented below:

The project organisation is depicted in the figure below:



The expected sequence of execution of the subject project is presented below:

Table 1: The planned sequence of execution for Punjab Power Plant, Jhang

NO.	ACTION	DATE
1.	Issuance of IFP by Owner	June 2017
2.	Issuance of Tender Documents to Pre-Qualified Bidders	Mid of July 2017
3.	Submission of Bids, including EPC, LTSA (from GT-OEM) and Simple Cycle O&M	Mid of August 2017
4.	Evaluation of Bids – preparation of Technical and Financial Evaluation Reports – determination of Lowest Evaluated Bidder	August 2017
5.	Award of Contract, Execution of EPC Agreement and issuance of Notice to Proceed	September 2017
6.	Simple Cycle Operation	15 months from NTP
7.	Combined Cycle Operation	26 months from NTP

1.1 Technical Findings: Assessment and Recommendation

Based on the recommendations of the representatives of project sponsor i.e. Government of Punjab , the Operator of Transmission Lines (NTDC), the Operator of Gas Pipelines in Northern Pakistan (Sui Northern Gas Pipeline Limited) and the recommended concept during pre-feasibility stage was as following:

- Net Output Range 1,100 to 1,400 MW – based on ISO conditions;
- Minimum Net Efficiency 60% (net) at ISO conditions with Once-Through cooling;
    - 1 block in 2 x GT - 2 x HRSG – 1 x ST configuration, or
    - 2 blocks in 1 x GT - 1 x HRSG – 1 x ST configuration, or
    - 1 block in 3 x GT - 3 x HRSG – 1 x ST configuration;
- Triple-pressure-reheat HRSG;
- Dual fuel (natural gas as primary fuel and diesel as backup fuel);
- Simple cycle operation will be required for early power generation;
- Once-through cooling system with water from adjacent canal plus wet/dry cooling tower for 1-2 months' outage period of canal per year.

The above recommended configurations were planned as indoor installation with natural gas as main fuel and diesel as back-up fuel. Following the above schedule the staged construction for early operation in single cycle mode; hence bypass stacks/diverter damper behind GTs is required.

1.2 Approach

Based on discussion with representatives of Owner, transmission line operator and gas pipeline operator in June 2017 the following assumptions and principles were taken into account during feasibility stage:

- Efficient power plant(s) fired by natural gas (Re-Gasified LNG) with 1,100 MW – 1,400 MW (net) range;
- 1,100 MW – 1,400 MW (net) Combined Cycle concept;
- Fuel availability for Jhang site of 200 MMCFD approximately;
- Completion time for initial electricity generation 14-15 months for first SC;
- The design principles - heavy-duty gas turbines min. capacity 300 MW (Alstom, GE, Mitsubishi, Siemens, Ansaldo) – minimum "F-class" machines;
- Estimated cost of fuel 7 US$/MMBTU (HHV) at site;
- Generation & efficiency of power plant – comparison of NPV for three (3) years of commercial operation;

- NPV comparison for EPC cost
- NPV comparison for LTSA cost for period of 12 years
- NPV comparison for O&M contractor costs for period of simple cycle operation for 9 months.

In addition to the outcomes of the Bankable Feasibility Study the following cases have been considered to consolidate the technical configuration of the plant and the accompanying operational modes as more detailed input to the financial models and tariff calculations.

Operation mode:

- Case 1: 7,200 operating hours/annum on RLNG;
- Case 2: 800 operating hours/annum on HSD.

1.3 Results and recommendations

Taking into account:

- Costs of Energy - Unit Prices in Rs. / kWh based on RLNG price of 7 US$/MMBTU – LHV;
- Requested and accepted by Owner sequence of execution the project –
  SC COD1– 15 months from NTP
  SC COD2 – 15 months from NTP
  CC COD – 26 months from NTP
- Required by Government of Punjab (GoPb) lowest specific investment cost per installed MW;
- Lead time for delivery major equipment to site and proposed Time Schedule for execution the Project.
- Reference Site Conditions (RSC):
  - Ambient temperature 26°C;
  - Rel. Humidity 70%;
  - Barometric pressure 0.9954 bar, equivalent to 150 maSL;
  - Water (canal) temperature 25°C;
  - Grid PF 0.85.

The recommended proposal is as following:

Table 2: The recommended configuration – Jhang site

NO.	ACTION	DATA
1.	Combined Cycle Power Plant at Jhang site (Net, ISO)	1,100 -1,400 MW
2.	Heavy-duty gas turbines, F or H-class (ISO)	300 - 490 MW
3.	Configuration - 1 x 2xGT-2xHRSG-1xST	-
4.	Basic fuel	natural gas (RLNG)
5.	Back-up fuel	HSD
6.	Minimum Net efficiency (LHV) in Combined cycle operation (ISO)	60%
7.	Staged construction for early operation in SC mode (from EDOC): SC – first unit CC	 after 15 months after 26months
8.	Indoor installation	-
9.	Once-through cooling system with water from adjacent canal plus wet/dry cooling tower for 1 -2 months (January/February) outage period of canal per year	-
10.	The plant shall be complete in all respect with auxiliaries and balance of plant (BOP) and all other facilities required	-
11.	Potentially, evaporative cooling for GT air intakes	-
12.	Spare and capital parts (one set for each set) for 2 years' operation	-
13.	Operating modes (OP):	-
	OP1 - with once-through cooling	-
	OP2 - with cooling towers	-
	OP3 - with once-through cooling and evaporating cooling	-
14.	Discount factor	10%
15.	RLNG Price - US$/MMBTU-HHV	7.00
16.	RLNG Price - US$/MMBTU-LHV	7.75
17.	HSD Price – PKR/l-HHV	46.21
18.	HSD Price – PKR/l-LHV	48.99[1]
19.	Fuel price escalation	0%

[1] Fuel Prices based on NEPRA Tariff Determination for 1180 MW CCPP Bhikki

2 INTRODUCTION – OBJECTIVE OF THE BANKABLE-FS

Pakistan is facing growing power requirements which can be met through base load generation of electricity. The energy demand in Punjab region, being the major load centre of Pakistan, is approximately 68%[2] of entire national grid fed electricity. Due to planned development of gas pipelines and existing contracts for delivery of LNG, primarily from the Middle East, Punjab has initiated development of power plant generation projects based on natural gas.

The study follows an examination of the data collected during site visits and discussions with representatives of OEMs, EPCs and allied companies in Pakistan.

2.1 Project Owner Objectives

The GoPb has created Punjab Thermal Power (Private) Limited with a mandate to set up a 1100-1400 MW Combined Cycle Power Plant with a high efficiency and utilising RLNG as main fuel. The same is envisaged considering that adequate imported gas shall be available for utilisation by such a project. Such a higher efficiency plant when included in the current mixed generation capacity of the country will resultantly save the exchequer in a manner that such savings would effectively lower the average cost of electricity offered to the consumers. Additionally, the GoPb has envisioned achieving the lowest specific EPC cost (USD / kWh), which not only would improve the tariff but reduce the initial equity to be injected into the Project by the sponsor. The proposed project is to be executed on turnkey basis.

2.2 Third Party Surveys / Studies

The Third-Party surveys/studies will be made available to the tenderers to assist them in achieving the aforementioned timeline goals;

- Interconnection study;
- Transportation study;
- Groundwater Availability Study;
- Hydrological Study;
- Information about availability of gas;
- Environmental Impact Assessment Report for Jhang site;
- Topographic Survey of the Project Site;
- Geotechnical Investigation Report.

---

[2] Data Reference Book - Volume-2 by NTDC.

2.3 Project Consultants

Regarding the preparation of tender documents of EPC and LTSA contracts, the Owner is supported by a team of consultants which consists of NESPAK and Lahmeyer International as Technical Advisor, Ernst & Young (EY) is a Financial Advisor, Cornelius, Lane & Mufti (CLM) as Legal Advisor and Marsh Insurance as Insurance Advisor

National Engineering Services Pakistan (Pvt) Limited is Pakistan's leading engineering consultancy organization. It was established in 1973 as a private limited company by the Government of Pakistan. NESPAK is registered with a number of international funding agencies such as IBRD, ADB, IDB, etc. NESPAK has undertaken more than 3500 projects located in Afghanistan, Azerbaijan, Bahrain, Bangladesh, Benin, Cameroon, Chad, Comoros Island, Dominica, Ethiopia, Gambia, Ghana, Guinea, Iran, Iraq, Kazakhstan, Kyrgyzstan, Libya, Nepal, Nigeria, Oman, Pakistan, Qatar, Saudi Arabia, Senegal, Sierra Leone, Somalia, Sudan, Syria, Tajikistan, Tanzania, Thailand, Turkey, Turkmenistan, U.A.E, Uzbekistan, Yemen.

Lahmeyer International from Germany was established in 1890 in Frankfurt am Main and from the beginning of 2015 is a part of GDF SUEZ Group as a daughter company of Tractebel Engineering (Belgium). Tractebel Engineering ranks as one of the major international engineering companies operating in the energy and infrastructures sectors. Lahmeyer also offers a wide range of planning and engineering services for complex infrastructure projects in the fields of energy and water, as well as building and transportation. Lahmeyer, a trusted brand name, is continuing as an independent business unit of Tractebel Engineering. With well over 4,400 employees and an annual turnover of more than 600 Million Euro, joint company is one of the most significant energy, water, and infrastructures engineering companies worldwide.

In addition to the aforesaid, NESPAK will engage reputable financial, legal, tax and insurance sub-consultants for the said Project.

3 PAKISTAN POWER SCENARIO

The ever-increasing demand of electricity with limited addition of generating capacity in the recent years and other issues such as staggered outages for the power plants, unreliability and phasing out of older technology power plants has resulted in persistent load shedding hours. The main issues confronting the power sector include expensive generation mix, inefficient operation of aging thermal power generating stations, high losses of distribution companies and seasonal reductions in hydropower generation.

3.1 Analysis of Energy Market in Pakistan

3.1.1 Economic Growth vs. Energy Supplies

Pakistan's economy has been facing numerous domestic and external shocks since 2009 onwards mainly due to energy crisis. The economy of Pakistan during the last five years grew on average at the rate of 4.06 percent per annum. The energy crisis is shrinking the realization of Pakistan's economic growth and its stability. Power-outages have adversely affected the country's economy and many aspects of factors of common life. Gross Domestic Product (GDP) growth has been stuck at a level (see Figure 2), which is much lower than the level of Pakistan's long-term trend potential of about 6.5 percent per annum and is lower than what is required for sustained increase in employment and income and reduction in poverty.

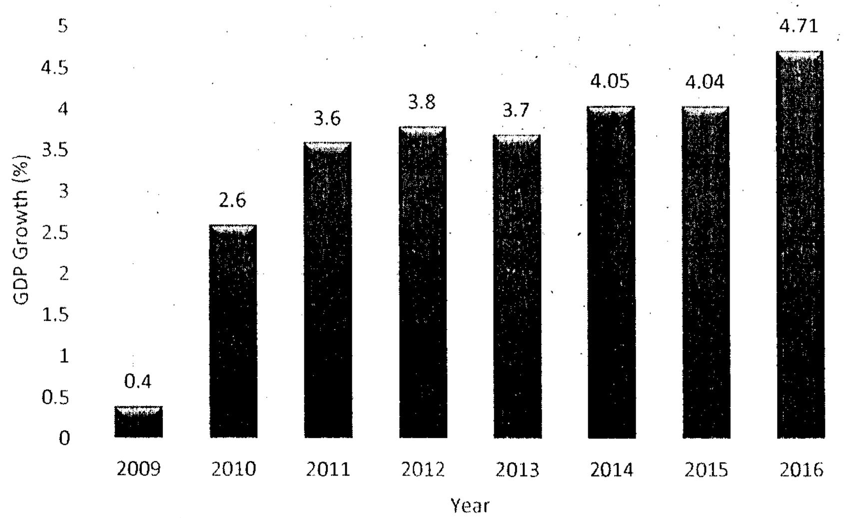


Figure 1: Pakistan GDP Growth Rate[3]

[3]Source: Economic survey, growth and investment, (finance division, Govt. of Pakistan). NEPRA State of Industry Report 2016 (Fig: 3).

3.1.2 Current Primary Energy Mix

Primary commercial energy supplies in Pakistan comprises of oil, natural gas, coal, hydro and nuclear electricity. The primary energy supplies of the country during fiscal year 2014-15 increased by 5.11% and reached 70.26 MTOE as compared to 66.85 Mean Ton Oil Equivalent (MTOE)during the same period last year. The overall contribution of gas in primary energy supplies of the country, during 2014-15, was the highest with 29.98 MTOE (42.66%) followed by the Oil 24.97 MTOE (35.54%), Hydro Electricity 7.75 MTOE (11.03%), Coal 4.95 MTOE (7.05%), Nuclear Electricity 1.39 MTOE (1.97%), LPG 0.46 MTOE (0.65%), Imported Electricity 0.11 MTOE (0.15%), LNG Imported 0.47 MTOE (0.67%) and Renewable Energy 0.19 MTOE (0.27%).

The overall contribution of Gas in primary energy supplies of the country, during 2014-15, was the highest with 29.98 MTOE (42.66%) followed by the:

- Oil24.97 MTOE (35.54%);
- Hydro Electricity7.75 MTOE (11.03%);
- Coal4.95 MTOE (7.05%);
- Nuclear Electricity1.39MTOE (1.97%);
- LPG0.46 MTOE (0.67%) and
- Imported Electricity0.11 MTOE (0.15%).

The following table (Table 4) provides the data regarding primary commercial energy supplies by source from year 2010-11 to 2014-15:

Table 3: Primary Energy Supplies by Sources - Current Final Energy Mix[4]

Fiscal Year	Unit	Gas	Oil[1]	LNG Import[2]	LPG[3]	Coal	Hydro Electricity[4]	Nuclear Electricity[4]	Renewable Electricity[2]	Imported Electricity[5]	Total	Annual Growth Rate(%)
2010-11	MTOE	30.68	20.67		0.34	4.35	7.59	0.82		0.06	64.52	2.27
	% share	47.55	32.04		0.53	6.74	11.77	1.27		0.10	100.00	
2011-12	MTOE	32.03	19.96		0.32	4.29	6.81	1.26		0.07	64.73	0.32
	% share	49.49	30.83		0.50	6.62	10.52	1.94		0.10	100.00	
2012-13	MTOE	31.14	20.97		0.31	3.86	7.13	1.09		0.09	64.59	-0.21
	% share	48.22	32.47		0.48	5.98	11.03	1.68		0.14	100.00	
2013-14	MTOE	30.96	23.01		0.36	3.59	7.61	1.22		0.10	66.85	3.50
	% share	46.32	34.42		0.54	5.37	11.38	1.82		0.15	100.00	
2014-15	MTOE	29.98	24.97	0.47	0.46	4.95	7.75	1.39	0.19	0.11	70.26	5.11
	% share	42.66	35.54	0.67	0.65	7.05	11.03	1.97	0.27	0.15	100.00	

[1] Excluding petroleum products exports and bunkering.
[2] LNG Imports and Renewable Generation reported for the first time in FY 2014-15.
[3] include imports and production from field plants.
[4] Converted @ 10,000 Btu/kWh to retpresent primary energy equivalent of hydro and nuclear electricity as if this was generated by using fossil fuels
[5] WAPDA importing electricity from Iran since October, 2002.
Source: Pakistan Energy Yearbook, HDIP, Islamabad

[4] NEPRA State of Industry Report 2016.

Final energy is a form of energy available to the user following the conversion from primary energy. Gasoline or diesel oil, purified coal, purified natural gas, electricity, mechanical energy are different forms of final energy. When going from primary energy to final energy, there is always loss of some energy, which depends on the efficiency of the conversion device. Table 5gives the final energy consumption by source from 2010-11 to 2014-15:

Table 4: Final Energy Supplies by Sources

Fiscal Year	Unit	Gas[2]	Oil[1]	LPG	Coal[2]	Electricity[3]	Total	Annual Growth Rate (%)
2010-11	Million TOE	16.78	11.25	0.50	4.03	6.28	38.84	0.19
	% share	43.20	28.97	1.30	10.36	16.17	100.00	
2011-12	Million TOE	17.62	11.62	0.48	4.06	6.25	40.03	3.05
	% share	44.02	29.03	1.20	10.14	15.62	100.00	
2012-13	Million TOE	17.52	12.22	0.53	3.66	6.25	40.18	0.40
	% share	43.60	30.41	1.31	9.11	15.56	100.00	
2013-14	Million TOE	16.28	12.72	0.59	3.45	6.79	39.82	-0.91
	% share	40.88	31.94	1.47	8.65	17.06	100.00	
2014-15	Million TOE	15.76	13.85	0.76	4.63	6.99	41.98	5.44
	% share	37.53	32.99	1.80	11.03	16.65	100.00	

[1] Excluding consumption for power generation.
[2] Excluding consumption for power generation and feedstock.
[3] @ 3412 Btu/kWh being the actual energy content of electricity.
Source: Pakistan Energy Yearbook, HDIP, Islamabad

3.1.3 Fuel Consumption in Power Sector

The share of installed capacity of thermal power plants using oil, natural gas and coal to the total installed capacity in the country, during 2015-16, was about 65.50% while the electricity produced by the thermal power plants, during 2014-15, to the total electricity generated in the country during same period was about 64.01%. The statistics of different fuel used and their percentage share to the total fuel used for thermal electricity generation of the country from 2010-11 to 2014-15 are given in table 6 as follows:

Table 5: Fuel Consumption for Thermal Power Generation – years 2010-2015

Fiscal Year	Unit	Gas	Furnace Oil	Diesel Oil	Coal	Total	Annual Growth Rate (%)
2010-11	TOE	6,493,766	7,827,500	105,160	43,169	14,469,595	-8.22
	% share	44.88	54.10	0.73	0.30	100.00	
2011-12	TOE	6,732,876	7,206,839	203,072	46,800	14,189,587	-1.94
	% share	47.45	50.79	1.43	0.33	100.00	
2012-13	TOE	7,084,177	7,342,755	218,584	28,204	14,673,720	3.41
	% share	48.28	50.04	1.49	0.19	100.00	
2013-14	TOE	6,602,422	8,486,744	304,994	71,902	15,466,062	5.40
	% share	42.69	54.87	1.97	0.46	100.00	
2014-15	TOE	6,847,894	8,234,479	565,953	67,638	15,715,964	1.62
	% share	43.57	52.40	3.60	0.43	100.00	

Source: Pakistan Energy Yearbook, HDIP, Islamabad

3.1.4 Total Installed Power Generation Capacity

The total nominal power generation capacity of Pakistan as on 30th June, 2016 was 25,374 MW; of which 16,619 MW (65.50%) was thermal, 7,116 MW (28.04%) was hydroelectric, 787 MW (3.10%) was nuclear and 852 MW (3.36%) was renewable energy (wind, solar and bagasse). The following table 7 explain the total installed capacity of Pakistan from July, 2012 to June, 2016:

Table 6: Installed Generation Capacity (MW) in Pakistan Power System[5]

As on 30th June		2012	2013	2014	2015	2016
HYDEL						
WAPDA Hydel		6,516	6,733	6,902	6,902	6,902
IPPs Hydel		214	214	214	214	214
Sub-Total		**6,730**	**6,947**	**7,116**	**7,116**	**7,116**
% Share (Hydel Installed Capacity)		28.65	29.28	30.02	28.51	**28.04**
THERMAL						
GENCOs with PEPCO		4,785	4,785	4,590	5,762	5,762
K-EL Own		2,381	2,359	1,951	1,874	1,874
IPPs	Connected with PEPCO	8,312	8,342	8,700	8,696	8,696
	Connected with K-EL	252	252	252	252	252
CPPs/SPPs connected with K-EL		239	203	200	35	35
Sub-Total		**15,969**	**15,941**	**15,693**	**16,619**	**16,619**
% Share (Thermal Installed Capacity)		67.99	67.19	66.21	66.58	65.50
NUCLEAR						
CHASNUPP (I&II)		650	650	650	650	650
KANUPP		137	137	137	137	137
Sub-Total		**787**	**787**	**787**	**787**	**787**
% Share (Nuclear Installed Capacity)		3.35	3.32	3.32	3.15	3.10
RENEWABLE ENERGY (WIND, SOLAR & BAGASSE)						
RE Power Plants connected with PEPCO		1	50	106	439	852
Sub-Total		**1**	**50**	**106**	**439**	**852**
% Share (RE Installed Capacity)		0.00	0.21	0.45	1.76	3.36
Total Installed Capacity of the Country		**23,487**	**23,725**	**23,702**	**24,961**	**25,374**

Source: State of Industry Reports by NEPRA 2016.

3.2 Load Demand and Supply

Electricity demand in Pakistan shows seasonal variations. The maximum power demand occurs in the summer months from May until September. A lower peak demand occurs in the winter month of January. In general, the electricity demand is increasing year by year. The Increase in peak demand coincides with peak demand in June and keeps increasing in the summer months until September. The summer peak demand is mainly covered by hydropower, but the winter peak is covered by thermal power, owing to shutdown of the canals from the end of December until mid-January – see Figure 4.

[5]Source: State of Industry Report 2016 by NEPRA]

The peak hour timing is normally from 5 PM to 11 PM in summers. The hourly load figures for a typical working and non-working day in summer and winter during 2015 are provided in Figure 5 and 6.

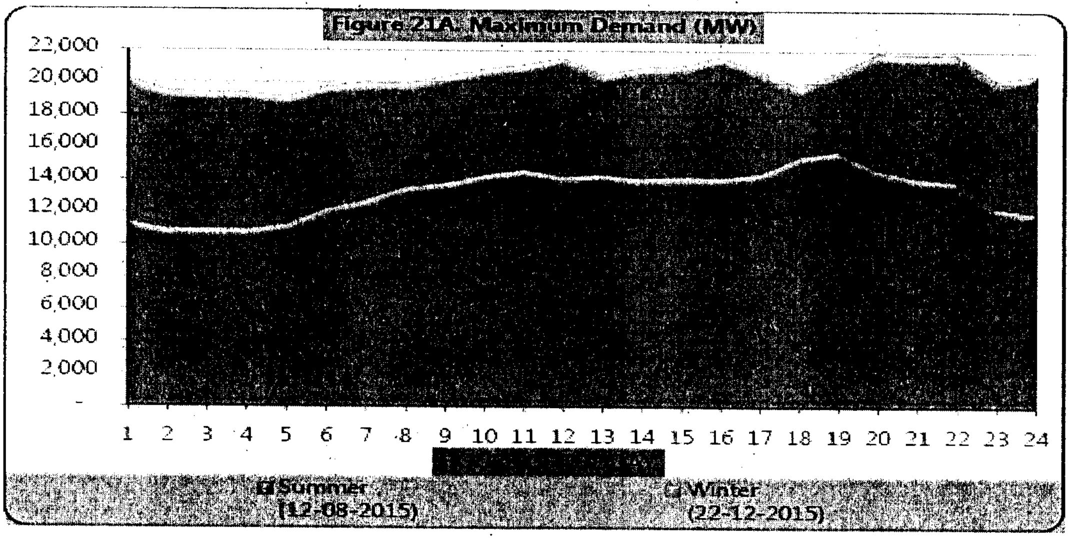


Figure 2: Typical Maximum Hourly Demand during summer and winter[6]

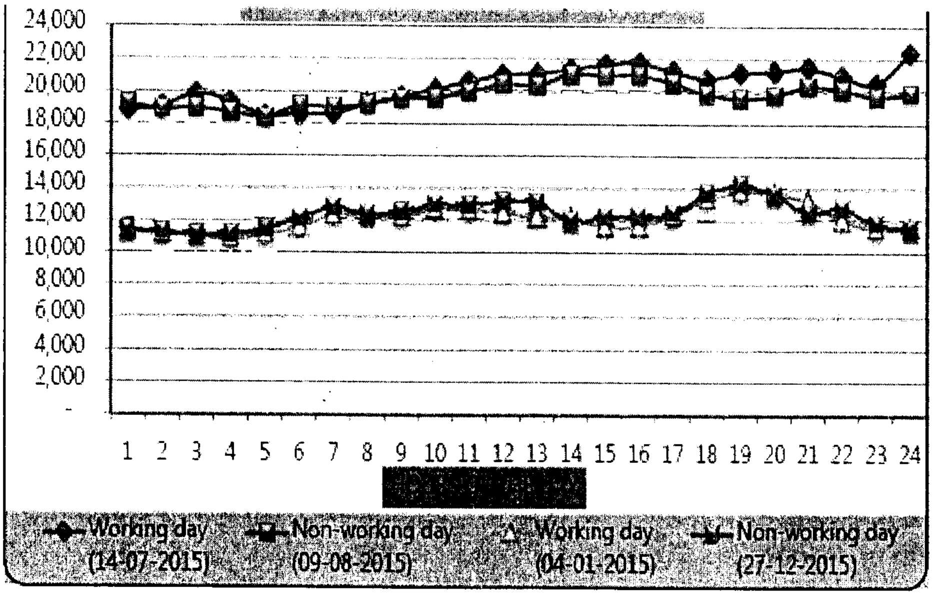


Figure 3: System Demand for a Typical Working and Non-working Day in summer and winter[7]

[6]State of Industry Reports by NEPRA 2016.
[7]State of Industry Reports by NEPRA 2016.

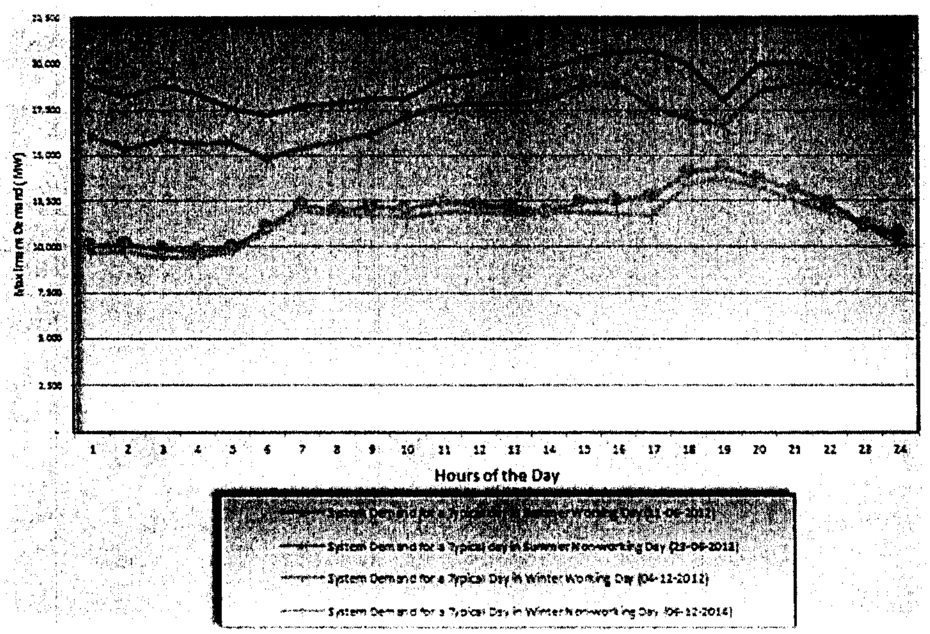


Figure 4: System Demand for a Typical Working and Non-working Day in summer and winter[8]

Historically, Pakistan has been facing the deficiency in electric power supply. With the exception of few years in late nineties, load shedding has become a routine. The actual position of demand and supply of electric power for the last few years, as given in Table 8. Clearly depicts that the country has been badly hit by power shortages during last few years.

[8]State of Industry Reports by NEPRA 2016.

Table 7: Electricity Supply and Demand during PEPCO / NTDC System Peak Hours[9]

A: Actual Figures				
Financial Year ending 30th June	Generation Capability (MW)	Demand During NTDC's System Peak Hours (MW)		Surplus/ (Deficit) (MW)
2012	12,320	18,940		-6,620
2013	14,600	18,827		-4,227
2014	16,170	20,576		-4,406
2015	16,500	21,701		-5,201
2016	17,261	22,559		-5,298
B: Projected Figures				
Financial Year ending 30th June	Planned Generation Capability as per NTDC (MW)	NTDC Projected Demand Growth Rate (%)	NTDC's Projected Demand during Peak Hours (MW)	Surplus/ (Deficit) (MW)
2017	20,106	6.05	23,816	-3,710
2018	24,640	5.56	25,140	-500
2019	26,663	5.17	26,439	224
2020	29,059	4.86	27,725	1,334
2021	33,776	4.89	29,082	4,694

3.2.1 Demand Forecast

The growing pace of urbanization and industrialization in Pakistan puts a premium on demand for electricity. Electricity demand depends upon a number of factors viz. electricity tariffs, Gross Domestic Product (GDP), population, demand side management (DSM) etc.

National Power System Expansion Plan (NPSEP) prepared for National Transmission and Despatch Company (NTDC) in 2011 provides medium-term load forecast up to the year 2020 for the PEPCO / NTDC system and a long-term load forecast up to 2035 for the PEPCO / NTDC system and the KESC / K-Electric system.

[9] State of Industry Reports by NEPRA 2016.

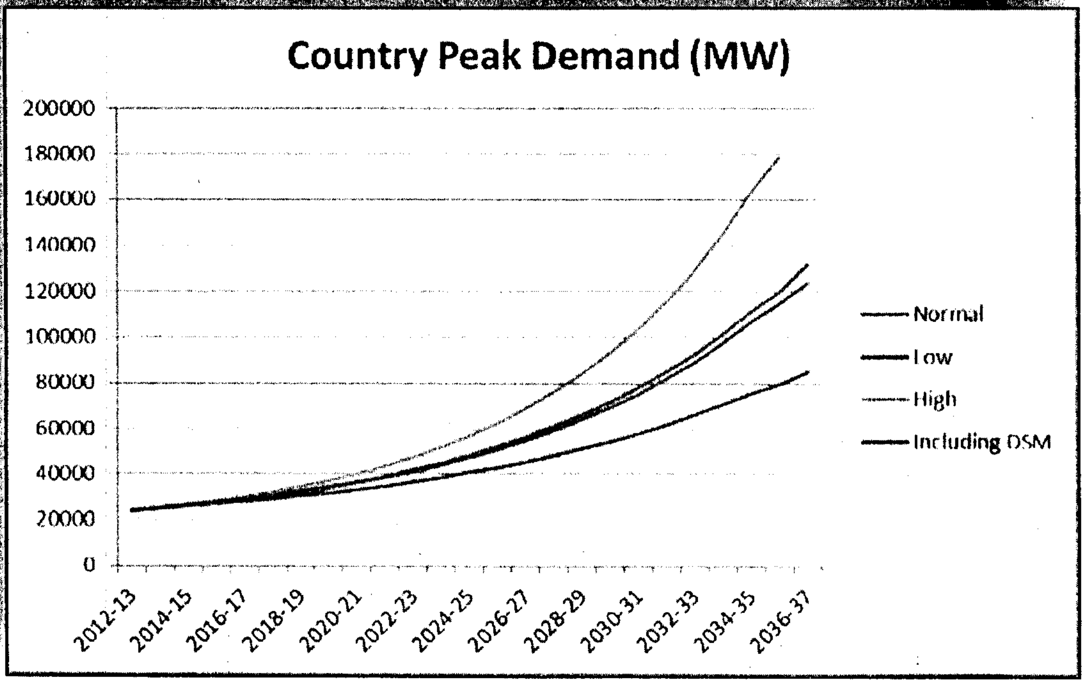


Figure 5: Peak Demand Forecast[10]

As per NPSEP, even with low growth scenario, peak demands in years 2019-20 and 2029-30 are estimated as 42,612 MW and 82,457 MW respectively – see Figure 7.

3.2.2 Future Supply

The choice of generation options for future load supply has to take into account system size, variation in daily and seasonal peak loads, system reliability requirements, operational and maintenance constraints, fuel availability, synergy with the existing system, and requisite generation mix. In addition to the power system factors that are important for the selection of generation units, the technical and economic characteristics of the generating units have to be taken into consideration. These include operational and maintenance requirements, fuel efficiency, emission levels, construction schedule, and investment and O&M costs. Various power generation options for Pakistan are briefly discussed hereunder.

[10]Source: NTDC Electricity Demand Forecast Based on Regression Analysis – 2014, http://www.ntdc.com.pk/planning.php, 15 August 2017.

3.2.2.1 Gas and Oil Fired Thermal Power Generation

Pakistan is facing shortage of locally extracted gas supply to support domestic, industry and power generation sector demand. The high price of oil imported from international market makes it an expensive feedstock for power generation. In this scenario, Pakistan is importing natural gas through transnational pipeline(s) and liquefied natural gas (LNG) to cater to immediate energy shortages. The cost of electricity generation on imported LNG is much lower compared to oil based on current oil and landed LNG prices.

3.2.2.2 Hydropower Generation

Compared to the known hydrocarbon resources, excluding coal, Pakistan has a huge potential of hydropower. Hydropower generation potential in Pakistan is estimated as 60,000 MW, which could be economically harnessed. Out of this vast hydropower potential, only 11% has been developed so far.[11]

Hydropower is one of the best available options of meeting challenges of projected future energy demands of the country as it is sustainable, reliable, renewable, clean, low cost and indigenous thus can be the principal source of energy.

However, hydropower is associated with big dams and superstructures. Most of Pakistan's population lives off agriculture and the rivers cross over from one province into another, thus complicating the issues related to water rights and its usage. Mangla and Tarbela, two existing dams, are multipurpose dams whose primary aim is to store excess summer flows for winter crops, leaving little potential for power generation during low-water-use months in winter, which complicates the supply situation during those months. Ghazi Barotha is a run-of-the-river Hydro project downstream of Tarbela Dam and as such is dependent on water releases from Tarbela. Winter months hit the economy with two blows: natural gas, because of a surge in domestic demand for heating, is less available for power generation, and low water releases drive down hydropower generation drastically. It is therefore imperative that besides hydropower, reliable and cheap base-load power generation should be added into system to cater to load requirements during winter.

3.2.2.3 Coal Fired Power Generation

Pakistan is a coal-rich country, however, coal has not been developed for power generation due to lack of infrastructure (reliable transportation lines), insufficient financing and absence of modern coal mining technical expertise. It is estimated that Pakistan has coal resources of more than 185.5 billion tonnes.

Unavailability of reliable coal is the main obstacle to significant progress in coal power generation. The coal sector currently is not in a position to supply large quantities of coal due to existing mining and transportation capabilities to coal-based power plants. Sizeable amounts of capital investment are needed before coal-mining operations can become credible partners to coal-fired plants. In fact, the Pakistan coal sector currently has virtually no mechanized mining.

---

[11] Hydropower Resources of Pakistan published in 2011 by PPIB.

The development of the mining and associated generation based on the lignite coalfields at Thar has been evaluated and has been under consideration. There have been water availability and other infrastructure related issues for which solutions are being investigated. While these issues are being evaluated and a political consensus and method of operation are developed among the various arms of the governmental structure in Pakistan, the need for power continues to become more severe. The other option would be heavier fuel oil fired plants, which will introduce the scale and technology of modern coal plants and will provide a basis for the next wave of coal-based plants.

3.2.2.4 Future Power Generation Mix

In Table 10, as per data provided by WAPDA Hydro, GENCOs, AJKHEB, PPIB, AEDB, PPDB, PAEC information, least generation cost plan for Pakistan is shown. As can be seen from the Plan, contribution of costlier oil fired power generation has been proposed to be gradually reduced and share of coal fired power generation is required to be increased from 0.1% to 34% by year 2020-21.

Table 8: Least Cost Power Generation Plan

	2010-11		2020-21		2029-30	
	(MW)	(%)	(MW)	(%)	(MW)	(%)
Hydro	6,555	31%	17,590	30%	41,546	37%
Thermal- gas	6,571	31%	11,242	19%	12,015	11%
Thermal-oil	7,838	37%	7,056	12%	6,855	6%
Thermal-coal	30	0.1%	15,691	27%	37,774	34%
Bagasse and Bio-Waste Plants	0	0%	100	0.2%	100	0.1%
Nuclear	461	2%	3,187	5%	6,947	6%
Wind	0	0%	1,800	3%	5,400	5%
Imports	0	0%	2,000	3%	2,000	2%
Total	21,455	100%	58,866	100%	112,639	100%

3.3 Transmission Network

The National Transmission & Despatch Company (NTDC) is the entity responsible for carrying out the design, construction, maintenance, and operation of the grid system, consisting of transmission lines and grid stations throughout the country, except for K-Electric area. NTDC transmission network links generating stations and load centres of the entire country creating one of the world's largest contiguous grid systems. The national grid, connecting hydro generation in the north and thermal generation in mid-country and the south, consists of a large network of transmission lines and grid stations to transmit power to load centres throughout the country. Details regarding transmission lines and grid stations being operated by NTDC are provided in following tables:

Table 9: Transmission lines with NTDC[12]

A: Transmission Lines						
As on 30th June	500 kV		220 kV		Total Transmission Lines and No. of Circuits	
	No. of Circuits	Total km	No. of Circuits	Total km	No. of Circuits	Total km
2012	30	5,078	121	7,948	151	13,026
2013	30	5,144	124	8,358	154	13,502
2014	30	5,183	124	9,104	154	14,287
2015	30	5,197	124	9,814	154	15,011
2016	33	5,197	129	9,814	162	15,011

Table 10: Grid Stations with NTDC[13]

B: Grid Stations						
As on 30th June	500/220 kV		220/132 kV		Total No. of Grid Stations and MVA Capacity	
	No. of Grid Station	MVA Capacity	No. of Grid Station	MVA Capacity	Total No. of Grid Station	Total MVA Capacity
2012	12	14,850	29	18,044	41	32,894
2013	12	15,750	29	18,231	41	33,981
2014	13	17,400	35	21,030	48	38,430
2015	13	18,624	37	24,063	50	42,687
2016	14	18,624	37	24,063	51	42,687

3.4 Key Players in Pakistan

3.4.1 Central Power Purchasing Agency (CPPA-G)[14]

CPPA-G is a Company incorporated under the Companies Ordinance, 1984 and wholly owned by the Government of Pakistan (the **"GOP"**). Since June 2015, the petitioner has assumed the business of National Transmission and Dispatch Company (the **"NTDC"**) pertaining to the market operations and presently functioning as the Market Operator in accordance with Rule-5 of the NEPRA Market Operator (Registration, Standards and Procedure) Rules, 2015 (the **"Market Rules"**).

3.4.2 National Transmission & Despatch Company Limited

[12]Source: State of Industry Report 2016 by NEPRA.
[13]Source: State of Industry Report 2016 by NEPRA.
[14] http://www.cppa.gov.pk/Home/CompanyProfile

The National Transmission & Despatch Company (NTDC) Limited was incorporated in 1998. It was organized to take over all the properties, rights, and assets obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). NTDC operates and maintains 500 KV and 220 KV grid stations and transmission lines in Pakistan.

3.4.3 Private Power and Infrastructure Board

The Private Power and Infrastructure Board (PPIB) was created in 1994 as "One Window Facilitator" to promote private sector participation in the power sector of Pakistan. PPIB facilitates investors in establishing private power projects and related infrastructure, executes Implementation Agreement (IA) with project sponsors, and issues sovereign guarantees on behalf of GOP.

3.4.4 National Electric Power Regulatory Authority

The National Electric Power Regulatory Authority (NEPRA) was established in 1997 for regulation of electric power generation, transmission, and distribution in Pakistan. NEPRA protects the interests of consumers and of companies providing electric power services. NEPRA is responsible for determining electricity tariffs, granting licenses to power companies, proscribing procedures, and standards for power sector etc.

3.5 An Overview of Energy Scenario in Punjab[15]

3.5.1 Major Facts

- Punjab contains 60% of all industry with more than 48,000 units;
- Electricity Consumption in Punjab is 68% of the total national consumption;
- The annual demand growth is 6-8%. We are facing power shortfall ranging from 3000 to 5000 MW;
- There is an identified Hydropower potential of only 600 MW on canal falls/rivers;
- 5-7 hours of power load shedding during peak demand is a norm in urban and rural areas;
- DISCOs located in Punjab not only have low distribution losses but their revenue collection efficiency is better than the DISCOs located in other provinces. Thus the province of Punjab ends up subsidising the losses of other provinces both financially and in terms of load-shedding;
- Despite being the largest consumer of power and gas, Punjab having no local gas reserves of its own has no control over quantum, duration and usage of either gas or power;
- Energy Department has facilitated and initiated more than 55 power generation projects in public and private sector with combined capacity of more than 13000 MW including three RLNG CCPP projects i.e. Balloki Power Project, Bhikki Power Project and Haveli Bahadur Shah Power

[15] Based on http://energy.punjab.gov.pk/punjab_energy_scenario.html, (10:00am) 12 April 2015.

Project (approx. 3600 MW gross) which will substantially improve stability of power generation in Punjab province.

Table 11: Electricity Peak Demand and Consumption (Punjab) – 9 Aug 2017[16]

DISCO	DEMAND (MW)	SUPPLY (MW)	SHORTFALL (MW)
LESCO	5270	3635.83	1634
FESCO	3082	1913.72	1168
IESCO	2565	1506.36	1059
GEPCO	2276	1770.72	506
MEPCO	3769	2302.65	1466
Total	16962	11129	5833

[16]Source: http://www.cppa.gov.pk/, 15 August 2017.

Table 12: Gas Demand and Supply – status 2016

ENTITY	DEMAND – MILLION CFT PER DAY	SUPPLY – MILLION CFT PER DAY	ENTITY
National	5850	4131	1719
SNGPL	2670	1463	1207

3.5.2 System Efficiencies

The system efficiencies are presented in below table:

Table 13: System Efficiencies

ENTITY	DISTRIBUTION LOSES	REVENUE RECOVERY RATIO
IESCO (Punjab)	9.10%	91.00%
LESCO (Punjab)	13.94%	99.2%
GEPCO (Punjab)	10.58%	99.41%
FESCO (Punjab)	10.24%	100.6%
MEPCO (Punjab)	16.41%	99.99%
PESCO (KP)	33.77%	88.49%
HESCO (Sindh)	24.24%	72.09%
QESCO (Baluchistan)	23.80%	71.63%
KE (Karachi)	25.66%	87.63%

- The above table indicates that DISCOs located in Punjab not only have low distribution losses but their revenue recovery ratio is also much better than the DISCOs located in other provinces. Thus the province of Punjab ends up subsidising the losses of other provinces both financially and in terms of load-shedding;

3.6 Opportunities in Punjab

Punjab with population of 93 million is the largest province of Pakistan and contributes 60 % of the GDP. It has a large industrial base with more than 48,000 units. There is a growing unmet demand of energy which offers an opportunity for investments in power generation projects based on various indigenous sources. Steps for investing in the Power Sector through Punjab Power Development Board (PPDB):

Hydro

- There is an identified Hydropower potential of 600 MW on canal falls/rivers;
- The installed electricity generation capacity is approximately 21000 MW, presently out of which 6599 MW comes from hydropower. The identified hydropower potential in the country is approximately 41,722 MW;
- 9 small hydro power projects, whose feasibility studies are completed and are available. These projects are established at following sites: Pakpattan Canal-RD-112, LDBC-RD-196, UCC-RD-283, UCC-RD-128, UCC-RD-000, Gujrat Branch-RD-2.5.

Coal

- Coal resources of Punjab are mainly found in the Salt Range of Punjab. A study by M/s Snowden Australia has indicated 595 million tons' coal reserves in Punjab. These reserves are mainly located in four districts, namely Jhelum, Chakwal, Khushab and Mianwali, and have the potential to generate 3700 MW for 30 years;
- A coal purchase agreement has been signed for a minimum of 2400 tons/day of coal supply from Baluchistan (Chamalang) for a 300 MW plant in District Muzaffargarh in JV mode;
- Energy Department is seeking private sector investment in proposed 300 MW power plant at District Rahimyar Khan based on imported coal;
- 16 Industrial Estates under Punjab Small Industries Corporation have been targeted for establishment of dedicated power plants (10-50 MW) using mix of coal, biomass and solid waste. These will be dedicated projects with energy buy back guarantee.

Biomass, Biogas and Waste to Energy

- Huge potential of biomass based power generation exists on unutilized crop residue of around 43.204 million tons per annum consisting of rice husk, rice straw, and cotton stalk, wheat straw, corn stalk;
- With 32 million livestock population in Punjab, 24 million m3 biogas can be produced, Punjab has approximately 11 million tons of biomass available for power generation; Lahore has daily waste collection about 5000 tons. Waste disposal sites in Lahore are located at Mehmood Booti, Saggian and Baagrian; 32 MW Thermal Power Plant on Municipal solid waste near Faisalabad City

with completed feasibility study and identified land is ready for interested investors in JV/PPP mode.

Solar and Wind

- Huge potential for generation of power through solar energy especially in Southern Punjab;
- 5000 Acres of land in Cholistan has been reserved by the Government of Punjab for the establishment of solar power plants;
- 50 MW CSP Solar project in District Muzzafargarh is planned in public sector/JV mode;
- Wind corridor in Kalarkahar area, around 10-20 KM wide and 250 Km long, promises considerable potential for wind power projects.

3.6.1 Policy and Institutional Framework

Punjab Power Generation Policy - Government of Punjab has developed and an enabling power policy to facilitate investment in this vital sector. Punjab Power Policy 2015 provides a framework for the development of power plants in both public and private sector as well for joint venture projects. The policy is intended to promote all types of technologies including Hydro, coal, solar, wind and biomass. Hydro projects in the private sector would be implemented on Build-Own-Operate-Transfer (BOOT) basis while other projects in the private sector can be established on either BOOT basis or on Build-Own-Operate (BOO) basis.

4 BASIC PROJECT PARAMETERS AND CONDITIONS

4.1 Reference site conditions

The owner of the project is Government of Punjab (Pakistan). The Government of Punjab is executing project via newly established company (PUNJAB THERMAL POWER (PVT.) LIMITED) and it is planning to install 1,100 – 1,400 MW (Net) CCPP at Jhang site based on EPC turnkey contract.

Table 14: Reference Site Conditions

NO.	DATA	DATA	DESCRIPTION
1.	Ambient temperature	26°C	From 0°C to 50°C
2.	Rel. Humidity	70%	From >5%@0°C to 100%@50°C
3.	Barometric pressure	0.9954 bar	acc. to 150 maSL
4.	Water temperature for once through cooling	25°C	-
5.	Grid PF	0.85	From 0.8 lag to 0.9 lead

4.2 Site selection

The site is located about 23 km from Jhang and is adjacent to TS (Trimmu-Sidhnai) Link Canal. Railway line is approximately 5.5 km from the site. Nearest main road is Jhang-Multan road (N5) which passes 80 km from the site. It is approximately 500-700 meters from existing Haveli BS site.

National Transmission and Dispatch Company (the **NTDC**) and the planning division of Water & Power Development Authority (**WAPDA**) after due consideration of load flow, availability of grid station, transmission lines and in view of the requirements and electricity demand of the area, has recommended the site located at District Jhang, Punjab for the Project. The site location is favourable in term of accessibility and water availability. Power evacuation and spur gas pipeline's connectivity.

From a power evacuation standpoint, the site posits an advantage because CPPA/NTDC will not have to add significant transmission infrastructure to the area. As per the current power evacuation plan the project will feed net generation of to the nearest Toba Tek Singh (TTS) 220 KV grid station which is 35km from the site and the proposed dispersal is 220KV twin-bundle in the existing lines. For this project the salient features of the site are given below:

Table 15: Site selection data

NO.	DATA	DESCRIPTION
1.	Address of the site with coordinates	Jhang
2.	Name of nearest Canal + Canal's Discharge	Trimmu-Sidhnai Link Canal

NO.	DATA	DESCRIPTION
3.	Type of Canal	Perennial, maintenance outage 1-2 months annually (January - February)
4.	Distance of site from nearest city	23 km from Jhang

Figure 6: Jhang site – June 2017

4.3 Availability of space

Punjab Thermal Power (Pvt) Limited has procured a land of approx.. 1300 canal The latest estimated footprint of future power block is 675x 400 m for permanent facilities. In addition, sufficient space (approx. 200 x 400 m) for construction laydown, deposition area of removed top soil and access road will be made available.

4.4 Boundary conditions

4.4.1 Road access

The Contractor shall ensure safe and undamaged transport of all Plant equipment from Port Qasim's unloading berth up to the site.

Punjab Power Plant site falls in District Jhang near Trimmu Barrage along T.S. Link Canal currently approachable by canal track. However, permanent main access from Jhang-Haveli BS road is considered more appropriate.

4.4.2 Evacuation of Power

National Transmission & Despatch Company (NTDC) will be responsible for power evacuation.

The interconnection scheme proposed by NTDC is given below:

- Interconnection scheme for Power dispersal of Jhang RLNG Power plant (2 Gas Turbine and 1 Steam Turbine)

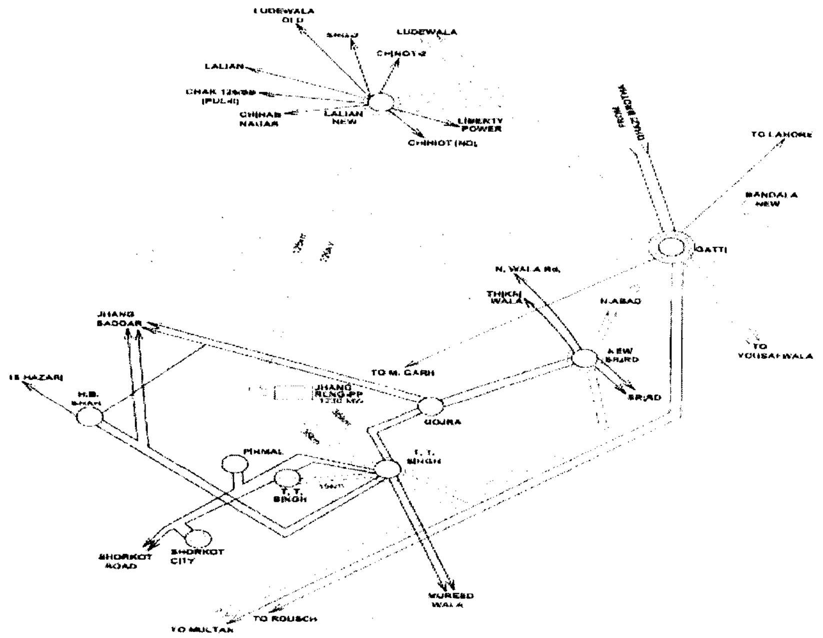


Figure 7: Evacuation of power from Haveli BS site – diagram/map

Step-up transformers 450 – 650 MVA size is required. AIS in 1 ½ breaker type included in EPC scope. Furthermore, generated power will be transmitted by interconnection system presented on Figure 10.

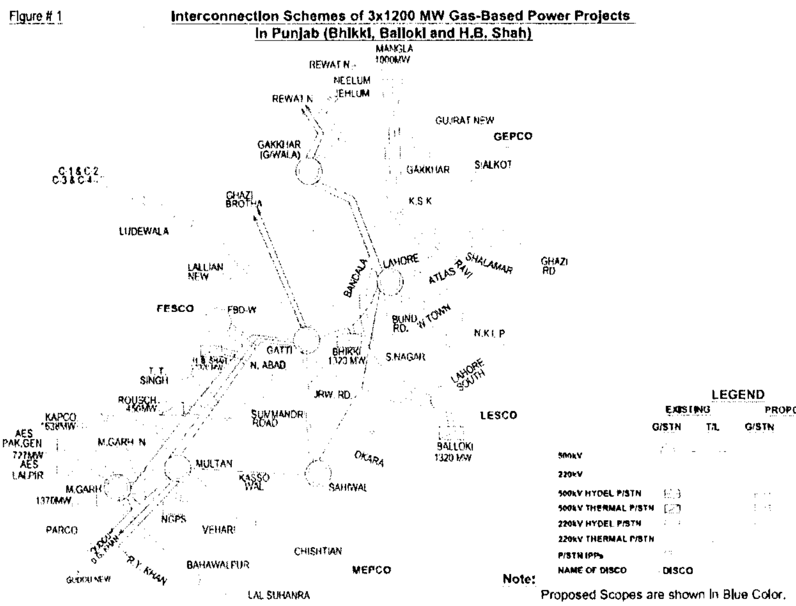


Figure 8: Interconnection system of transmission lines in Pakistan

Based on the system studies undertaken by NTDC (July 2017), it is concluded that the proposed interconnection scheme for the project is reliable for power dispersal to the National Grid under normal and single line contingency conditions.

4.4.3 Gas pipe lines in Punjab region

Natural gas, as the name implies, is found in gaseous form naturally, underground at varying depths and geographical formations. Comprised primarily of methane, natural gas is odourless and colourless when it comes out of the ground. After impurities are removed, the natural gas is introduced into the pipeline system where it is transported to the consumers.

The location of the Project falls in the operating region of Sui Northern Gas Pipelines Limited (SNGPL) that supplies the natural gas supply to domestic and industrial consumers. SNGPL receives natural gas in bulk quantity from various gas fields and injects in to its pipeline network. SNGPL transmission system extends from Sui in Baluchistan to Peshawar in Khyber Pakhtoon Khwa (KPK). Gas quantities to various consumers are allocated generally by Ministry of Petroleum and Natural Resources. Existing gas pipeline system of SNGPL is presented in Figure 16.

Re-Gasified Liquefied Natural Gas (RLNG) for the Project will be supplied by SNGPL. As per SNGPL, they are undertaking two Projects (i.e. Project 1 and Project 2) to receive 1.2 BCFD R-LNG gas. Under Project-1, 400 MMSCFD gas is transported downstream Sawan (Starting Point of SNGPL) by laying a 42" diameter, 110.6 KM pipeline from Sawan to Qadirpur. Under Project 2, up to 800 BCFD R-LNG supply shall be transported downstream Sawan for which around 760 KM pipeline infrastructure of 42"-16" diameter shall be laid.

As informed by SNGPL, offtake point for supply of gas to the Project from SNGPL system will be near Shorkot. A 24" diameter, 92km long pipe will be laid by SNGPL from Kabirwala to the Power Plant Site. The gas regulating and metering station (GRMS) will be installed by SNGPL inside the Site boundaries.

As informed by SNGPL, the initial gas pressure is 550-600 psig and gas booster compressor should be kept as an option in the Employer Requirement for EPC Contractor to cater any contingency/emergency due to pressure drop in future.. If any EPC Contractor do not opt for the option of gas boosting compressor, the design downstream of the SNGPL interconnection point shall be such to compensate sudden drop in the pressure and the same shall be demonstrated by the EPC Contractor.

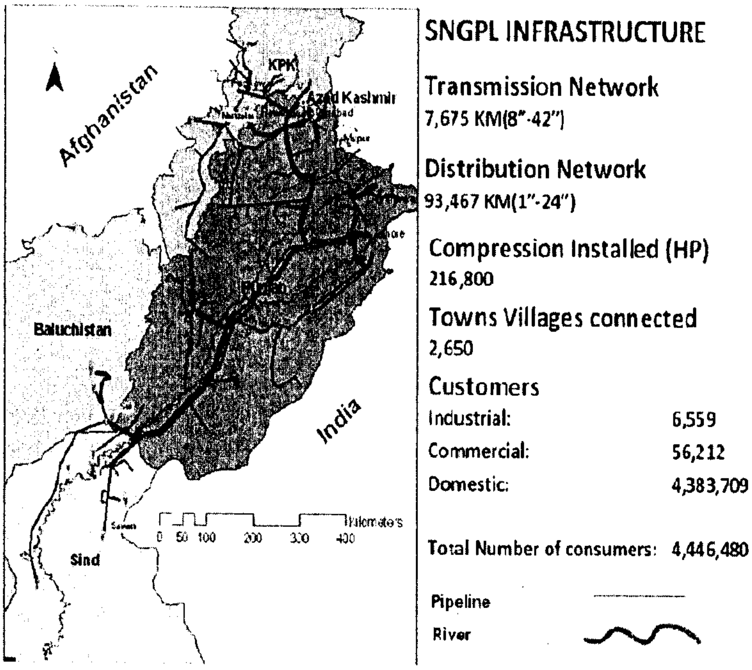


Figure 9: Gas pipelines system in Punjab region[17]

4.4.4 Raw Water Intake / Outfall

Canal water for cooling and other purposes of the CCPP shall be extracted from the existing canal. The cooling water system blow down water, collected storm water, and all other treated plant effluents shall be discharged through an outfall pipeline into the canal. Interface point will be at the outlet of the outfall pipeline to the existing sewerage canal system.

Sanitary sewage of the buildings of the CCPP site will be treated in a dedicated biological sewage treatment plant and the treated effluent will be discharged into the canal. Interface point will be at the outlet of the outfall pipeline to the canal.

[17] Based on data Sui Northern Gas Pipeline Limited – Pakistan.

Figure 10: Canal – along the Haveli BS site and new project site

The average water temperature is estimated to be 25°C. The average flow in canal is presented in Table 18. The existing power plant, Haveli Bahadur Shah, is approximately 500m upsteam of the proposed project site; it is expected that due to the increased temperature of the water being discharged through the outfall, the water intake temperature for the proposed project may be higher. Studies would need to be performed during the time when Haveli Bahadur Shah is in operation in Combined Cycle mode and the same shall have to be taken into account for the proposed project.

Table 16: Canal Flows

MONTH	TS Link (m3/s)	
	Max	Min
Jan-12	131	0
Feb-12	142	0
Mar-12	127	39
Apr-12	170	0
May-12	227	170
Jun-12	311	212
Jul-12	326	278

MONTH	TS Link (m3/s)	
Aug-12	326	142
Sep-12	297	42
Oct-12	326	140
Nov-12	185	54
Dec-12	207	39

4.4.5 Canal Water Analyses

The indicative results of water analysis are mentioned below – see Table 19.

Table 17: Canal Water Composition

No	Parameter	Units	Sample # 1	Sample # 2
1.	pH	--	7.65	7.66
2.	Temperature	OC	22	22
3.	Biochemical Oxygen Demand (BOD5)	mg/L	53	57
4.	Chemical Oxygen Demand (COD)	mg/L	103	108
5.	Total Suspended Solids (TSS)	mg/L	13	16
6.	Total dissolved Solids (TDS)	mg/L	157	904
7.	Grease &Oil	mg/L	<5	<5
8.	Phenolic Compounds as Phenols	mg/L	<0.1	<0.1
9.	Chloride	mg/L	13.49	13.49
10.	Fluoride	mg/L	<1.0	<1.0
11.	Cyanide	mg/L	<0.05	<0.05
12.	An-Ionic Detergents	mg/L	<1.0	<1.0
13.	Sulphate as SO_4^{2-}		24.28	31.48
14.	Sulphide	mg/L	<1.0	<1.0
15.	Ammonia	mg/L	<5.0	<5.0
16.	Pesticides	mg/L	N.D	0.04
17.	Cadmium	mg/L	<0.003	<0.003
18.	Chromium trivalent and hexavalent	mg/L	<0.005	<0.005

No	Parameter	Units	Sample # 1	Sample # 2
19.	Copper	mg/L	<0.005	<0.005
20.	Lead	mg/L	<0.005	<0.005
21.	Mercury	mg/L	<0.001	<0.001
22.	Selenium	mg/L	<0.005	<0.005
23.	Nickel	mg/L	<0.005	<0.005
24.	Silver	mg/L	<0.005	<0.005
25.	Total toxic metals	mg/L	N.D	0.5
26.	Zinc	mg/L	<0.005	<0.005
27.	Arsenic	mg/L	<0.005	<0.005
28.	Barium	mg/L	<0.005	<0.005
29.	Iron	mg/L	1.4	1.8
30.	Manganese	mg/L	0.021	0.025
31.	Boron	mg/L	<0.005	<0.005
32.	Chlorine	mg/L	<1.0	<1.0
33.	Nitrogen as nutrients	mg/L	N.D	N.D
34.	Phosphorus as nutrients	mg/L	N.D	N.D
35.	Potassium as nutrients	mg/L	N.D	N.D
36.	Turbidity	NTU	29	9.0
37.	Dissolved oxygen	mg/L	9.3	19

4.5 Climate

The climate of the study area is arid. Jhang is the nearest climate station which is operated and maintained by Pakistan Meteorological Department (PMD)[18].

Climate station of Jhang provides a fair representative estimate for the climate parameters of the Study Area. Prominent climate parameters for years 2004-2016 of Jhang are described below.

[18]Climate station of Jhang provides a fair representative estimate for the climate parameters of the mentioned area.

4.5.1 Temperature

The daily maximum temperature rises up to 47°C in June, and the mean daily minimum temperature is 4.4°C in January.

Mean monthly temperature in June rises to a highest value of 33.9°C and falls to the lowest value of 12.9°C in January. June and July are the hottest months in summer sun. December and January are the coldest months in winter sun.

Table 18: Monthly Mean of Daily Temperatures (2004-2016)[19]

MONTH	MEAN DAILY MAX. TEMPERATURE (°C)	MEAN DAILY MIN. TEMPERATURE (°C)	MEAN DAILY TEMPERATURE (°C)
January	18.7	6.1	12.4
February	25.4	7.2	16.3
March	27.4	14.1	20.7
April	35.1	18.3	26.7
May	41.2	23.7	32.4
June	41.4	26.8	34.1
July	38.3	26.4	32.3
August	37.2	26.5	31.1
September	37.7	25.6	31.6
October	35.7	19.5	27.6
November	29.3	11.6	20.4
December	25.0	8.2	16.6

4.5.2 Rainfall

The average annual rainfall of the area is about 650 mm (25.6 inches). The maximum rainfall occurs during the months of July, August and September, which is about 65% of the annual rainfall. The variation of monthly rainfall over the year for Jhang is given in Table 21.

Table 19: Mean Monthly Rainfall (mm)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	13.5	8.0	0.0	43.0	10.0	100.9	42.5	170.1	49.6	-1.0	10.0	4.6

[19]Source: Pakistan Meteorological Department.

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	62.2	50.4	44.8	3.5	9.9	8.4	105.8	70.8	66.5	11.5	0.0	0.0
2006	2.2	9.8	22.4	0.0	3.4	49.3	3.5	62.1	1.5	7.0	10.9	28.9
2007	-1.0	43.4	44.2	2.8	8.2	154.5	112.8	4.0	42.6	0.0	0.0	11.2
2008	16.8	16.3	3.7	91.4	71.4	18.4	73.4	132.7	14.0	0.0	0.0	42.1
2009	16.4	8.6	15.1	46.6	0.0	36.6	77.4	81.6	36.2	24.4	0.0	0.0
2010	19.0	4.3	9.1	9.0	5.7	69.0	157.0	121.7	31.2	0.0	0.0	2.2
2011	0.0	8.9	8.8	14.9	4.1	36.0	99.6	12.2	75.8	-1.0	0.0	0.0
2012	0.0	10.9	4.0	9.6	7.0	14.0	131.1	4.3	111.0	50.0	0.0	16.4
2013	0.0	63.1	30.6	13.0	3.4	93.8	67.0	55.7	0.0	-1.0	0.0	1.0
2014	0.0	16.5	34.3	29.3	33.4	64.0	97.7	18.6	14.4	11.0	10.6	0.0
2015	14.2	12.0	85.5	31.0	4.4	37.2	123.6	90.6	41.8	18.4	-1.0	0.0
2016	9.8	16.6	147.2	11.2	13.8	64.0	164.1	145.0	4.2	-1.0	0.0	0.0

4.5.3 Relative Humidity

Variation in monthly relative humidity over a year is given in Table 22 and Table 23.

Table 20: Relative Humidity (%) at 08:00 am

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	95	88	78	56	52	62	66	76	73	72	84	90
2005	92	91	85	56	51	49	74	74	81	77	88	89
2006	89	92	86	56	52	57	73	83	77	83	92	93
2007	89	92	88	63	50	68	76	79	82	82	91	91
2008	86	84	79	71	58	69	72	83	80	82	87	92
2009	93	87	84	69	54	54	76	77	82	82	88	88
2010	95	84	83	58	49	57	80	86	84	80	86	89
2011	90	88	82	66	50	65	80	84	89	82	88	89
2012	91	82	78	71	46	53	69	75	82	79	89	90
2013	89	90	85	67	48	61	72	80	73	78	87	93

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	92	88	84	70	55	53	72	71	78	77	86	93
2015	94	91	90	70	52	59	78	81	76	81	87	89
2016	92	87	88	67	55	59	79	81	75	79	88	91

Table 21: Relative Humidity (%) at 05:00 pm

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	69	55	37	33	30	44	48	59	50	45	60	62
2005	66	61	55	28	30	30	58	64	53	42	51	51
2006	51	50	49	28	31	33	51	61	49	50	64	63
2007	45	59	51	29	29	45	56	54	55	40	61	51
2008	50	39	35	35	33	46	52	60	49	47	46	61
2009	55	49	44	30	30	28	50	54	49	42	50	45
2010	70	47	41	24	21	31	57	68	51	44	44	48
2011	48	53	38	32	24	42	60	63	65	44	49	46
2012	48	39	36	36	23	32	48	52	60	46	52	57
2013	51	60	44	33	31	37	53	58	47	47	48	53
2014	48	49	47	34	31	34	50	48	53	45	47	59
2015	66	57	58	38	27	38	55	61	47	48	53	49
2016	65	43	57	35	30	35	55	60	48	46	55	58

4.5.4 Wind Speed& Direction

Wind Speed at 05:00 pm and at 08:00 am (Knots). The mean wind speed shows the variation of a lowest value of 0.4 Knots in December to 2.0 Knots in June. During summers, wind speeds are generally higher than wind speeds in winters. Data is given in Table 24, 25 and Table 26.

Table 22: Wind Speed at 05:00 pm (Knots)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	0.8	1.3	1.5	2.0	1.9	2.5	2.4	1.5	2.1	1.3	0.5	0.6
2005	1.3	1.4	1.4	1.7	1.4	3.5	1.9	1.8	1.7	0.7	0.3	1.2
2006	0.9	2.3	2.6	1.9	2.6	2.7	3.2	2.1	1.5	1.1	0.4	0.2

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007	0.3	1.6	1.3	1.0	1.5	2.3	1.7	2.5	1.5	0.6	0.3	0.3
2008	0.6	1.6	1.3	1.3	2.3	2.5	3.4	1.8	2.1	1.0	0.1	0.1
2009	0.9	1.7	2.1	0.0	1.9	2.6	2.6	2.1	1.1	0.0	0.0	0.0
2010	0.8	1.7	1.3	1.3	1.5	2.7	1.1	1.9	0.5	0.6	0.1	0.0
2011	0.5	2.1	1.2	1.5	1.7	2.0	1.4	1.2	1.3	1.0	0.1	0.2
2012	0.5	1.1	1.2	2.1	1.0	2.1	2.1	1.9	1.0	0.8	0.1	0.3
2013	0.3	0.8	1.0	0.9	1.1	1.5	1.7	1.6	1.1	0.0	0.1	0.0
2014	0.4	1.1	1.1	0.7	0.8	1.2	1.4	1.5	1.1	0.3	0.6	0.1
2015	0.3	0.8	0.6	0.8	0.7	1.3	1.5	0.5	0.1	0.2	0.1	0.1
2016	0.3	0.1	0.1	0.1	1.2	1.0	1.5	1.7	1.6	0.5	0.2	0.8

Table 23: Wind Speed at 08:00 am (Knots)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	0.6	0.5	0.6	1.9	2.1	2.2	2.3	1.5	1.7	1.4	0.4	0.3
2005	0.3	1.0	0.8	1.1	1.1	1.5	1.5	1.2	1.1	0.6	0.4	0.2
2006	0.1	0.3	1.5	1.3	2.1	2.0	2.8	1.0	0.9	0.3	0.3	0.1
2007	0.0	0.4	0.6	0.8	1.7	1.7	1.7	2.3	1.0	0.3	0.1	0.0
2008	0.2	0.1	0.2	0.4	1.7	2.9	2.2	1.4	1.2	0.3	0.1	0.1
2009	0.0	0.1	0.5	0.0	0.8	1.2	1.9	2.3	0.8	0.4	0.0	0.0
2010	0.3	0.6	0.3	0.3	0.9	1.1	1.0	1.0	1.0	0.5	0.0	0.0
2011	0.1	0.2	0.5	0.5	1.3	1.7	1.3	0.9	0.5	0.3	0.1	0.0
2012	0.0	0.4	0.6	0.7	1.5	1.2	1.3	1.7	0.5	0.3	0.0	0.2
2013	0.3	0.3	0.3	0.5	0.8	1.3	1.5	0.9	0.6	0.4	0.0	0.0
2014	0.1	0.2	0.5	0.8	0.6	1.6	1.9	1.0	0.7	0.1	0.0	0.0
2015	0.3	0.4	0.2	1.3	0.5	0.6	0.8	0.3	0.5	0.0	0.0	0.1
2016	0.1	0.0	0.1	0.7	0.9	1.0	2.1	0.8	1.4	0.3	0.1	0.1

Table 24: Wind Direction at 05:00 pm (Knots)

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2004	N	N18E	N56E	N67E	S77E	S16E	S06E	S65E	S34 W	S32E	N32E	E
2005	C	N05 W	N22E	N67E	N36E	S38E	S89E	S12 W	N82E	S30E	C	C
2006	C	C	S79E	N25E	S34E	S38E	S35E	S45E	S45E	S45E	C	N22E
2007	C	S10 W	N45 W	E	S77E	S17E	S45E	S43E	E45S	C	C	N45 W
2008	N	C	N45 W	C	S43E	S39E	S41E	S45E	S53E	S45E	N45 W	N45E
2009	N45 W	S45E	N45E	N72 W	S76E	S	S43E	S32E	S45E	C	S45 W	C
2010	N23E	S63E	N45E	S45 W	S63E	S36E	S29E	S45E	S77E	S45E	S45E	C
2011	C	S45E	S79E	S31E	S38E	S40E	S45E	S45E	S45 W	S45 W	C	C
2012	C	N45 W	C	S31E	S	S11 W	S37E	S35E	S45E	S45E	C	N45 W
2013	C	S	S45E	S45E	S34E	S39E	S37E	S27E	S45E	S45E	C	S45E
2014	C	S45E	S45E	S45E	N45 W	S14E	S45E	S23E	S31E	S45E	C	S45E
2015	S45E	S45E	C	S45E	S45E	S31E	S31E	S31E	C	S45E	C	C
2016	E	N45 W	C	N45 W	S62E	S40E	S45E	S32E	S45E	S45E	C	N

4.6 Seismic Data

The Punjab Plain, in which the Project site is located, shows low to moderate level of seismicity which is associated with the faulting in the basement rocks covered by the alluvial deposits. The basement high, depicted by outcrops of basement rocks near Sargodha, Chiniot, and Shahkot and extending from Sargodha to Faisalabad and further southeast towards Indian border shows a concentration of earthquakes with magnitude up to 5.5 on the Richter scale.

Probabilistic seismic hazard assessment recently carried out for Project area as part of the re-vision of seismic provisions of the Building Code of Pakistan shows that the Project area falls in seismic Zone 2A. Therefore, the Project structures may be designed to cater for the requirements of Zone 2A of Building Code of Pakistan seismic provisions (2007).

The Contractor shall be responsible to investigate and verify the specific seismic requirements of the Plant site and design his civil structures, supports as well as the Plant equipment accordingly.

4.7 Emission Limits (pollutants, liquids, noise)

National Environmental Quality Standards (NEQS) set limits for ambient air quality, drinking water, noise levels, municipal and liquid industrial effluents, industrial gaseous emissions and motor vehicles exhaust and noise. The NEQS were first promulgated in 1993 and have been amended in 1995 and 2000, 2009 and 2010. In 2009 the NEQS were amended to include standards for Motor Vehicles Exhaust and Noise, while in 2010 the amendments included standards for Ambient Air, Drinking Water and Noise. The following standards are specified therein:

- NEQS for Ambient Air, 2010;
- National Standards for Drinking Water Quality, 2010;
- NEQS for Noise, 2010;
- NEQS for Municipal and Liquid Industrial Effluents, 2000;
- NEQS for Industrial Gaseous Emission, 2000; and
- NEQS for Motor Vehicles Exhaust and Noise, 1993.

4.8 Standards and regulations

The following national policies, laws, regulations and guidelines are applicable for environmental studies:

- National Conservation Strategy, 1992;
- National Environmental Policy, 2005;
- Punjab Environmental Protection Act, 1997 (Amended 2012);
- Pakistan Environmental Protection Agency (PAK-EPA) (Review of IEE and EIA Regulations, 2000);
- Pakistan Environmental Impact Assessment (EIA) Procedures;
- Land Acquisition Act (LAA), 1894;
- Other relevant acts and ordinances;
- Antiquities Act, 1975;
- The Punjab Special Premises (Preservation), Ordinance, 1985;
- Guidelines for Public Consultation; and
- Sector Guidelines for Environmental Reports, Major Thermal Power Plants, October 1997.

4.9 Health and safety aspects

There are various villages adjacent to the Project Area. Noise and vibration during the operation phase are likely to affect the health of local residents and animals. Some of the noise sources from the proposed Power Plant during the operation phase include noise from the operation of the turbines, boilers (steam blowing and purging) as well as combustion.

The Health and Safety Management Framework has been prepared for EPC Contractor to develop a detailed plan to reduce and remove any harm due to plant activities to local management, staff and local residents' health and ensure human safety of the management and staff at the power plant.

4.10 Assessment of long-term availability of gas

Government of Pakistan has finalized the agreement with Government of Qatar for import of LNG. An LNG handling, regasification, storage, treatment and processing terminal has already been constructed by Elengy Terminal Pakistan Limited, a subsidiary of Engro Corporation. Government of Pakistan is also proceeding with construction of further LNG terminals as well importing LNG from other sources.

The Re-Gasified LNG will be transported from Karachi to the Site by Sui Southern Gas Company (SSGC) and Sui Northern Gas Pipeline Limited (SNGPL).

In addition to the aforementioned, Government of Pakistan has set up Pakistan LNG Limited with the mandate to buy, import, store and distribute LNG throughout the country via existing SSGC and SNGPL network. For the same purpose a new LNG terminal is being established at Karachi Port.

5 OPTIMIZATION OF TECHNICAL PLAN CONFIGURATION

The sequence of optimisation process followed listed below aspects and priorities discussed between NESPAK/Lahmeyer and representatives of Owner:

- Time - availability:
  - Delivery 1st GT to site –6.0 months (181 days);
  - Delivery 2nd GT to site –7.0 months (212 days));
  - COD SC 1 – approx. 14.0 months (442 days);
  - COD SC 2 – approx. 15.0 months (456 days);
  - COD CC – approx. 26.0 months (791 days);
- Proven and available technology:
  - GT model – proven technology with min 7000 hrs of commercial operation experience;
  - Confirmed 8 orders for mentioned model by date of submission of EPC proposal;
  - Successful Completion of Rotor Dynamic Balance Test
    - ⇨ Unit 1: 131 days from NTP;
    - ⇨ Unit 2: 162 days from NTP;
- Performance numbers:
  - Min 60% (net) for CC (ISO);
- QA/QC and HASE aspects.

5.1 Timeline & technology aspects

NESPAK/Lahmeyer was informed that required power generation based on RLNG is expected by the owner no later than in second half 2018. Additionally, NESPAK/Lahmeyer was asked for presentation reasonable time of execution tender process and predicted time for response of credible and experience EPCs to tender announcement. Based on assumptions and experiences taken from 3 RLNG CCPP projects in Punjab province (Bhikki, Balloki and Haveli BS site) and high expressed interest of companies currently involved in Pakistanis power generation projects (knowledge of local regulations, potential subcontractors etc.) and depending on technology, the predictable time for preparation of EPC proposals is estimated between 3 weeks - 1.5 month. All further calculations carried out considered the above-mentioned technical and schedule constrains.

5.2 Fuel aspects

The owner informed that new power generation block(s) will fire RLNG contracted in Middle East. The fuel availability for Jhang project site is expected on the level max 200 MMCFD from mid of 2018.

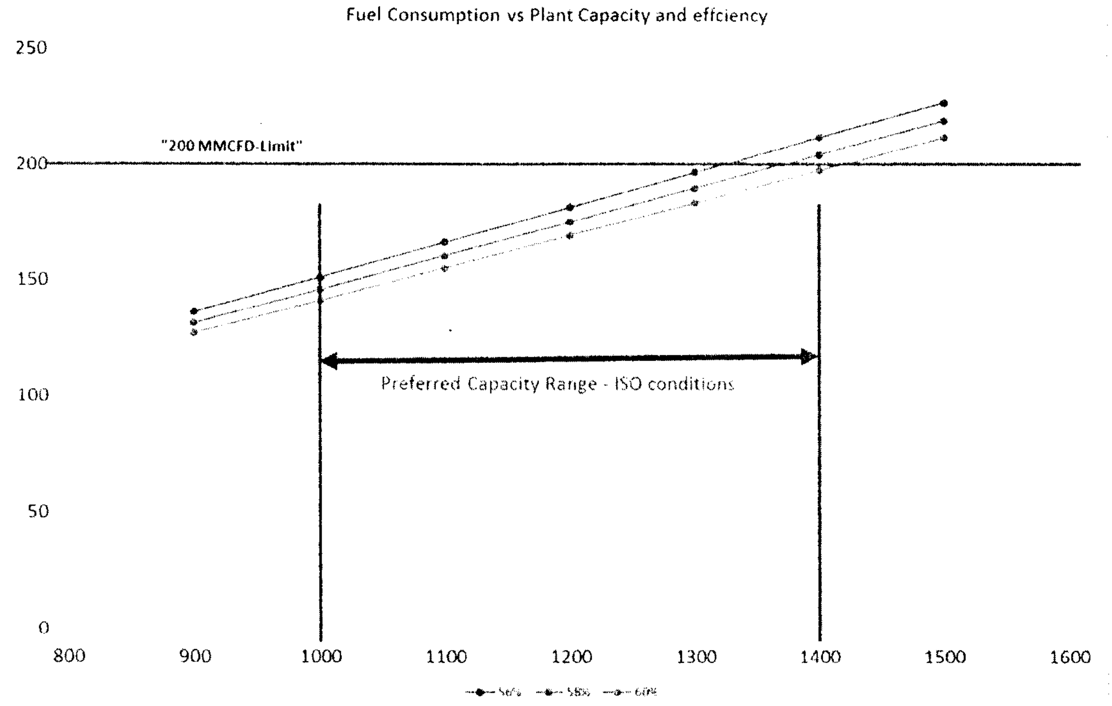


Figure 11: Estimated Fuel Consumption vs. Plant Capacity

The estimated fuel consumption vs. the power plant capacity and efficiency is presented with mentioned limit of available fuel is presented on Figure 13. Taking into account additional calculation results for GE 9HA.01 -series gas turbine block including climate conditions and efficiency vs ambient temperature are presented on Figure 14.

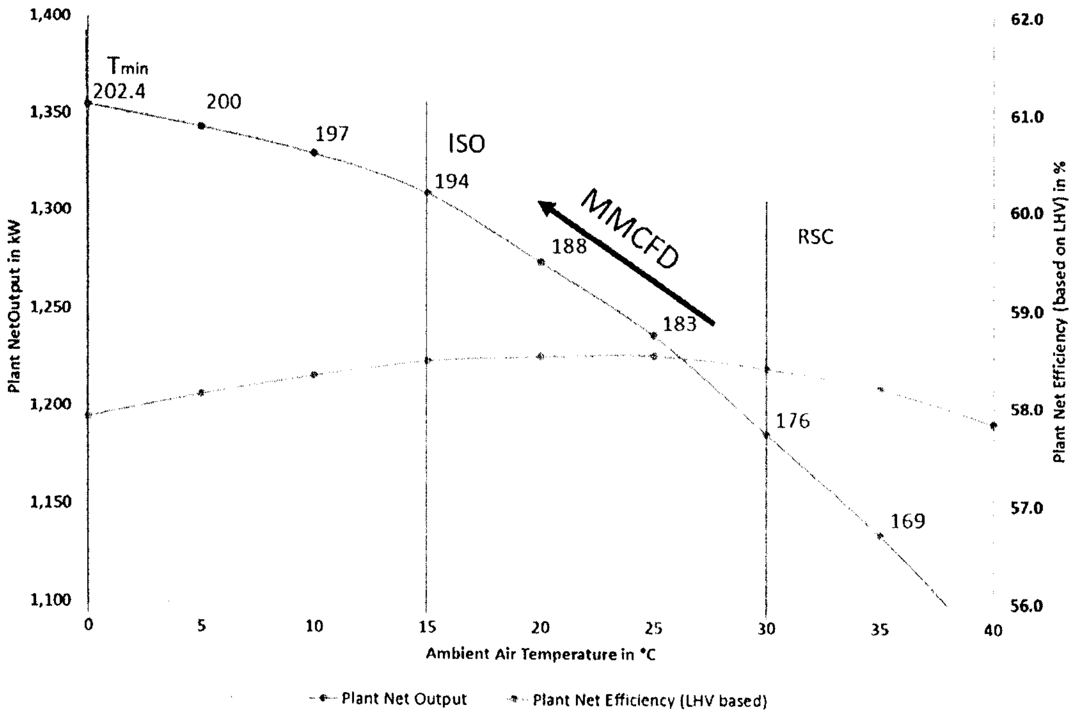


Figure 12: Capacity and efficiency vs ambient temperature (No supplemental firing - GE 9HA.01-series gas turbine)

The Owner recommended taking analysis similar assumptions as for previously executed projects at Bhikki, Balloki, Haveli BS project - utilisation of available gas and generation with maximum available efficiency. NESPAK/Lahmeyer considered supplementary firing as a one of possible ways of generation additional amount of power, but higher consumption of fuel shall be considered too. As a result of the pre-feasibility stage the SF is not recommended.

5.3 Recommended technical configuration and equipment features

5.3.1 Methodology of selecting the CCPP basic configuration

The configuration design of the CCPP is performed in order to find the optimum plant configuration at the given climatic conditions. Based on the key design parameters the following analyses are performed in the study:

- CCPP Net output of approx. 1,100 – 1,400 MW at ISO conditions;
- Execution in very short period – SC COD 14-15 months, CC COD 26 months;
- Variation of gas turbine size.

The above analyses were performed with GT types of large frame classes' machines having ISO rating of 300 to 490 MW to cover the capacity requirements.

Advantages of the gas turbines of this size are the high efficiency in combined cycle configuration and thus reduction of fuel consumption, lower specific investment costs and lower space requirements in comparison to similar installed capacities.

The layout of the triple-pressure steam cycle with single reheat is chosen to reduce emissions and to achieve higher efficiency. Triple-pressure steam systems yield lower stack temperature compared to dual-pressure systems, which improves overall plant efficiency. The combined cycle efficiency is optimized using constraints as the live steam pressure, the minimum temperature difference for pinch points, the superheat approach temperature difference, the steam turbine inlet temperature and the exhaust steam wetness at the steam turbine outlet.

In terms of the shaft configuration the multi-shaft configuration has been chosen in this study due to the possibility of early power generation in open cycle operation during the project implementation phase.

5.3.2 Thermodynamic design of the combined cycle

For an effective combined cycle power plant, the thermodynamic design of the steam cycle is the most important issue due to the given parameters of the gas turbines, which are predetermined by the manufacturers' standard design. Decisive for the steam cycle efficiency is the HRSG configuration and design.

In order to achieve the Net output of 1,100 to 1,400 MW under ISO conditions and as a result of the pre-feasibility stage two gas turbines shall be installed. The heat of the exhaust gases will be utilised in the respective heat recovery steam generators. The main configuration applying the large GT size is chosen in order to reach the maximum possible cycle efficiency. The concept is based on HRSGs of triple-pressure with single reheat and without supplementary firing.

The thermodynamic calculations are based on natural gas as the main fuel. The calculations are performed without water or steam injection into the combustion chamber of the GTs and no air inlet cooling. Operation with a back-up fuel shall be considered.

5.4 Fuel system

The gas supply terminal is situated within the power plant's boundaries. There the gas pressure will have a pressure of 37.9 bar(g) and temperature of around 35 deg. F to 90 deg. F.

The fuel system will comprise the natural gas control and metering system together with gas treatment skid, fine filter and condensate return line to gas station's condensate tank, fuel consumption meters, all necessary equipment like stop valve, control valve, pressure transmitters, gas heater, the respective instrumentation and an automatically operated purging system. Gas supply is considered stable and therefore no storage facilities are considered necessary.

The fuel gas supply system will be designed for flow of sufficient fuel gas according to all requirements of the two (2) Gas Turbines up to peak load operation as well as safe supplies during rapid changes of gas flow due to changing load requirements. The reference composition of gas, which is resulting from imported RLNG is as following, see Table 27.

Table 25: Gas composition

NO.	COMPONENT	COMPOSITION (mole - %)
1.	Methane (C1)	90 +/- 08
2.	Ethane (C2)	Not more than 15
3.	Propane (C3)	Not more than 05
4.	Butane and Heavier (C4+)	Not more than 03
5.	Nitrogen (N2)	Not more than 10
6.	Carbon Dioxide (CO2)	Not more than 03
7.	Contaminants	
	• Total Sulphur, max	3.5 grains/100 SCF (max)
	• Hydrogen Sulphide, max	.24 grain/100 SCF (max)
	• Solid particle size, max	10 micron (max)
	• Hydrocarbon Dew Point, max	0°C (max)
	• Water content, max	7 lbs./MMSCF (max)
8.	Gross Calorific Value	950 to 1170 Btu/Scf
9.	Gas pressure at interface: 550-600 psig	
10.	Gas temperature at interface: 35 deg. F - 90 deg. F	

Note: However, in case the gas temperature falls below 35 deg. F due to any unforeseen variation in the gas supplier's system, the design of equipment to be supplied by the EPC Contractor shall ensure safe, reliable and continuous operation of the power plant.

5.4.1 Back up fuel

The analysis of potential necessary investment costs regarding necessary back-up fuel facility for Jhang project site was estimated about 30-40 MUS$ (fuel systems and tanks). Additionally, ca. 48 MUS$ for 7 days minimum 60% load diesel for a 1100 – 1400 MW plant storage shall be taken into account. Furthermore, 48MUS$ as a necessary cost of burning diesel during every 5-6 years (diesel cannot be stored longer without deterioration and has to be burnt). Additionally, the fuel cost for diesel combustion in combined cycle mode causes prices 11 Rs/kWh compared to 6.5 Rs/kWh on gas, where plant efficiency is assumed 54% power on diesel and 60% on gas.

Table 26: High Speed Diesel (HSD) composition

NO.	TEST	TEST METHOD	VALUES
1.	Distillation 90% recovery, °C (°F)	ASTM D 86	Max. 365 (689)
2.	Color ASTM	ASTM D 1500	Max. 3
3.	Flash point (PMCC), °C (°F)	ASTM D 93	Min. 54 (130)
4.	Sulphur content, %wt.	ASTM D 1551/1266/4294	Max. 1.0
5.	Copper strip corrosion 3 hrs. at 50° C (122°F)	ASTM D 130	Max. No: 1 STR IP
6.	Viscosity, Kinematic 40° C cSt	ASTM D 445	Min. 1.0
7.	Max. 6.5	Max. 6.5	
8.	Cloud Point, °C(°F), Winter/Summer	ASTM D 2500	Max. 6(43) / 9(48)
9.	Pour point, °C(°F) Winter / Summer	ASTM D 97	Max. 3(37) / 6(43)
10.	Conradson carbon residue on 10% distillation residue, % wt.	ASTM D 189	Max. 0.2
11.	Ash, %wt.	ASTM D 482	Max. 0.01
12.	Sediment, %wt.	ASTM D 473	Max. 0.01
13.	Water, %Vol.	ASTM D 95	Max. 0.10 (import)
14.	Cetane number or	ASTM D 613	
15.	Centane Index	ASTM D 976	Min. 45
16.	ASTM D 976	Min. 45	
17.	Min. 45	ASTM D 3242 / D-664	Nil

Note: The reference HSD composition for Performance Guarantees shall be as follows: Sulphur content: 1%; LHV: 17,800 Btu/lb. The acid dew point due to sulphur shall be calculated by the bidder and stack temperature shall be chosen by the bidder at least 5K above such dew point. Calculation results shall be submitted by the bidder together with Performance Guarantees.

After receiving confirmation from Ministry of Petroleum & Natural Resources of Government of Pakistan that gas will be made available at all times. In terms of day to day operation NESPAK /Lahmeyer recommended to implement project based on single fuel supply (gas). As required by the regulator (NEPRA), Diesel should only be used as a back-up solution.

5.5 Acceptance criteria for GTs

The Plant shall be designed, manufactured, installed, and shall be suitable and complete in every respect for continuous operation at base load, as well as at part loads, and shall exhibit high availability and reliability. The Plant shall comprise well-proven components, built to internationally recognised standards, and shall be designed to achieve high levels of operability, reliability, availability, and maintainability. Standardisation and interchangeability of equipment and parts shall be optimised. Components and systems which are unused and of proven design shall be used. The Plant shall comply with all the applicable national and statutory codes.

The Plant shall be designed to permit unconstrained operation over the full range of ambient conditions. The design and materials of major Plant items shall be proven by evidence of the following minimum operational experience in comparable ambient conditions, and water temperature.

Regarding the latest experiences in Pakistan, costs of fuel, the availability of type of heavy duty machines and power blocks designed with this technology and considering the requirements of the Client, the below GT models are considered during feasibility stage:

- GE Water & Power - 9HA.01.
- Siemens – SGT5-8000H;
- Ansaldo – GT26;
- Mitsubishi Hitachi Power Systems - MHI701J.

The Plant's design shall facilitate on-site maintenance of all equipment. The Plant shall be provided with suitable weather protection to enable operation and maintenance procedures to be undertaken under all weather conditions.

The plant shall be designed for a lifetime of 240,000 operating hours over a period of 30 years. It shall be designed for not less than 10 cold starts, 30 warm starts and 50 hot starts per year. Equipment and components normally subject to wear and tear shall be designed to have maximum practical life between major inspections and shall be designed such that it does not prevent Plant operation at full load except for scheduled maintenance activities. The Contractor shall provide details of equipment subject to wear and tear together with anticipated periods of operation between replacements or overhauls. Additionally, the Consultants calculations for selected GT series took into account evaporating cooling mode (estimated CAPEX ca. 3-4MUS$), which can increase power generation during very hot period at Jhang project site.

5.5.1 The results of calculations for main fuel – Re-Gasified LNG

GT Pro calculations for biggest considering GT models look as following:

Table 27: GT Pro calculation at ISO for gas fired mode

OEM	MODEL	PLANT OUTPUT (gross) MW / CONFIGURATION		PLANT EFFICIENCY for 1x (2+1) LHV BASED (%)	
		1xGT	1x (2+1)	Gross	Net
GE	9HA.01	404	1,210	62.22	60.84
Siemens	SGT5-8000H	371	1,148	60.66	59.17
MHPS	M701J	440	1,325	62.28	60.54
Alstom	GT36-S5	444	1,373	61.44	59.82
GE	9HA.02	491	1,472	62.46	61.00

5.5.2 The results of calculations for auxiliary fuel – HSD

GT Pro calculations for biggest considering GT models look as following:

Table 28: GT Pro calculation at ISO for gas HSD mode

OEM	MODEL	PLANT OUTPUT (gross) MW / CONFIGURATION		PLANT EFFICIENCY for 1x (2+1) LHV BASED (%)	
		1xGT	1x (2+1)	Gross	Net
GE	9HA.01	423	1,259	58.49	57.17
Siemens	SGT5-8000H	393	1,206	57.23	55.88
MHPS	M701J	465	1,384	58.56	57.20
Alstom	GT36-S5	*	*	*	*
GE	9HA.02	*	*	*	*

* For GT models: GT36-S5and 9HA.02 no data based on diesel operation mode.

5.5.3 The results of calculations with evaporating cooling mode – Re-Gasified LNG

For Alstom machines type GT26 result of calculations look as following:

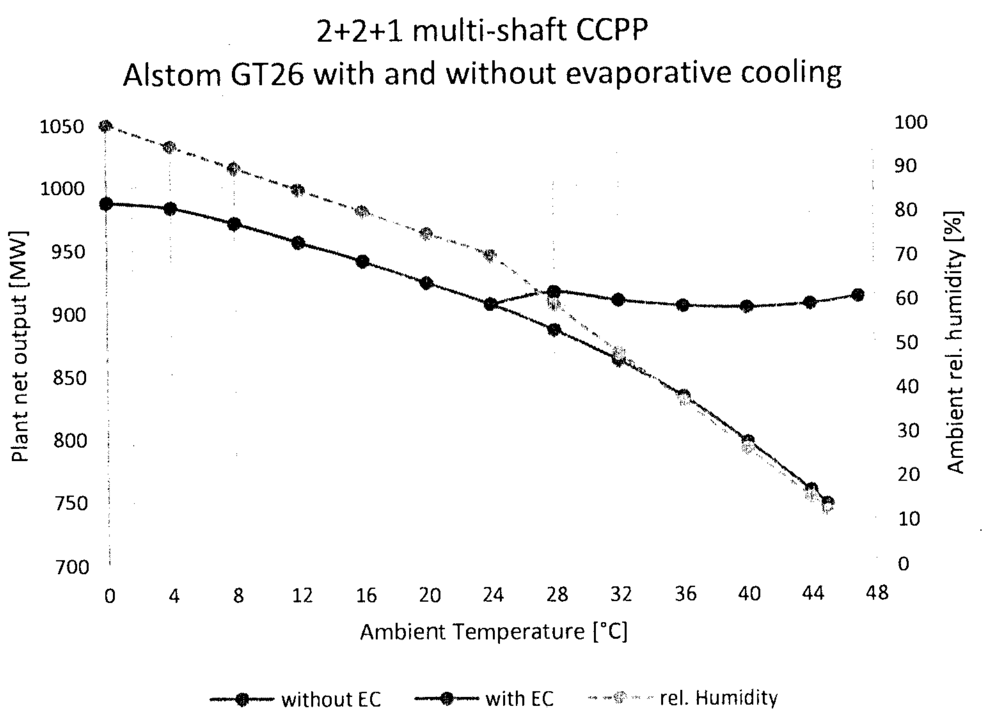


Figure 13: Plant output for 2-2-1 configuration with Alstom GTs – GT26

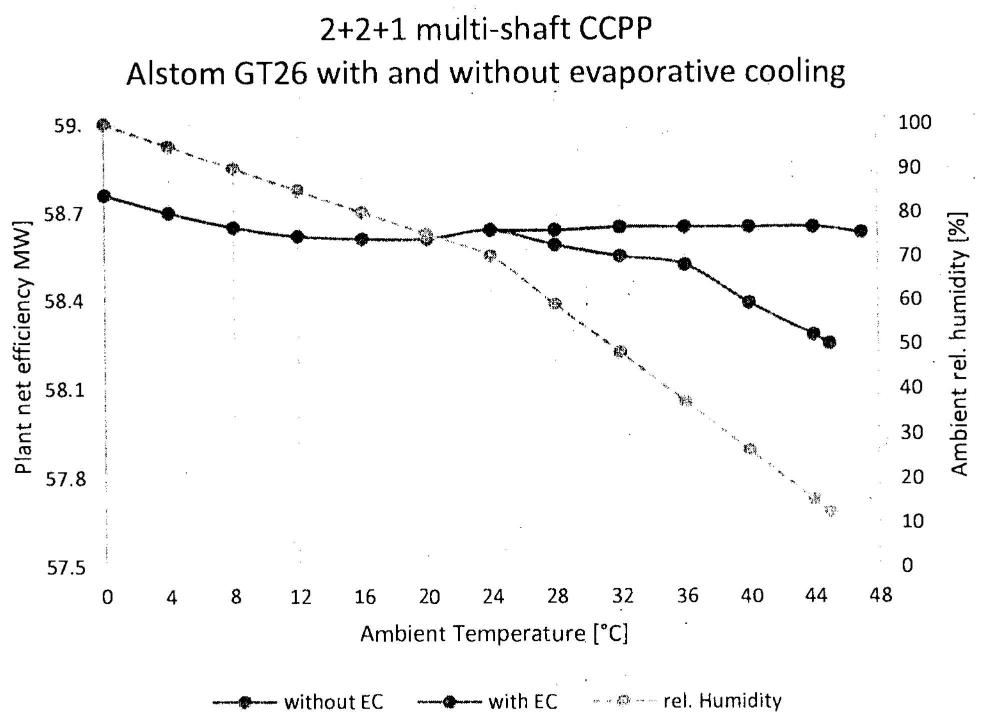


Figure 14: Plant efficiency for 2-2-1 configuration with Alstom GTs – GT26

For Siemens machines type 8000H result of calculations look as following:

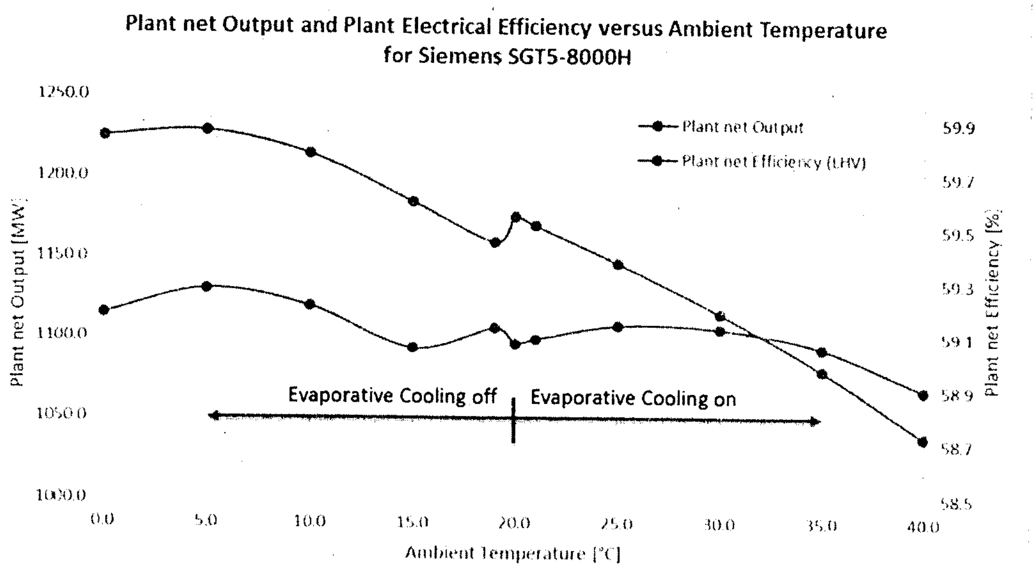


Figure 15: Plant output and efficiency for 2-2-1 configuration with Siemens GTs – 8000H

For GE machines type 9HA.01 result of calculations look as following:

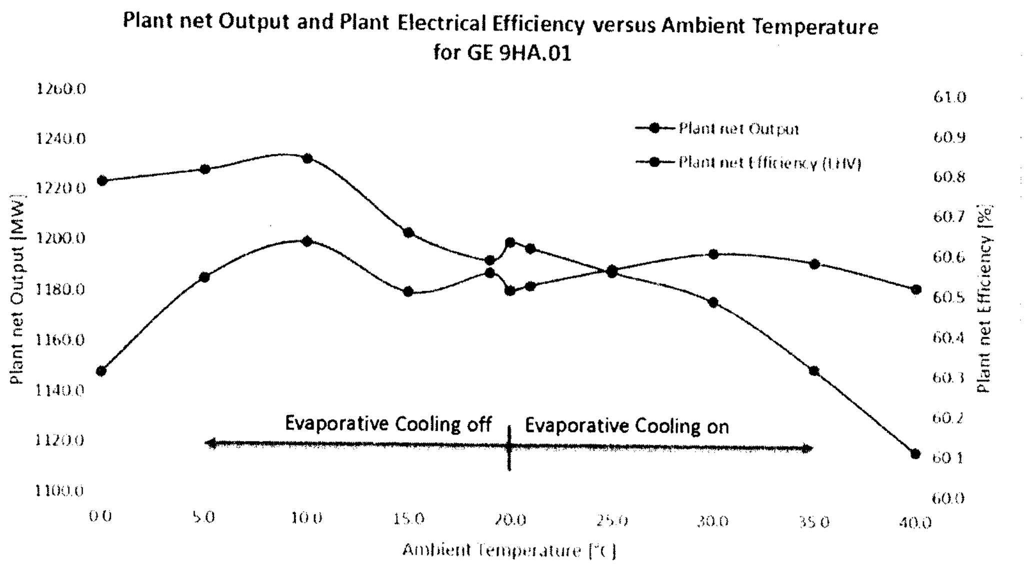


Figure 16: Plant output and efficiency for 2-2-1 configuration with GE GTs – 9HA.01

For MHPS machines type MHI701J result of calculations look as following:

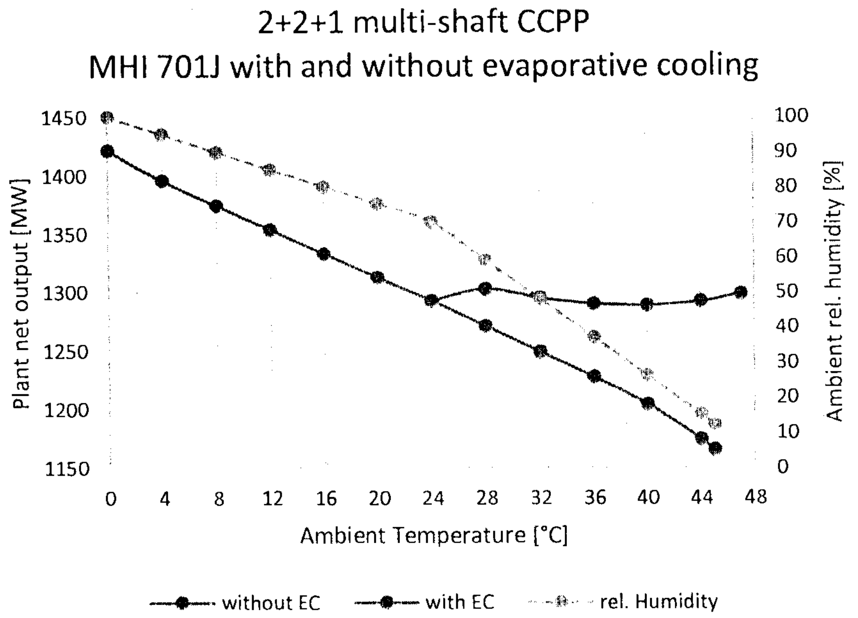


Figure 17: Plant output for 2-2-1 configuration with MHPS GTs – MHI701J

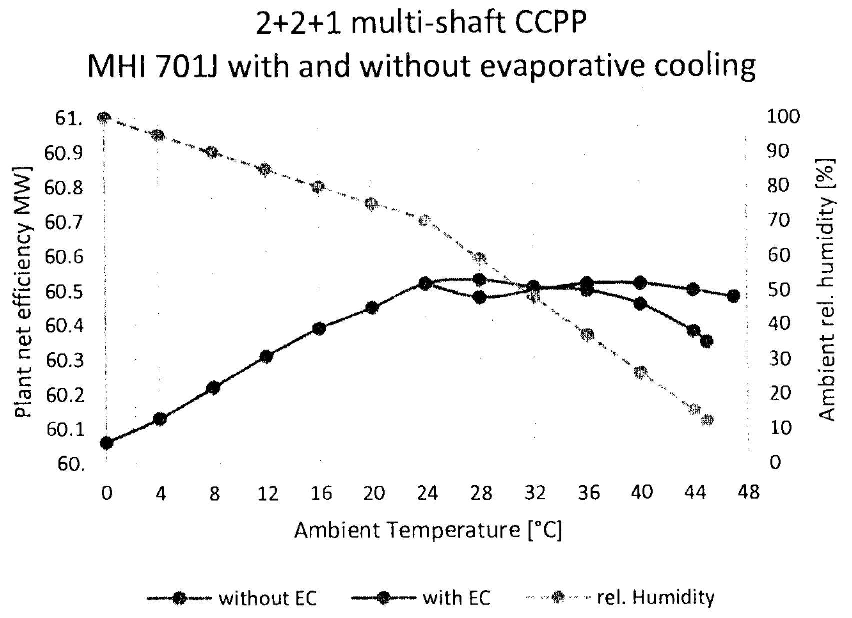


Figure 18: Plant efficiency for 2-2-1 configuration with MHPS GTs – MHI701J

The details of calculations were presented in Annex C.

5.5.4 Comments on GT Pro calculations vs. executed projects in Punjab province

Based on last collected data from 3 RLNG based CCPP projects (Bhikki, Balloki and Haveli BS sites) and proposals submitted in the end of 2015 – see table 31.

Table 29: Results of tenders for Bhikki, Balloki and Haveli BS project - 2015

Data/EPC bidder	CMEC	ENKA	HARBIN	HYUNDAI ENG	POWER CHINA
Bhikki project					
GT model offered by the bidder	SGT5 8000H	9HA.01	9HA.01	MHI701J	9HA.01
Output (CC-net, MW)	1,124.6	1,150.3	1,156.7	1,281.4	1,156.8
Efficiency (CC-net, %)	60.1	61.5	61.6	60.9	61.9
Haveli Bahadur Shah project					
GT model offered by the bidder	SGT5 8000H	9HA.01	SGT5 8000H	MHI701J	9HA.01
Output (CC-net, MW)	1,123.1	1,200.8	1,128.1	1,291.5	1,207.9
Efficiency (CC-net, %)	60.1	62.1	60.5	61.3	62.5
Balloki project					
GT model offered by the bidder	SGT5 8000H	9HA.01	9HA.01	MHI701J	9HA.01
Output (CC-net, MW)	1,122.5	1,196.6	1,195.1	1,282.4	1,203.7
Efficiency (CC-net, %)	60.0	61.8	61.4	61.0	62.2

The results got from calculations in 2017 are slightly conservative in the area of performance numbers – for example currently GE confirmed in its commercial projects that efficiency of approx. 62.0% (net, ISO) is achievable;

- Siemens "Fortuna" CCPP, Lausward, Düsseldorf – Germany, 61.5% (1-1-1 configuration)
- GE CCPP, Bouchain - France, 62.22% (1-1-1 configuration).

Additionally, performance tests executed at Bhikki and Haveli BS sites for SC phase showed that submitted performance numbers for Single Cycle mode (gas) are achievable and will be improved in the later phase of the projects.

Based on NESPAK/Lahmeyer permanent investigations and contacts with OEMs the major improvements are constantly made in the area of:

- New materials (blades, burners);

- Combustion processes (fuel injection, the shape of combustion chamber, etc.);
- Changed GT operating parameters and set up (pressure, temperature, flows);
- Adjustment of "GT part" and "steam part (HRSG, steam turbine)";
- Reduction of auxiliary equipment power consumption;
- Increasing of GT capacity– new GT models e.g. 9HA.02, GE (491 MW), GT36-S5, Ansaldo (444 MW);
- Manufacturing and testing time (new OEMs test facilities, implementation 3D printing technology, etc.)

Those collected data and outcomes from direct meetings with many companies show that during coming 5-10 years the performance numbers CCPP plants will be strongly improved and reaching efficiency 65% (gross) is achievable (ISO). Additionally, the EPC execution time will be decreased based on constantly collected experience for latest GT technology (H-class machines) projects.

5.6 Meeting with EPCs/OEMs and the Client, June- July 2017

Following requirements of the Client:

- Delivery time for GT1 – 6 months from NTP, GT2 – 7 months from NTP;

And other aspects of the project, as following:

- Necessary time for implementation credible and reliable technology which guarantees high efficiency and low costs of power generation (tariffs);
- Necessary time for mobilization contractors and subcontractors in Pakistan,
- Collected experience from 3 RLNG based CCPP projects in Punjab province

Based on collected experience from last 3 RLNG based CCPP projects the few issues were discussed with the Client:

- Back up fuel requirements - dual fuel combustion in GT – finally confirmed;
- Sequence of project execution – Single Cycle stage → Operation →Combined Cycle stage.

Conclusions: NESPAK/Lahmeyer recommended the technical configuration 2-2-1 (2xGT-2xHRSG-1xST) as the reasonable from cost and O&M point of view.

5.7 Reference Site Conditions

For further analysis, listed below RSC are taken into account:

- Reference Site Conditions (RSC);
- Ambient temperature 26°C;
- Rel. Humidity 70%;
- Barometric pressure 0.9954 bar;
- Water (canal) temperature 25°C;
- Grid PF 0.85.

So, influence of ambient temperature on design outcomes at RSC are presented below.

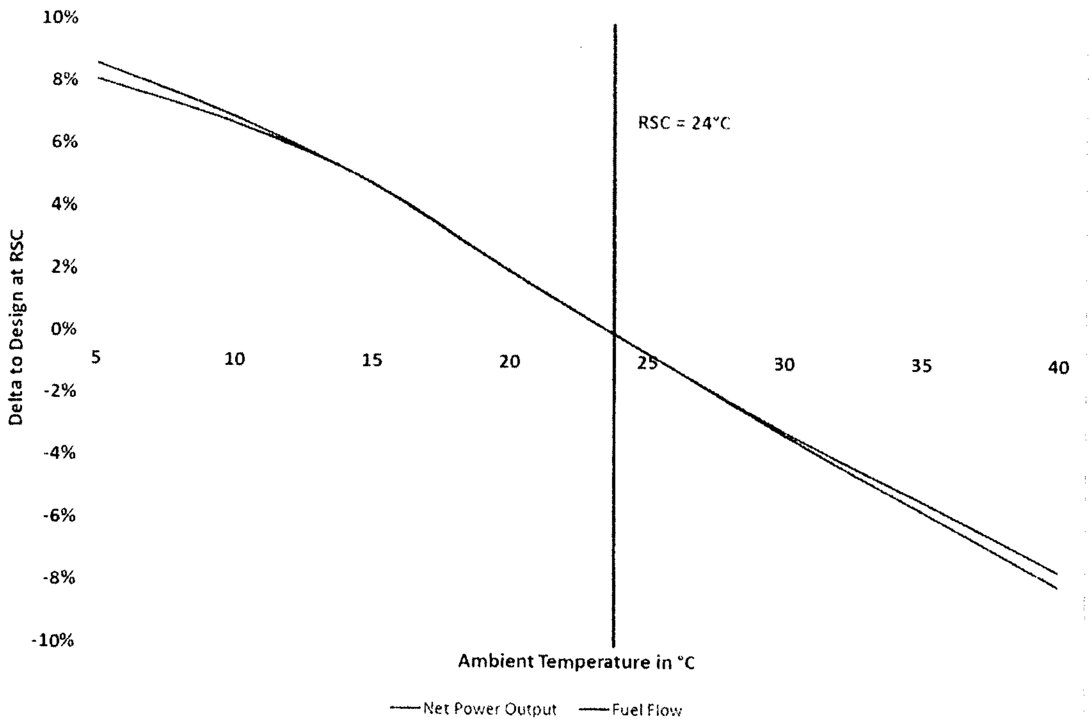


Figure 19: Influence of Ambient temperature on Design outcomes at RSC

As a conclusion of outcomes listed above meetings the assumed sequence for execution Jhang project located close to Haveli BS site is as following:

Table 30: The planned sequence of execution Jhang project

NO.	ACTION	DATE
1.	Issuance of IFP by PTPL	June 2017
2.	Submission of applications by EPC candidates	July 2017
3.	Assessment of applications and finalization of tender documents	July 2017
4.	Issuance of tender documents to pre-qualified bidders	End of July 2017
5.	Submission of EPC and LTSA bids	August2017
6.	Evaluation bids - evaluation report EPC & LTSA - lowest evaluated bidder	August/September 2017
10.	Grievance period & Preparation of contract documents EPC & LTSA completed in parallel	10days
11.	Award of Contract	September 2017
13.	NTP	September 2017
14.	Critical items ready for shipment (GTs)	February 2018
15.	First Shipment and inland transport to site	March 2018
16.	Availability of gas and 220 kV evacuation required	August 2018
17.	Single Cycle Operation	December 2018
18.	Combined Cycle Operation	November 2019

Based on NESPAK/Lahmeyer experience the estimated schedule is presented in Annex B.

5.8 Interfaces

In general, the Contractor shall indicate interface points in his general layout drawing. Employer and Employer's Representative shall coordinate these with the respective companies to get them confirmed.

5.9 Operation mode

For further assessment process of tender proposals, Lahmeyer and NESPAK considered below operational mode:

- OP1 - with once-through cooling;
- OP2 - with cooling towers;

- OP3- with once-through cooling and evaporating cooling.

6 PROJECT IMPLEMENTATION CONCEPT

6.1 General

Based on typical format of execution EPC projects the major phases (costs) vs. time look as following:

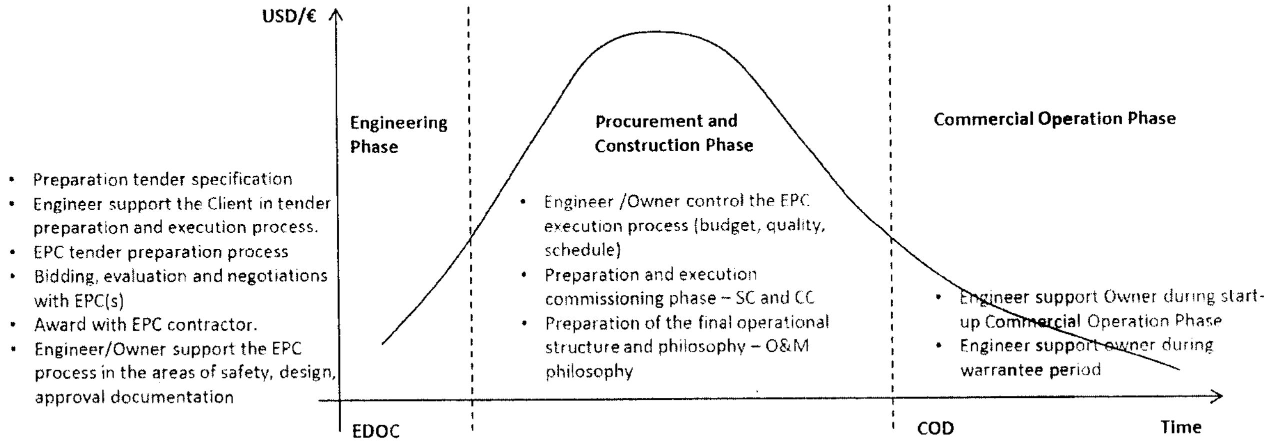


Figure 20: Major phases of the EPC project

The cost line increases in the beginning following necessary procurement and mobilisation process (advance payments) and engineering activities. Furthermore, the EPC is engaged on site – start-up of site investigation and beginning of construction works – underground.

Any power plant project, subsequent to the EPC Contract becoming effective, would typically be implemented in phases:

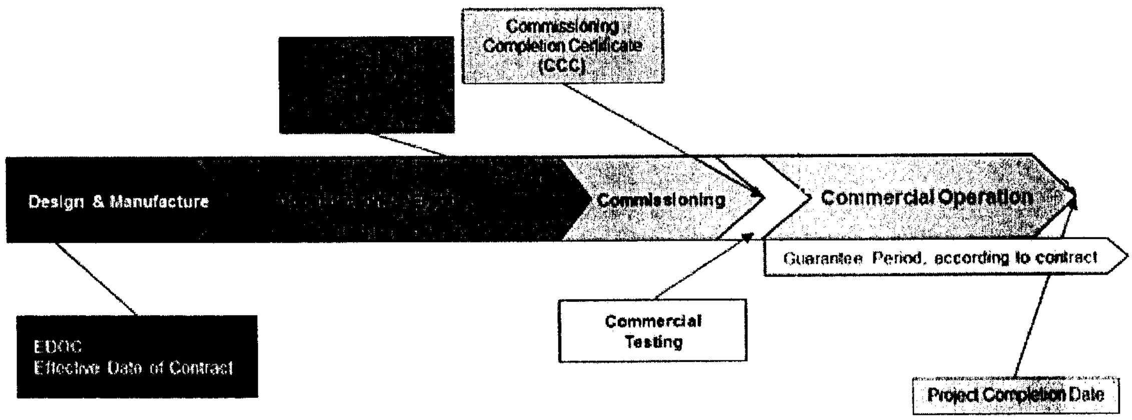


Figure 21: Main Phases of the EPC project

The execution of EPC turnkey project usually is supported by Engineer's organisation. The organisation chart shows the Engineer (Lahmeyer's example) involvement in particular phases of the project.

aa

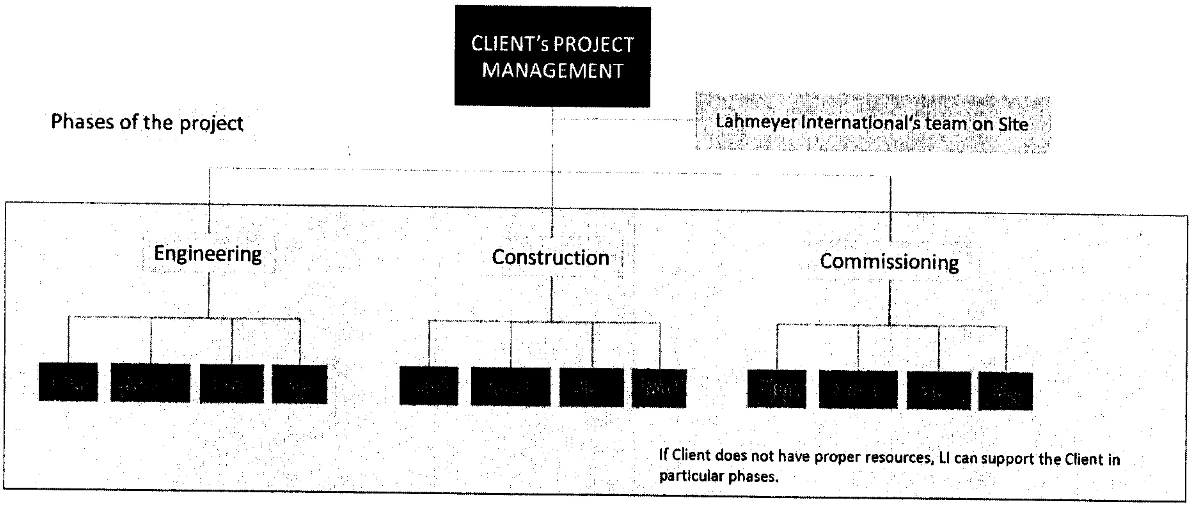


Figure 22: Client/OE's team organisation structure

6.2 Codes and Standards

Reference to special codes and standards (see Annex A), where designated either directly or as relevant, is intended to provide a measure of performance, safety, in-shop and on-site testing, and methods of design, construction and/or installation which must be equalled or exceeded in order to be acceptable. If more than a single degree of quality or accuracy is permitted within the scope of a particular code or standard, the highest quality shall be applicable and the degree of accuracy commensurate with the intended function shall be selected but with the understanding in either case that the decision as to degree shall be made finally by the Owner/Engineer.

In all instances, the finally accepted applicable code or standard shall be the latest version published on contract conclusion. Any changes in applicable codes or standards after the contract has been signed shall be mutually agreed between the parties. For the applicable Codes and Standards which are widely used as reference for conducting performance testing at manufacturers' test facilities and at site.

Where no specific code or standard is mentioned then the various items of plant, parts, material and equipment shall be tested in accordance with the relevant American, British, Italian, Japanese or German standards. IEC standards are compulsory for electrical equipment.

6.3 Engineering phase

The "Engineering phase" contains final approval design assumptions, standards and other clauses, which will be applied for:

- basic design process/ready for construction design process;
- procurement process;
- construction and commissioning - as-built documentation and O&M documentation.

Based on collected experience from 3 RLNG based CCPP projects similar solutions are predicted and the Client and Nespak/Lahmeyer expect more efficient approach of EPC contractor to design phase. The EPC contractor shall follow the rules and assumptions presented in Feasibility Study and Functional Specification.

6.4 Site activities

All parties involved in manufacturing, erection and commissioning or working close to live/operational plant/equipment are required to read, take note of and strictly follow all approved project procedures. The owner is supported on site by Engineer organisation – example of Lahmeyer's (LI's) see chart below (Figure 26).

The below structure allows to keep proper quality and pending process of all EPC phases. Additionally, the quality procedure shall be drawn up to ensure the safe and efficient testing and inspections, e.g. during commissioning, of the project, which will depend entirely on the full cooperation of full parties involved.

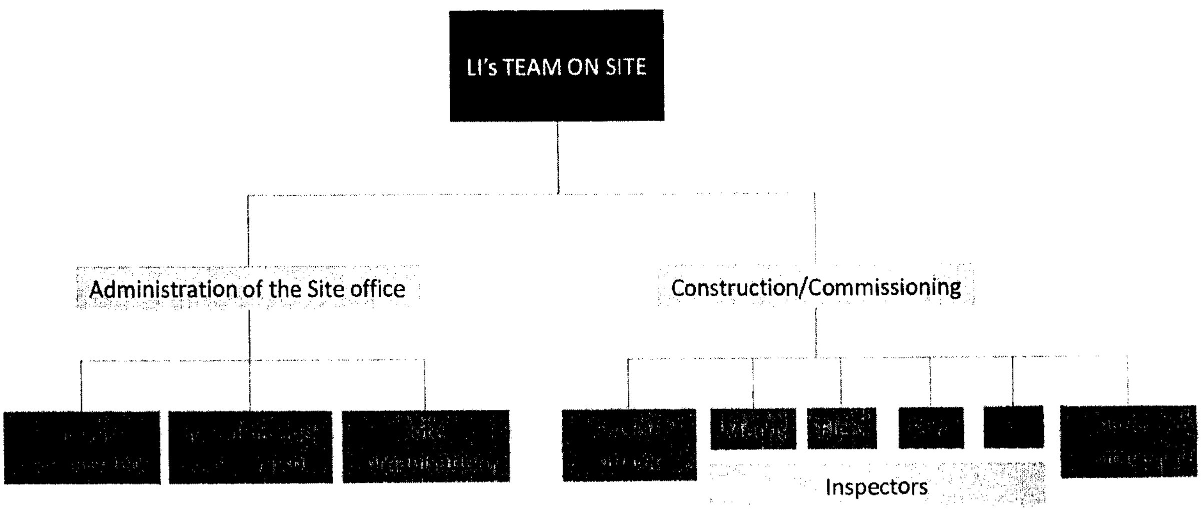


Figure 23: OE's Engineer Site organisation structure – LI's team supports NESPAK team

6.5 Communication

The communication rules shall follow agreed project manual between Client, Engineer and Contractor. It is, therefore, essential to introduce and agree on the Project Manual at the earliest stage of the Project, in any case prior to mobilising staff to site.

6.5.1 Scheduling – requirements

Typically, assuming Project Execution by an experienced EPC Contractor, this Contractor would develop a Project Time Schedule or Project Programme. Engineer's activities would then concentrate on reviewing this Programme and closely following up on all activities. Engineer would also analyse the schedule, e.g. on room for improvement, criticality of activities, etc. and advise the Employer accordingly. The Programme, shall also allow to judge on the progress of works in the frame of Invoice Verification. It is therefore essential for the success of a Project that the Contract Programme complies with certain minimum requirements as further detailed hereunder.

It is further essential this Programme to be made available to Engineer allowing to fully interrogate and analyse this schedule. Nowadays large infrastructure Projects would normally use the Primavera (P6) software.

6.5.2 Schedule Structure and Composition

The project shall have a work breakdown structure (WBS). This is required, in order, to categories the activities into different codes that relate them to the project. The codes shall act, as tags or attributes of each activity to allow the programme to be grouped, summarized, and filtered in or out of the display in soft copy.

The contractor shall develop a WBS based on the Activity Code function. This will require the contractor to assign relevant codes to each activity in a time scheduling software tool (e.g. Primavera).

The WBS shall have a hierarchal structure that is developed by the contractor breaking down the project tasks into definable and recognizable activities of manageable and logical headings. The contractor shall ensure that this is a fully integrated and co-ordinated structure, which is arranged under at least four levels.

These should be, as follows:

- Level 1: key phases of the project;
- Level 2: project systems, as described in scope of works;
- Level 3: key disciplines;
- Level 4: sections or areas of projects.

The contractor shall ensure that contract schedule has clearly identified all the project key deliverables, milestones and have shown these within the WBS. The design and engineering phase of the schedule, shall show for each system and discipline the relevant design activities, which are clearly identified and sequenced in order of their priorities, leading to submission of corresponding drawings, studies, and reports etc.

The procurement and manufacturing phase shall indicate the dates for placing of order with subcontractors and suppliers for each system, discipline and show the interrelationship between these and their relevant predecessors from the design and engineering phase.

The schedule shall also show all dates of placing order for material and equipment, their corresponding delivery periods and detailed design within their manufacturing period, arrival dates at port of importation, custom clearance and the transportation to site.

The construction and erection phase shall show for each system, discipline and area of construction clearly defined activities that are linked to their relevant predecessors from the design and engineering and the procurement and manufacturing phases.

The programme shall have a measurable finish point for each group of activities, which is identified and indicated in the schedule by a Milestone event with a designated zero duration.

6.5.3 Periodical update

Periodical update of schedule according to deliverables and visual inspection during supervision activities is a comparison of planned stage and current status of the project.

- **Programme updates**

Once the project is up and running the contract schedule will require updating and status. As a consequence of this process there is potential for creation of three versions of the contract schedule. These are as following:

- Contract Schedule (baseline);
- Contract Schedule (current);
- Contract Schedule (recovery).

<u>Contract Schedule (baseline)</u> - this shall be the approved contract schedule, as previously stated shall not be changed or altered without approval and it will remain unstated.

<u>Contract Programme (current)</u> - this shall be the same version, as Contract Schedule (baseline) but set up by the contractor at the end of each month with the same activities' logic links or their original durations as in the Contract Schedule (baseline). The contractor after each set up the schedule shall carry out time analyse to establish the new position of the programme. An electronic unfiltered copy of this programme shall also be included in the Monthly Report.

<u>Contract Schedule (recovery)</u> - if after time analysis the Contractor find the key contract dates are overrun by more than one calendar month, it shall then make appropriate changes to the logic and resource level of the activities with the negative total float, in order to maintain the original key dates.

This adjusted schedule shall be labelled, as Contract Schedule (recovery). The contractor shall note all the changes that are made to each activity and log these, describing each change and the reason for it. An electronic unfiltered copy of this recovery schedule including these logs shall also be included in the Monthly Report.

6.5.4 Schedule review

The review of Contractors schedule in accordance to consistency, time schedule logic and contractual agreed baseline shall be done by the Owners Engineer. It is necessary to make the comparison of progress reports from Contractor with own schedule updates and analyses.

6.5.5 Progress report

Contractor's Monthly Progress Report shall be based on the contract schedule. A typical content for Contractor's Report should comprise the following aspects to allow Lahmeyer as swift review and subsequent own reporting to the Employer. Ideally these requirements should already be covered in the EPC Contract and be defined as Contractor's deliverables. If not included accordingly Engineer shall try to agree such content during the kick-off meeting.

6.5.5.1 Progress of Design and Engineering

Contractor's narrative and explanation, as to the reason(s) for any variance between planned and actual and the corrective actions it has taken to resolve this. Contractor's brief overview on the status of submissions and approval and any relevant actions taken to resolve any design problems encountered during the reported period.

Contractor's full list of drawings and other documents submitted for approval, drawings which were approved by Owner and drawings issued for construction in the reported period, all with respective approval status. Contractor's list of the critical issues relevant to this section including S-curve of the overall planned cumulative progress compared to actual cumulative progress.

6.5.5.2 Procurement and Manufacture

Contract's brief overview on the status of procurement and any relevant actions taken to resolve manufacturing, shipment and delivery problems encountered during the reported period. Contractor's full list of procurement activities, which were completed in the last reported period and a new list of procurement activities planned for the next report period with reference to the relevant Contract Programme. This shall include detailed material flow chart. Contractor's critical issues relevant to this section including S-curve of the overall planned cumulative progress compared to actual cumulative progress.

6.5.5.3 Commissioning and Handovers

Contractor's brief overview on the status of commissioning phase noting any relevant actions taken to resolve any related problems, which had been encountered during the reported period.
Contractor's list of commissioning activities from the primavera programme, which have been completed during the reported period and four weeks look-head programme for the next reporting period. Contractor's list of the critical issues relevant to this section including S-curve of the overall planned cumulative progress compared to actual cumulative progress.

6.5.6 Health, Safety and Environment

Contractor shall highlight occurrence of any incident in this report period compared to the previous report period noting any improvement trend or otherwise and state any actions taken to better this situation.

6.6 Training

The Contractor shall provide a comprehensive training programme for the Employer's management, operation, and maintenance staff that covers the entire scope of the Works, which as a minimum complies with the following requirements. The Owner shall select capable employees with proven technical/management knowledge for smooth execution training program.

The Training Program shall provide a basic understanding of the equipment and associated auxiliary systems of the Contractor's scope of supply, and shall support the installation, start-up and operations of the individual components.

6.7 QA/QC – Quality Assurance and Quality Control

This Quality Assurance and Quality Control is intended to keep necessary quality of contractor activities during all phases of the project. It contains rules and procedures for project organisation during the time of time of Engineering, Procurement, Manufacturing, Erection, Commissioning, Testing and inspection, and finally Hand-over.

The basic aspects and requirements related to above mentioned phases of the Project comprise:

- Definitions;
- General duties and rules;
- Share of responsibilities;
- Preparation of tests/inspections;

- Performance of tests/inspections;
- Management of documentation and approvals;
- Interface management.

It is imperative that all contractors comply strictly with the Contract and approved procedures. This shall ensure that the Engineers' representatives and other parties (Contractor, Client) involved in the project have available the same information at the required time. The Owners' safety regulations are to be used as the main safety references, wherever available. If these are not available or not enough, the Contractor shall establish these regulations according with QA/QC procedures and site requirements in full consultations and approval with the Owner and Owners' responsible Engineer.

6.7.1 Purpose

The objective of above clauses is to provide a picture for a daily activity on site during delivery equipment's and material, during tests and inspections, manufacturing, erection and commissioning of power station equipment under the Contract in force. It aims at itemizing the stipulations as put down in the contract documents.

The requirements of these guidelines are governed by following basic principles:

- To ensure safe working conditions;
- To ensure quality of work on site and in workshops;
- To produce transparency of the works at site to the effect as to render an adequate assessment and control of the site activities by the Owner/Engineer;
- To standardize the documentation of construction phase, testing and commissioning for a reliable start-up of the plant.

The whole of the works supplied by the contractor shall be subject to visual, dimensional, material, non-destructive, hydraulic, and functional and performance inspection and tests by the Owner/Engineer. These will be required during manufacture, erection and after completion, at the manufacturers' workshops and/or on site.

6.8 QA/QC requirements

During the project period, tests and inspections shall be prepared and carried out by the contractor and witnessed by the Owner/Engineer in order to ensure that the material, workmanship and proper functioning related to the equipment supplied and installed within this contract are in conformity with the contract requirements, steps, approved design drawings, applicable standards and state-of-the-art technology. The following test/inspection series shall be carried out:

- Workshop tests and inspections;

- Site tests and inspections;
- Construction completion inspections;
- Pre-commissioning tests;
- Commissioning tests;
- Tests on completion;
- Performance Test.

The above mentioned documents (test/inspection procedures and programme) shall be submitted to the Owner/Engineer for approval at least two months before the start of the related test/inspection series. The final (corrected and approved) document sets shall officially be submitted to the Owner/Engineer before start of respective test/inspection series.

6.9 QA/QC responsibilities

The organisation of all QA/QC activities shall be adapted to the project's requirements and shall be documented as described in the contract documents. QA/QC committee organisations shall be based on:

- Daily programme;
- Weekly programme;
- Inter-related coordination among the groups.

Minutes shall be taken at every meeting of the QA/QC committee and copies distributed to all parties concerned together with all necessary programmes. The following responsibilities shall be agreed between the parties in accordance with the contract for each project participant:

- Contractor;
- Engineer;
- Owner;
- Third parties.

6.9.1 Contractor's responsibility

The contractor is responsible for the safe and efficient design, erection and commissioning of the plant. The procedures are subject of Engineer's approval and shall be in accordance with any safety and permit regulations enforced by the Engineer at the site. For the successful realisation of the project, the contractor shall provide or submit the following QA/QC documentation as required in respect of contract documents, specification, drawings and details:

- Project quality plan;
- Safety assessment;
- Inspection test plans;
- Schedule of quality records;
- Procedures to be used for the work under the contract;
- Detailed and comprehensive check lists;
- Contractor's QA/QC organisation.

With the commencement of the first activities the contractor shall prepare a programme on a daily basis, which he hands over to the Owner/Engineer and which shall be explained in regular meetings. This daily programme shall describe, which tests and inspections are going to be performed on which equipment giving details on date, time, location and applicable test procedure.

The daily programme shall enable the Owner/Engineer to plan the participation of his staff in the proposed tests and to monitor the activities. In addition to this, the daily programme will be used in the meeting of the subsequent day to assess the progress of work and to discuss problems and findings encountered on the previous day.

All test/inspection documents (procedures, reports, certificates, etc.) with the relevant attachments shall be retained by the contractor by means of a transparent filing scheme allowing efficient document retrieval and shall be part of the general power plant documentation (quality control programme). All documents shall always be made available to the Owner / Engineer whenever requested by him.

6.9.2 Engineers' responsibilities

Engineer groups comprise several teams, each of them will be in charge of plant and equipment erected under the contract or a section of the main contract. The team leader who will be a senior resident Engineer (SRE) or his designated representative nominated by the PRE will be responsible for the overall coordination of the plant and equipment within his scope of responsibility. The senior Engineer/commissioning manager is responsible for the overall coordination of all activities.

The commissioning team leader will form commissioning sub-committees as may be necessary to ensure that commissioning activities are adequately supervised. The role of the groups will be to work together during each phase or part of the project assigned to them.

The Owners' operations department is required to note and appreciate that the PRE, as the Engineers' representative at site, has the authority to issue the certificate of commencement of reliability test run and taking-over notwithstanding any objections from Owners' operations department.

6.9.3 Owner's responsibilities

The Owner's QA/QC team shall set up the agenda for erection and commissioning panel meetings. They should include:

- Coordination and dates;
- Issues from QA/QC committee and sub-committee(s);
- Review of major procedures;
- Review of regulations concerning issue of permit to work;
- Review of safety regulations and safety clearance requirements;
- Amendments to list of contractors' authorised persons;
- Review/approval of procedures, check lists and start-up documents;
- Review of commissioning programme (day number basis) for each section of plant and target dates;
- Status of operation and maintenance manuals;
- Availability of test equipment and calibration certificates;
- Safety clearance/permit to work/permit-to-operate status;
- Availability of commissioning supplies.

6.9.4 Third parties' responsibilities

The third parties required for the successful implementation of the project shall have the responsibilities assigned to them as per the relevant contract. In general, they will be contracted by the Contractor and shall report though the contractual channels. Therefore, Contractor must call for third party assessment in conformity with the local regulation and with the Contract requirements.

In any case, the parties shall strictly follow the safety regulations and work permit procedures stipulated by the Owner/Engineer.

6.10 Work permit

The contractor shall introduce a permit to work system for all works that are internal to the project and for equipment or systems having interfaces with any other contractors / third parties. In case that activities interface with any existing installations of the Owner, the PTW system of the Owner shall be utilized. Please refer to the work permit procedure.

The Owners' safety regulations are to be followed in all circumstances.

6.11 Test Programme and Documentation

All tests and inspections shall be performed per the approved Test Procedures. Those procedures include all relevant test sheets, the programme and necessary details on notification, reports, certificates and their documentation. On completion of a system or sub-system, the contractor shall conduct an internal test or inspection to prove that the specific requirements are fulfilled. Any deficiencies shall be rectified before the Owner / Engineer will be notified.

6.11.1 Test Procedures

The contractor shall submit for approval three months prior to testing, detailed test procedures for equipment, sub-systems and complete systems covered under the contract. These procedures shall include details of all functional/performance tests to be conducted either in the manufacturers' works or at site. Detailed lists shall be provided which shall specify applicable codes, functional and other tests to be carried out on each item of equipment, each sub-system and each complete system. The lists shall be supplemented with logic diagrams to show the correct plant functioning requirements together with system flow diagrams showing all points of measurement for both functional and performance tests.

Where data acquisition systems are to be employed in performance tests, all software to be used shall be subject to the Engineers' approval. Sample calculations shall be submitted together with the approval document.

The procedures, list, logic diagrams and flow diagrams together with test results shall be correlated and presented as a single bound document to form a comprehensive set of test procedures and records of the tests conducted on the plant.

All tests and inspections shall be carried out according to the applicable procedures, which describe in detail the activities, methods and measurements carried out to test an equipment or plant component. The procedures shall be prepared strictly in accordance with the applicable standards as defined in the contract document.

The final, i.e. corrected and approved document sets shall officially be submitted to the Owner/Engineer before starting the respective test/inspection series.

6.11.2 Test Sheets

For each test required as per the test/Inspection programme a test sheet shall be prepared by the contractor, filled in during the test, signed by the test participants and distributed to the parties involved along with the appertaining test/inspection report.

General requirements for test sheets:

- Reference to the respective equipment/instrument;
- Clear equipment code (KKS);
- Basic technical data;
- Reference to the respective procedure and code or standard;
- Measured values;
- Acceptance criteria (limit values);
- Space for comments/observations;
- Attached drawing (P&ID, single line diagram, etc.) or sketch with the marked sys-tem/equipment;
- Signatures of all parties involved (contractor, Owner and Engineer).

The test sheets shall be submitted to the Owner/Engineer for approval along with the related procedures at least three months before starting the related activities.

6.11.3 Notification and Performance of Test/Inspection

The contractor shall give the Owner/Engineer a prior notice for the various tests as described in the contract documents, so that the Engineer /Owner representative(s) to participate, if they consider appropriate. With respect to site-related tests the contractor shall generally notify in writing the Owner/Engineer on the date of test/inspection as specified in the contract documents, if not agreed otherwise.

Such a notification shall contain the following information:

- Place, date and time of inspection;
- Reference to test/inspection procedure;
- Contractor's representative responsible for carrying out the test/inspection and the evaluation of the results;
- All necessary technical documents.

In case the contractor fails to perform the test at the notified time, notification procedure shall be repeated. The same applies, if the test was unsuccessful and must be carried out again.

If the Owner/Engineer fail to notify a time after having been asked to do so, or fail to attend at any time or place duly appointed for execution of the said tests, the contractor shall be entitled to proceed in absence, and the said tests shall be deemed to have been executed in the presence of the Owner/Engineer.

6.11.4 Testing Instruments and Equipment

The manufacturer shall maintain calibration registers showing equipment type, identification number and location, frequency of checks and method of checking for each equipment.

All instruments to be used for any inspection or testing shall be of the agreed accuracy, to the approval of the Engineer and subject to routine calibration against standard instruments. Calibration records shall be available for inspection by the Owner/Engineer.

Instruments and apparatus used for any inspection or testing (both on site and workshop) shall be of the best quality and subject to the Owner's/Engineer's approval, and if required by the Engineer shall be calibrated to an agreed standard at a laboratory of international standing. The laboratory shall be nominated by the contractor and approved by the Engineer.

For site inspections the contractor shall be responsible for and shall include in his delivery all safety measures such as barriers, warning signs etc. required for inspection and testing while erection is in progress.

6.11.5 Test Reports

Immediately after completion of any test or inspection a report with attached test sheets shall be prepared by the contractor, signed by the participants (representatives of contractor, Owner and Engineer) and distributed to all parties involved. The "final documentation" will only be accepted if each inspection is signed by all parties.

6.12 Certificates

Upon completion of an important project phase a certificate shall be prepared by the contractor, signed by and distributed to the concerned parties (contractor, Owner and Engineer). Signing of such certificate allows the contractor to start the next phase (e.g. pre-commissioning, plant overall tests). The form sheet for such certificate shall be prepared by the contractor and submitted for approval to the Owner / Engineer. General requirements for certificate are as following:

- Reference to the respective system/equipment;
- Reference to the respective project phase;
- Space for comments/observations;
- Attached drawing (P&ID, single line diagram, etc.) with the marked system/equipment,

- Attached Punch List.

6.12.1 Erection Completion Certificate

After a certain plant system has been completely installed and before any commissioning can commence, the contractor shall receive an Erection Completion Certificate (ECC) related to the system (or sub-system). The ECC shall only be approved and released, if the system has been inspected successfully and the outstanding items and all non-conformance reports are cleared. All necessary and related documentation must be available before the certificate can be issued.

6.12.2 Commissioning Completion Certificate

After ECC has been released, the commissioning takes place. Commissioning completion has to be certified with a certificate, generically called CCC.

6.12.3 Provisional Acceptance Certificate

After a system passed the tests on completion, the contractor shall receive a provisional acceptance certificate (PAC). The PAC shall only be approved and released, if the system has been tested successfully and the outstanding items are cleared. All necessary and related documentation must be available before the certificate can be issued.

On release of the PAC, the client has taken over the related unit for commercial operation. The full documentation required for a complete PAC shall comprise at least:

- Plant overall test report;
- Trial run report;
- Reliability test run report;
- Performance test report;
- List of outstanding items that are agreed to be cleared during the warranty period.

6.13 Administration of Outstanding Items

All pending items that have been found during tests/inspections shall be written down and administered in the following way:

- For workshop inspections the outstanding items shall be compiled by the contractor and attached to the appertaining test/inspection report;
- For site-related tests, for which no certificate is issued, like commissioning of plant components and plant overall tests according to the approved procedures the out-standing items shall be compiled by the contractor and attached to the appertaining test report. The Engineer will enter these items in the official punch list;

- The issuance of a certificate in case of completion of an important project phase is accompanied by a punch list, which is prepared by the Engineer and attached to the appertaining certificate.

6.14 Non Conformity

If any of the tested items fail to comply with the requirements of the specification in any respect whatsoever at any stage of manufacture, works test, erection site test and commissioning, the Owner/Engineer may reject the item or defective component thereof, whichever he considers necessary. After adjustment or modification, the contractor shall submit the item for further inspection and/or test.

In the event of a defect on any item being of such nature that the requirements of the specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the contractor to the satisfaction of the Owner/Engineer.

All requests for design changes and non-conformity reports issued during construction activities are reported using the agreed form and submitted to the Owner/Engineer for approval.

The Owner/Engineer will evaluate the necessity to involve the project Engineers in the design and non-conformity resolution approval.

After approval, all Engineering changes implemented at site are reported in a "red marked-up"-copy of the drawing. These will be the base for the as-built documents edition, which will be officially managed by the contractor.

6.15 Documentation

All procedures, reports and certificates shall be preserved by the contractor and shall be part of the general power plant documentation in accordance with the quality control programme.

6.16 Third Party Inspection

Some of the tests/inspections require participation of specific testing/inspection authorities as mentioned in the contract documents. The following examples for such tests/inspections are given below, which are not meant to be limited:

- Boiler pressure test;
- GTs – oil/gas fuel lines;
- Protection system tests;
- Safety valves settings;
- Continuous emission monitoring system;

- Firefighting system;
- Fire alarm system.

The Contractor is fully responsible for the co-ordination and notification related to such tests/inspections.

6.17 Manufacturing

The contractor shall describe in detail the degree, to which each plant component, or any part will be assembled in the factory, and the tests to be carried out on the parts assembled.

Type, sample, and routine tests shall be executed in accordance with the relevant codes and standards, or may be specifically approved for such equipment, where the test requirements are not clearly specified, e.g. where standards do not exist.

The contractor shall prepare a programme of all tests/inspections, which shall be submitted to the Owner/Engineer for approval. This programme shall give an overview of scope, type and sequence of the tests/inspections comprising the following documents:

- Manufacturer's QA/QC organisation chart;
- Time schedule with at least monthly update;
- Block diagram showing the main test/inspection phases and mile stones;
- Detailed list of all tests/inspections to be carried out mentioning all relevant details (e.g. place of tests/inspections, reference to relevant procedures etc.).

6.17.1 Review of Contractors Schedules and Documentation

The Engineer will review the contractors' production schedules and delivery programmes and will check their compliance with the contractual milestones dates of the relevant EPC contract. The Engineer will give recommendations for acceptance and / or necessary modifications in order to comply with the contractual requirements. Acceptance of the production schedules and delivery programmes will be executed by the Owner.

QA/QC levels for structures, materials and components based on the criticality of losing the unit capability in the event of failure shall be classified by the contractors and reviewed by the Engineer, recommendations for acceptance will be given.

The contractors shall submit for review detailed test procedures for equipment, sub-systems and complete systems covered under this contract. These procedures shall include details of all performance tests to be conducted in the manufacturers' factory. The lists shall be supplemented with logic diagrams to show the correct plant functioning requirements together with system flow diagrams showing all points of measurement for both functional and performance tests.

The procedures, lists, logic diagrams and flow diagrams together with test results shall be correlated and presented as a single bound document to form a comprehensive set of test procedures and records of the tests conducted in the workshop.

6.17.2 Tests and Inspections during Manufacturing

Workshop tests and inspections typically comprise type tests, detailed workshop tests, Final Acceptance Tests (FAT) and pre-shipment inspections.

6.17.3 Original Equipment Manufacturer

The basic information shall be made available by the original manufacturer for testing and inspection of equipment

- Erection and testing procedure;
- Block diagrams;
- System description and Functional diagram;
- Signal exchange with DCS;
- Description of applied logic control system;
- Detail design documents.

6.17.4 Pre-shipment Inspection

Pre-shipment inspections are used to certify the quality and quantity of equipment that shall be imported. These inspections, which are conducted prior to shipment and in the country of exportation, assure the importer that the goods conform to the technical specifications and the quality standards laid down in the contract and that the quantities exported are accurate. The basic purpose in performing a pre-shipment inspection is to bring under control any under- or over-invoicing of imported goods and other unfair or improper practices.

6.17.5 Workshop Inspection / Factory Test Reports

The workshop inspection reports will prepa5red by Engineer and describe clearly the particular materials, parts, or components, which were inspected. Nomenclature given in the drawings and specifications to be delivered by the Contractors will be used in identifying parts. Each report will describe the stage of the part or component or item at the time of the inspection, the type of inspection made and the results of the inspection. Measurements taken during the inspection will be recorded in the report.

Factory Acceptance Tests witnessed, will be described by applicable testing procedure and results achieved. All defects, sub-standard or questionable conditions, discrepancies or deficiencies will be fully described in the report. The report will also indicate results of discussion about such conditions with the manufacturer and the steps, which the manufacturer proposed in order to rectify such noted deficiencies.

Expediting and Manufacturing Progress Reports summarise the Consultant's review of manufacturing and delivery status in the projects.

6.18 Erection

On site, the received material shall be inspected in open case inspections, before the parts and components are transferred to the contractors' warehouse. During installation all necessary tests shall be performed and finally, when the plant or parts of the plant have been completed, this shall be approved by a certificate following an erection completion inspection.

6.18.1 Materials Received

Effective material control is a prerequisite for meeting the schedule and providing a quality execution of the project. All incoming materials are to be inspected by the contractor before storage.

An open case inspection is carried out in order to verify:

- Availability of delivery note, packing list, release for shipping and manufacturing certification manual as required;
- Availability of the preservation instruction, if any, and the O&M manuals;
- Material compliance to shipping documents, and
- Packages, integrity and lack of damages on materials.

For each open case inspection, the contractor shall issue a "received material report", recording the conformity or any damages and discrepancy observed. In case of damage the report shall be forwarded to the Owner/Engineer so that he may review the damage. The Engineer's approval has been obtained for any repair, replacement or acceptance to any damaged item. All non-conformity materials shall be identified as "waiting for disposition".

Each contractor is responsible to preserve materials at site and to provide suitable warehouses and storage area taking into account the related storage requirements and provisions.

6.18.2 Installation and Erection Testing

The Owner/Engineer performs surveillance on the contractor's installation and erection activities in order to ascertain the conformance of the work to the contractual requirements and that suitable workmanship is utilized by the contractors.

All contractors shall carry out their inspections and tests on the basis of the site quality control plan (QCP), using suitable and calibrated equipment, in order to ensure that all the requirements will be met.

6.18.3 Erection Completion Inspections

As soon as the erection/installation of a confined system has been completed, an erection completion inspection of said system shall be carried out. The degree of completion of the system is determined by the requirement, that a safe and complete pre-commissioning shall be possible, since a piecemeal pre-commissioning is not acceptable. Prior to start of the erection completion inspections all site tests/inspections related to this system shall be completed and the respective reports signed, if not explicitly agreed otherwise.

In order to simplify the organisation of the inspections, the whole plant shall be divided into defined and confined systems/subsystems, on which basically an inspection schedule has to be prepared and distributed to all parties involved. The inspections shall be carried out according to the inspection schedule, i.e. system by system, in the following disciplines:

- Civil;
- Mechanical;
- Electrical;
- I&C.

6.19 Commissioning

For the proper planning of the Commissioning period, the Contractor and Engineer should take in account the site conditions and other constrains just like the numerous subcontractors, the quality of the storage, and prefabrication and construction processes and latest expectations of the Client (e.g. implementation new technology or technics). Also, weather conditions (e.g. high temperatures and humidity with a high content of oil, dust, silica, and salt in the air) are crucial.

6.19.1 Test/Inspection Programme and Commissioning Procedures

The contractor shall prepare a programme of all tests/inspections, which shall be submitted to the Owner/Engineer for approval. This programme shall give an overview of scope, type and sequence of the tests/inspections comprising the following documents:

- Commissioning organisation chart;
- Time schedule with at least monthly update;
- Block diagram showing the main test/inspection phases and mile stones;
- Detailed list of all tests/inspections to be carried out mentioning all relevant details (e.g. place of tests/inspections, reference to relevant procedures etc.).

The operation of the plant included in the works shall be under the supervision and responsibility of the contractor until the date of issuance of "taking-over certificate" for the works.

The contractor shall be responsible for the safe and efficient setting to work of the whole of the plant and equipment. The methods adopted shall be subject to the approval of the Engineer or his representative on site, and shall be in accordance with any safety and permit regulations in force by the Owner on the site. The contractor shall give sufficient detail in his programme to satisfy the Engineer that the sequence and duration of the proposed commissioning activities are logical and realistic. Details of the contractors' commissioning staff necessary to achieve the programme shall be given.

6.19.2 Tests and Inspections during Commissioning

During the commissioning phase, all tests and activities necessary to the first start-up of the plant shall be carried out in compliance with the contractual requirements to confirm that the plant can perform under steady state and transient operating conditions.

The commissioning and start-up planning shall be carried out well in advance to the beginning of the commissioning activities and are subject to the approval of the Owner/Engineer. During this period and after the beginning of the commissioning, the planning documents are to be updated by the commissioning manager as required. The commissioning manager provides test procedures based on the detailed test programme prepared by the manufacturers.

Commissioning testing starts in accordance with the relevant section of each contract document after construction, i.e. when the respective erection completion certificate (ECC) has been issued. The contractor will be responsible for commissioning testing under the authority of the senior commissioning Engineer/commissioning manager. Commissioning testing will continue until all agreed tests have been completed to the satisfaction of the parties concerned. During these tests the involvement of the Owners' operation or other relevant departments shall be necessary and it is important that they be involved as much as possible as part of their "on the job training". However, it is underlined that the responsibility of commissioning lies on Contractor's shoulder and cannot be shifted in any way to Owner's staff

The commissioning tests shall include tests to show that:

- The plant may be started up and shut-down, in an economical and well-controlled manner, using the methods described in the contractor's draft instruction manuals, without the use of any special or unusual skills on the part of the operators and without imposing any stress or loading on any plant item beyond that for which it is designed;
- The plant may be shut-down satisfactorily under emergency conditions using the methods described in the contractor's draft instruction manuals;
- The plant may be run stable at any load within its design range, under automatic control.

6.20 Tests on Completion

To carry out the onsite tests of such a magnitude in correct and satisfactory manner, careful planning and proper execution are essential at every stage of the test. In this section various requirements before, during and after conducting of equipment tests are discussed.

The tests on completion shall comprise the following tests:

- Plant overall tests;
- Trial run / Initial operation;
- Reliability test run;
- Performance test.

For each of the tests mentioned above a test procedure shall be prepared by the contractor in accordance with the contract documents. After test completion test reports shall be prepared by the contractor and signed by all parties concerned.

6.21 Plant Overall Tests

This series of tests shall demonstrate that the plant or parts thereof can react as per design on change of operating modes, varying load demands and trip scenarios.

The following tests shall be performed as an example:

- First synchronisation;
- Load rejection;

- Load rejection to house load;
- Load ramps;
- Automatic change over to stand-by equipment;
- Load capability test;
- Start-up time on cold, warm and hot conditions.

During the plant overall tests also plant optimisation works shall be carried out, such as:

- Improvement of the performance of closed-loop controls;
- Clearance of all fault indications;
- Improvement of VDU mimic displays.

6.22 Performance Tests

As soon as possible after the satisfactory completion of the reliability test run official performance and efficiency tests are to be carried out which may repeat the tests carried out at the manufacturers' works, and any other tests the Engineer may require in order to determine that the plant is in accordance with the specification and guarantees. The start of the performance test shall be mutually agreed between contractor, Owner and Engineer.

The performance test procedures shall be prepared strictly in accordance with applicable international codes and standards. The contractual performance guarantees shall be as defined in the "guarantee data".

The date upon which performance tests are completed is defined as the date by which the test report has been signed by all involved parties, the contractor has removed all test instruments and returned the plant and equipment to its pre-performance test condition, such that it can be used by the Owner for commercial power generation. The performance test shall be carried out by the contractor to the requirements of the Engineer, after the satisfactory completion of the reliability test run.

During tests, the plant shall be operated by the Owners' O&M staff under the direction of the contractors' representative and to the mutual satisfaction of the parties concerned, but under the general supervision of the Engineer.

The performance of a power plant is widely understood in terms of *efficiency* and *heat rate*. Heat rate is the heat input required per unit of power generated (kJ/kWh), for specific fuel being fired and specific site conditions.

6.23 Incident Reports

From the date of commencement of the tests on completion and until the expiration of the defects liability period, all incidents shall be reported under an approved incident reporting system. An incident is defined as any failure or interruption such as an unscheduled trip or inadvertent operator or maintenance action causing a trip, occurring in any portion of the plant covered by the contract. Incident reports shall be submitted within 36 hours from time of occurrence.

6.24 Control Systems Reports

From the date of commencement of the tests on completion and until the expiration of the defects liability period all control systems changes, alarm and trip setting changes, etc., and maintenance activities due to module or component failures or defects or incidents shall be reported under an approved control systems reporting system.

6.25 Commissioning completion

The positive and successful completion of the reliability test run is the basis to commence commercial operation of the plant. Once commercial operation has been agreed, the "provisional acceptance certificate" shall be issued and the plant shall be taken over by the Owner. The provisional acceptance certificate will be countersigned by the contractor and Owner/Engineer.

The last tests (i.e. the performance test) shall be conducted shortly after the completion of the reliability test and shall demonstrate that the plant meets all contractually agreed parameters.

6.26 Taking over

After successful of commercial operation agreed time and issuing of PAC - provisional acceptance certificate the plant shall be ready for taking over by the Owner.

7 DESCRIPTION OF PLANT EQUIPMENT

7.1 Gas Turbine

Based on major project assumptions:

- High cost of fuel – imported LNG;
- Fuel price 8.7 US$/MMBTU-HHV at Site;
- Expected 8,000 operating hours/year;
- Estimated future capacity of power plant - 1,100 -1,400 MW (net, ISO);
- Planned minimum 25 years of based load operation

Only the most advanced, reliable heavy duty gas turbine with dual fuel firing system shall be taken into account. Finally, Lahmeyer recommended below listed GT series:

- Mitsubishi Hitachi Power Systems - M701J;
- GE Water & Power - 9HA.01;
- Alstom - GT26;
- Siemens - SGT5-8000H.

Furthermore, as it was presented above, power augmentation via evaporation cooling could be considered too. In principle, 1 block - a multi shaft configuration with a 2-2-1 configuration with a two heavy duty gas turbines (H class), could achieve 1,100 – 1,400 MW (net, ISO) at high efficiency. 2 blocks with single shaft configuration (2 x 1-1-1) and 1 block with multi shaft (3-3-1) have been considered in the pre-feasibility stage, but have not been considered in this stage anymore.

For evaluation process of submitted EPC tenders the 3years' life-cycle cost, based on NPV basis will be considered, twelve (12) year will be considered only for LTSA costs. Additionally, O&M costs for commercial operation of single cycle during nine (9) months will be considered too.

The block(s) shall be designed as an indoor design with separate fin-fan coolers and advanced, experience-proven inlet air system for low cost operation in the local conditions. Additionally, for required SC operation mode the exhaust ducting system including all necessary equipment for single cycle operation of the gas turbine shall be provided too.

The GT unit generator packages shall be provided complete in every respect including all components required for safe and reliable operation in this dusty area and hot climate, whether mentioned or not mentioned in this Employer's Requirements.

A combined gas distribution piping system including insulation valves and instrumentation for each the GT units shall be provided. This system shall include but not be limited to:

- Final gas filters in front of each GT unit dual type or pulse type;
- Piping interconnections of all equipment;
- Sample points;
- Gas detection system;
- Dry low NOX combustion system for RLNG;
- Gas flow metering separate for each GT-unit.

7.2 Heat Recovery Steam Generators

Heat Recovery Steam Generators (HRSG) shall be design as an "indoor". Gas turbine and HRSG shall be started up commonly. The gas turbine exhaust gas at start-up is directly led to the HRSG. The HRSG shall be shut down in accordance with the normal gas turbine shutdown. The HRSG shall be provided as once through boiler and/or with adequately dimensioned steam drums to ensure stable operation under all load conditions.

The supporting structure shall be designed considering the internal forces and expansions, as well as forces from wind, earthquake, etc.

The HRSG shall be arranged with its total pressure parts comprising of steam drums, super-heaters, evaporators, economisers, headers, integral pipework, etc. in the form of a self-contained unit supported by its own steel structure.

Headers shall be fabricated from seamless steel pipes and shall be provided with removable butt-welded end caps to facilitate internal cleaning and inspection. Suitable means of access shall be provided between all tube banks for inspection and cleaning purposes.

In order to avoid low temperature corrosion in any part of the economizer or the stack, the feed water temperature shall not drop below a certain limit depending on the sulphur content of the fuel.

The evaporator systems shall be designed to operate over the full load range without drumming or vibration and the design shall ensure an even distribution of water through the tubes.

In case of using a natural circulation system, the down comers shall be designed to achieve a uniform circulation ratio to the individual evaporator tubes over the full load range.

Each superheater shall be of the self-draining type. Means of steam temperature control shall be employed for the high steam pressure systems to enable a constant steam outlet temperature to be obtained over the range of 70% 110% base load steam flow. A superheated steam sampling point shall be provided, complete with CCW cooling and all necessary pipework.

All superheater drain valves shall be motor operated if the valves are required to be operated during start-up, shutdown or normal operation of plant.

A reasonable number of thermocouples shall be provided for measuring and recording the tube metal temperatures during the commissioning period i.e. on temporary basis as well as for normal operation i.e. as permanent installations.

The desuperheaters shall be of the variable spray nozzle type, to ensure proper atomisation over the whole range of operation. Steam downstream of the superheaters shall be conditioned to meet the steam turbine manufacturer's requirements at all times. The desuperheaters shall be sized for the full continuous operating range and 110% of the maximum steam mass flow rate over all continuous operating pressures of the HRSG. The last attemperator shall be installed upstream of the last superheater section i.e. water injection into the live steam line upstream of the steam turbine is not permitted.

Feed water shall be used for spray water, which shall be branched off, upstream of the control valves. Injection water flow measurements shall be provided on the main line as well as on all branch lines. The desuperheating pipework and all valves shall be designed to withstand the maximum pressure of the feed pump and the final feed water temperature.

A roof deck with side wall panels will be provided for each HRSG. This arrangement will cover all top mounted drums, valves and instrumentation. Provisions will be taken for adequate ventilation and heating, so that excessive temperature built up and freezing of any equipment will not be experienced.

7.3 Condensate System

The condensate system shall be designed for the supply of condensate from the ST condenser to the feed water system. The condensate system shall be complete in any respect for safe and reliable operation and shall include, but not be limited to the following main components:

- 2 x 100% condensate pumps complete with motors, couplings, coupling protection;
- Pneumatic or motorised control valve as minimum flow device leading back to condenser;
- Non-return valves and motorised isolating valves at each pump suction and discharge line;
- Sealing water system for valves without bellows normally operating under vacuum all, necessary supporting steel structure, frames, cooling and lubrication system including local instrumentation, drains and vents, control system, switches, etc.,
- Spray water system supplying main condensate from the main condensate pump discharge to the by-pass desuperheating stations, if desuperheated by condensate pumps, ST exhaust hood spray, etc.,

The main condensate flow shall be controlled by the condenser hotwell level control system actuating a control valve in the main condensate pump discharge. The total condensate flow capacity shall be the maximum condensate flow plus all make-up requirements including desuperheating requirements for by-pass stations. The feed water storage tank level is controlled by discharge of main condensate from the condenser and the make-up water from the make-up water storage tank.

The make-up water supplied by the make-up water pumps shall be sprayed into and degassed in the condenser. The gland steam condenser condensate and the minimum flow of the condensate pumps shall be fed to the condenser.

The condensate shall flow via the condensate pumps to the feed water storage tank. It shall be ensured that any HRSG tube wall temperature shall be kept above the acid dew point. In order to avoid low temperature corrosion in any part of the economisers or the stack, the HRSG water inlet temperature shall not drop below a certain limit, depending on the sulphur content of the fuel. All system components must be designed for zero delivery flow of the main condensate pumps. The pumps shall be protected against maximum pressure and minimum flow.

Condensate pumps with sufficient redundancy and capacity shall be provided to supply the maximum condensate flow of the Plant. The standby pump shall be capable of starting automatically in case of failure of the running pump.

The pumps shall work without cavitation under all operating conditions. The available NPSH at minimum level of the condenser hotwell and with maximum head losses of the suction strainers and suction pipe shall be higher than the required NPSH at all loads, from the minimum to the maximum flow.

7.3.1 Make-up Water Supply System

Make-up water shall be used for the condensate feed water system (water losses) and for drain condensate cooling. In case the feed water level in the feed water tank drops, make-up water shall be fed to the condenser via a control station. To minimise the O_2 content in the condensate system make-up water shall be sprayed into the condenser by means of spray nozzles. The quantity of make-up water shall be monitored continuously.

For filling the feed water system, the make-up water pumps feed the make-up water to the feed water tank directly. Therefore, a connection at the feed water tank shall be provided.

2 x 100 % make-up water pumps (one in standby) shall feed the make-up water to the make-up water consumers. A flow measurement shall be provided to each make up water consumer. All parts or components of the make-up water supply shall be made from stainless steel.

7.4 Feed Water and Steam System

7.4.1 Feed Water

The feed water system shall include, but not be limited to the following main components:

- a combined feed water storage tank for the HRSG or a separate feed water storage tank for the HRSG including steam heating device, and all necessary equipment;

- a spray or degassing type deaerator system which may be combined with the feed water tank(s):(if required);
- LP steam and or ST bleed steam supply system for each feed-water tank heating to required temperatures including steam pressure reducing stations, all necessary nozzles, flanges, local instrumentation, vent and drain system, control system, warming up facilities, etc.;
- Feed water pumps in sufficient redundancy;
- Automatically operated minimum flow devices with integrated non-return flow function, separate for each individual pump;
- All necessary connecting pipes, including hangers, supports, vent and drain systems, valves, motor valves, non-return valve, strainers, traps;
- Components of the feed water system piping system, if not specified elsewhere.

Feed water storage in case of maximum outlet flow and no inlet flow to feed water storage tank shall be sufficient for a time period of min. 7 minutes. The feed water tank(s) / deaerator(s) shall be operated above atmospheric pressure under all load conditions. The feed water tank(s) temperature shall be preferably >130°C. The feed water storage tank(s') level shall be controlled by a combination of make-up to condenser and condenser level control valve at discharge of condensate pumps.

7.4.2 Steam System

The steam systems shall be complete in every respect for safe and reliable operation and shall include, but not be limited to the following main components:

- Steam piping from each HRSG outlet to steam headers near to ST;
- HRSG start up piping with control and motor isolation valves and silencer;
- Steam piping to ST, steam piping connection to by-pass station(s), including stop valves and isolation valves;
- Appropriate steam supply for gland steam, start-up and heating requirements of the plant;
- Spray water pipelines to individual desuperheating stations including spray water flow control stations with individual flow measurement;
- All required draining and venting systems;
- All required warm-up lines for all steam lines including the lines from and to the steam bypass stations;
- Drains and condensate collection system with drain pumps, including start-up atmospheric drains flash tank with necessary silencer, including all necessary equipment.

All drain valves shall be of an approved throttle controlling type and shall have cast or forged steel bodies with covers and glands of approved design.

7.5 Steam turbine and Condenser

7.5.1 Steam turbine

The steam turbine shall be of the condensing type without steam extraction for feedwater heating or other heating purposes. The steam is produced in the HRSGs at three pressure levels, including a reheat after the HP part of the turbine. The amount of produced steam is transferred to the steam turbine to generate power for export to the grid and to cover the auxiliary electricity demand of the auxiliaries.

For the considered configuration of two gas turbines with HRSG producing steam to one common header and feeding one steam turbine, there are restrictions of the turbine manufacturers with regard to the capacity and design. Therefore, the final decision to select one or two steam turbines as well as the selection of live steam parameters should be left to the contractor for competitive reasons.

The LP exhaust steam is condensed in a surface condenser cooled by water of the channel XXX. Depending on ST-manufacturer, the LP exhaust can be of single or double flow design.

The following general requirements shall be considered:

- HRSG with 3 pressure with reheat, condensing type;
- Modified sliding pressure operation (fixed pressure at low ST loads and sliding pressure at higher ST loads).

Steam turbine generator package shall be completed in every respect for reliable, efficient and safe operation for achieving high service life time whether mentioned or not in this Employer's Requirements. The following major design features shall be considered:

- Steam admission valves consisting of stop- and control-valve for HP and LP steam;
- Complete oil system;
- Turbine and generator bearing with 2-plane proximity vibration system (monitor, record, trend);
- Hydrogen-cooled electrical generator.

7.5.2 Condenser

The following general requirements shall be considered:

- Manufacturing, assembling and testing in the workshop to the highest extend possible for improved quality and short erection time on site as applicable;
- Satisfactory performance up to highest cooling water temperature;
- The condenser shall be complete in every respect for reliable, efficient, and safe operation for a high service lifetime including 100 % bypass operation of steam turbine;

7.6 Fuel System

7.6.1 Fuel Gas System

The gas receiving station will be in the scope of the selected gas supplier. The pre-treated gas shall be supplied via one (1) 16" pipeline levels to the power station. The respective terminal point shall be the isolating flange. Fiscal metering and gas analysis via gas chromatograph shall be part of the GRMS of the gas supplier.

A connection of the Plant's DCS to the gas supplier's metering and analysing instruments shall be provided by the Contractor for data evaluation. Further, independent metering shall be provided for the power station by the Contractor for verification purposes. One check-meter shall be implemented on the power plant premises for control purposes.

In order to ensure the required gas quality appropriate filters shall be provided for each line as required. For safety reasons emergency shut-off valves shall be supplied downstream yet in proximity to the terminal points. Special attention shall be paid to ensure increased safety against fire hazard due to gas handling, e.g. NFPA standards or equivalent have to be adhered to. Hazardous areas shall be defined by the Con-tractor in the Master plan for Hazard Zones according to applicable regulations and standards.

The fuel gas flow at the terminal points will be sufficient for maximum output at an inlet pressure of around 37.9bar(g). Depending on the GT model, the inlet gas pressure requirement to the GT may differ between 27 to 54 bars. The EPC Contractors will include a gas compressor system within its scope.

The fuel gas system shall be provided complete in every respect for safe and reliable operation whether mentioned or not mentioned in these Employer's Requirements. The scope of supply shall include but not be limited to the following main equipment / installations:

- Isolation valve with flange connection at terminal point, connection by Contractor;
- One emergency shut-off valve for the gas supply line in proximity to the terminal points;
- One Check meter with accuracy of ±0.5% and adequate measuring range (online gas chromatograph);
- Connection to gas supplier's GRMS and telemetry (if available), online operation data measuring and recording of data in the plant DCS;
- One single vertical separator scrubber (100% DFR);
- One dual dust filter.

All equipment shall comply with the special aspects and properties of re-liquefied fuel gas. All equipment to be supplied as pre-packaged modules for improved quality and short erection time on site, complete with all accessories as motors, controls as required for automatic unmanned operation, start/stop capability from DCS, status reporting, valves and piping, instruments and cabling. The 100 % Design Flow Rate (DFR) of the gas system shall correspond to 105% of the maximum fuel gas consumption at minimum calorific value of all GT units.

The check – meter shall measure the current as well as accumulated gas flow at an accuracy of 0.5%. The possibility of continuous monitoring and recording of measurements via DCS shall be provided.

7.6.2 Fuel Oil Systems – Back up fuel

A fuel oil system will be provided to supply diesel oil, as back-up fuel for the GTs, to ensure continuous uninterrupted operation of GTs, if the gas supply is interrupted. The fuel oil system will be optimized and have sufficient redundancy to ensure the maximum availability of the GTs including the phase during a changeover between fuel types.

The fuel oil system will include facilities for sufficient number of simultaneous road tanker unloading to ensure continuous HSD operation, a series fuel oil storage tanks for 7 days' full load operation, and all related equipment. The fuel oil system will be designed to be operable under the coldest specified ambient conditions.

7.7 Raw Water System

During ten to eleven months per year, raw water will be taken from an irrigation canal adjacent to the site of Haveli BS PP, the Trimmu-Sidhnai link canal (TS link) and future Jhang project site. The flow of the canal is sufficient to use 'once through' cooling as the main cooling system technology (called **'System A'** in the following).

During approx. one to two months per year, water from the canal will be unavailable. In this period, the raw water will be taken from a well field (called '**System B**' in the following). The water treatment installations shall be designed to be fed by canal water and well water qualities.

According to preliminary findings - Groundwater Availability Study, the existing wells show sufficient quantity and suitable quality of well water to provide for the needs of the cooling tower as well as other water needs. However, the main source of recharge of the underground aquifer is judged to be vertical penetration of canal water flowing parallel to the site. This is crucial, since the expected times of high well water extraction is during the period when the canal is empty. It has to be determined if and how the extraction of the needed quantities of raw water from the aquifer will be possible during unavailability of the main recharge source (canal water). Special attention shall be paid to the stability of buildings and foundations of heavy equipment such as gas turbines and the cooling tower structure.

For System A, the Contractor shall supply the following pre-treatment systems:

- Raw water pre-settlement system;
- Raw water clarification system;

- Sludge dewatering system;
- Hypochlorite preparation, and dosing facilities;
- Clarified water storage basin;
- Clarified water pumping station.

For System B, the Contractor shall supply:

- Well gallery including a sufficient number of wells, well pumps and water transfer piping;
- Aeration vessel with 2 x 100% air compressors (if required);
- 2 x 100% Mechanical filters (sand or multimedia) with backwash facilities;
- Filtered water tank;
- All necessary equipment (such as pumps, piping, shelter, etc.) for satisfactory operation.

The Contractor's supply shall include but not be limited to the engineering design, manufacturing, material testing, delivery, installation, commissioning and trial operation of the equipment. The Contractor shall be fully responsible for the design, detail engineering, manufacture, transportation, erection and operation of the whole canal water treatment plant. The Contractor shall perform all required water analyses prior to system design. The raw water treatment system design shall be based on the results of the raw water analyses. The annual hydrograph levels shall be considered as well as the seasonal variations of raw water and well water qualities.

7.8 Water Intake and Discharge System

The following requirements shall be considered for the complete water supply and discharge system required for the power plant during availability of the canal:

- Water shall be extracted from the canal;
- Intake water shall be chlorinated by means of an electro chlorination plant;
- Satisfactory operation of the water intake pumps (main cooling water pumps and auxiliary pumps) under worst condition without cavitation at all water levels shall be provided; head losses of the canal water supply system as well as minimum submergence of pumps shall be considered;
- Proven design and high reliability;
- Easy handling of equipment;
- Easy maintenance and repair;
- Suspended solids shall be removed from the canal water by means of intake water screens arranged upstream of the intake water pumps. The intake water screens shall be periodically cleaned by compressed air impulse provided by 2 x 100 % air compressors;
- The screening facilities shall be designed for continuous operation;

- Screening equipment shall be cleaned automatically dependent on the water level in the sedimentation pond;
- Common cross channel between outlet of intake water pipes and the river water filtration system with the possibility to separate filter units for maintenance purposes to be provided.

The canal water intake and screening plant, as well as the cooling water discharge structures shall be provided complete in every respect including all components required for safe and reliable operation, whether mentioned or not mentioned in these Employer's Requirements. The scope of supply shall include but not be limited to the following studies, main equipment/installations:

- Housed in intake water pump structure;
- Intake water screening equipment upstream of the intake pumps;
- 2 x 100% Air compressor station for backwash of screening facilities;
- Isolation valves for separation purposes of intake pumps and pipelines as well as the common cross channels;
- As far as required, cathodic corrosion protection system;
- Monitoring system for water supply and water discharge for quality control etc.;
- According to Environmental legislation, the temperature increase of the discharged water shall not exceed 3°C at 100 m a distance from the discharge water outlet in the canal.

7.9 Main Cooling Water System

In case of more than one CCPP block, each block shall be equipped with independent main cooling water system. The main cooling water system shall mainly supply circulating water to the condensers as well as cooling water to the closed cooling water coolers. The thermal energy to be extracted from the condensers and the individual auxiliary coolers is determined by the cooling requirements of the particular consumers.

During ten to eleven months per year, main cooling water will be taken from an irrigation canal adjacent to the site of Jhang PP. The flow of the canal is sufficient then to use 'once through' cooling as the main cooling system technology (called **'System A'** in the following) then.

During approx. one to two months per year, water from the canal will be unavailable. In this period, mechanical draft cell-type cooling (called **'System B'** in the following) will serve as the heating sink.

Both main cooling systems, System A – Once-through cooling - and System B - mechanical draft cell-type cooling towers -have to be connected in a manner to allow smooth switch over from System A to System B operation. Interconnection points shall be upstream and downstream of the condenser (after the closed cooling cooler connection). They shall share the cooling water piping through the condenser as well as bypass cooling connection for closed cooling water coolers.

All necessary equipment in order to enable switch over from one main cooling water source to the other (System A to B and vice versa), shall be provided, such but not limited to save isolation of both main cooling water sources (canal water and closed cooling tower water), flushing facilities, etc. Different water quality of main water cooling systems A and B shall be considered for common equipment and interconnection points.

7.9.1 System A – Once-through Cooling

For 'System A' – Once-through Cooling main cooling water system where the water used for cooling purposes shall be extracted from the canal and passes through the screening (filtration) system to the suction of the main cooling water pumps and back to canal via discharge facilities.

The system shall meet the cooling requirements of the steam turbine condenser and closed cooling water system. The major requirements for System A are as following:

- Hydraulic calculation of main cooling cycle and turbine condenser for optimisation of the main cooling pump design data including siphon effect;
- The main cooling water system shall be based on canal water intake with cooling water pumps. After passing the condensers, the cooling water shall be discharged back to canal;
- Two groups of different pumps shall be considered:
    - 3 x 50 % main cooling water pumps per unit - see the main cooling water system;
    - 3x 50 % auxiliary cooling water pumps per unit - raw water demand of the unit - see the raw water treatment system;
- Isolation valves shall be provided to allow for isolation and maintenance of one intake pump or one of the intake pipelines without interruption of the CCPP operation;
- Start-up pump may be proposed by Contractor;
- The complete unit shall be operated without trip after a failure of one main cooling water pump;
- Butterfly valves with adjustable closing time shall be arranged at the main cooling pumps discharge. The closing time shall be optimised to avoid the system water hammer effect. A water hammer analysis shall be executed by the Contractor;
- Chemical injection to avoid hardness deposition, corrosion, and organic and biological growth within the system, as required for safe and continuous plant operation through-out the year;
- The chemical laboratory shall be equipped for raw water and cooling water analysis;
- Inlet and outline pipe routing shall be optimised in length and location. Pipes to be corrosion protected;
- The cooling system shall be made from proven material;
- The circulating water system shall be designed for continuous operation under all prevailing climatic and load conditions. Materials shall be carefully selected to resist the effects of erosion and corrosion at Site conditions. Materials are subject of approval;

- Interconnection to and interaction to main cooling system B shall be considered in all design aspects.

The system shall be complete in any respect for safe and reliable operation and shall include per unit, but not be limited to, the following main components:

- Cooling water screening system;
- 3 x 50 % main cooling water pumps complete with motor, coupling and coupling protection, reverse rotation locks, foundation frames common to support pump and motor, etc. shall be provided. Stop gates with integrated water level equalising valves, including guide rails, lifting equipment, cover plates, etc., for isolation of each water pump inlet;
- Optional a filling pump might be considered;
- Complete pipe and valve system between the main cooling water pumps up to the condensers and from the condensers back to the discharge system to the canal as well as the interconnection to other systems required for reliable operation;
- Reliable preservation of the equipment during stand still of 1 to 2 months per year;
- In addition, all relevant general requirements being mechanical, electrical, I&C, corrosion protection, insulation, etc. shall be adhered to. The following systems are associated to the once-through main cooling water system:
    - The closed cooling water system, which is required for cooling purposes of main equipment such as GT and ST oil coolers, sealing oil coolers, generator coolers, condenser vacuum pumps, feed water pump sets, condensate pumps (if necessary), sample coolers, and plant compressors, hydrogen generation plant etc.;
    - The chemical dosing system (e.g. chlorine dosing system) is required to protect the inner pipe surfaces against biological growth and as corrosion protection;
    - The mechanical draft cell-type main cooling system (System B).

7.9.2 System B – Mechanical draught cell-type cooling tower

During 1 to 2 months per year, canal water won't be available. Therefore, an alternative re-cooling system to be considered for this period, called 'System B'. Preferably, this alternative re-cooling system shall consist of a number of mechanical draught cooling tower cells. Main cooling water, taken from treated well water, shall be pumped in a close loop (except for losses, CT make up water and blow down) from cold-water basin via condenser and closed cooling water coolers and back to hot water inlet of the cooling tower cells.

The EPC contractor shall consider a safety margin which allows the operation of the steam turbine generator unit with one separated cell during maintenance and/or repair periods. The arrangement of the mechanical draught cell type cooling tower shall consider easy handling at normal operation. Safety equipment as well as all equipment for maintenance shall be provided (handrails, lifting devices, bird grids, etc.).

The heat flow to be extracted from the steam turbine condenser and the individual closed cooling water coolers is determined by the cooling requirements of the particular consumers.

Each cooling tower cell shall be equipped with a cold water basin. The cooled water shall be led to a common collecting channel and further to a collecting basin in front of the main cooling water pumps. It shall be possible to isolate each cooling tower cell for maintenance and cleaning purposes without interruption of operation of the remaining cells. Shut-off valves (warm water supply), drain pits and stop gates (cold water basin) shall be provided.

The air intake above the cold water basins shall be equipped with adjustable louvers to eliminate dust ingress by the fans and to avoid increased spray losses. The louvers shall be arranged from the bot-tom section up.

Each cooling tower cell shall be equipped with a fan, appropriate gear, driving shaft and motor arranged on a common non-corrosive base frame. The fan blades shall be made of glass fibre reinforced polyester. The fan blade leading edges shall be covered by suitable erosion protection material. The fan system shall be statically and dynamically balanced. A vibration sensor shall be provided for each fan, which trips the same when vibration exceeds allowable limits. The fan shall be protected against reverse rotation. The shafts shall be made of stainless steel. The reduction gear box shall be made of high grade cast iron. The whole driving system shall be equipped with forced oil lubricating system.

Each of the fans of the cell type cooling tower shall be switched on/off individually depending on the cooling water temperature.

The cooling tower fill shall be of rigid proper-type filling modules, safe from attack by chemicals at any temperature and site condition. They shall be fire resistant. The tower filling modules shall withstand all cleaning procedures without any damage. The proper-type filling modules shall be cleaned by means of spray water or pressurised air. In case of damage the tower filling modules shall be removable without any difficulties. Hangers shall be made of stainless steel.

Main cooling water pumps provided, shall be capable to run in single and in parallel operation plus 1 x 50% spare pump. It should be considered that the cooling water pumps of System A can be used also for System B. The complete unit shall be operated without trip after a failure of one main cooling water pump. The complete main cooling system shall be optimised with consideration to the siphon effect. A head loss calculation is part of the scope of supply of Contractor and subject of approval. The chemical laboratory shall be equipped for raw water (coming from well field) and cooling tower water analysis. Inlet and outline pipe routing shall be optimised in length and location. Pipes to be corrosion protected.

The main cooling water system shall be designed for continuous operation under all prevailing climatic and load conditions. Materials shall be carefully selected to resist the effects of erosion and corrosion at Site conditions. Materials are subject of approval. Interconnection to and interaction with main cooling system A to be considered in all design aspects. Reliable preservation of the equipment during stand still of 10 to 11 months per year to be provided.

The system shall be complete in any respect for safe and reliable operation and shall include per unit, but not be limited to, the following main components:

- Mechanical draught cell-type cooling tower, complete with foundation, reinforced concrete structure, cold water basins, and fan with gear and motor, etc. (refer to heat and mass balance diagram);
- All necessary pipes, compensators, valves, etc., for the distribution from the particular cooling tower cells to the condenser and back to cooling tower cells, as well as the interconnection to other systems required for reliable operation;
- Three main cooling tower water pump sets each of 50% capacity, complete with motor, coupling and coupling protection, reverse rotation locks, foundation frames common to support pump and motor, etc.;
- Three booster pumps sets each of 50% capacity, complete with motor, coupling and coupling protection, reverse rotation locks, foundation frames common to support pump and motor, etc. as applicable;
- Chemical injection to avoid hardness deposition, corrosion, and organic and biological growth within the system, as required for safe and continuous plant operation through-out the year.
- Stop gate, guides and lifting devices (fixed or movable), for separation and handling of each cooling tower cell and its equipment;
- All necessary lifting devices required for maintenance and repair work on fans, motors, pipes and valves, installed on the fan elevation;
- Complete and proper corrosion protection considering the actual atmospheric conditions including coating of the reinforced concrete;
- Coarse grids with cleaning equipment in the discharge channel of each cooling tower cell line;
- In addition, all relevant general requirements being mechanical, electrical, I&C, corrosion protection, insulation, etc. shall be adhered to.
- The following systems are associated to the mechanical draught cell-type cooling tower main cooling water system:
    - The closed cooling water system, which is required for cooling purposes of main equipment such as GT and ST oil coolers, sealing oil coolers, generator coolers, condenser vacuum pumps, feed water pump sets, condensate pumps (if necessary), sample coolers, and plant compressors, hydrogen generation plant etc.;
    - The chemical dosing system (e.g. chlorine dosing system) is required to protect the inner pipe surfaces against biological growth and as corrosion protection;
    - Blow down system;
    - Cooling tower make up water connection;

- The once-through main cooling system (System A).

7.10 Closed Cooling Water System

The closed cooling water system shall serve cooling water mainly but not limited to following equipment: ST oil coolers, sealing oil coolers, generator coolers, condenser vacuum pumps, feed water pump sets, condensate pumps (if necessary), sample coolers, etc. The system shall operate as a closed system of clean water with make-up from the make-up water storage tank. On the primary side, the closed cooling water coolers shall be supplied with water from the main cooling water pumps (alternatively System A or System B).

The Closed Cooling Water System shall be complete in every respect for safe and reliable operation and shall include, but not be limited to the following main components:

- Two (2) x 100% closed cooling water pump sets, complete with motor, coupling and coupling protecting, reverse rotation locks (if necessary), foundation frames to support pumps and motors, non-return valves, located at the closed cooling water pump discharge and all manually operated shut-off valves for isolation of the closed cooling water pumps;
- Two (2) x 100 closed cooling water coolers, tube and shell type;
- On load tube cleaning system for cleaning the inner surface of the tubes of the closed cooling water cooler;
- The complete pipe and valve system including control and safety valves, etc. between the closed cooling water coolers lead to the individual user requiring cooling water and back via the closed cooling water pumps to the inlet side of the closed cooling water coolers;
- An elevated cooling water expansion tank, which is required to compensate level variation within the system and to serve cooling water to the user in emergency cases with all the necessary equipment, with the necessary equipment;
- All other necessary pipes, valves, throttling valves, compensators, drains, vents, fittings, etc., for the complete closed cooling water systems;
- If required booster pumps to systems arranged elevated.

The following systems are associated to the closed cooling water system:

- Main cooling water systems (System A and B) for heat exchange from the closed cooling cycle to the main cooling cycles;
- Make up water system. Demineralised make up water is required to compensate water losses in the closed cooling cycle;
- The chemical dosing system is required to protect the inner pipe surfaces against biological growth and corrosion.

7.11 Chlorination Plant

Sodium hypochlorite solution shall be injected into the raw water at the water intake and into the main cooling water cycle as biocide in order to prevent organic growth. In addition, treated wastewater shall be disinfected upstream of the outfall. Appropriate chlorination of the wet cooling tower shall be considered.

In order to avoid handling with liquid chlorine, the concentrated hypochlorite solution shall be produced by means of electrolyser units on site, using salt (NaCl) solution as electrolyte. The NaCl solution shall be prepared from solid NaCl salt by dissolution with filtered water. Dosing of hypochlorite solution needs to be considered for the intake water pump suction lines, cooling water of system A, potable and service water system, and the waste water treatment system.

Appropriate chlorination into the cooling tower pond shall be taken into account during the operation period of one to two months per year. The Contractor shall detail the preservation scheme of the cooling tower system during the standstill times (presumed to be February to December).

The dosing rate for the potable and service water shall meet the legal regulations (Pakistani and WHO standards, whichever is more stringent) to make the water suitable for continuous human consumption.

7.12 Water Demineralisation Plant

The water demineralisation plant shall be designed to cover the demand of the following systems:

- Make-up water for steam / condensate cycle and auxiliary steam/condensate cycle;
- GT compressor washing;
- GT power augmentation by evaporation cooling;
- Water for preparation of chemical solutions;
- Make-up water for closed cooling water systems;
- If the Contractor's design for the cooling tower system requires demineralised water, this shall be taken into account as well.

The water demineralisation plant system shall be based on reverse osmosis (RO) and electro-deionisation (EDI) technologies. Filtered water shall be extracted from the filtered water tank to be demineralised in the water demineralisation plant. Alternatively, to the EDI system, mixed bed ion exchangers can be used. The plant shall include:

- chemical dosing for de-chlorination;
- pH-adjustment;
- inhibition of scaling and fouling;
- activated carbon filters for removal of residual chlorine (if required);

- candle filters for removal of fine suspended solids and for membrane protection;
- membrane degasser for CO2 removal (if required);
- reverse osmosis module racks (2 pass system if required), each consisting of high pressure pumps, pressure vessels with RO membrane elements and energy recovery units (pressure exchanger);
- and EDI modules.

Both reverse osmosis/EDI trains to be operated simultaneously for limited periods, e.g. during initial filling of systems and tanks. Cleaning in place (CIP) facilities shall be included for RO membrane cleaning. The concentrate from the reverse osmosis and EDI processes shall be recycled as far as possible to minimize the raw water demand of the system. The residual brine to be disposed shall be treated as required according to applicable waste water discharge limits and directed to the waste water monitoring basin.

The water demineralisation plant shall be arranged in a dedicated building shown on the general layout plan.

7.13 Potable and Service Water Treatment and Distribution

Potable water shall be produced for the needs of the Jhang project site with a total staff number of approximately 200 persons. The supply of water to local colony will be considered during design phase. Service water shall be provided for the needs of the power plant (e.g. cleaning of surfaces, preparation of chemical solutions).

Service water shall be taken from the filtered water tank and distributed by a dedicated service water pump station (2 x 100% pumps plus pressure equalisation vessel) to the service water grid of the plant. A sufficient number of flexible hoses shall be provided for cleaning purposes to be connected to the service water grid.

The amount of potable water shall be sufficient for approx. 200 people at 250 litre/day/person. The amount of required service water shall be investigated for general purposes, cleaning, etc. The Contractor shall carry out a detailed investigation of the water demands on site; the design of the systems shall be based on these values.

7.14 Firefighting Water

Water for firefighting shall be available according to the Codes and Standards of NFPA (National Fire Protection Association, USA) regulations. Sufficient volume of water may be provided by using water quality of filtered water, permeate water, potable/service water or demin water. The Contractor may provide the continuous available volume either via a permanent dedicated fire water tank or one sufficiently sized storage tank of either of the water qualities mentioned above or by combining the volumes of all tanks of the qualities mentioned above.

Fire water system shall be provided with 2 x 100% electric pumps and one diesel driven pump.

7.15 Sanitary Waste Water Plant

The sanitary waste water treatment system shall be designed to suit the needs of maximum 200 people on the plant site. The system shall be designed to meet the applicable effluent standards for discharge into surface waters. The Contractor shall inform himself in detail about the environmental regulations to be applied at site.

The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case treated water discharge is not permitted during this time by the canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided.

Additionally, sanitary waste water from the plant area shall be treated in biological treatment plant where all sanitary effluents will be reduced from organic matter to stable sediment. The water discharged from this plant shall be conveyed to the cooling water outfall. Separated sludge shall be collected in a sludge collector pond and suitably disposed of. The system shall have a sufficient treatment capacity and will be divided into several pits each performing a phase of the treatment (retention basin, aeration basin, clarifier, sludge pit). The separated clear water phase shall be chlorinated before discharge. The chlorination shall be performed by hypochlorite solution generated in the chlorination plant. The treated effluent from the sanitary waste water treatment plant shall be transferred through piping to the treated water monitoring basin by gravity or dedicated pump station.

7.16 Industrial Waste Water Treatment and Disposal

The industrial waste water treatment plant shall be constructed to treat all waste water occurring during operation and maintenance of the power plant. The facilities have to be capable to achieve discharge limits for discharge into surface waters, stipulated in the most recent issue of the Pakistan National Environmental Quality Standards (NEQS).

The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case treated water discharge is not permitted during this time by the canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided at the plant site.

All oil contaminated drains and wash waters from the plant area shall be collected and treated by oil separators. The oil separators shall have two stages and shall be designed to meet the applicable waste water discharge standards for residual oil and grease.

In case of accidents large amounts of oil may lead to a blocking of the oil separators. Therefore, the de-watering of transformer areas shall be equipped with a retention basin with sufficient capacity to hold up the maximum possible oil discharge plus the firefighting water in case of fire (NFPA Standard).

The oil free water from the oil separators and all other industrial drains shall be directed to the waste water retention basin. The waste water will be treated by the following steps: clarifier, secondary oily cleaning stage, and mechanical filters. The effluent from the mechanical filters and the boiler blow down shall also be directed to the treated waste water basin for regular sampling and analyses in the plant chemical laboratory. From there, all plant effluents shall be finally discharged through the cooling water outfall pipes to the canal.

Chemical drains from the water demineralisation plant, electro-chlorination plant, battery room, etc. shall be collected in a separate drainage system, stored in a chemical waste water pit and treated on demand in a waste water treatment tank by means of precipitation and neutralisation chemicals. The treated effluent from the chemical waste water treatment tank shall be discharged treated waste water monitoring basin and from there to the cooling water outfall.

Separated sludge from waste water and oily water treatment, as well as effluents from boiler acid cleaning and GT compressor washing shall be disposed of externally by a certified waste disposal contractor.

The gas turbine wash waters and effluents boiler acid cleaning shall be collected during the washing procedure in dedicated tanks (to be provided) and disposed of externally by a certified waste disposal contractor.

7.17 Laboratory

A laboratory for the following functions shall be supplied, completely furnished, and equipped for the following purposes:

- Water analyses for steam, condensate, feed water, canal water, potable water, waste water, and cooling water examinations;
- Lubrication oil analysis.

All chemicals, wear and tear material, glass ware shall be sufficient for a period of two years of plant operation. The chemical laboratory shall be equipped with all required equipment for analysis work done on all kinds of waters of the CCPP such as waters from the water/steam cycle (condensate, feed water), canal water, desalted water, potable water, cooling water, waste water, etc., as well as the major tests and analyses of lubricants and turbine lubrication oils. The equipment shall include state-of-the-art instrumental analysis equipment like UV/VIS spectrometers.

All equipment shall be arranged within solid laboratory rooms complete furnished and selected according to standard power station requirements. The storage of all chemicals, glassware and wear and tear material shall be in separate rooms under safe secured conditions.

The laboratory room shall be provided with all installations such as working tables, electrical system, water (potable and demineralised), gas, compressed air system with fittings and accessories, fume hoods, air conditioning, forced ventilation, heating radiators, initial set of chemicals for laboratory use, safety equipment and installations. The equipment and instruments shall be of the latest most modern design and fit for the purpose envisaged.

7.18 Chemical Dosing System

The amount of chemicals for all systems shall be determined by the Contractor. Due to unavailability of sufficient cooling water from the canal adjacent to the site in January of each year, a dedicated cooling tower system shall be used. The Contractor shall provide all chemical dosing needs for this system. The chemical dosing regimen shall be proposed according to the boiler manufacturer's requirements. Detailed information shall be provided by the Contractor. The details given below shall be considered as an example for the required information.

For the purpose of corrosion protection, the pH-value of the condensate/HRSG feed water shall adjusted by the injection of aqueous ammonia (NH_3) solution. If required oxygen scavenger solution shall be injected for oxygen removal within the water/steam cycle. Ammonia and oxygen scavenger shall be dosed by independent dosing systems. The use of hydrazine shall be avoided due to its hazardous health effects. A suitable alternative oxygen scavenger substance shall be proposed.

The injection points for the ammonia and oxygen scavenger solution shall be at the feed water pumps suction lines and at the condensate extraction pump pressure line.

The amount of chemicals shall be determined by the feed water flow and by the actually measured pH value and oxygen content of water samples extracted at the sampling points of the water/steam cycle.

If applicable, Tri-sodium phosphate (Na_3PO_4) shall be added to avoid deposits of hardness in the boiler tube system. The injection point for the tri-sodium phosphate solution shall be at the boiler drum(s), if drums are considered in the design. The amount of chemical shall be determined by the hardness actually measured at boiler blow-down.

To avoid corrosion problems and for adjustment of the pH value in the circuits of the closed cooling water system, a corrosion inhibitor (for example caustic soda ($NaOH$)) shall be added. The amount of chemical shall be determined by the pH value actually measured. The injection points shall be at the suction lines of the cooling water circulating pumps.

All dosing stations for conditioning chemicals shall be skid mounted units and comprise preparation and dosing tanks, chemical unloading pump or bag unloading facility, an adequate number of dosing pumps, and dosing pipelines. All dosing stations shall be designed according to international safety standards.

7.19 Sampling System

This specification covers the sampling system and the associated equipment as well as sample coolers, pipework valves in every respect and suitable for satisfactory operation.

A typical arrangement of equipment for a sample conditioning is a sample cooler with a local temperature indicator of the sample downstream. Electro actuated shut-off valves shall be provided in the sampling pipes, which shall be closed automatically in case of failure of the cooling water (excessive temperature of the sample). A throttle valve shall be located downstream of the sample coolers and the shut-off valve in order to avoid steaming of the sample. After the throttle valve parallel sampling lines are installed for automatic and manual analyses or for blow down drain.

The scope of supply of the sampling system is required to collect samples from various locations to cool the samples, reduce the sample pressure and to perform manual sampling and continuous chemical analyses as required. Cooling water for the sample coolers shall be provided from the closed cooling water system.

7.20 Fire-fighting System

Fire protection and detection systems shall be provided to protect life, property, equipment, and operation of the Plant. The detection and fire alarm, fire protection and fire-fighting systems shall include, but not be limited to the following:

- Fire-fighting water storage, may be combined with raw water tank, depending on local regulations;
- Fire-fighting pumps;
- Fire water ring main system, including hydrants;
- Fire protection systems; and
- Fire alarm and detection system.

All firefighting systems shall be subject to the approval of the project insurance company. The systems shall be complete with all necessary piping, pumps, safety valves, mobile equipment, vehicles etc.

7.21 Compressed Air System

Compressed air systems supplying instrument and service air shall be provided. The design and sized shall ensure a reliable supply of instrument and service air as applicable in the correct quantity and quality conditions for the various users around the power and water units. Instrument and service air quality shall match the respective consumers' requirements.

The equipment shall be designed with appropriate redundancy, including a minimum of one standby unit (for example, at least 2x100% heavy duty air compressors, 2 x 100% air dryers, air filters, receivers), and a control system and pipework distribution ring with appropriate sectionalising.

Compressors should be suitable for continuous operation but the design of the compressor/receiver system shall be such that total operation time is evenly distributed on the different equipment with operation cycles designed for optimum lifetime and reliability of the equipment. The duty compressor shall operate continuously; a pressure relief valve shall be applied to discharge surplus air/pressure.

Pressure switches used for automatic control purposes shall not be used for alarms. Separate switches, each with a dedicated isolating valve, shall be provided for alarm purposes.

The air receivers shall enable the plant to be shut down in a safe and controllable manner and enable standby compressor plant to come into operational service without reduction in air de-livery. For this purpose, the air receivers shall have sufficient capacity.

The design supply pressure and flow of the compressed air system shall be suitable to meet the requirements of all consumers that operate simultaneously at most demanding normal operating conditions.

An interconnection shall be provided between the instrument and service air pipelines up-stream of the air dryers on each system. In the event of low air pressure, the service air shall be automatically shut off via a positive solenoid valve actuation monitored and controlled automatically from the DCS. The air distribution main piping shall be galvanised carbon steel.

For the service air system, valved quick release couplings shall be provided. Each branch shall be isolated by its own stop valve and be provided with a drain trap. Sockets shall be positioned to ensure that maintenance tools can be used from hoses not exceeding 30 m in length.

Automatic traps with manual by-pass arrangements shall be installed at regular intervals and at low points in the system.

7.22 Electrical Plant Concept

This chapter describes the main criteria and features for the design of the electrical equipment and installations for the Jhang project. The electrical equipment shall mainly comprise the following scope of supply:

7.22.1 EHV Switchyard/Equipment

- 220 kV outdoor Switchyard and auxiliary systems, mainly:
    - Switchyard including bus bars, breakers, disconnect & earthing switches, CTs & PTs,
    - Substation Automation System (SAS) with integrated control, monitoring and protection functions,
- Control and interlocking bay control units, SAS, SCADA and DCS
    - Switchyard bus bar protection and Transmission line protection, breaker failure protection, synchrocheck, overvoltage etc.
    - Substation automation system;
    - Telecommunication, tele-protection and SCADA systems;

  - Control/alarm and protection data communication link to National Power Control Center, Islamabad (NPCC);
  - MWh and kVARh metering facilities;
  - Earthing grid;
  - Lightning protection;
  - Switchyard lighting;
  - Fencing of switchyard area,
- Connection to 220 kV power lines for grid interconnection;
- 220kV interconnecting overhead conductor to Step-up transformers.

7.22.2 Electrical Systems CCPP

- 2 x GT and 1 x ST generator(s);
- Generator connection(s) (IPB), generator circuit breaker(s);
- Step-up transformers, unit auxiliary transformers, station service transformers;
  - MV power distributions air insulated switchgear withdrawable;
- LV power distributions (MCC);
- DC/UPS systems & Emergency diesel generators;
- Electrical control & protection system;
- MV/LV/DC motors;
- Earthing / lightning & cathodic corrosion protection system;
- Plant lighting;
- Cable and support systems.

For dimensioning, design and layout of the various plant components and installations the following features and aspects were considered:

- Connection and Integration into the existing 220 kV grid system;
- Ratings to safely cope with normal and fault conditions, the prevailing site conditions, avoiding any over-stressing of material and equipment;
- Equipment to be of standard design, providing highest degree in safety, reliability, availability, redundancy concepts and ease in operation;
- Equipment arrangements to consider adequate space and access for transport, installation, commissioning, operation and maintenance.

The electrical plant shall be designed for continuous operation at unit MCR in parallel with the grid as well as for part load operation. It shall include facilities for safe shut-down in case of a total grid system blackout.

The System Operator will maintain the System Operating Voltage of the Total System within the target voltage levels (limits) as specified as under:

- Under (N-0) normal steady state operating conditions, System Operating Voltage of the Total Power System will be maintained within the bandwidth of +8% to –5% of Nominal System Voltage (220 kV) i.e. 238 kV Maximum to 209 kV Minimum;
- Under (N-1) contingency operating conditions excluding transient conditions, the voltage variation shall be in the range of +10% and –10% of Nominal System Voltage (220 kV) i.e. 242kV Maximum to 198kV Minimum.

These limits of System Operating Voltage are provided strictly for voltage regulation purposes and are not to be construed as NTDC transmission system operating voltages at the Point of Connection.

The Frequency of the Power System shall be nominally 50Hz and shall be maintained within the limits of 49.8 to 50.2 unless exceptional circumstances prevail.

Under Planned Outage conditions, the maximum negative phase sequence component of the phase voltage on the Power System should remain below 1% unless abnormal conditions prevail.

Each Generating Unit must be capable of continuously maintaining constant output for system frequency changes within the range 50.5 to 49.5 Hz.

All Generators Units must be capable of supplying rated power output (MW) at any point between the limits 0.80 power factor lagging and 0.90 power factor leading at the Generating Unit terminals.

The short circuit ratio of Generating Units shall be not less than 0.5%;

The Active Power output under steady-state conditions of any Generating Unit directly connected to the Power System should not be affected by voltage changes in the normal operating range.

The Reactive Power output under steady-state condition should be fully available within the voltage range of +5% at all voltage levels.

Each Generator must be capable of contributing to frequency and Voltage Control by continuous modulation of Active Power and Reactive Power supplied to the NTDC Transmission System.

In addition to the above, all other requirements as specified in the NEPRA Grid Code must be adhered to.

All generation units must be capable of providing primary frequency regulation (reference is made to Pakistani Grid Code). All parts and components shall be complete in every respect and suitable for safe, reliable and continuous operation of the Project

The layout, design manufacture of all electrical equipment will comply with the latest edition of the relevant EN/IEC standards. In case if EN/IEC standards do not exist for particular applications, the relevant equivalent national standards shall be applied.

The 220kV EHV switchyard shall be designed as conventional air insulated breaker and ½ breaker scheme, total 3 bays, three incoming feeders from step-up transformers, and four line outgoing feeders. The switchgears will be located inside the switchyard with a local switchgear protection and control building. The interconnection to the step-up transformers of the CCPP shall be realized by overhead conductors. The grid interconnection point shall be the EHV-gantry of the switchyard.

The GT generators shall feed, via generator circuit breakers, generator step-up transformers, and the power plant 220 kV switchgear into the grid system. The GT step-up transformers will be situated next to the GT building and will be connected via 220 kV overhead lines with the HV switchyard.

The GTs will be started from SFC-bus line, which is connected via static frequency converters (SFC) to the 11kV BOP MV switchgear. As the GTs shall maintain a certain power output, load control mode is required, to ensure stable load and frequency.

All generators GT´s and ST) shall be connected with generator circuit breaker) to the related step-up transformer. The ST step-up transformer shall be placed next to the GT step-up transformers.

The main transformers and the isolated phase bus ducts shall be designed to be able to transmit the maximum output of the power block at all possible ambient temperatures.

The GT and ST consumers shall be provided by unit auxiliary transformers interconnected to generator busbar connections. The two GT generators and one ST generator shall feed the dedicated MV switchgears with unit auxiliary transformers to step-down the MV-level at 11 kV. The ST MV switchgear busbar shall consist of two busbar sections and sectionaliser, closed in normal case; the GT MV switchgear busbars with one section, without any sectionaliser circuit breaker.

The MV-switchgears for the GT units shall be equipped with two incoming circuit breakers for high reliability. The redundancy power supply will be generated by the 3-winding unit auxiliary transformer of the GT-lines. If anyone unit auxiliary transformer is failed, the next unit auxiliary transformer can take over the load with its second outgoing winding. The redundancy system for the steam generator unit supply will be realized with two income unit auxiliary transformer to feed the 11kV ST switchgear sections.

All the electrical equipment shall be affixed with KKS Identifications with English description labelling to be agreed with Employer/Engineer

The auxiliary consumers of the CCPP shall be feed by one MV-BOP switchgear This MV BOP switchgear is fed by each one of the three MV unit-switchgear.

Each 3-winding unit auxiliary transformer shall be designed to carry the entire station auxiliary load of two units and BOP common consumers of one CCPP configuration.

DC and AC-UPS with back-up emergency power generators will be required to ensure safe and controlled shut-down of the power unit in emergency case.

The ST-unit shall be supplied by its own generator line and will also feed the dedicated consumers including water treatment as well water intake station.

Larger motors (greater than 250kW) shall be connected to the MV switchgears. FC driven motors for Boiler Feed Water Pumps (voltage level as per manufacturer standard) shall be connected via frequency converters to the MV switchgears. LV auxiliary power supply for the units and power supply for various common plant auxiliaries shall be provided by station MV/LV transformers.

All loads connected to the MV and LV systems shall be considered during the design; however, the MV switchgear shall be designed taking into account only coincident loads. Ample margin in the busbar capacity shall be kept for future load growth. In addition, separate MV switchgear will be used for the water intake. These MV switchgears will be subordinated to the main MV switchgear of the BOP common unit.

MV and LV switchgear, dry type transformers, DC equipment and safe AC equipment shall be located inside the fully air-conditioned power building with at least n+1 redundancy.

All electrical equipment shall be type and routine tested in the factories with relevant certificates.

The type test certificates shall be issued by international accepted independent parties like TUEV etc., in English language and shall certify that the type test are according to EN/DIN/IEC Standards.

The maximum sound level shall not exceed the maximum allowed noise pressure level of 85 dB(A) in one-meter distance as per IEC.

The electrical power plant configuration is shown as attached in the Single Line Diagram 00140 EV 7100 R 001. It is noted that the SLD is containing tentative figures and numbers and shall be verified during tender and design phase by prospective EPC Contractor.

7.22.3 220 kV High Voltage Switchyard

The interconnection of the CCPP with the 220 KV substation (breaker and a half scheme) will be accomplished through 220 KV overhead conductors from the relevant step-up transformers to corresponding three breaker bays. Connections among various equipment shall be through Aluminium Conductors Steel Reinforced (ACSR) conductors, All Aluminium Conductors (AAC) conductors, or tubular conductors as deemed most economical. All support structures and gantries shall be of galvanised steel. All support insulators for CT's, Bus Pole etc. shall have high creepage distance and be suitable for hot line washing.

7.22.3.1 Main Components and Associated Systems

- Air Insulated Switchgear
    - Breaker and ½ breaker scheme bus bar system
    - Two line outgoing feeders,
    - Three step-up transformer incoming feeders,
    - Circuit breakers, isolating switches, earthing switches, surge arresters, CTs and VTs, etc.,
    - Overhead interconnection facilities to step-up transformers, and line network interconnection,
    - Substation Automation System (SAS) with integrated control, metering and protection.

7.22.3.2 System Description

The engineering calculations, general arrangement, detailed design and the fabrication of structural steel /equipment shall be in accordance with applicable EN/IEC standards and shall be submitted simultaneously to the owner for review and approval prior to fabrication.

Take-off towers are not included in the entire scope and shall be delivered by third parties; however, the construction and design of the HV gantries shall be recognize the position and design of the take-off tower. Equipment as following shall be delivered as a minimum:

- The substation shall be protected with suitable lightning masts and /or conductors to provide the necessary zone of protection for shielding against direct lightning strokes;
- All necessary platforms for Circuit breaker, CT's, Bus pole etc.;
- Any needed structure withstanding the maximum design loading conditions;
- Gantries/ structures providing supports to terminate the overhead conductors to transformer with ACSR line conductors as necessary and two overhead ground wires;
- Any galvanized structural steel supports as required including high strength carbon steel bolts, washers, and nuts for all structural connections;
- Any electrical equipment of the air insulated switchgear, such as high-voltage bus work, breaker, isolators, earthing switches, the utility metering equipment, and any HV instrument transformers (CTs / VTs).

The local control of the 220 kV AIS will be located in a separate building adjacent to the switchyard and shall be by means of numerical microprocessor control logic. Local operation control by means of discrepancy switches must be provided for all switching devices. Positions of disconnect and earthing switches and CBs shall be indicated. All instruments for the control and indication of 220 kV switchyard shall be provided.

The Control cubicles for each feeder shall contain all operating and interlocking controls and the protective breakers for the drives. The local control cubicles shall be of free-standing, floor mounted type. The local control cubicles shall be installed inside the building; outside adjacent to the respective CB bay another local switch for test purposes shall be provided.

The 220 kV substation shall be controlled, in addition to the local control cubicles, from a local panel inside the switchyard building (220 kV control room) as well as from the central control room of the CCPP. The local220 kV operator workstation shall have keyboard, mouse and two monitors, and shall be provided as part of DCS.

All protection devices shall be provided in separate cubicles and shall be installed in the control and protection room of the switchyard building. IEC 61850 protocol for interconnection and signal exchange to DCS is required.

Requirements from SCADA control and monitoring or connection to LDC is not required; however, there shall be sufficient space for future installations.

AC & DC distribution panels of self-standing type shall be installed in the 220 kV substation supply room. The supply room can be one of the partitions of the building. These distribution panels are to be fed from the CCPP's own sources.

7.22.4 Generators

Two turbo generators for the GT-units and one turbo generator for the ST-unit with all required auxiliaries shall be supplied, installed and commissioned.

The generator capacity at specified design air ambient temperatures, rated power factor and at any subsequently specified condition shall be identical or above the allocated turbine capacity at design ambient conditions and the temperature range as defined in the relevant mechanical employer requirement.

7.22.4.1 Main Components and Associated Systems

- Gas turbine configuration
  - Two GT generators with neutral grounding transformer and grounding resistors;
  - Isolated busbar system for interconnection to the step-up transformer;

- Two GT generator circuit breakers with generator circuit breaker compartment, with all switches, busbars, current transformers, voltage transformers, surge arresters, etc.;
- circuit breaker between T-off and unit auxiliary transformer for each GT generator. in order to proceed for maintenance without unit shutdown.
- Static excitation system for each GT generator and digital automatic voltage regulator;

- Steam Turbine configuration
  - One ST generator with neutral grounding transformer and grounding resistor
  - Isolated busbar system for interconnection to the step-up transformer;
  - One ST generator circuit breaker with generator circuit breaker compartment, with all switches, busbars, current transformers, voltage transformers, surge arrestors etc.;
  - Two circuit breaker between T-off and unit auxiliary transformers. In order to proceed for maintenance without unit shutdown;
  - Static excitation system for ST unit generator and digital automatic voltage regulator.

7.22.4.2 System Description

The generators shall be of the 3-phase, 50Hz, synchronous, hydrogen cooled type (total enclosed water to hydrogen cooling, TEWHC) for rotor and for stator windings is either hydrogen or water). The generator capacity shall match with the GT output respectively ST output. The design power factor of the generator power factor shall be 0.85 lag to 0.95 lead.

The final generator capacities will be defined by the EPC Contractor according to the GT unit and ST unit capacity at site conditions. The generator voltage will be 21-23kV (in accordance to manufacturers' design)

The connections between the generator line terminals, the generator circuit breaker, the step up transformer, the related auxiliary transformers as well as for the generator neutral shall be performed by enclosed three-phase isolated busbar system for the two GT generators and one ST generator.

The connections between the generator line (T-off) and unit auxiliary transformer shall be coupled with a motorized disconnector/circuit breaker to de-energize the unit auxiliary transformer from the generator-line in case of failure.

The GT generators and ST generator shall be provided with a static excitation system and digital automatic voltage regulators.

7.22.4.3 General Generator Design Conditions

Moreover, the design shall be such as to meet the following conditions and requirements:

- The synchronous generator with its associated auxiliaries shall be capable to deliver its maximum continuous rating (MCR) without detrimental spot heating within the limits of the permissible temperature rises at conditions as specified and the following items;
- The rotor winding is to be manufactured of hard-drawn silver alloy copper and shall consist of flat coils wound on the edge, fully insulated against each other and against the rotor body;
- The hydrogen system consists of hydrogen coolers, a seal oil unit and instrumentation and controls. Generator rotor mounted fans provide hydrogen circulation through the closed system. Means are provided to permit purging of the hydrogen within the generator using carbon dioxide and vice versa. There should be four hydrogen coolers of sectionalized design with cooler to be sections accessible from outside to permit inspection or cleaning without loss of hydrogen pressure. If the stator cooling system will be realized with water cooling the system must be completely independent of any other system and uses high purity demineralized water in a closed circulation loop;
- Multifunctional redundant digital protection equipment shall be provided for generator protection;
- Operation with MCR at rated frequency and the rated voltage without exceeding the allowable temperature rises;
- To withstand a metallic short circuit when operating at rated voltage and load without detrimental effect to the windings or other components for a duration of 3 seconds;
- To withstand, when operating at rated no-load voltage, the connection to the power system network through the generator step-up transformer even in case of a phase angle displacement of 90 degrees;
- In conjunction with its excitation system the generators shall operate satisfactorily at every load (within the stability limits);
- All components of the generator shall be designed and constructed in such a manner that undue or harmful vibrations are eliminated and that at no operating condition avoidable noise will occur;
- Generators and related cooling systems shall be designed to class F and operated to maintain internal heating within insulation class B limits throughout the entire operational range and throughout the ranges of ambient temperatures;

- A generator capability diagram according to IEC 60034-3, clause 13 for operation at IEC conditions shall be provided;

All generator auxiliaries shall be integrated into the unit sequential control system. Local control of all AC/DC motors shall be effected from one local board, incorporating also all inter-locking criteria as well as start/stop signals as required for the relevant motor starters accommodated in motor control centres (MCC). Moreover, all analogue and binary measuring and control signals for remote services shall be brought by serial interface via redundant remote bus system to the entire DCS monitoring devices. Excitation System and Voltage Regulator

Excitation systems have a powerful impact on generator dynamic performance and availability; it ensures quality of generator voltage and reactive power, i.e. quality of delivered energy to consumers. Static excitation systems for the GT and ST generators (SES), with excitation transformer feeding rotor directly from thyristors bridges via brushes shall be required. However, manufacturers' standard on the method of excitation - static excitation or brushless method – may be accepted.

Main functions of the excitation systems are to provide variable DC current with short time overload capability, quick-acting control of the generator voltage with suitable accuracy and reactive power respectively, ensure stable operation with network, contribution to transient stability subsequent to a fault, communicate with the DCS by bus, and to keep machine within permissible operating range.

The excitation power shall be supplied via a 3-phase cast resin insulated type excitation transformer fed from the dedicated 11 kV Units switchgears.

The excitation system shall comprise the following:

- State of the art technology;
- Associated excitation switchgear;
- High availability due to redundant AVR;
- Static excitation package incl. any necessary equipment as transformer, thyristor assemblies, microprocessor-based voltage regulators for control / supervisory manual and automatic, LV and HV connections, etc.;
- Instrument transformers;
- Field breaker, de-excitation, over voltage protection;
- Aux. excitation system with external AC and DC power supply for initial excitation, commissioning, protective relay setting, test runs.

The entire excitation system shall be installed in a local air conditioned control room nearby the turbine generator unit; field installed cubicles shall be accommodated in IP 32 protection class.

7.22.5 Generator Connections and Generator Circuit Breaker

Generator Busducts (IPB= Isolated Phase Busduct) shall have the following main functions:

- Link between generators and step-up transformers including generator circuit breaker with disconnectors and earthing switches;
- Connections to unit auxiliary transformers circuit breaker), neutral point and/or current/ voltage transformers as required.

Quantities and ratings may vary depending on the specific requirements of the system/equipment supplied by the EPC Contractor. The EPC Contractor is responsible for completeness and correct design of all systems supplied by him. The Contractor shall perform all calculations required for determination of the final design parameters and submit to the Consultant.

7.22.5.1 Isolated Phase Busduct

For each GTG unit:

- One (1) single-phase isolated phase busduct (IPB) system for connection between the generator, the generator breaker switchgear and the generator transformer with tie branches, resp. taps as required for connection of:
    a) Unit transformer via disconnector;
    b) Earthing Switches (as far as not part of generator circuit breaker);
    c) Instrument transformers, surge arresters and all other equipment and devices (as far as not part of generator circuit breaker);
- One (1) set of busbars and equipment as required for performance of the neutral connections to be provided in the generator neutral terminal box;
- One (1) set of generator current transformers (line and neutral side).

The components to be connected to above tie branches/ taps have also to be provided

For each the STG unit:

- One (1) single-phase isolated phase busduct (IPB) system for connection between the generator, the generator breaker switchgear and the generator transformer with tie branches, resp. taps as required for connection of:

a) Two Unit transformer via circuit breaker;

b) Earthing Switches (as far as not part of generator circuit breaker);

c) c) Instrument transformers, surge arresters and all other equipment and devices (as far as not part of generator circuit breaker);

- One (1) set of busbars equipment as required for performance of the neutral connections to be provided in the generator neutral terminal box;
- One (1) set of generator current transformers (line and neutral side).

The components to be connected to above tie branches/ taps have also to be provided.

The busbars shall consist usually of hollow aluminium tubes (or copper) tubes/bars or sections supported on post type insulators. All insulators shall be easily replaceable. Contact surfaces of bolted connections shall be silver plated. The design shall be co-ordinated with the equipment connected thereto. Flexible connections and expansion joints shall be provided at terminals and at intermediate points to avoid stresses due to expansion and vibration.

The enclosure of the IPB shall be made of tubular shaped aluminium sheets. The enclosure shall be self-cooled, totally enclosed, vermin proof and sealed against the ingress of dust and moisture. Duplex silica gel breathers shall be provided for each enclosure section Drain plugs shall be installed at the lowest parts of the housings or enclosures. Where the enclosures pass through walls, etc., supports and suitable external sealing arrangements shall be provided.

7.22.5.2 Generator Circuit Breaker

One (1) three phases, single phase isolated generator circuit breaker system with:

- Circuit breaker;
- Disconnector switches;
- Start-up system isolator switch (only for Gas turbine GCB);
- Earthing/shortening switches;
- VT and CT Instrument transformers as required;
- Surge arresters and surge capacitors.

The circuit breaker shall be of the self-blast type and use SF_6 as an insulating and arc-extinguishing medium. It shall have two separate contact systems, one for load current carrying and one for arc interruption. The disconnecting switch shall be of air-insulated with motor and with manual drive.

The earthing switch shall be of rotary-blade, air-insulated, motor driven type with manual drive. The operation shall be interlocked with the circuit breaker and the disconnecting switch. All current and voltage transformers for indication, metering, protection and excitation shall-comply with the requirements of the plant. The generator circuit breakers shall conform to IEEE Std. C37.013.

7.22.5.3 Motorized Disconnector for UAT

The disconnectors shall be located within the isolated bus duct between the T-off and unit auxiliary transformer and shall be designed, manufactured and type testes for isolation purpose of the dedicated transformer in accordance with the requirements.

The disconnecting switch shall be of air-insulated with motor-and manual drive and capable to withstand the nominal current range of the system.

An interlocking device between generator circuit breaker and EHV feeder breaker of step-up transformer is required to protect the disconnectors against actuation by energized system.

7.23 Power Transformers

Following transformers shall be supplied, installed and commissioned:

- 2 x Generator transformers BAT, one for each GT-unit, ratio: 220/ U_{Gen} kV, three-phase, 3-limb, oil immersed, outdoor type step-up transformer, Cooling ONAN/ ONAF, tap changer: on-load, motor operated (MR), manually controlled;

- 1 x Generator transformer BAT, for the ST-unit, ratio: 220/ U_{Gen} kV, three-phase, 3-limb, oil immersed, outdoor type step-up transformer, Cooling ONAN/ ONAF, tap changer: on-load, motor operated (MR), manually controlled;

- 2 x Unit transformers BBT, one for each GT-unit, ratio: U_{Gen} /11 kV for MV-Unit-switchgear, 3-winding, three phase, oil immersed, outdoor type transformer, connected to the GT generator busbars, Cooling: ONAN/ONAF, tap changer: on-load, motor operated (MR), manually controlled;

- 2 x Unit transformers BBT, for ST-unit, ratio: U_{Gen} /11 kV for MV-Unit-switchgear, 2-winding, three phase, oil immersed, outdoor type transformer, connected to the ST generator busbars, Cooling: ONAN/ONAF, tap changer: on-load, motor operated (MR), manually controlled;

- Auxiliary MV/LV (oil filled or dry type) station transformers as required at rated voltage, indoor or outdoor type transformers, Cooling: AN, tap changer: off load, number and rating are depending on number of LV-distributions;

- Neutral earthing transformers for each generator;

Multifunctional digital protection equipment shall be provided for transformer protection. The indicated numbers and ratings of transformers are preliminary only and have to be defined/ verified finally by the EPC Contractor to match with the turbine outputs and further electrical requirements of the envisaged plant and shall be submitted to the Consultant.

The interconnection between the generator circuit breaker and the step-up transformer shall be realized by enclosed busbar system (IPB). Overhead conductors shall be used for the connection to the HV switchgears.

The capacity with ONAN cooling shall be at least 60% of the ONAF capacity.

The step-up transformers shall be equipped with a self-cooled / forced air cooled type of cooling. The fan units shall be mounted underneath the radiators required for operation at full rated power within specified temperature rise limits at 100 % excitation as specified in IEC 60354 in accordance to the maximum ambient air temperature of 50°C under thermal steady state conditions.

The unit auxiliary transformers shall be equipped with a self-cooled / forced air cooled type of cooling. The fan units shall be mounted underneath the radiators required for operation at full rated power within specified temperature rise limits at 100 % power output as specified in IEC 60354 in accordance to the maximum ambient air temperature under thermal steady state conditions.

- On load tap changers (OLTC), for manual control and remote Voltage control shall be provided;
- The OLTC tapping steps shall be 10 x ±1.25%, 21 steps;
- The NLTC tapping shall be 2 x ± 2.5 %, 5 steps.

Manual operation (MVR) from the local control kiosk and from the remote operation control room shall cause one tap movement only unless the control switch is returned to the off position between successive operations.

Oil immersed transformers shall be supplied with an on line condition monitoring system.

Dry type transformers shall be installed in steel enclosures with a degree of protection IP21 and shall be installed indoors in fully air conditioned rooms. Dry type transformers installed in rooms separated by partition walls (due to fire protection) and doors as IP00 are also acceptable. All other transformer shall be oil-immersed transformers.

The transformer oil must be pure virgin of naphtha base petroleum product, without any antioxidant (uninhibited) in accordance with latest edition of IEC 60296.

For oil type transformers the following temperature rises shall not be exceeded at the design temperatures:

- Top oil 50 K;
- Average winding temperature 55 K (60 K for ODAF);
- Winding hot spot 60K.

Dry type transformer (insulation class F)

- Windings: 85 K;
- Other parts: 85 K.

Power transformers shall be designed, manufactured and type and routine tested according IEC 60076. All current carrying components such as bushings, tap changers (IEC 60542) and connection components shall have a minimum rated load carrying capacity equal to 120% of that of the associated windings under all service conditions.

The transformer shall be able to operate safely for 30 seconds with a voltage of 1.3 times rated voltage imposed to the feeder winding. Further they shall be able to operate continuously at the GT/STMCR within the limits of temperature rises, at voltage variations of +10% at their feeder windings, at any frequency variation between 5% and +5% and at any combination of voltage and frequency variation of total +10% together with any voltage ratio to be adjusted by the tap changer.

Oil immersed transformers shall be provided with high conductive electrolytic copper windings. Dry type transformers may be provided with equivalent aluminium windings. Insulation material of oil immersed transformers shall be of class A (IEC 60076-2). Insulation material of dry type transformers shall be of class F (IEC 60076-2).

The short circuit capability of the transformers shall be such that they can withstand for 3 seconds without damage or deterioration secondary short circuits when fed from the primary side with the maximum possible fault current.

Vector groups, impedance voltages and on load tap changer ranges shall be defined during the detail design by the EPC Contractor. Based on the final transformer data the EPC Contractor shall prove that the finally selected voltage ratios and tap changer ranges are suitable for operation of the plant under all operation conditions and within the applied operation voltage ranges.

As far as applicable a rigid, weather-proof IP65 marshalling kiosk shall be provided for each transformer for accommodation of electrical control, measuring and monitoring equipment, alarm circuits, MCBs and current transformer secondary's.

7.24 Black Start Unit

Not Required.

7.25 Electrical Auxiliary Systems

All below MV and LV switchgear including all required sub-distributions, auxiliary boards, emergency diesel generators, DC equipment and safe AC equipment described with all required auxiliaries shall be supplied, installed and commissioned. Each GT unit shall have its dedicated sections 11 kV supplied from respective 11 kV three winding of the unit auxiliary transformer to provide power supplier for MV and LV unit consumers. The second leg of the three winding transformer shall feed the redundancy income of the next 11 kV GT switchgear unit electrical power. The redundancy system for the steam generator unit supply will be realized with two incoming unit auxiliary transformer to feed the 11kV ST switchgear sections. The redundant supplies to the 11 kV Bus from two UAT's via circuit breakers shall be interlocked with HSTS.

The unit auxiliary supply system comprising of a single busbar medium voltage (MV) system at 11 kV AC nominal/rated voltage, which is connected to a low voltage (LV) system at 400V AC through several MV/LV auxiliary transformers.

BOP and common consumer shall be supplied from 11kV BOP Common Consumer switchboard and will be energized with one outgoing feeder from all three 11kV unit switchboards. Each section is permanently energized; interlocked with redundancy income circuit breaker and sectionaliser between the incomer circuit breaker. Also on the LV-side the interlocking is realized with the outgoing CB for feeding the secondary 400 V SWGR via transformer. One outgoing is normally open; the other normally closed that only one transformer can be feed the associated BOP and common systems.

Automatic quick transfer devices between two incomers of the common busbar shall serve to secure power supply in case of tripping of one transformer to maintain power supply for BOP and auxiliaries and in case of maintenance purposes.

The design of the electrical and instrumentation and control facilities all requirements shall be followed, accordingly e.g. electrical and I&C redundancies shall not be less than mechanical ones, reliable power supply and remote control of common facilities shall be maintained in case of outage of one single component.

At least all equipment, which when failure could cause an outage of the total Plant, shall be provided with 100% redundant electrical supply equipment.

Busbars shall be made of high conductive electrolytic copper conductors with the connection points suitably protected against corrosion. They shall be colour coded, rigidly supported on cast resin insulators and shall comply with the requirements of the relevant standard specifications.

All MV and LV switchgear, dry type transformers, DC equipment and safe AC equipment shall be suitably housed inside fully air-conditioned buildings with at least n+1 redundant A/C units.

Low voltage switchgear and control gear assemblies shall be designed and type tested assemblies (TTA) in accordance with IEC standard. All bolts, screws, washers, etc., shall be corrosion protected.

Each feeder's indicators or push buttons shall be coloured acc. to IEC 60073/ 60204-1. The final design will be subject to approval.

Fire-proof closure to the floor of the MV/LV-switchgear rooms shall be provided to seal the outgoing power cables according to NFPA 850.

The design temperature of electrical equipment shall be according IEC if installed in air conditioned rooms with n+1 redundant A/C units. For all outdoor equipment the design temperature shall be the maximum temperature which can occur in the place of installation, however minimum 47°C.

As a standard for electrical buildings / rooms a combination of cable room and above located switchgears room may be accepted, as this combination forms one fire zone. Any cable running between the two rooms there is no need for fire proofed seal then, if the cable room does not receive cables from other various located switchgear rooms.

All cubicles shall have a minimum 20% of inside spare space room when commissioning is finished.

All equipment as required for interfacing with the remote control system (DCS) shall be provided. Further requirements from the section "Control and Instrumentation" shall be considered.

Multifunctional digital protection equipment shall be provided for:

- MV switchgear and feeder protection;
- LV switchgear protection (air circuit-breaker incomers and couplers); and
- MV motors and large LV motors protection;
- MV/LV transformer protection.

7.25.1 MV Power Distribution

The voltage levels of the MV switchgears shall be in accordance DIN IEC 60038. The final rated voltage of the MV Power distribution system shall be defined by the EPC Contractor during the detail engineering.

The MV switchgear shall be of metal-clad compartmented design. The individual cubicles are to be bulk headed from one another by double sheet metal partitions or approved equivalent system. The design of the individual cubicles shall be such as to obtain segregated compartments and suitable for extension on both sides; relevant space shall be provided.

Permanently installed short-circuit-proof earthing switches are to be provided in the lower part of the switchgear cubicle and these are to be locked mechanically with the corresponding circuit breaker.

The earthing switches of the in feed panels are to be equipped with interlocking relays wired to the terminal board in the relay recess preventing closure of the earthing switches when the breaker at the remote end is closed.

7.25.2 LV Power distribution

The LV switchgear including all required sub-distributions, auxiliary boards, shall have accordance IEC 60038 a voltage level of 400/230 V for three-phase four-wire or three-wire systems. Low voltage switchgear and control gear assemblies shall be designed and Type Tested Assemblies (TTA) according to IEC 60038 standard.

Most of the unit and station auxiliaries of the plant are to be supplied at a low voltage level of 400V AC for motors and for auxiliaries via LV switchgear. The MV at 11 kV is stepped down through a number of auxiliary transformers to the 400 V AC level and is fed to different LV switchgear.

The LV switchgears shall be of metal-clad compartmented type proof design. The individual cubicles are to be bulk headed from one another by double sheet metal partitions or approved equivalent system. All cubicles shall have a minimum 20% of inside spare space when commissioning is finished.

For the CCHP configuration the following LV equipment shall be provided:

- Main LV switchgears:
    a) Two metal enclosed air insulated single bus-bar switchgear line-ups interconnected by a bus sectionaliser;
    b) Two cable incoming feeders incl. measurements;
    c) motor feeders as required;
    d) Cable feeders as required;
    e) Two spare feeders;
- LV switchgears for various external facilities or plant components further away such water intake plant etc.;
- GT MCCs (by GT supplier):
- Local LV distribution board, lighting distribution and sub distributions as well as power socket outlets and plugs;
- LV motors (motors smaller than 250 kW).

During normal operation, the bus sectionaliser CBs of each of the above LV switchgears will remain open and the incomer CBs of the respective LV switchgears will remain closed. The two incomer CBs and the bus sectionaliser CB are interlocked with each other such that a maximum two CBs will remain closed at a given time. This is essential to avoid paralleling of the two power supply sources. The bus sectionaliser CB would close only when one of the two incomer CBs is tripped to ensure continuity of supply to the auxiliary loads. The transfer scheme for such a transfer will be selected later; however, this transfer device shall be automatic. In addition to automatic transfer, it shall be possible to operate the CBs manually by the operator.

The LV switchgears for the HV switchyard will be interconnected to the 11kV MV switchgears of the CCPPs.

LV sub-distributions, such as lighting distribution board and power socket outlets shall be provided on different places of the CCPP as necessary.

All LV switchgears (main LV distribution for the GT as well as the MCCs) shall be arranged in continuous line-ups and shall be separately installed in the LV switchgear rooms of the turbine building. The LV switchgears serving HV switchyard shall be installed in the EHV building next to the 220kV switchyard. The LV switchgears required for various external facilities or plant components further away such as water intake plant etc. will be installed at a suitable location next to the facility.

The main incomer CBs of each LV switchgear line-up shall be electrically operated with a 110V DC spring charging motor. The operating mechanism shall be equipped with provision of local and remote control and with electrical interlocks. The breakers shall have magnetic release for short circuit protection and thermal release for overload protection. The closing and opening device shall be rated for 110V DC power supply. The incomer CBs compartments shall be equipped with necessary indication lamps and meters etc. All main incoming and outgoing circuit breakers of the distribution system and motor breakers for larger motors shall be of withdrawal type.

All other circuit breakers shall be of moulded case type and shall be manually operated unless otherwise specified.

Each LV switchgear bus section shall be sized to carry the total coincident load on both the buses; however, all connected loads shall be taken into account for sizing purpose.

The switchgear bus-bar and CB ratings shall be determined by the EPC Contractor based on connected loads and based on short circuit studies.

7.25.3 Safe AC- and DC systems

Fully redundant DC and Essential AC (UPS) power supply systems are required for the combined cycle power plant to ensure safety and reliability. Dedicated 110V DC power supply systems comprising of batteries, battery chargers and DC switchboards and 400/230V AC UPS with transfer switches and 230V AC essential switchboards are envisaged. In addition, a fully redundant 24V DC Switchboard having two bus sections, each fed from 110V DC/24V DC Converter is dedicated for DCS. The batteries shall be of lead-acid type. Each battery cell shall have an individual container preferably of clear plastic. The EPC Contractor shall size the batteries as per the equipment loads. The CBs, bus bars and fuses of the switchboards shall be sized based on connected DC loads. The DC short circuit withstand capability of the switchboards shall be chosen based on the DC short circuit calculations.

With the battery chargers shut down, the minimum load demand shall be evaluated according to the following load profile:

- 1 hr normal operation of the plant;
- 4 hrs. Plant shut down including operation of all essential / emergency drives as required for safe shut down, as well as the DCS and all necessary I&C components.

Each AC system shall comprise of 2 x 100% rated batteries and N+1 battery chargers.

The battery chargers shall consist of solid state static rectifiers and three phase dry insulated transformers designed to supply power converter at nominal load and to simultaneously recharge the batteries from 10 % to 95 % of full capacity in 24 hours. The chargers shall be equipped for fully automatic float charging of batteries. The boost charging shall be possible by means of a change-over switch. Each charger shall be complete with all necessary instruments, breakers and overload protections.

Rectifiers and inverters shall be designed for operation with natural cooling. If air-cooling is required, then 2 x 100% air fans with monitoring and alarm signal shall be provided.

Each DC control power supply system shall be provided with redundant (N+1) chargers, 2 x 100% batteries and sectionalized distributions. For the 24V DC supply of the I&C redundant (2x100%) DC/DC converters will be accepted. The DC/DC converters shall be equipped as a complete unit comprising internal fuses, cabinets, protection and the necessary instruments.

Each safe AC system shall consist of redundant (2 x100%) inverters. Batteries for the UPS shall be type tested accordance IEC 60896 if lead acid batteries or IEC 62259 if NiCd will be provided.

The UPS shall be designed as a complete panel unit with instruments, circuit breakers and overload protections both on AC & DC side. The UPS shall be of solid state design with full wave converter. The rated output current shall be selected to allow 20% increase of capacity. The UPS and the associated essential AC switchboards shall be sized and rated based on connected loads.

DC and safe AC distributions may be of the Form 2b, fixed installed type.

7.25.4 Emergency Diesel Generator

Small Emergency Diesel Generator Units (EDG) shall be used and connected to the essential auxiliary LV switchgear of the CCPP- blocks for emergency purposes only. The diesel generator unit shall run on HDS for 24 hours' emergency- and essential load operation. All necessary tanks, pumps etc. shall be provided. The fuel system from day tank to the injection pump has to be in natural gravity intake.

The emergency diesel generator units shall be designed, constructed and tested acc. to ISO 3046, ISO 8528 and IEC 60034, latest edition.

The EDG will be connected to the switchgears with cables. The circuit breaker within the LV switchgears shall be used as generator circuit breaker. All necessary protection and synchronisation function with the main power supply shall be provided. An automatic start up and synchronisation system for the units shall be provided. The starting system shall be sized to allow 5 consecutive starts. Emergency Diesel generator shall automatically start at a voltage failure; however manual initiation of starting and synchronizing (parallel operation with the grid) for test purposes shall also be possible.

The EDGU shall be capable of supplying the critical/essential loads of the plant automatically, isolating the unimportant and non-critical loads and shall be installed in a separate room next to the main LV switchgear of each CCPP block. The emergency diesel generator (installed indoor) shall have a protection class of minimum IP23, shall be designed for class F insulation and shall be operated with class B temperature rise. In this case the terminal box shall be protection class of minimum IP44.

7.26 Motors

Motors of the same type must be fully interchangeable and shall comply - as far as applicable - with EN/DIN/IEC standard motor dimensions. All A.C. motors shall be of the squirrel cage type provided with either deep slots or double squirrel cages. All medium and low voltage motors are designed to start fully loaded by the driven equipment and to accelerate their connected loads to rated speed with a minimum of 80% of rated terminal voltage.

The general construction shall be stiff and rigid; no light metal alloy casings shall be accepted for M.V. motors. All precautions shall be taken to avoid corrosion. Each motor shall be fitted with adequate lifting hooks or eye bolts, as suitable. All motors shall have a protection class of minimum IP55 with additional weather protection if installed outdoors (e.g. sun shades) and IP 54 if installed indoors and not subject to hosing

7.27 Cable Systems

The cabling system shall include all HV, MV and LV power cables, instrumentation, control, measuring and communication cables as well as all related raceways such as trays, conduits, trenches, ducts, termination and fixing materials. All electric interconnections within the scope of equipment supplies are included. Segregation between redundant circuits shall be provided as far as practicable. All cables shall be designed to cope with:

- the short circuit conditions;
- a voltage drop of 3%;
- the applied reduction factors regarding ampacity due to ambient conditions;
- armouring for subsoil installations;
- Flame retardant low smoke and fume (LSF) sheath material.

Power circuits above 2,000 A (MV and LV) shall preferably consist of isolated phase bus-bars or fully insulated bus-ducts applying hardly inflammable and self-extinguishing insulation material, or metal-enclosed 4-phase (3 phases and neutral) bus ducts for LV circuits, respectively.

All HV and MV cables shall be of the XLPE insulated, screened, and self-extinguishing PVC for the outer sheath, single core type with stranded copper conductor. Cable screening shall be earthed at both ends. Termination shall be provided by suitable sealing ends, dependent on final application.

Conductors of MV and LV cables shall be of plain copper. All LV power cables shall either be XLPE insulated, and self-extinguishing PVC for the outer sheath, single or multicore type. Conductors shall be not less than 2.5 mm^2 in cross section and shall be stranded for all cross sections above 4 mm^2.

All instrumentation, signal and control cables shall comply with the latest IEC standards. All cabling, except fibre optic cables, and wiring shall have fine stranded copper conductors, thermoplastic insulation and thermoplastic inner sheath. They shall have galvanised steel wire armour for cable laying in trenches and severe condition areas and shall be of the flame retardant type and during combustion shall emit no halogen and produce minimal smoke. They shall have a minimum conductor cross-section of 1.5 mm^2 and must use generally a common core screen for protection against induction (shielded cables). Multi-core I&C cables below 60 V shall have reduced cross sections as required for interconnection of the related electronic systems. Multi-core cables with more than 7 cores shall have approximately 20% spare cores for future use.

Profibus solution for connecting any field nodes may be also accepted. Communication cables shall be preferable of the optical fibre cables, however if conventionally cables are used the multi-pair type with insulated conductors twisted to pairs shall be used.

7.28 Electric Control and Protection Systems

Overall plant control shall be provided as defined in the instrumentation and control part of this document. Automatic and/or manual control of electrical equipment of the plant shall be co-ordinated and designed accordingly as following:

- Electrical control system;

- Synchronisation devices;
- Electrical metering system;
- Electrical protection system.

The following particular control facilities for electrical equipment shall be provided:

- Generator control GTs and STs, including generator voltage control, excitation system and synchronisation by the generator CB, MV and respectively EHV breaker;
- EHV switchgear control system (substation automation system),
- MV control system and LV control (remote control of incoming feeders of the main LV boards), part of the DCS;
- MV and LV automatic transfer devices (independent from the DCS system);
- Remote control of the emergency diesel generator units, automatic start up and synchronisation devices;
- All further electrical equipment which needs to be remote controlled.

7.28.1 Protection System EHV and CCPPs

Protection of electric plant and individual installations shall be as required for selective detection of faulty equipment/circuits, for safe and reliable operation of the plant components.

The protection relays shall be of numeric type with an adequately documented past service period in power plants. The systems for generators, transformers and related equipment shall be mounted in appropriate cubicles installed in the central control room, those of MV and LV distribution/MCC feeders in the respective switchgear cubicles.

Any pertaining event or status, i.e. operative, alarm or trip generated by any protection system shall be indicated locally, resettable locally and in the central control room and time stamped by the alarm/ event-logging recording system of the plant's control system (DCS).

The Generator facilities will be responsible by own control devices for protecting its power facility systems in case the frequency and voltage of the transmission system exceeds the operational limits.

7.29 Lighting System

A complete lighting system, with the individual components being of approved type and constructed of best quality materials shall be supplied, installed and commissioned. The scope of supply shall comprise, but is not limited to the following:

- Lighting main distributions (fed from Building Services Board);
- Lighting sub-distributions;
- Lighting Control Panel for external lighting;
- Maintenance power supply;
- Internal Lighting fixtures with LED lamps, drivers and all allied accessories;
- Power / maintenance socket outlets and light plug socket outlets;
- Aviation lighting where required (e.g. Main Stack and Bypass Stack);
- LV cables with all allied accessories;
- Poles for external lighting;
- Cabling, wiring, lighting switches and sockets as well as all installation material, as required for indoor and outdoor lighting, small power and maintenance power supply for all equipment, buildings, structures, sub-station, roads and outdoor operation areas, etc. to be provided under this Contract. The requirements for the housing area installations, including the related auxiliary transformers and their connections.

The lighting system shall include the internal building lighting, emergency and escape lighting and external lighting. The system shall be designed to be fully in accordance with the latest edition of the international electro technical commission (IEC).

7.30 Earthing & Lightning Protection, CP System

In general, a meshed earthing system underneath all power and station facilities shall be installed. The earthing system shall be calculated according to IEEE 80. For the construction of the earthing system approved standards, such as IEC 62305, and all required IEC Standards shall be applied. The EPC Contractor shall supply, install and commission a complete earthing and lightning protection system for all installations, comprising all required conductors and earth rods, connecting material, protection equipment and all kinds of fixing material to form a complete, safe and reliable system.

All interconnections of the earthing grid to equipment and the connections between the earthing grid and the earthing rods shall be made by the thermite welding process. Only those connections located in earthing pits and occasionally intended to be opened for testing purposes shall be of the bolted type.

Earthing conductors buried in the soil shall be tinned copper tapes. Other type of conductors such as stranded copper, coated as necessary, shall be considered in cases where this is necessary but shall be subject to the Engineer's approval. The minimum diameter of each strand in such case shall be 20 x 2.5 mm for copper and 30 x 3.5 mm for galvanised steel. Earthing conductors embedded in concrete shall be either copper conductors or galvanised steel tapes. Adequate corrosion protection shall be provided when conductors leave the concrete, respectively the soil.

At a maximum interval of 20 m, the conductors shall be led into the buildings by suitable means and connected to the indoor earthing system. Steel structures and lightning protection systems shall in general also be connected to the earthing installations. The design of the earthing system and the materials to be used shall comply with the requirements for the specified cathodic corrosion protection and shall be subject of approval to the Engineer.

7.31 I&C and Communication Systems

The Instrumentation & Control (I&C) system will support an efficient and reliable operation, control, and supervision of the whole plant by a minimal operational staff. Start-up, synchronisation and loading of the GT units, the HRSGs and the ST unit from the Central Control Room will be possible fully automatic through pressing one pushbutton by the operator.

Plant operation, control, and supervision will be based on a Distributed Control System (DCS).). A modern, up-to date I&C system capable of providing information of the latest developments related to the instrumentation and control of the plant including the hardware, the software, and the operation principles will be used.

The control system structure will be adapted to the plant configuration and its balance of plant. It will include the control of the auxiliary systems cooling system, fuel supply etc.

There will be no potential for single points of failure in the DCS system. The system structure will reflect the redundancy provisions of the plant so that no single fault within the system will cause any operational disturbance or spurious operation. Failure of any single device will not affect the ability of the system to communicate with other devices in the system.

The main control functions will be executed by the process stations (PS) and the operator stations (OS) which support through the Human Machine Interface (HMI) the communication of the operator with the plant. Additionally, Engineering (ES), Information Management (IMS) and Asset Management Stations (AMS) may extend the functionality. For the exchange of process data process stations are connected to each other via a highly reliable, redundant process bus. For data exchange with data servers and workstations running the HMI software, the process stations will be connected via a redundant process bus, communication bus or network.

Measuring devices, control valves, actuators and switches will be connected to process stations via individual cables, or via bus cables.

The control system will be connected via gateways to the Local Area Network (LAN) of the office environment, and to Wide Area Network (WAN) for information exchange with remote offices. Data and information management, data storage and backup systems and Information Management Systems will be fully integrated into the DCS.

An energy and plant optimisation system will oversee the technical installations, commercial procedures, contracts, and restrictions thereof. It will support the operating staff in creating optimised unit schedules. A Plant Asset Management System (PAMS) will optimize the operation and maintenance of all remotely controlled I&C devices in respect to asset information and mechanical equipment performance.

Each Gas Turbine Generator (GTG) and Steam Turbine Generator (STG) will have its own control and protection systems as hardware and software. The control system will include all necessary control functions such as governor control, start-up/shut-down sequence control, GTG fuel gas control, auxiliary equipment control, etc. The GTG and STG control systems will be redundantly connected to and consistently integrated with the DCS.

A continuous emission monitoring system (CEMS) will be installed, including flue gas analysers at each HRSG stack for NOx, SO2, Particulate Matter, CO, Volatile Organic Carbon (VOC, only at Aux. Boilers) and the reference parameters O2, flue gas pressure and flue gas temperature, sample conditioning equipment, calibration gases, analysers for temperature, pH-value and flow rate of treated plant effluents to be discharged to the sewerage canal, data acquisition module, data evaluation and visualisation equipment for the measured emission data with connection to the DCS.

7.32 Civil works

The complete scope of the civil works for the Jhang power plant project shall provide all buildings and structure for the entire plant to accommodate all necessary work stations for the operation and maintenance of the plant and to accommodate the complete mechanical, electrical and I&C equipment necessary for the operation of the plant. Furthermore, the complete infrastructure for the power plant and all temporary facilities needed for the erection of the plant shall be provided within the scope of the civil works. The scope of civil works shall at least comprise the following:

- The complete site installation for the EPC Contractor's use;
- Field laboratory;

- Site offices for Owner / Owner' s Engineer (supply & erection, fully furnished and handed over to the Owner/ Owner' s Engineer);
- Site preparation works including demolishing old reinforced concrete structures, grading, levelling of the site;
- Access to the site connected to the public road;
- Complete civil engineering and planning for the complete project;
- Multifunction building;
- Security building and necessary infrastructure;
- Main gate house;
- Workshop / central store;
- Turbine hall;
- HRSG foundations;
- Step-up transformers foundations,
- Switchgear building;
- Circulating cooling water pump house;
- Cooling towers and foundations;
- HV-switchgear building;
- Open switch yard;
- Demineralised water plant building;
- Diesel oil tanks and related facilities;
- Industrial waste water treatment plant building;
- Raw water pump house;
- Road grid system, parking areas, hard stands;

- Appurtenant structures, landscaping and gardening;
- Pipe and cable bridges;
- Pipe and cable trenches and ducts,
- Complete subsoil piping systems for raw water supply from the river, industrial waste water, sewage water, storm water, potable water and firefighting;
- Fencing and gates.

The scope of work shall cover buildings, structures and appurtenant structures complete in every respect, equipped and fitted out ready for use. The project is located outside of the urban environment of Jhang and for that reason the architectural design for the entire power plant project shall reflect to the particular requirement of the Owner. Furthermore, for the acceptance of the project and to meet the demand of the Owner the architectural design of the buildings shall be made to show a sophisticated industrial design with elegant architectural appearance and modern design features.

8 SITE STUDIES / SURVEYS

8.1 Environmental Assessment

The environmental impacts of the project are being assessed in an Environmental Impact Assessment (EIA) Report being prepared as a standalone document in accordance with the requirements of the Punjab Environmental Protection Act, 1997 (amended 2012); Pak-EPA Regulations, 2000 for review of IEE and EIA; Pakistan EIA procedures; and Sectoral guidelines for environmental reports: Major Thermal Power Stations, October 1997. The EIA report is attached as Annex I

8.2 Geotechnical Investigations

A Geotechnical Investigations being carried out at site and the information received / evaluated so far has been considered for the purpose of feasibility stage study. The partial geotechnical report has been provided at Annex F.

It is found that the topmost soil layer mostly comprising of low plastic Silt/Silt with Sand (ML) in firm to stiff state. The thickness of this layer is approximately 3 m below NSL. Above layer is underlain by a medium dense to very dense Poorly Graded Sand with Silt/Silty Sand (SP-SM/SM) up to a maximum drilled depth of 40 m below NSL.

Spread foundations for lightly loaded structures like boundary wall and residential apartments can be placed at 1.0 m depth below NSL and the net allowable bearing pressure has been estimated as 80 kPa for 1.0 to 3.0 m range of widths.
Spread foundations for other lightly loaded structures like ancillary buildings can be placed at 2.0 m depth below NSL. For such structures, 1 to 5 m width shave been considered.

The mat foundation distributes the structural loads uniformly over a wide area thus minimizing the chances of differential settlements. As such, for the moderate to heavily loaded structures (where spread foundations tend to be close enough) and the sensitive structures, mat foundations would be an appropriate choice. For such structures, 5 to 25 m wide mats have been considered.
Mat foundations should be placed on silty sand layer below the top silt layer (about 3.0 m below NSL).

For very heavily loaded/sensitive structures with specific loading requirements like vibrational loads or large lateral loads, like gas and steam turbines, HRSGs, transformers and gantries, cooling towers etc., if raft foundations are not feasible, bored cast in-situ reinforced concrete (R.C.) piles could be an appropriate alternative choice. The allowable load capacities will be confirmed based on the results of full-scale pile load tests.

Groundwater table was encountered in all the boreholes carried out until now at depths ranging from 3.1 to 3.5 m below NSL during the current investigations.

The water table in the area is very shallow, generally 3.1 to 3.5 m deep, therefore, any excavation below groundwater table would necessitate dewatering. In order to achieve water-free excavation surface at the locations of foundations of the structures, proper dewatering techniques may be required.

It is essential to ensure proper drainage of the area around the structures, in the design. Besides, proper paving should also be provided adjacent to the exterior walls of the building. These arrangements would stop ingress of surface water into the ground in the vicinity of the structures and would provide safety against any possible distress.

8.3 Groundwater Study

The project area is located in Lower Rechna Doab, which is a part of central Punjab Plain. The Punjab Plain is a part of the Indo-Gangetic Plain, which forms one of the most prominent and extensive physiographic division of the Indian subcontinent. Geologic evidence suggests that the Indo-Gangetic Plain lies in a great trough which came into existence in Middle-Tertiary time. However, the present boundaries of the trough were formed during the post-Siwalik period. Since that time (late Pleistocene) the mighty Indus and its present and ancestral tributaries have deposited vast quantities of sand, silt, clay and gravel in the subsiding trough. A variety of erosional and depositional processes associated with the constantly shifting of rivers courses has given rise to the formation of an alluvial complex, which is essentially heterogeneous in character.

Groundwater is one of the major sources of domestic water consumption in and around the project area. Farmers have also installed shallow wells for the agriculture purposes within the premises of the proposed plant. About 10 number of Deep wells up to 300 ft. deep having discharge capacity of 2.0 cusecs discharge have been installed by existing CCPP Power plant adjacent to Plant Site. Public Health Department – Toba Tek Singh have also installed deep wells along the TS Link canal adjacent to proposed CCPP Power plant each having the discharge capacity of 2.00 cusec.

Hence the proposed plant area is overlying the rich aquifer with fresh water along the TS Link Canal. However away from the canal quality of water is decreasing.

Recently conducted groundwater investigation for existing Power Plant adjacent to PTPL Site has been considered for feasibility stage study. The investigation was carried by collecting existing wells data such as depth to water table, depth of well, discharging capacity, water quality and groundwater potential of the project area through electrical resistivity survey. The data of the investigation revealed that;

- Depth to water table in the area ranges 10 to 13 ft. below ground surface;
- Electrical conductivity (EC) ranges from 567 to 1775 μ S/cm;
- Groundwater quality in Irrigation tube wells is generally fresh;

- Depth of irrigation shallow tube wells varies from 80 to 130 ft.;
- Capacity of irrigation wells ranges from 0.5 to 1.0 cusec capacity;
- Depth of hand pumps varies from 25 to 40 ft.

Electrical resistivity survey by using Terrameter SAS 300B of ABEM, Sweden and using the Schlumberger electrode array was also carried out and test drilling as per recommendations of ERS was carried out accordingly and revealed following information;

I.	Designed capacity	= 2.0 cusecs;
II.	Drilled depth	= 290 ft.;
III.	Cased depth	= 241.5 ft.;
IV.	Casing material	= Fiber Glass;
V.	Diameter of housing casing	= 18" diameter for Housing;
VI.	Diameter of strainer/blank casing	= 10" diameter for strainer/blind;
VII.	Pump setting depth	= 45 ft.;
VIII.	Discharge	=900 GPM;
IX.	Specific capacity	= 62.40 GPM/ft.

Preliminary groundwater study report is attached as Annex G.

For the construction of the required quantity of water / required nos. of well, the detailed Hydrogeological Study of the area including but not limited to pump out test and water balance study shall be conducted by the Contractor.

8.4 Hydrological/ Flood Study

The proposed site of 1100-1400 MW CCPP Punjab Power Plant is located adjacent to existing 1230 MW CCPP Haveli Bahadur Shah Power Plant. The site is about 5 km from Haveli Bahadur Shah, district Jhang. Another important hydraulic structure Trimmu Barrage is in close vicinity of the site. Haveli Main Line canal and Trimmu-Sidhnai (T-S) Link, off-taking from Trimmu Barrage also pass by the proposed plant site. A detail study report based on storm water drainage is attached as Annex M.

As per study report flood peak of 3,120 and 6,080 cusecs may approach towards project site in the event of 10-year and 100-year return periods respectively. Accordingly, flood levels of 487.31 ft.

(148.53m) and 487.93 ft. (148.72m) in the project area were estimated against the two rainfall events, respectively. The average natural ground levels of the plant site are ± El. 148.0 m. In view of the findings of the flood study, finish ground level (FGL) in the plant area is recommended to be 500 mm higher than the maximum flood levels i.e., 149.22 m. Finish floor level shall be adjusted accordingly.

In order to ensure the safety of power plant, it is also recommended to provide an embankment outside the boundary wall with top level 500 mm higher than the maximum flood level.

Further, a study on rare breaching scenarios (50,000 - 100,000 cusecs) from LMB Chenab River has been carried out to evaluate the flood depths within the project area. The possibility of breaching has been considered from RD 0+000 to RD 20+000 of LMB.

It is important to highlight that the only vary rare possibility of breaching is due to poor maintenance of LMB and the failure of embankment due to piping action. Whereas, design capacity of Trimmu barrage is 18,265 m3/s (645,000 cusecs). Barrage was constructed in 1938 and became operational in 1939. At present Barrage capacity is being revised to about 875,000 ft3/s under Punjab Irrigated Agricultural Investment Program (PIAP) project.

Flood protection embankments on Chenab River have been constructed to sufficiently protect the downstream population/crops against flood ingress. Natural terrain slopes in Indus river basin are mainly towards south east. Therefore, most of the planned breaching sections are along right sides of the rivers so that flow through breach can converge in same river at downstream. For Trimmu barrage, the designated breaching section is located between RD 16+000 to RD 18+000 of the right marginal bund (RMB) with a critical breaching level of 152.43 m (500ft) at RD 15+000 of the left marginal bund (LMB).

As per study report based on LMB breaching scenario the high flood levels have been evaluated are 149.71 m for 100,000 cusecs and 149.44 m for 50,000 cusecs discharge. The average natural ground levels of the plant site are ± El. 148.0 m. In view of the findings of the flood study, finish ground level (FGL) in the plant area shall be 500 mm higher than the maximum flood levels i.e., 150.21 m.

8.5 Transportation Study

A detailed transportation study was carried out from Port Qasim to Haveli BS site and Jhang project site to observe general road conditions with particular reference to site specific constraints / limitations and recommendations for remedial measures before undertaking the transportation of subject equipment. The visit was conducted by a team of experienced Highway and Structure Engineers accompanied by a representative of M/S Crescent Carriers (one of the leading goods transport company specializing in super heavy / large consignments). The following route is recommended for transportation of the equipment of the power plant:

- Port Qasim to Site via Port Qasim Road, N-5, Eastern Bypass, M-9Hyderabad, Moro, Sukkur, Sadiqabad, Lodhran (along N-5) and Khanewaland subsequently via Khanewal-Haveli BS Road before arriving at the Site

Detailed findings are presented in the study enclosed as Annex H.

8.6 Power Interconnection Studies

Power interconnection studies for the Project have been performed by NTDC and the report is attached as Annex J.

In the Report, the results of load flow and short circuit studies have been presented for the connectivity of the power plant with the National Grid. The interconnection studies have been carried out to evaluate the adequacy of the proposed interconnection scheme for power evacuation from said power plant to the National Grid in the light of NEPRA Grid Code.

National Transmission & Despatch Company (NTDC) will be responsible for power evacuation for which the interconnection scheme proposed by NTDC is given below:

- 220KV D/C transmission line, approx. 125km on twin-bundle Rail conductor, from Lalian for looping in-out of one 22KV circuit of Jhang RLNG power project to T.T Singh (near Jhang RLNG power project).

The load flow and short circuit analysis has been carried out with the proposed interconnection scheme for various operating scenarios for the months of January and July-to-Sept corresponding to the typical winter (low hydro) and summer (high hydro) scenarios respectively. In this regard, the peak load scenarios of January 2019, January 2020and Aug/Sep. 2021 have been simulated in accordance with the expected CODs of gas and steam turbines to analyse the impact of the proposed 1230 MW RLNG based CCPP at Jhang on the system network under normal and N-1 contingency conditions.

The results of short circuit studies indicate that the maximum three phase and single phase short circuit levels at the 220 kV switchyard of 1230 MW RLNG power project at Jhang would be 43.5 kA and 43.2 kA respectively in year 2022. The short circuit rating of 50 kA has been proposed for the 220 kV switchgear equipment of 1230 MW RLNG power project at Jhang in view of future expansions in NTDC and FESCO transmission networks. Moreover, the short circuit levels at the existing and planned220 kV substations in the vicinity of the proposed power plant will remain within their switchgear equipment rating.

9 PROJECT FINANCIAL ANALYSIS

The financial feasibility of the proposed RLNG based power plant ("the proposed project") is based on the technical and operating assumptions and data available with the NESPAK/LI ('Technical Advisors"). Following resources have also been considered by the Technical Advisors while developing estimation of project and operating costs:

- Price data base of the Thermo flow-Software and PEACE (Plant Engineering and Construction Estimator)
- Market sounding with OEMs and EPCs contractors
- Internal price information (including EPC/LTSA bid results of other three RLNG power projects) available with Technical Advisors

Since the proposed project is being developed on lines similar to other three RLNG power projects and the bidding process for the EPC/LTSA Contractors is underway, therefore, the tariff determinations of three RLNG power projects has been considered as a primary basis for project cost estimation for the proposed project.

This section provides a summary of the general, project cost, operating and financing assumptions (collectively "base case assumptions") applied in the development of financial analysis.

9.1 General assumptions

- General assumptions applied in the development of the project financial feasibility are outlined in table below:

Table 31: General assumptions applied in the development phase of Jhang project

General assumptions	
Deprecation rate (p.a.)	3.33%
Depreciation method	Straight line
Discount rate	10.0%
Corporation tax rate	Exempt
General Sales Tax (LNG output)	17.0%
General Sales Tax (HSD output)	64.0%
Custom duty (plant and equip. import)	5.0%

- All calculations have been performed in USD and no indexation has been applied under the base case.
- Where applicable, an exchange rate of PKR 105 per USD has been used to convert the figures into USD.
- The plant during its entire life cycle is assumed to operate 90% time on LNG fuel and remaining 10% time on HSD fuel. However, for the purpose of this financial feasibility, 100% operations have been assumed at LNG.
- For the purpose of this feasibility analysis, plant capacity (gross) has been assumed at 1,180.130 MW on LNG and 1,076.880 MW on HSD in line with NEPRA tariff determination No. NEPRA/TRF-347/QATPL-2016/5034-5037 dated April 14, 2016 for Bhikki Power Project, ("Bhikki tariff determination").
- Auxiliary load for the plant has been assumed at 2.0% on LNG and 3.4% on HSD.
- Plant capacity (net) has been assumed at 1,156.675 MW on LNG and 1,039.980 MW on HSD, in line with Bhikki tariff determination.
- The configuration of proposed power plant has been assumed at 2 + 2 + 1 i.e. 2 GT's + 2 HRSG's + 1 ST.
- Plant / load factor i.e. availability of the plant has been assumed at 92%.
- Net thermal efficiency has been assumed at 60.11% (for RLNG – combined cycle operations) and 53.04% (for HSD – combined cycle operations), based on the lowest efficiency bids submitted in the case of Bhikki Power Project.
- Degradation has been considered as a normal feature of plant and hence assumed to be a pass through item under cost plus tariff.
- In line with Bhikki tariff determination, a discount rate of 10.0% has been used to calculate NPV for the purpose of this feasibility study.
- In line with NEPRA's earlier tariff determinations for three RLNG based power projects (i.e. at Bhikki, Balloki and Haveli Bahadur Shah), for the sake of this financial feasibility analysis, RLNG and HSD reference prices have been assumed at USD 7.0 per MMBtu - HHV and PKR 46.21 per liter (excluding GST) respectively.

9.2 Project cost assumptions

The summary of the project cost together with brief description of underlying basis is as under:

Table 32: Estimated Project Costs - Jhang project

NO.	PROJECT COST	USD MILLION
1.	EPC	611.236
2.	Customs Duties & Cess	27.741
3.	LTSA Initial Service Parts	20.880
4.	Gas Pipeline Cost	37.365
5.	Non EPC & Project Development	60.131
	CAPEX	**757.353**
6.	Financing Fees and Charges	23.395
7.	Interest During Construction	73.323
8.	One month LNG escrow account	37.162
	TOTAL PROJECT COST	**891.233**

The above mentioned project cost has been estimated on the following basis:

9.2.1 EPC cost

- EPC cost has been estimated based on highest per MW EPC cost of (~USD 488,000) determined by NEPRA in case of the three RLNG power plants i.e. at Bhikki Power Project, HBS Power Project and Balloki Power Project.
- Plant capacity is based on plant capacity determined for Bhikki Power Plant (i.e. 1,156.675 MW) to arrive at the estimated total EPC cost. This is subject to revision based on the outcome of the on-going bidding process.
- The EPC Cost assumed is adjusted to reflect impact of weighted rate of escalation (4.3%) covering US CPI and Local CPI variation over last two years.
- NEPRA approved USD 14.45 million additional cost items, which were not covered in the EPC contract of Bhikki Power Project. However, due to location of plant distant form city centre, the cost of housing complex in this case shall be significantly higher as compared to Bhikki housing cost, consequently an additional USD 11.74 million has been assumed.

9.2.2 Custom duties

- Taxes and Customs Duty have been computed in light of the applicable laws of Pakistan and will be treated as pass through item as per actual. Based on the reference exchange rates of PKR 105 for 1 USD, the Taxes and Custom Duty for the Project represent 6.15% (custom duties 5% and Provincial Infrastructure Cess 1.15%) of the Offshore EPC Cost.

9.2.3 LTSA initial spares

- LTSA initial spare parts price of USD 20.88 million is assumed consistent with the Bhikki Tariff Determination. The higher gas pipeline cost as compared to Bhikki Power Project is primarily attributable to relatively longer distance between the Site and the gas off-take point.

9.2.4 Gas pipeline

- Project costs also include spur Gas Pipe Line Cost of 92 Kms from off-take point Kabirwala to Punjab Power Plant site. This cost is an initial estimate provided by SNGPL and shall be subject to adjustment as per actual.

9.2.5 Non EPC cost

Non-EPC and project development costs have been budgeted at USD 60.131 million substantially in line with the Bhikki Tariff Determination. These include engineering and related consultancy, administrative expenses, O&M mobilization cost, land cost, security and surveillance, insurance during construction, fixed O&M and LTSA during construction and testing and commissioning cost.

- The engineering and consultancy cost is estimated at PKR USD 12.6 million. The estimation is based on Bhikki power project engineering and consultancy cost of USD 10.0 million escalated at 8% per year for local and foreign escalation;

- Administrative expenses of USD 10.508 million were determined for Bhikki power plant for 27 months. On similar lines, an amount of USD 11.676 million, on pro-rata basis, is estimated for a period of 30 months for Jhang project;

- O&M mobilization fee of USD 6.0 million is assumed in line with benchmark allowed for all the three RLNG power plants by NEPRA;

- Land area measuring 1,360 canals has been estimated to be required for the project. The land has been purchased through land acquisition at the rate of PKR. 2.5 million per acre, which comes to a total of USD 4.05 million. In addition, an approximate amount of USD 0.57 million is estimated to be spent toward the cost of compensation for structures, crops and trees. The total cost of land hence works out to be USD 4.62 million;

- The security and surveillance costs are assumed at USD 8.257 million in-line with the Bhikki Tariff Determination;
- Insurance during construction has been assumed as 1% of the EPC cost which is in line with the Bhikki Tariff Determination and in accordance with benchmark established in other projects;
- The testing and commissioning cost has been estimated in line with the cost allowed by NEPRA for Bhikki Tariff Determination.

9.2.6 Financing fees and IDC

- Financing fees have been assumed at 3.50% of the debt amount;
- Interest during construction (IDC) is based on an initial upfront equity investment of PKR 10.0 billion and thereafter project funding based on debt to equity ratio i.e. 75:25 for a construction period of 30 months;
- Following yearly spend profile has been assumed to compute ROE and IDC:

Table 33: Yearly spend profile - Jhang project

YEAR	EQUITY (%)	COMMERCIAL DEBT (%)
1.	42.74%	25.75%
2.	42.26%	59.25%
3.	15.00%	15.00%
Total	100.00%	100.00%

9.2.7 One month LNG escrow

One month LNG escrow has been assumed at USD 37.162 million based at per day cost of RLNG at USD 7.0 / MMBTU (HHV), in line with NEPRA's earlier tariff determinations for previous three RLNG projects..

9.3 Means of financing

The project cost is assumed to be financed as follows:

Table 34: Assumption of project costs for Jhang project

Year	Equity drawn (USD)	Debt drawn down (USD)	Total (USD)
1	95.24	172.13	267.37
2	94.15	396.03	490.18
3	33.42	100.26	133.68
Total	**222.81**	**668.42**	**891.23**

9.4 Project tariff and equity investment returns

Taking into consideration, a guaranteed Return on Equity (IRR) of 16% under power policy 2015 and earlier tariff determinations, the project tariff has been computed, which constitutes the following two components:

- Energy Purchase Price (EPP);
- Capacity Purchase Price (CPP).

The underlying assumptions utilized in tariff computation for simple and combined cycle operations is explained in the sections to follow.

9.4.1 Fuel cost component

9.4.1.1 RLNG operations (Simple cycle)

Fuel cost component is estimated at PKR 7.1134 / kWh based on:

- A calorific value of 3,412.15 BTU/kWh;
- Net efficiency levels of 39.05%; and
- RLNG price of USD 7.0 / MMBTU (HHV).

9.4.1.2 RLNG operations (Combined cycle)

Fuel cost component is estimated at PKR 4.6212 / kWh based on:

- A calorific value of 3,412.15 BTU/kWh;
- Net efficiency levels of 60.11%; and
- RLNG price of USD 7.0 / MMBTU (HHV)

9.4.1.3 HSD operations (Combined cycle)

Fuel cost component is estimated at PKR 8.7491 / kWh based on:

- A calorific value of 36,019.20 BTU/scf;
- Net efficiency levels of 53.04%; and
- HSD price of PKR 46.21 / litre excluding GST.

9.4.2 Variable O&M component

Variable O&M cost comprise foreign LTSA and O&M Operator Fee. LTSA cost is estimated on Bhikki power plant's LTSA prices quoted by OEM GE for maintenance of equipment at USD 441.6 per factored fired hour. Total factored fire hours are estimated to be 16,800 per year.

Similarly, O&M operator fees is estimated at USD 20.7 million in line with Bhikki tariff determination.

Based on the above assumptions variable O&M cost is estimated at PKR 0.3169 / kWh for RLNG operations and PKR 0.4572 / kWh for HSD operations.

9.4.3 Fixed O&M component

Fixed O&M comprises of foreign and local components. Foreign component consists of fixed annual LTSA costs of USD 6.960 million and O&M operator fees of USD 7.058 million in line with Bhikki tariff determination.

Local component is of USD 6.25M, which represents company's budgeted overhead/ O&M fee (local) during operations same as allowed for Bhikki Power Project.

Based on the above assumptions fixed O&M cost is estimated at PKR 0.2100 / kWh for RLNG operations.

9.4.4 Insurance cost component

The insurance cost component is assumed at PKR 0.0633 / kWh. Annual insurance premium is estimated at 1.00% of the EPC cost in line with the Bhikki Tariff Determination.

9.4.5 Working capital cost component

In line with the Bhikki Tariff Determination, Jhang project has estimated its working capital requirement equivalent to 40 days of cash cycle taking into account the normal payment cycle of the PPA applicable to energy payments receivable from the Power Purchaser and 7 days of HSD inventory.

Cost of short term borrowing has been assumed at 3mKIBOR + 2%. Further, cost of 60 days SBLC at the rate of 1.5% per annum has been assumed as part of the working capital cost.

Based on the abovementioned assumptions working capital cost component is estimated at PKR 0.0731 / kWh for RLNG operations.

9.4.6 Return on equity component

The Return on Equity component (including Return on Equity During Construction) has been based on an internal rate of return of 16% which is in line with the Power Policy 2015 and previous rulings of the Authority on the matters related to RLNG generation. Calculations are based on expected equity utilization up to COD for a construction period of 30 months. Corporate income tax and Withholding tax payable on income are assumed to be pass-through and are not included in the Tariff.

9.4.7 Debt servicing component

Debt servicing component is based on 100% debt financing from local banks and financial institutions. The debt amount is estimated at USD 668.425 million. Key terms of financing are provided below:

- Semi-annual repayment frequency;
- Repayment period of 10 years;
- 3-month KIBOR base interest rate plus 3.0% spread;
- Reference KIBOR rate of 6.14%.

Based on the abovementioned assumptions debt servicing is estimated at PKR 1.0715/ kWh during the first 10 years of RLNG operations.

9.4.8 Proposed Tariff

Based on the base case assumptions described above, tariff for LNG and HSD operations under simple cycle and combined cycle is as follows:

Table 35: Proposed Tariff (PKR/KWh) for Jhang project

Proposed levelized tariff (PKR per kWh)	RLNG		HSD
	Combined cycle	Single cycle	Combined cycle
Fuel cost component	4.6192	7.1104	8.7491
Variable O&M	0.3169	0.3169	0.4572

Proposed levelized tariff (PKR per kWh)	RLNG		HSD
Energy Charge	**4.9361**	**7.4273**	**9.2063**
Fixed O&M (Local)	0.0647	0.0647	0.0720
Fixed O&M (Foreign)	0.1453	0.1453	0.1616
Cost of working capital	0.0882	0.0882	0.0981
Insurance	0.0633		0.0640
Return on Equity	0.4916		0.5467
Debt service cost – repayment	0.4260		0.4738
Debt service cost – interest	0.2806		0.3121
Capacity Charge	**1.5597**		**1.7283**
Tariff	**6.4958**	**7.7255**	**10.9346**

10 REQUIRED PERMITS AND APPROVALS

10.1 General

Setting-up a new enterprise such as thermal power plant requires piece of land adequate for installation of its main equipment, accessories, auxiliaries, construction of maintenance workshop, stores, administration building, internal access roads and supply of various commodities viz. water, fuel, chemicals etc. and discharge of various effluents, air emissions etc. All these additions affect the social features, environmental equilibrium, zoological life and biological growth in the vicinity of new structures and these changes need to be acknowledged by the concerned monitoring and managing governmental organizations and relevant permits and approvals are accorded.

10.2 Environmental Clearance

Environmental impact of every new enterprise is of different intensity varying mild to severe. Accordingly environmental study of various impact levels in view of the specific nature of the project is conducted and remedial measures are concluded for effective mitigation of significant adverse effects if any.

The Project is located in the province of Punjab. As such a petition along with Environment Impact Assessment (EIA) Study report is to be lodged by the Owner to Punjab Environmental Protection Agency (PEPA) for their perusal and consideration.

Concerned office will process the petition and announce through the press about conducting the public hearing meeting. Government functionaries, concerned NGOs and the inmates of the project area are invited for participation to express their concerns if any, addressing the public grievances and elaborating the mitigation measures in view to monitor and manage Natural Environment Quality Standards (NEQS).

10.3 Water Supply and Discharge

The Owner will have to enter into an agreement with Irrigation Department, GoP for utilization of water and construction of intake and outfall structures at the Trimmu-Sidhnai Link Canal.

10.4 Construction

The construction phase of the project is very critical with environmental view point as the dust / dirt control, sewage treatment, effluent treatment etc. are yet to be established and measures for mitigation of adverse effects are either overlooked or partly implemented.

Environmental management and monitoring plan (EMMP) will be worked out and included in Environment Impact Assessment (EIA) study report for consideration of various stake-holders. The PEPA may visit from time to time for monitoring EMP measures at the site.

10.5 Operation

Prior to commercial operation of the plant an operation permit has to be obtained from the power purchaser. The detailed procedure for obtaining this permit should be coordinated with the power purchaser to start the application process in due time.

11 PROJECT RISKS AND MITIGATION MEASURES

This chapter identifies, analyses, quantifies, if possible, and proposes measures how to mitigate risks at the different stages of the project. After a general analysis of the involved risks, structuring and preventive mitigation measures, this chapter presents a quantitative and a qualitative risk analysis.

At the end of this chapter the Consultant summarizes the risk, the party to the project finance which will bear the risk, the planned mitigation measures, the effect on the lender, and the effect on the joint venture of shareholders.

11.1 General

It is planned that the CCPP project will be realized as a limited-recourse financing. The creditworthiness of the project and how much recourse is necessary to support the project financing will depend on the volume and the stability of the underlying cash-flow resulting from revenue-producing contracts, mainly independent of the non-project assets of the project. Any component of the project that could unduly result in less revenue or greater expense than anticipated at the time predicted could result in project failure.

In answer to this, the network of contracts in project financing is designed to avoid risk and to allocate risks to the party which can best absorb it. The risk allocation process in structuring a project financing, permits to spread the risks over all participants, including the lender. The risk allocation will create commitment of all participants to the timelines, input and output prices, etc. The contracts form the framework for project viability and control the allocation of risks. An important part of the successful closing of a project financing is the risk structuring process. As in a typical project finance analysis, this feasibility study considers risks in terms of uncertainty in regard to cost, loss or damage.

The actual gearing realized will therefore be determined by the unique risks presented in a project, and equally on the appetite of the credit markets to accept the risks.

11.2 Qualitative Analysis

The following sections identify, describe and analyse the key risks involved and the necessary mitigation measures in the project. For the analysis the consultant distinguishes two main phases: First the pre-completion phase until issuance of the final acceptance certificate and the operating period after completion of the project (post-completion phase).

11.2.1 General risks

11.2.1.1 Political Risks

The political risks include change in government's policies vis-à-vis imported LNG and LNG based power plants. The risk can be mitigated by obtaining all necessary approvals and executing agreements with various stake holders viz. power purchaser and gas supplier etc. before embarking on the implementation phase and by fully agreed long term strategy of development power generation assets in Pakistan approved by major political parties and groups.

11.2.1.2 Currency Risks

In general, the different forms of currency risks involved in transnational project financings like the Haveli BS project include (i) non-convertibility, (ii) inability to transfer, and (iii) the devaluation of the local currency risk.

The non-convertibility risk concerns the ability to convert the currency into foreign exchange as a predecessor to moving money out of the host country. Insufficient foreign exchange reserves to convert local currency may result in the risk that the central bank of the host country will be unable to convert the local currency.

The currency transfer risk arises in situations in which currency local and/or foreign is not allowed to be transferred out of the country. This risk could manifest itself in the situation in which the central bank of the host country notionally converts the local currency into the foreign exchange but then refuses to transfer it out of the country.

Finally, the currency devaluation risk, or rate of conversion risk, is the term used to describe the difficulties encountered by a project company to repay its debt service denominated in a foreign currency. The conversion rate risk is therefore relatively insignificant for this project when local workforce is engaged and during O/M period in case of order local services. In case of purchase of fuel - RLNG and technology (e.g. F-class GTs) is significant.

11.2.2 Pre-Completion stage

The following sections highlight the below stated project risks prevailing during the pre-completion stage:

- Lead time of manufacturing major equipment (GT, ST, step up transformer, compressor), especially GT which are required on site during 6-7 months from NTP;
- Transportation and infrastructure risks;
- Force Majeure;
- Political;
- Investment costs.

11.2.2.1 Lead time of manufacturing major equipment

The manufacturing risk of major equipment may cause delay in completion – more challenging periods than schedules executed for RLNG based CCPP projects. GE, Siemens confirmed their credibility of manufacturing major equipment. EPC contractors are ready to provide guarantees for completion time, but crucial part depends on confirmation by EPC that purchased orders fulfil the Owner requirements for Jhang project.

11.2.2.2 Transportation and Infrastructure Risk

The transportation infrastructure risk potentially involves (a) a completion delay risk and (b) a cost overrun risk. The former consists of the risk that the transport of the heavy machinery is delayed which could lead to a late commissioning risk. The latter consists of the risk that the EPC contractor will have to undertake some works to ensure the transport of the heavy machinery.

NESPAK provided a transportation survey to check if all components of GTs F/H - class machines and generators could be transported from Karachi port to the Site along the chosen route, in safe conditions. The consultancy concluded that if transported on adequate transport equipment, the transport infrastructure risk for the heavy machinery involved in the Haveli project is actually quite low. Some difficulties and delay and/or cost overrun could occur under the following circumstances:

- A delay in case the late shipment the heavy machinery from OEMs workshops to Karachi port. This risk is considered to be rather minimal. It is to be classified as a low frequency high impact scenario;

- A delay in case the logistic problems in Pakistan – route from Karachi port to the Site, which the 4 axles heavy trucks transporting the turbine and the generator will have to cross, refuse or delay the permissions for the trespassing of bridges despite the fact that the consultant considers that there is no technical problem for the trucks to pass[20]. Nonetheless, it is important to initiate the application for the trespassing in time in order to avoid any delay to this regard;

- Delay of the generator transport if the single road identified for transporting the generator – the heaviest of the heavy machinery – is for some reason blocked. This risk, however, equally needs to be classified as a low frequency high impact scenario.

The transport risk has to be borne by the EPC contractor and a logistics contractor. For Jhang project those risks can be easily mitigated based on collected experiences for 3 RLNG based CCPP projects.

11.2.2.3 Investment Cost Risk

The investment cost risk consists of the risk that the capital costs to be engaged turn out to be so high that the project will not be financially sustainable at a given RLNG price and sales tariffs for electricity.

In order to mitigate the investment costs risk, the project will be implemented under a lump-sum turnkey contract. After the signature of the EPC contract the investment cost risk and the involved

[20] The consultancy considers that the actual passing of the bridges does not cause any issue.

cost overrun, risk will be borne by the EPC contractor with whom the project company will sign a fixed-price time certain contract. With this approach, the investment costs are fixed prior to start of construction / financing decision. No significant changes to the agreed lump sum turnkey fee against the specified scope can occur.

Owner will sign an EPC contract after selecting the contractor through a competitive bidding process. However, the competition will be limited in regards to the maturity of many EPC contractors at Pakistan's market and limited experience (except of HEI and Power China) of particular EPCs in this region and additionally by challenging timeline.

The consequent opaqueness of costs may create a significant investment cost risk for the project company. The risk may be mitigated by a very deep assessment of submitted EPC tenders and it will have to reduce its price in order for the project to become financially more attractive.

The cost overrun risk during the completion period consists mainly of a higher than expected construction or equipment costs. This would lead to higher interest costs and debt service. The project company of Haveli BS project will sign a turnkey fixed-price, time-certain contract with the EPC contractor with liquidated damages which would fully compensate the project company. Any type of cost overrun during the pre-completion period until the issuance of the preliminary acceptance certificate (PAC) will therefore be assumed by the EPC contractor. Until the issuance of the final acceptance certificate the EPC contractor will have to bear the risk in case key components fail or break down. The cost overrun risk after the issuance of the PAC will be borne by the operating company.

Notwithstanding, a minor cost overrun risk still remains with the project company, i.e. the overrun in estimated costs due to very high site preparation difficulties. This risk will have to be assumed by the project company.

One specific investment cost risk involves the commissioning costs. The commissioning of the plant will involve significant gas costs (and diesel if back up fuel case will be implemented). If these fuel costs would need to be covered by "normal" revenues under the power purchase agreement, the project risks to be not feasible. These additional gas costs will need to be passed through to the power purchaser.

Design changes: The issued permissions will be based on the design assumptions of the previously executed 3 RLNG based CCPP projects compiled by the NESPAK and Lahmeyer. The effects on these existing permits due to design changes during the further course of the project need to be assessed by the EPC.

11.2.2.4 Lack in Availability of Gas Risk

The commissioning of the plant (SC mode) is projected to take place during the months of September and October 2018. For the commissioning of the plant, it is necessary that latest by the end of July 2018 the regulating and metering station will be established at the site by the gas supplier and that gas is available at the required pressure and quantity for the commissioning of the power plant.

This risk will mainly have to be mitigated by the current investments of the gas supplier.

11.2.2.5 Lack of power evacuation

The connection to the transmission line will need to be available by early August 2018. Any delay in access to the grid / network will lead to a delay of commercial operation date and a concomitant flow of revenues to cover debt service and operation and maintenance expenses. In addition, a delay in completion may result in liquidated damages payments payable under the output contracts or in the worst case even in a cancellation of the contract. The connections have to be established by the grid operators. If these companies do not begin necessary work on time, the connection could be delayed.

11.2.2.6 Site preparation

Jhang project is a green field project. Before the start of the construction the site will be prepared by the owner with the support of the EPC contractor. A delay risk is inherent in the preparation of the site as unexpected complication could increase the works required; for instance, the project is situated in an area which is not clear from ownership point of view and potential clashes with local society can create unexpected difficulties.

Such complications might be covered by an owner's guarantee.

11.2.2.7 Issuing of permits

Another important completion risk is a delay in issuance of necessary permits and signing of security documents e.g. power purchase agreement, gas supply agreement, implementation agreement etc. GoPb and its company will have to arrange the requisite permissions and sign the security documents with various stake-holders. The project is risking a delay to this regard which will need to be managed by the Owner. The equity partnership also needs to be framed in such a way that the Project is not victimized on political basis.

This includes the involvement of Chamber of Commerce of the Project area, and non-Governmental organizations, so that community thrust is behind the Project.

11.2.2.8 Force Majeure Risk

Force majeure is a common clause in contracts that essentially frees both parties from liability or obligation when an unpredictable event or circumstance beyond the control of the parties, such as a war, strike, riot, crime, or an event described by the legal term "act of God" (such as flooding, earthquake, or volcanic eruption), prevents one or both parties from fulfilling their obligations under the contract.

Force majeure clauses will need to be included in all major project contracts, i.e. in the EPC contract, the gas supply contract, the transmission connection, the PPA and the heat purchase agreement, and the agreements related to operation and maintenance, etc.

Force majeure provisions in project contracts must be carefully coordinated. Otherwise, the situation could arise in which, for example, the contractor is excused from its obligations to complete the project by a date certain, while the off-take sales agreement does not provide the project company with a similar relief. During pre-completion phase can affect EPC contractor, during post-completion can affect O&M contractor services.

11.2.3 Post-Completion

Post-completion risks can be defined as events that lead to a lower than expected revenue generation for the Owner. To this regard the listed below post-completion risks have been identified by the consultant:

- Market risk (fuel);
- Project management risk;
- Technology risks;
- Plant performance risks;
- Operating risk;
- Force majeure.

11.2.3.1 Market risk

As mentioned earlier, the project will need to generate revenue from sales of electricity. The market risk comes in two forms: (i) price and (ii) access to purchasers for sale of the project's electricity. As discussed in the chapter related to the market analysis, the market risk is minimal regarding the great demand for stable generated electricity in Pakistan.

In addition, the project is also confronted with a significant market risk related to the gas supply. This risk equally comes in form of two risks: (i) price and (ii) constant availability. Neither the gas supplier nor the plant can bear the risks related to the volatility of crude oil prices. The risk will need to be mitigated by a pass-through clause in the PPA. The long-term stability of the gas supply will need to be assured in the gas supply agreement with the gas supplier.

11.2.3.2 Project Management Risk

The project management risk consists of a possible delay. Two distinct phases may be distinguished: the phase until financial close and the phase until commercial operation. The project management risk until financial close should be borne by the developer and the risk during construction period should be borne by the EPC contractor with strong control and advice of Nespak and Lahmeyer.

11.2.3.3 Technology Risk

The latest series of heavy duty gas turbines considered for this project are proven H-class technology– already implemented at Bhikki, Balloki and Haveli BS site (GE 9HA.01 models) in Pakistan. Burning only one fuel type, natural gas of very good quality, will keep the technology risk very low. The HRSGs with 3-pressure steam system and the extraction-condensing steam turbine are proven systems being built in many applications of similar plants worldwide. All other systems will be of proven type as well. The operation and routine maintenance by an experienced O&M company as well as the know-how and guarantees of the gas turbine OEM in a long term service agreement will limit the technology risk to a minimum.

Additionally, for implementation latest H-class machines by the OEMs who do not have prior commercial operation experience, these OEMs companies will provide additional extended guarantee to improve the comfort of Owner.

11.2.3.4 Plant Performance Risk

The plant performance risk consists of the risks that the plant after commission does not produce the expected level of output. This would basically result in a loss in revenues for the joint venture company and might in the worst case result in a default on debt repayment. The risk will have to borne by the EPC contract until the PAC or taking over of the plant.

After the issuance of the PAC for SC mode, the risk will be borne by the project company. As protection against a revenue shortfall, the lenders can allocate the risk partially to the professional operating company. In addition, it is suggested that the shareholders will provide additional equity facility.

11.2.3.5 Operating Risk

The operation and maintenance strategy aims to minimize management costs and to ensure long-term reliability of the plant. It is assumed that professional operating company will be running the plant. They will be responsible for running operations and daily maintenance measures. Day-to-day decisions about the project's operation are crucial for the success or the failure with regard to the assurance of a stable cash flow.

Owner and Project Company will be signing a long-term service agreement. Within contracted 100,000 Factored Fired Hours (or: Equivalent Operating Hours) it is strongly suggested to undertake the gas turbine inspections with the original equipment manufacturer. Subsequent inspections may be undertaken by another equipment manufacturer for economizing on costs. Overall, the proposed concept minimizes the existing operation risk related to cost overruns and/or lack of quality of service.

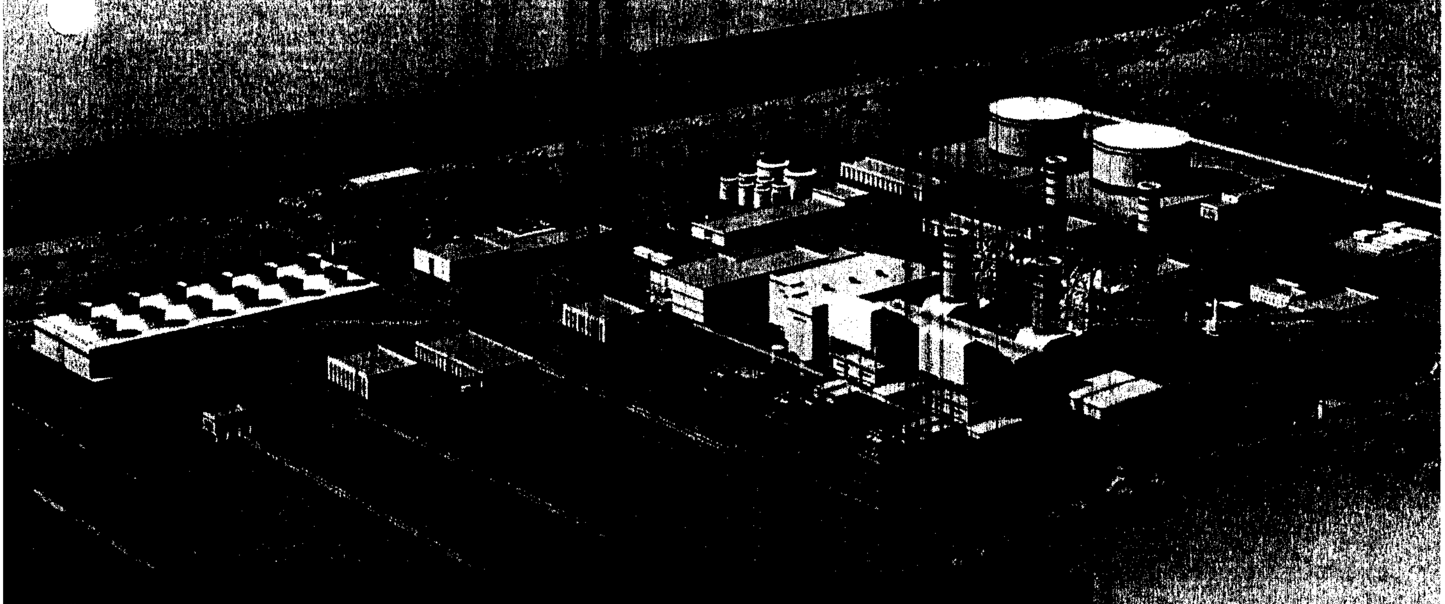
11.2.4 Risk Summary

Risk summary is presented in below table (Table 36) with hierarchy presented in Risk Matrix – see Figure 34.

DRAFT

PUNJAB THERMAL POWER COMPANY (PVT.) LIMITED
GOVERNMENT OF PUNJAB

1,100 - 1,400 MW (GROSS) RE-GASIFIED LIQUEFIED NATURAL GAS (RLNG) BASED COMBINED CYCLE POWER PLANT, JHANG, PUNJAB, PAKISTAN



ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

AUGUST 2017

NESPAK

NATIONAL ENGINEERING SERVICES PAKISTAN (PVT.) LIMITED
Geotechnical & Geoenvironmental Engineering Division
NESPAK House, 1-C, Block N, Model Town Extension, Lahore
Tel: +92-42-99231917, 99090310 Fax: +92-42-99231918, 99231950
Email: gtnesp@wol.net.pk Web site: www.nespak.com.pk

1,100-1,400 MW (GROSS) RLNG BASED COMBINED CYCLE POWER PLANT AT JHANG, PUNJAB

DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Table of Contents

List of Figures

List of Tables

List of Annexes

List of Abbreviation

AA	Ambient Air
ADM	Air Dispersion Modeling
AIS	Air-Insulated Switchgear
AMSL	Above Mean Sea Level
AOI	Area of Influence
AP	Affected Person
ASME	American Society of Mechanical Engineers
BCFD	Billion Cubic Feet per Day
BCP	Building Code of Pakistan
BHU	Basic Health Unit
BOD_5	Biological Oxygen Demand
C&W	Communication and Works
CAD	Computer Aided Design
CAS	Compulsory Acquisition Surcharge
CBD	Conventional Biological Diversity
CBM	Confidence Building Measures
CBO	Community Based Organizations
CC	Combined Cycle
CCF	Chief Conservator of Forest
CCMP	Construction Camp Management Plan
CCPP	Combined Cycle Power Plant
CCR	Central Control Room
CCT	Clean Coal Technologies
CCTV	Closed Circuit Television
CCW	Closed Cooling Water
CEMS	Continuous Emissions Monitoring System
CEO	Chief Executive Officer
CHP	Combined Heat and Power
CITES	Convention on International Trade in Endangered Species
CMP	Change Management Plan
CNIC	Computerized National Identity Card
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
COD	Commercial Operation Date
COO	Chief Operational Officer
CPPA	Central Power Purchase Authority
DCR	District Census Report
DCS	Distributed Control System
DFO	Divisional Forest Officer
DG	Director General
DO	Dissolved Oxygen
DO	District Officer
DRO	District Remount Officer

DWO	District Wildlife Officer
E&RT	Environment and Resettlement Team
ECA	Employment of Child Act
ECO	Economic Cooperation Organization
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EM	Effective Microorganisms
EMC	Environmental Monitoring Cell
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
EPD	Environmental Protection Department
EPRF	Emergency Preparedness and Response Framework
ERS	Electrical Resistivity Survey
ESP	Electrostatic Precipitator
EUAD	Environment and Urban Affairs Division
FBC	Fluidized Bed Combustion
FGD	Flue Gas Desulphurization
FSA	Full Supply Arrangements
GDP	Gross Domestic Product
GIS	Geographic Information System
GM	General Manager
GMT	Greenwich Mean Time
GoP	Government of Pakistan
GoPb	Government of the Punjab
GT	Gas Turbine
GW	Ground Water
HAZOP	Hazard and Operability Studies
HBS	Haveli Bahadur Shah
HC	Hydro Carbons
HFO	Heavy Fuel Oil
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HSD	High Speed Diesel, back-up fuel
HSE	Health Safety and Environment
HSMF	Health and Safety Management Framework
HVAC	Heating Ventilation and Air Conditioning
I&C	Instrumentation and Control
IEC	International Electro-technical Commission
IEE	Initial Environmental Examination
IEE	Initial Environmental Examination
IP	Intermediate Pressure
IPP	Independent Power Producer
ISC	Industry Source Complex
IUCN	International Union for the Conservation of Nature
JICA	Japan International Cooperation Agency

KV	Kilovolt
LAA	Land Acquisition Act
LAC	Land Acquisition Collector
LES	Livestock Experiment Station
LNG	Liquefied Natural Gas
LP	Low Pressure
LPG	Liquefied Petroleum Gas
LTSA	Long Term Service Agreement
MD	Man Days
MER	Monthly Environmental Report
MMCFD	Million Cubic Feet per Day
MMM	Mitigation Management Matrix
MSDS	Material Safety Data Sheet
MW	Mega Watt
NCS	National Conservation Strategy
NEPRA	National Electric Power Regulatory Authority
NESPAK	National Engineering Services Pakistan
NFPA	National Fire Protection Association
NG	Natural Gas
NGO	Non-Governmental Organization
NH_3	Ammonia
NHA	National Highway Authority
NL	Noise Level
NOC	No Objection Certificate
NO_x	Oxides of Nitrogen
NPO	No Project Option
NPPMCL	National Power Park Management Company Limited
NPV	Net Present Value
NTDC	National Transmission and Despatch Company
O&M	Operation and Maintenance
OGRA	Oil and Gas Regulatory Authority
OIC	Organization of the Islamic Conference
P&D	Planning and Development
Pak-EPA	Pakistan Environmental Protection Agency
PAP	Project Affected Person
PCAP	Pakistan Clean Air Program
PEQS	Punjab Environmental Quality Standards
PHED	Public Health Engineering Department
PIDA	Provincial Irrigation and Drainage Authority
PKR	Pakistan Rupee
PM	Particulate Matter
PPA	Power Purchase Authority
PPE	Personal Protective Equipment
PSHA	Pakistan Seismic Hazard Assessment
PTPL	Punjab Thermal Power (Pvt.) Limited
RLNG	Regasified Liquefied Natural Gas

RSC	Reference Site Conditions
RTR	Reliability Test Run
RTR	Reliability Test Run
SAARC	South Asian Association for Regional Cooperation
SAS	Substation Automation System
SC	Single Cycle
SCADA	Supervisory Control And Data Acquisition
SCF	Standard Cubic Feet
SCFD	Standard Cubic Feet per Day
SCR	Selective Catalytic Reduction
SNCR	Selective Non Catalytic Reduction
SNGPL	Sui Northern Gas Pipeline
SOP	Standard Operating Procedure
SO_x	Oxides of Sulphur
SPSS	Statistical Package for Social Sciences
ST	Steam Turbine
SW	Solid Waste
T&P	Tools and Plants
TC	Tehsil Council
TDS	Total Dissolved Solid
TG	Turbine Generator
TMA	Tehsil Municipal Administration
TOR	Terms of Reference
TS	Trimmu-Sidhnai
TSP	Total Suspended Particles
TSS	Total Suspended Solid
TTS	Toba Tek Singh
UBC	Uniform Building Code
UC	Union Council
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPS	Uninterruptable Power Supply
US$	United State Dollar
VOC	Volatile Organic Compound
WAPDA	Water and Power Development Authority
WMF	Waste Management Framework
WW	Wastewater
WWT	Wastewater Treatment

1,100-1,400 MW (GROSS) RLNG BASED COMBINED CYCLE POWER PLANT AT JHANG, PUNJAB

DRAFT ENVIRONMENTAL IMPACT ASSESSMENT REPORT

EXECUTIVE SUMMARY

A. INTRODUCTION

Pakistan is facing acute power shortages. It has been reported that the shortfall in power generation has tremendously increased to about 5,000 – 7,000 megawatt (MW) and power shortage is estimated to cost the economy 2% of Gross Domestic Product (GDP) each year[1]. Government of Punjab (GoPb) has initiated a fast track Project to install a 1,100 - 1,400 MW Regasified Liquefied Natural Gas (RLNG) based Combined Cycle Power Plant (CCPP) at Jhang to reduce the ongoing acute power crisis. Another CCPP of similar nature is already being constructed under the umbrella of Ministry of Water & Power in the vicinity of proposed location for new CCPP. GoPb has decided to setup the project in Independent Power Producer (IPP) mode and for that purpose; a company in the name of Punjab Thermal Power (Pvt.) Limited (PTPL) has been established as Proponent of the Project. GoPb/PTPL engaged M/s National Engineering Services Pakistan (NESPAK) Pvt. Limited for providing the consultancy services to conduct the Environmental Impact Assessment (EIA) and Feasibility studies for the proposed Project. The implementation of the project will be Engingineering Procurement and Construction (EPC) contract based.

An EIA team from NESPAK comprising Environmental Engineers, Ecologists, Environmental Scientist, Thermal Power Plant Experts, Graphic Information System (GIS) Experts and Sociologists worked on the Project.

B. EIA METHODOLOGY

Keeping in view the Punjab Environmental Protection Act (amended 2012), Review of IEE and EIA Regulations, 2000, and Pakistan Environmental Impact Assessment (EIA) Procedures, the following approach and methodology has been adopted for conducting EIA study for proposed Project:

- Desktop Study;
- Review of Environmental Laws and Institutional Requirements;
- Delineation of Area of Influence (AOI);
- Analysis of Alternatives;
- Baseline Survey of AOI;
- Stakeholders and Public Consultations;
- Screening of Potential Environmental Impacts and Mitigation Measures;
- Environmental Management Plan (EMP);
- Conclusions and Recommendations; and
- Report Preparation and Documentation.

C. LEGISLATIVE REQUIREMENTS AND FRAMEWORK

18th Amendment in the Constitution of Pakistan has fundamentally altered the division of legislative powers between National and the Provincial Assemblies, resulting in a significant increase in the extent of Provincial autonomy. For the subject project, Environment

[1] *Annual Plan 2015-16, Ministry of Planning, Development and Reforms, Government of Pakistan*

Protection Department (EPD), Punjab is the concerned authority. The EIA report has been prepared keeping in view the following national policies, laws, regulations and guidelines:

- National Conservation Strategy, 1992;
- National Environmental Policy, 2005;
- Pakistan Labor Policy, 2010;
- Punjab Environmental Protection Act, 1997 (amended 2012);
- Pakistan Environmental Protection Agency (PAK-EPA) (Review of IEE and EIA Regulations, 2000);
- Pakistan Environmental Impact Assessment (EIA) Procedures;
- Punjab Environmental Quality Standards (PEQS), 2016;
- Punjab Wildlife Act, 1974;
- Punjab Plantation and Maintenance of Trees Act, 1974;
- Cutting of Trees Act, 1975;
- Pakistan Antiquities Act 1975 & Punjab Antiquities Amendment Act, 2012;
- Punjab Katchi Abadis Act, 1992;
- The Punjab Special Premises (Preservation), Ordinance, 1985;
- The Factories Act, 1934;
- Pakistan Penal Code, 1860;
- Land Acquisition Act (LAA), 1894;
- Punjab Irrigation and Drainage Authority (PIDA) Act, 1997;
- Labor Laws; and
- Other relevant acts and ordinances.

The major guidelines considered included Pakistan Clean Air Program (PCAP); Guidelines for Public Consultation; Guidelines for the Preparation and Review of Environmental Reports, 1997; and Sectoral Guidelines for Environmental Reports, Major Thermal Power Plants, 1997.

Apart from the national policies, laws, regulations and guidelines, some international treaties, conventions, and standards/policies such as Convention on Biological Diversity, 1994; The Rio Declaration, 1992; Kyoto Protocol, 1992; Convention on the International Trade of Endangered Species (CITES), 1975; UNESCO Convention on the Protection of the World's Cultural and Natural Heritage.

D. ANALYSIS OF ALTERNATIVES

Different alternatives considered for the Project include the No Project Option (NPO), other power generation options, site alternatives, fuel alternatives, technology alternatives, pollution control alternatives, alternatives considered for the cooling system and wastewater discharge alternatives.

E. PROJECT DESCRIPTION

The proposed Project is essentially an RLNG based CCPP. The Power Plant has a capacity of producing 1,100-1,400 MW (Gross) electricity. For proposed CCPP imported LNG will be re-gasified at the LNG terminal in Karachi and transferred through pipeline to Project site. High Speed Diesel (HSD) can be used as back-up fuel. The Project Site is located in Moza Kot Dewan which is about 25 km from Jhang City and adjacent to Trimmu-Sidhnai (TS) Link Canal (about 100 m). The Power Plant is accessible through Jhang-Shorkot Road which passes approximately 0.9 km from the Project Site. The proposed power plant is 200 m away from existing RLNG CCPP Haveli Bahadur Shah (HBS).

The power plant will be installed to operate first in open cycle mode and then it will be converted into combined cycle. The open cycle operation of the power plant generates the electricity by using gas turbine only without the recovery to waste heat to generate additional electricity by running a steam turbine.

To increase the overall efficiency of thermal power plants, multiple processes can be combined to recover and utilize the residual heat energy in hot exhaust gases. The term "combined cycle" refers to the combining of multiple thermodynamic cycles to generate power. Combined cycle operation employs a Heat Recovery Steam Generator (HRSG) that captures heat from high temperature exhaust gases to produce steam, which is then supplied to a steam turbine to generate additional electric power. The combined cycle operation of the power plant increases the efficiency as compared to the single cycle operation.

i. Components of the Power Plant

The Project includes the complete engineering design, procurement, construction, commissioning, and operation of the plant including: (a) Civil Works (b) Equipment and Machinery and (c) Other Physical Facilities. The major works include:

- Civil Works;
- Equipment and Machinery;
- Physical Facilities;
- Gas Turbines and Auxiliaries;
- HRSGs;
- Steam Turbine and Auxiliaries;
- Power Transformers;
- Generator and Excitation System;
- 220 kV Substation; and
- Distributed Control System

ii. Gas Source, Quality, Quantity and Transportation

RLNG will be the main fuel for the Project supplied by SNGPL. The planned supply for the Project is up to 200 Million Cubic Feet/Day (MMCFD) (236,000 Cm^3/h). The maximum content of total Sulphur and Hydrogen Sulphide will be 20 grains / 100 SCF and 1 grain / 100 SCF respectively. There will be no storage facility of RLNG at the power plant site. High Speed Diesel (HSD) will be used as back-up fuel.

iii. Transmission and Distribution System

Power will be evacuated by National Transmission & Despatch Company (NTDC). For that, 220 KV step-up transformers will be required and 220 KV AIS in 1 ½ breaker type will be included in EPC scope to be built within the boundary wall of the Project.

iv. Water Requirement

The water during the plant operation will be used for cooling, sanitary and other plant uses. Cooling water for once through cooling system will be taken from canal next to project site. The water requirement for the plant will be about 22 Cumecs (770 Cusecs). This required quantity of raw water will be taken from TS-Link Canal with a maximum discharge of 325.9 m^3/sec (11,500 ft^3/s or Cusecs), which is running parallel to the Project Site. Existing HBS CCPP will also intake same quantity of water for cooling purposes. During a yearly period of canal closure (6-8 weeks) the cooling demands of the power plant will be met using cooling towers. During this period, water will be taken from underground wells that have to be developed as part of the EPC Contract.

v. Air Emissions

The plant is not expected to generate high concentrations of air pollutants in case of Primary Fuel RLNG. The internal combustion temperature will be greater than 1,300 °C. Flue gas cleaning is not required due to the low Sulphur content of the fuel. A maximum content of total Sulphur of 20 grains/100 SCF will lead to 28.45 mg/Nm³ SO_2 emissions at 15% O_2. However, in case of back-up fuel HSD, relatively high SO_2 emissions such as 546.6 mg/Nm^3 @15% O_2 (dry) are expected for both Combined and single-Cycle operations. The design limits of gaseous emissions are well within PEQS limits for stack emissions.

vi. Implementation Schedule

Considering implementation of the project through a single EPC contract, the implementation arrangement, financing and Operation and Maintenance (O&M) after Commercial Operation Date (COD) of the CCPP will be 26 months after Notice to Proceed.

vii. Project Cost

The total project capital cost has been estimated around US $898.169 Million i.e. PKR 94.3 Billion at reference exchange rate of 1 US $ = 105 PKR.

F. DESCRIPTION OF BASELINE ENVIRONMENT

A team of experts carried out field visits to the proposed Power Plant site located in Kot Dewan (Project and AOI) adjacent to TS-link canal and adjoining areas namely Dhueen Muhammad, Basti Kora Wala, Basti Shamme Wala, Moza Qadeemi, Kot Mehmood Wala, Malu Mor, Moza Mansoor Sial and existing RLNG CCPP HBS in order to collect the baseline data of physical, ecological and socio-economic aspects. For the collection of baseline information, checklists, proformas, satellite imagery (Google Earth), and general topographic sheets were used. The relevant collected data was computerized and analyzed using software such as Geographic Information System (GIS), Microsoft Office (Word, Excel etc.), Statistical Package for Social Sciences (SPSS), Computer Aided Design (CAD), etc.

i. Physical Environment:

The topography of the proposed Project Site is relatively flat as the area is located in plain terrain of Jhang, Punjab. Average elevation of the site is 150 m (490 ft) approx. above mean sea level (amsl). The total area demarcated for the proposed power plant is about 649,804 square meters (160.57 acres) which included both permanent and temporary areas and access road of about 36,543 sq. m or 9.03 acres. The area is mostly agriculture land and the featured quantification of land use at project site is shown is in Figure 6.2.

The area is dominantly composed of alluvial sediment deposited by the Chenab River. Alluvial deposits brought by the Chenab River and its surroundings are the products of the events that evolved during the Pleistocene and recent geological time. These alluvial deposits are more than 500 m thick. The project site is prone to floods and there have been few flood events in past. On the basis of preliminary soil investigation, there is generally brown silty clay available up to 03 m depth of investigation and from 03-40 m, grey loose to dense fine sand / silty sand is present. The proposed Power Plant Project site per Building Code of Pakistan (BCP, 2007, Seismic Provisions) falls entirely in the zone 2A which is the region of moderate seismic risk. The climate of the area is semi-arid, hot subtropical with foggy winter, pleasant spring, summer with dust and heat wave periods, rainy monsoon, and dry autumn. June is the hottest month with the mean minimum temperature of 25.70 °C and the mean maximum temperature as 40.40 °C. The maximum rainfall occurs during the monsoon season in the months of July (mean rainfall of about 143.9 mm).

The major surface water sources in the AOI are the TS-Link canal and Haveli Main Line. The groundwater in the AOI is extracted through tube wells and hand pumps installed in nearby villages and along the banks of the TS-Link canal. Groundwater is mainly used to meet the irrigation and drinking water demands of the area. Groundwater table was encountered at shallow depths of about 3 m (10 ft) during the soil investigations conducted in July, 2017.

No conventional solid waste management system exists in the AOI. Most of the solid waste was found to be stored in the forms of heaps at various locations near the villages. Similarly, there is no proper sewerage system in the AOI, only some open drains are constructed in the vicinity for the discharge of wastewater. In general, each village drains its sewage through small open drains into the depression area found near to each village.

Another RLNG based CCPP of 1,230 MW capacity is being implemented at about 200 m away on northern side of proposed Jhang Project. National Power Park Management Company Limited (NPPMCL) under the umbrella of Ministry of Water and Power is Proponent of that Power Plant. The EPC Contractor is responsible for power plant equipment procurement, transportation, construction and installation. The total area of HBS plant is about 260,000 square meters along with an access road of 1.3 Km to connect the plant with Jhang-Shorkot Road. This plant has started power generation and electricity is being dispatched to the National Grid (Gatti Faisalabad Grid Station) through a 500KV transmission line coming out of plant from its west boundary.

The environmental monitoring and testing was performed at planning phase of HBS RLNG based CCPP, in 2015. Ambient air quality for CO_2, NO, NO_2, SO_2, PM_{10} and $PM_{2.5}$ was monitored at four (04) points in the AOI. All the parameters were within the PEQS limiting values. The background noise level monitoring was carried out in the AOI at eight (08) locations. These results were compared with the PEQS. All the points except NL-03 and NL-05 are in compliance with the PEQS Noise Level Category A. The points NL-03 (near Bhakkar-Jhang Road) and NL-05 (near Khanewal-Kabirwala Road) exceed the PEQS Noise Level Category A because of heavy traffic on both roads. The surface water sampling was done from TS-Link Canal, Haveli Main Line and natural rain water ponds. All the samples were collected as grab samples. These were labelled and preserved before transportation to the laboratory for testing. Ground water samples were collected from hand pumps and tube wells from five locations. Results of all the monitored parameters and samples were compared with the PEQS and all the tested parameters were in compliance with the PEQS for drinking water. Another round of environmental monitoring has also been conducted in July & August 2017 to check the changes in pollutants levels as compared to baseline conditions due to construction and operation of existing HBS CCPP. However, the latest monitoring results do not represent the baseline levels. The environmental monitoring carried out in 2015 forms the baseline for existing HBS CCPP and the proposed Project.

Five (05) grab samples of wastewater were collected from the surrounding villages and from the natural storm water pond. Based on the analysis, all the samples are exceeding the limits of BOD_5, COD and temperature.

ii. Ecological Environment

Original flora of the tract consisted of mainly three kind of trees, Shamee (*Prosopis spicigera*), Karir (*Capparis aphylla*), and Vann (*Salvadora oleoides*). Natural forest cover has been significantly reduced in the past. Some of the older stands of trees, consisting of these species still survive on slaught of urbanization in remote barren areas or in graveyards. There is probably little natural vegetation left in tract. The land owners raised trees like Gum Arabic (*Acacia nilotica*), North Indian Rosewood (*Delbergia sissoo*), Chinese Date (*Zizyphus jujube*), Mulberry (*Morus alba*), Lebbek (*Albizzia lebbek*), Chinaberry (*Melia azedarach*) etc. along the boundaries of their agricultural fields. Bodhi (*Ficus religiosa*) and Banyan Hindi (*Ficus bengalansis*) are grown for shade in their houses or deras. The soils are very fertile therefore; climate supports variety of agricultural crops and vegetables, with scarce growth of indigenous flora and grasses.

Shrubs and herbs which are commonly found in the AOI include Camelthorn (*Alhaji maurorum*), Gokshura (*Tribulus terrestis*), Rubber bush (*Calatropis procera*), Seabligh (*Sueda fruticosa*), Phogs (*Calligonum polygonides*), Pers (*Sesbania aculeata*) and Bitter Apple (*Citrullus colocyntbus*). Salt cedar (Tamarix dioca), Castorbean (Chenopodium botrys) are found on moist sandy soil along the rivers and is used for wicker-work, basket making etc.

The most common grasses found along the water courses or in moist places are Bermuda Grass (*Cynodon dactylon*), Lemon Grass (*Cymbopogan jawarnica*), Aini (*Elionorus hirsutus*) and Little Millet (*Panicum antidotale*), Munja (*Saccharum munja*) and Lesser Bulrush (*Typha angustata*). No endangered flora is found in the tract.

Based on physical observation at site and study of satellite images, total number of trees existing in the Project Area are approximately 449 (including all forest trees having a girth of 1 ft or above and fruit trees). These trees are mostly Gum Arabic (*Acacia nilotica*), Indian Rosewood (*Dalbergia sissoo*) and Date Palm (Phoenix dactylifera), which form nearly 70 % of the total number of trees, followed by Lebbek (Albizzia lebbek), Lasura (Cordia myxa), Indian Lilac (Azadrachta indica), Mulbery (*Morus alba*) and other species. Girth size of the trees existing within the power plant area is predominantly 0.6-1.22 m (2 feet to 4 feet).

The AOI being agricultural land is not very rich in wildlife Mammals. However, common mammals are Jackal (*Canis aurecus*), Squirrel (*Sciuridae funambulus)*, Fox (*Vulpus vulpus*), Rats (*Mus musculus)* and Mangoose (Herpestes auropunctatus). Wild bear (Sus scrofa) is also reported in the area, but its number has been reduced to a bare minimum as a result of extensive hunting and shooting.

Hog Deer (Axis poreinus) marked as an endangered species existed decades ago in AOI but was not seen at the time of study. Houbara Bustard (Chalmydotis undulate) is listed as "Vulnerable" in the IUCN Red List, is also found in AOI. Porcupine (Hystrix indica) is common and causes enough damage to young plants and crops. Domestic animals include goats, sheep, camels, cows and buffaloes. Another important domestic draught animal of the area is donkey which is used for pulling carts etc.

Common reptiles found in the AOI include snakes like Cobra (*Naja naja*), Rattle Snakes, Rat eater Snakes, small and medium sized Lizards and Turtles.

Important bird species found in the tract are Common Crow, Indian Mynah, House Sparrow and Pigeon are abundant in the area and are frequently sighted. Red-Vented Bulbul, Old World Quail, Grey and black partridges, Indian Roller (Chai) and Quail (*Coturnix ypsilophora)* are also present. Water fowls are seen in plenty during Kharif season which include little and medium sized Egrets, Mallard (*Anas platyrhynchos*) and White-Breasted Waterhen (*Amaurornis phoenicurus)*. Houbara Bustards (*Chlamydotis undulate*) and Falcon (*Falco peregrinus)* are also present in the area, although in a very limited number.

Different types of migratory waterfowl visit Trimmu Barrage wetland during winter. The most abundant are Jal Kookri *(Fulica atra)*, Common Teal (*Anas crecca)*, Common Duck (*A. acuta*), Duck Spp (*A. platyrhynchos*), Eurasian wigeon (A. *Penelope)* and Common Pochard *(Aythya ferina)*. Other species found in the area are Tachybaptus ruficollis, Phalacrocorax Niger, Ardea cinerea, Bubulcus ibis, Egretta garzetta, Ardeola grayi, Amaurornis phoenicurus, Gallinula chloropus, Porphyrio porphyrio and Hoplopterus indicus. Waterfowls are important as game species and are a great source of food for sport hunters.

Several fish farms exist in the vicinity, including the adjacent TS-Link canal and nearby pond area of Head Trimmu. Major carps found in pond area of Trimmu Head Works and Link Canal are Indian carps, such as Rahu/Labeo (*Labeo rohita*), Thela, Catla (*Catta catta*), mrigal (*Cirrhinus mrigala*), Long-whiskered catfish (*Aorichthys aor*), and Rita (*Rit rita*) are the other main varieties. Out of these varieties, Rahu (*Labeo rohita*) and Singhari (*Aorichthys aor*) are the most delicious, but their catches are being reduced every year on account of lesser quantities of water and pollution.

The main crops during Rabi are Wheat, Gram, Rape, Mustard, Barley and Oil Seeds. In Kharif, Sugarcane, Rice and Maize are grown. Wheat, Sugarcane and Rice are the major crops, whereas Guava, Mango and Citrus are the major fruits of the area.

In the power plant area, ecological systems with native trees provide an interesting instance wherein provisional, regulatory, habitat, and ancillary ecosystem services are simultaneously exploited, but are least recognized. Agriculture and trees area increasingly viewed as providing ecosystem services.

iii. Socio-Economic Environment

Social assessment of the people of the AOI was carried out through socio-economic baseline surveys; village profile survey, and public/stakeholders consultations/focus group discussions in the AOI. During the socio-economic survey, 99 respondents from the Project as well as AOI villages were selected.

The overall population of 99 households was calculated as 663. Average household size was concluded as about 6.7. The sex ratio (males per 100 females) for the AOI is found to be 106.9. Punjabi is the predominant language being spoken in the AOI, however, Urdu is also understood. In general, a wide range of castes were identified among respondents which mainly include: Sial, Bharwana, Arain, Syed, Rahmani, Sheikh and Bhatti. In the Major villages such as Kot Dewan, Moza Dhueen, Moza Mansoor Khan, Malu Mor and Moza Qadeemi in the AOI, primary schools for boys and girls were present while high school level education is available in Trimmu Colony and Malu Mor only. No degree college and vocational institution were found throughout the AOI for boys and girls.

The literacy level of the respondents, identified during the survey, depicts that the majority of the respondents in the AOI were illiterate and their weightage is 27.3% followed by 23.3% primary, 17.2% middle and 13.1% respondents having secondaery level education.

Joint family system is dominant in the AOI. The average monthly income of most of the respondents (mostly involved in agricultural works and labour) was found to be Rs. 15,001/- to 20,000/-. In the Project Area, the highest percentage of expenditure (33.3%) is by the group, which spends Rs. 5001-10000 per month, while the lowest group (4%) in the category has a spending of Rs. 30,001 and above per month.

The dominant source of income in the AOI is agriculture which is 78.8%. The second major source of income identified in the AOI was labour. Only few people were found who use to work in other occupations. Large land owners employ tenants for agricultural activities or give their land for cultivation on contract basis whereas small land owners cultivate their land by themselves with the help of their family members.

Most of the respondents reported that they were suffering from different diseases. On the contrary, only one dispensary is available in Moza Kot Dewan which is not effective due to non-availability of MBBS doctor and lack of medicine. Small level hospitals with limited health facilities exist in Malu Mor and Haveli Bahadur Shah. Seasonal fever, cough, cold and flu are the common diseases.

Natural (Sui) gas and landline telephone network partially exist in the area, however, most of the mobile phone networks are being used. The AOI is deficient in terms of civic facilities such as metalled roads network, playgrounds, recreational activities, street lights, drainage system etc. Crime and conflict resolution system mostly relied on the local culture. The local culture gives powers to elected chairman, vice chairman or Lumberdar of the villages.

Women in the AOI are suffering through economic and social poverty and are mainly dependent on male members of their family for economic reasons. They cannot take decisions regarding their own lives. They have no opinion in the family matters and are not asked about their preference/acceptance for marriage.

Shrines and graveyards are regarded as sacred heritage and receive devoted attention from the people. A shrine of saint was also identified in Qadeemi village in AOI. One graveyard also exists within the Project Area boundary. However, no Archaeological site falls in the Project Area. It was reported during socio-economic surveys that there are no active NGOs in the entire AOI.

G. STAKEHOLDER CONSULTATIONS

Stakeholders were identified, categorized and consulted at provincial and district levels (Departments like Environmental Protection, Irrigation, Agriculture, Wildlife etc.) and at village level (Direct and Indirect Affectees and Locals). Consultation with the provincial and district level departments were carried out through meetings and presentations while consultations with locals, Project Affected Peoples (PAPs) etc. were undertaken during the baseline survey of the AOI. Consultations were also carried out with labor and staff of existing RLNG CCPP HBS.

i. Provincial Level Consultations

It is emphasized that tree cutting should be avoided as much as possible and tree plantation plan as per legal compensation should be implemented. The power plant is being set up on agricultural lands, and affectees are sacrificing their land for a national cause. This shall be compensated to farmers and by increasing yield per acre of the area or by bringing barren land under cultivation. It was suggested that low level embankment/stone pitched earthen bund should be constructed for power plant. It was also stressed that the wastewater should be discharged into the canal only after proper purification/treatment proper waste management plan should be implemented involving relevant departments. These concerns are reported in detail in the EIA along with their addressal.

ii. District Level Consultations

It was emphasized that in view of the power shortage in the country such projects are the need of the time. The project should be executed ensuring that it will not cause any significant negative impact on the flora, fauna, wildlife and other environmental and social components. A major concern was the EPC contractor should have proper treatment facility and disposal arrangements for solid and liquid waste. It was suggested that the main road Jhang-Shorkoat road should be widened. The gauging should be done at canal water intake and outfall structures. The Proponent/EPC Contractor should focus on social welfare/CSR. These concerns are reported in detail in this EIA report along with their addressal.

iii. Consultations with Existing RLNG HBS Labor and Staff

It was informed by labor that EPC Contractor of HBS power plant have not provided equal facilities to local labor. This has resulted in social friction.

iv. Village Level Consultations

A series of public consultations were conducted with PAPs and locals to get their feedback/concerns. The main issues/concerns discussed were:

- Locals suggested the improvement of existing main road to reduce the accidents and pollution;
- The government should consider 100% Okaf land as site alternatives for this proposed project instead of acquiring 45% private land;
- The proposed power plant should also take measures for establishing health, education and recreational facilities in the AOI;
- Locals/PAPs should be provided subsidy or free electricity;
- The affectees of the Project Area must not only be compensated in cash or in land but they should also be compensated by the government in re-establishing their livelihood in the resettled area;
- Some locals demanded that alternate land instead of market price will be acceptable to them. Some showed concerns that cash compensation should be given to the PAPs directly and political interference should be avoided; and
- Locals demanded permission for cultivation of seasonal crops till the construction phase commencement.

H. IMPACTS AND MITIGATION MEASURES

The project impacts have been assessed for the design/pre-construction, construction and operation phases. The impacts have been categorized as positive and adverse as discussed below:

i. Potential Positive Impacts

The power plant is expected to generate 1,100-1,400 MW of electricity. Given that Pakistan currently faces a shortfall of about 5,000 to 7,000 MW per day, the generation of about 1,400 MW of electricity which will be added to the national grid, will help in reducing the current crisis of the electricity. It is estimated that about 3,000 and 200 workers will be employed during the construction and O&M phases respectively which will be a positive impact.

With the influx of laborers for the proposed project, there will be more opportunities for small scale businesses such as grocery shops, small cafes (khokas), vehicle tuning and tyre-repair shops etc. Construction of the access road for the construction of Power Plant and up gradation of existing tracks to the Project Area will result in improved accessibility. It is envisaged that basic amenities such as schools for children, hospital/health clinics, local shops etc. will be improved due to establishment of power plant in the vicinity.

ii. Impacts and Mitigation during Design/Pre-Construction Phase

The project will be constructed over a land area of 649,804 square meters (160.57 acres) which includes the permanent as well as temporary area requirement for construction camp and other construction related activities. The access road will have a total area of 36,543 square meters (9.03 acres). More than 50% of the land acquired for this project is government owned (Auqaf and Irrigation Departments) land which will be acquired as per the policy of GoPb. However, remaining private land will be acquired as per provision of LAA 1894. For the loss of livelihood, other compensation should be provided to the adversely affected population who may have usufruct or customary rights to the land or other resources taken for the project. The Proponent should provide livelihood assistance, loans,, training etc. to the affectees.

The implementation of the Project will affect built up area, agricultural fields, katcha track, tube wells and hand pump that will come under main Project Area and access road areas. The loss of private built up area, infrastructure and crops should be compensated according to the provisions of the LAA, 1894. Other government infrastructure should be relocated by the concerned department in consultation with the project Proponent. Fertile agricultural land shall have to be acquired for the power plant permanently. This will involve loss of agricultural land and crops. It can be mitigated by increasing the crop yield of agricultural lands in the vicinity of the Project Area and by bringing barren areas under cultivation. This can be done through soil and water conservation, application of micronutrients, fertilizers or high tech agricultural machinery.

The water requirements for construction may affect the quantity of surface or groundwater. This impact on TS-Link Canal and groundwater needs to be addressed carefully by considering the recommendations of Hydrogeological and Electrical Resistivity Survey (ERS) report. The Contractor will be responsible for obtaining all required permits and approvals before using any water source for construction.

iii. Impacts and Mitigations during Construction Phase

Soil erosion may occur during the construction phase in the Project Area as a result of improper runoff drawn from the equipment washing-yards. Discarded construction materials may also contaminate soil. Good engineering practices will help in controlling soil erosion at the construction site. Compaction of soil and phasing the removal of vegetation will also help to reduce soil erosion. Soil contamination may occur due to oil leakages and other spills. Oil leakages, chemicals and other liquids spills should be avoided/minimized by providing appropriate storage places depending on the type of material for storage. Around 1500 kg/day generation of solid waste and 240,000 litres/day of wastewater is expected. Contractor should consult with the Proponent, District Council and the Tehsil Municipal Administration (TMA) for disposal of solid waste. Untreated waste (liquid or solid) should not be disposed off in open fields or water bodies.

If the generated sewage is not properly treated or disposed off, this may also affect the groundwater resources. The groundwater supplies, which need to be tapped to meet campsite and construction works requirements, may affect the groundwater table. Hydrogeological studies recommendations should be considered to analyze groundwater potential before its utilization for camp uses. It will be the responsibility of the EPC contractor to ensure safe supply of water for construction purposes.

To avoid sewage, untreated wastewater, and chemicals & oil spillage from draining into the irrigation channels during construction activities, measures should be taken by the Contractor to carefully store the chemicals and treat sewage and other wastewater. Sewage from construction camps should be disposed off by development of on-site sanitation systems i.e. septic tanks along with soakage pits. Similarly utmost care should be taken to avoid any spills of oils and hazardous chemicals by best management practices and good house-keeping and following the Material Safety Data Sheet (MSDS).

Air quality is likely to be adversely affected by the construction of the Power Plant. Several types of emissions are expected, including gaseous emissions due to movement of construction machinery; fugitive dust emissions due to movement of machinery on dirt tracks, construction of roads and excavation of borrow areas; and particulate matter emissions during the operation of concrete batching plants and asphalt mixing plants. Noise from the construction activities (such as batching plant, vehicular movement etc.) will be significant and may exceed the PEQS limit. Water will be sprinkled on the dirt tracks to control fugitive dust emission. Regular tuning of vehicles should be made mandatory to reduce the emissions. Emission points from batching plants should be controlled efficiently by the installation of cyclone.

It is estimated that about 449 trees will be removed before the start of construction. Ten (10) trees will be planted as a replacement of each of the tree affected resulting in total of 4500 trees to be planted in accordance with the tree plantation plan specified in Environmental Management Plan (EMP). Physical damage to aquatic habitat of canal may be expected due to the construction activities which will be reduced by adopting good engineering practices and wastewater treatment facilities for discharge of contaminated water in canal. The impact on reptiles, rodents and birds will also remain insignificant on account of proportionately small area for Project installation and can, however, be avoided with vigilant movement of heavy machinery and equipment during construction. The project construction will also result in the loss of agriculture land which should be compensated by promoting modern agriculture practices in the area by agriculture department. The increase in availability of electricity will also improve agriculture yield. The precautionary steps to preserve endangered and vulnerable species i.e. Hog Deer and Houbara Bustard are suggested in report. A complete survey of AOI by Wildlife Department should be done to know population and conservation areas of these species, if required. Hunting of these species must be restricted and controlled. People should be given awareness for protection of wildlife.

The traffic congestions and accidents may occur during the construction phase. Efforts should also be made to discuss traffic conditions with the National Highway Authority (NHA) so that regular traffic is not disturbed. Transporters engaged by the plant should be forced to adhere to the load specifications of the access road. Induction of outside workers in the Contractor's labor force may cause cultural issues with the local community as the local community is very sensitive about their cultural values. Good relations with the local communities will be promoted by encouraging Contractor to provide opportunities for skilled and unskilled employment to the locals, as well as on-the-job training in construction for young people. Contractor will restrict his permanent staff from mixing with the locals to avoid any social problems. During the construction phase, the general mobility of the local residents and their livestock in and around the AOI is likely to be hindered. Contractor will have to take care as much as possible that the construction activities should not affect the privacy particularly with reference to women. Health and safety of worker and staff will also be triggered during the construction phase of proposed Project which will be mitigated by implementing a comprehensive Health, Safety and Environment (HSE) Plan, prepared by EPC Contractor. The contractor should prepare Construction Camp Management Plan (CCMP) for Project implementation prior to deputing on site and submit to Consultant for approval.

iv. Impacts and Mitigations during Operation Phase

Fire protection and detection systems shall be provided to protect life, property, equipment, and operation of the Plant. The detection and fire alarm, fire protection and fire-fighting systems shall include, but not be limited to the following:

- Firefighting water storage, may be combined with raw water tank, depending on local regulations;
- Firefighting pumps;
- Fire water ring main system, including hydrants;
- Fire protection systems; and
- Fire alarm and detection system.

The soil can be contaminated during the operation phase due to the many chemicals used in the Power Plant processes. If proper care is not taken for handling, storing and transportation of these toxic substances, they may cause damage to the health of the workers as well as their spills which will not only contaminate the soil and may also impact the workers. Even solid waste generated from the plant can contaminate the soil. Standard Operating Procedures (SOPs) should be followed to avoid spills of oil and other waste to prevent soil contamination. Floors with impervious top-surface should be designated to avoid the contamination of soils. However, in case soil contamination due to spillage of oil occurs, the contaminated soil should be removed to avoid further contamination of soils. To manage the waste generated from the power plant, provisions should be made for proper solid waste management as per guidelines of the Waste Management Framework (WMF) in Chapter 9 of this report.

Cooling water for main cooling cycle will be taken from TS-Link irrigation canal. The irrigation department has consented to provide water for the power plant. The release of hot water from new and existing RLNG HBS may have cumulative impact on canal water temperature rise. For this a modeling study is recommended. During a yearly period of canal closure (6-8 weeks) water will be taken from underground wells that have to be developed as part of the EPC Contract. Since the wells will be used only for up to a maximum of 8 weeks per year, a permanent impact is not expected. Tube wells existing in the vicinity of proposed Project can also be impacted by extensive groundwater extraction by the Project during canal closure. Hydrogeological and ERS report considerations and recommendations must be followed to ensure that the groundwater availability to these tube wells is not affected during the plant operation.

The plant operation will generate Industrial as well as sanitary wastewater. It is estimated that about a maximum of 2 m^3/h of sanitary, 4 m^3/h of industrial wastewater will be generated along with cooling tower blow down (expected concentration factor of 4-5) in canal closure period. The industrial wastewater treatment plant shall be constructed to treat all wastewater in compliance with PEQS. Only Sodium Hypochlorite (NaClO) is used in the cooling water, the level will be closely monitored to keep it at the specified value which is evaluated as acceptable for the environment. The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case treated water discharge is not permitted during this time by the canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided. The location of seepage pit will be finalized by EPC Contractor during the design.

Air quality can be impacted from SO_2, NO_x, PM_{10} and $PM_{2.5}$ emissions which are typical air pollutants. The cumulative impact on air quality due to simultaneous operations of Existing RLNG HBS and new/proposed RLNG Jhang is assessed. Both the plants will utilize RLNG as main and HSD as a backup fuel. The impact on air quality is not expected to be significant if both both plants are run on RLNG (main fuel) which is a clean fuel with less air emissions. The stacks emission estimates provided by the designers of both RLNG Power Plants run on RLNG[2] or HSD are within the thresholds of PEQS. The Air Dispersion Modeling (ADM) software was run for predicting cumulative ground level concentrations of the pollutants (SO_2, NO_x, PM_{10} and $PM_{2.5}$) from operation of both RLNG plants, to check the compliance with the standards and assess the impacts on receptors. The baseline values of NO_x, SO_2, PM_{10} and $PM_{2.5}$ were measured for four stacks (two stacks at HBS and two at new RLNG CCPP) at 24 hours and annual averaging periods. The 24 hours averaging measurements for SO_2, NO_x and PM_{10} are within thresholds specified by PEQS if both plants will run on RLNG (single cycle or combined cycle) and HSD (single cycle only). However, contribution of SO_2 from both plants (if run on HSD and combined cycle) at 24 hours averaging would be 131.0 µg/m^3 which exceeds 24 hours average SO_2 threshold of 120 µg/m^3 as specified by PEQS. In that scenario, close monitoring should be done and if emissions are beyond limits, scrubbers will be required.

The maximum cumulative ground level concentrations as determined by ADM at annual averaging period for all scenarios are within limits of PEQS whether both plants are run on RLNG or HSD. The long term baseline monitoring for $PM_{2.5}$ spreading atleast over a period of one year before commissioning of power plant or start of power plant construction should be done to determine the average annual concentration to assess compliance during plant operation. The maximum annual average contribution of $PM_{2.5}$ from the power plant will be 0.193 µg/m^3 which is quite low.

The stacks of the power plant will be kept high i.e. at minimum 45 m and 60 m above ground level for bypass stack and the main HRSG stack. Low (Nitrogen Oxides) NO_X burners will be used in Gas Turbine (GT) to control emissions and the water will be injected during the use of HSD to control the NO_X emissions. A Continuous Emission Monitoring System (CEMS) will be installed, including flue gas analysers at each HRSG stack.

Noise and vibration during the operation phase are likely to affect the health of local residents and animals. Some of the noise sources from the proposed Power Plant during the operation phase include noise from the operation of the boilers (steam blowing and purging) as well as combustion. Equipment noise will be controlled using conventional noise control measures, such as insulation, lagging, ear protection, and enclosures as needed to comply with the PEQS. Each GT shall be located in a compartment, which shall reduce the dissipated noise. The noise reduction shall achieve a noise level of 85 dB(A) measured one meter away at 1.5 meter height from the floor level. Additional efforts will include the declaration of a "no horn zone" and construction of a wall around the project site. An ambient noise measurement program will be instituted upon executions of the Project which will cover the construction and operation of the project. EPC Contractor should conduct noise and vibration study to minimize the impacts.

Large scale planting with suitable indigenous trees, shrubs and ornamental plants in the form of Tree Groves, and Linear plantation will be carried out in accordance with the Tree Plantation Plan to improve aesthetic value and offset the effect of removal of vegetation.

During O&M phase, the induction of outside labor may create social and gender issues due to the unawareness of local customs and norms. It will also cause hindrance to the mobility of the local women. Power Plant staff should respect the local community's sensitivity towards their customs and traditions. EPC Contractor would be required to prepare CCMP and submuit to Consultants for approval.

---

[2] Data provided by the designer to the best of their knowledge. NO_X values have been based on limits, which can be achieved and guaranteed, while the PM values are taken from similar projects on diesel fuel with a typical split between PM2.5 and PM10.

I. ENVIRONMENTAL MANAGEMENT PLAN

The EMP of this project is structured into several sections as Regulatory Requirements and Applicable Standards; Mitigation Management Matrix (MMM); Planning for the Implementation of EMP; Institutional Arrangements for the Implementation of EMP and Roles and Responsibilities; Environmental Monitoring Plan; Waste Management Framework (WMF); Emergency Preparedness and Response Framework (EPRF); Evacuation Framework; Health and Safety Management Framework (HSMF); Conservation and Management Framework; Site Restoration; Change Management Plan (CMP); Construction Material Transportation; Traffic Management Plan (TMP); Training Program; Communication and Documentation; Tree Plantation Plan and Environmental Cost.

MMM has been developed for this project which identifies the impacts and required mitigation measures recommended in EIA; the person/organization directly responsible for adhering to or executing the required mitigation measures.

The immediate institutional requirements considering the existing institutional setup of Proponent is the establishment of Environmental Monitoring Cell (EMC). The EMC will have a competent Environment & Resettlement Team (E&RT) that will render its duties in close coordination with the EPC Contractor and Proponent. This E&RT will remain on-board throughout the construction time and will finally be merged into the proposed HSE Section during O&M phase of the project.

The monitoring during the construction phase will be carried out by EPC Contractor and afterwards HSE Section of the Proponent will take the responsibility of all environmental monitoring activities. Before the commissioning of the Power Plant, EPC Contractor will run a Reliability Test Run (RTR) of the Power Plant at various loads to check the reliability of the Power Plant.

One kick off meeting will take place between the Proponent, EMC and EPC Contractor before the start of construction. Monthly meetings will be held during the construction phase at construction camp office. The minutes of meeting will be recorded in the form of a Monthly Environmental Report (MER) to be prepared by EPC Contractor and reviewed by EMC and will be submitted to the Proponent for final approval

An estimated cost for instrumental monitoring during all the three phases of the Project is calculated as Rs. 1,300,000/- for pre-construction phase; Rs. 23,000,000/- (annually) for construction phase; and Rs. 6,600,000/- (annually) for O&M phase of the project. The plantation cost is calculated to be about Rs. 2.95 million. Initial cost for establishment of EMC has been calculated as Rs. 29,200,000/- for setting up EMC during construction phase (26 months) and Rs. 15,200,000/- for annual site visits by HSE Section during operation phase.

J. CONCLUSION AND RECOMMENDATIONS

It is recommended that EMP will be made a part of all bidding/tender documents. EPC Contractor will be bound to completely implement relevant mitigation measures set out in the EMP and EIA for environmental sustainability. EPC Contractor shall prepare an Evacuation; Emergency Preparedness and Response; Waste Management and Health and Safety, Conservation and Management and other plans as specified in EIA based on the frameworks provided in EMP.

The impact on air quality is not expected to be significant considering the RLNG which is a clean fuel having less air emissions. The stack air emission will be well within the applicable PEQS limits. The maximum cumulative ground level concentrations as determined by ADM are within limits of PEQS if both plants are run on RLNG (single cycle or combined cycle) and HSD (single cycle only). However, contribution of SO_2 from both plants (if run on HSD and combined cycle) at 24 hours averaging would be 131.0 $\mu g/m^3$ which exceeds 24 hours average SO_2 threshold of 120 $\mu g/m^3$ as specified by PEQS. For annual averaging, the results of SO_2, NO_x, and PM_{10} are within thresholds of PEQS. The long term baseline monitoring for $PM_{2.5}$ for atleast a period of one year before commissioning of power plant or start of power plant construction should be done to determine the average annual concentration to assess compliance during plant operation. The maximum annual average contribution of $PM_{2.5}$ from the power plant will be 0.193 $\mu g/m^3$ which is quite low.

The temperature of cooling water discharge into canal should not be more than 3 degree centigrade. Provisions of cooling towers and deep wells have also been made in the project to be operated during the canal closure periods. Recommendations of hydrogeological and ERS studies should be followed to assess the groundwater potential as the deep wells will also be installed at the Site and to preserve the existing proposed water supply scheme near Project Area. Govt. will acquire the private land as per provisions of LAA, 1894 ensuring the assessment and payment of compensation for the loss of private land, assets and crops. To compensate the impact of loss of livelihood, special financial assistance should be provided to PAPs apart from its compensation.

Proponent and EPC contractor should also allocate special funds for social welfare of PAPs and nearby villages. The provision of this cost should be included in bidding document. Some Confidence Building Measures (CBMs) in the form of general improvement of the social infrastructure in the villages should be planned and implemented by the Proponent to lessen the loss of the local community and to build trust and confidence.

The loss of agriculture due to conversion of agriculture land in to built-up area will be compensated (apart from the compensation as per LAA, 1894) by adopting and promoting modern and scientific irrigation techniques and agricultural practices to be promoted in consultation with the agriculture and irrigation departments like improved variety of seeds, fertilizers and machinery on subsidized rates that will increase the yield and soil fertility.

EPC Contractor should prepare evacuation plan; emergency preparedness and response plan; waste management plan, HSE plan, borrow and quarry management plan, site restoration plan and other plans mentioned in the EMP. These plans should be communicated with supervisory consultant and Proponent for their review and approval. If there are any changes in Plant layout, or any other changes in project description then change should be carried out through Change Management Procedure (CMP) included in EMP of this report.

CHAPTER–1: INTRODUCTION

1.1 BACKGROUND

Power is a lifeline for the economic development of any country. Pakistan is facing acute power shortages. It has been reported that the shortfall in power generation has increased to about 5,000 – 7,000 megawatt (MW) and power shortage is estimated to cost the economy 2% of Gross Domestic Product (GDP) each year[3].

Pakistan is facing severe issues in power sector. The ever increasing demand of electricity with only marginal addition of generation capacity in the recent past has resulted in long load shedding hours causing resentment in the public in general and has hampered the economic growth of the country. The main issues confronting the power sector include expensive generation mix, inefficient operation of the aging thermal power generating units, high power losses of distribution companies and seasonal reductions in hydropower generation. Another important factor is the rapidly depleting gas reserves that have compelled the supply of gas to be cut down for power generation. This has resulted in greater reliance on alternate expensive fuels such as Heavy Furnace Oil (HFO) and High Speed Diesel (HSD). The cumulative installed capacity including the public and private sector of Pakistan for the year 2015-2016 is shown in Figure 1.1.

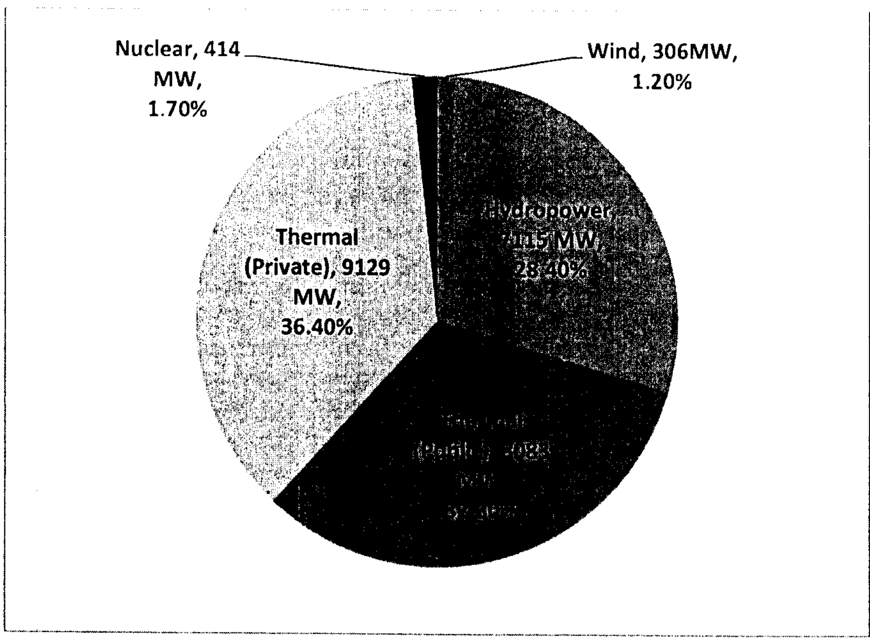


Figure 1.1: Installed Capacity- Pakistan (MW & %)[4]

The major share to the National Grid is from Private Thermal Power Plants i.e. 9,129 MW (36.40%). Public Thermal Power Plants contribute 8,803 MW (32.30%). Hydropower shares 7,115 MW (28.40%). Power generation through Nuclear and Wind is 414 MW (1.70%) and 306 MW (1.20%) respectively. The substantial increase in the electricity price during the past can be mainly attributed to fluctuating oil prices and greater use of fuel oil instead of natural gas. It is, therefore, vital to bridge this gap and the Government of Pakistan (GoP) is looking for fast track options to fill this gap on urgent basis with due consideration for the generation

[3] *Annual Plan 2015-16, Ministry of Planning, Development and Reforms, Government of Pakistan*
[4] *Power System Statistic 2015-2016 (41st Edition Planning Power, NTDC)*

mix for rationalizing providing electricity to the masses at affordable price. Installation of new Regasified Liquefied Natural Gas (RLNG) based Power Plants is a step in this direction.

The power shortages, in addition to other impacts, have environmental and social implications as well. Other than complaints of distress by the citizens, there have been impacts on the industrial, educational, health and other sectors. The shortage of power results in the use of firewood, kerosene and biomass resulting in deforestation and deterioration of air quality. The power outages also result in the use of small generators in cities and surrounding areas and their emissions of Oxides of Nitrogen (NO_x), Oxides of Sulphur (SO_x), Particulate Matter (PM), other pollutants and noise which have negative impacts on environment.

The gap between the cost of producing power and revenue desired from its sale has also widened. Compounding the problem is the cumulative effect of the inter-corporate circular debt in the energy supply chain. The problem of circular debt has to be resolved on war footings. Several options which have lower generation costs include hydropower, coal, RLNG etc. Although, GoP is actively pursuing hydropower option, but it entails a longer implementation period. Import of RLNG across the globe will help to bridge the gap between supply and demand which is being faced by Pakistan. GoP has decided to import LNG, re-gasify it near Karachi and transport to power plant site through pipeline.

The reserves of natural gas in Pakistan are depleting rapidly; therefore, the present focus is on the imported RLNG. Considering the above situation, use of RLNG is most appropriate option which can lead to cleaner power generation. GoP intends to increase this share. This will require the installation of new power plants. The GoP has planned to use RLNG to lessen its heavy reliance on furnace oil.

Considering the above context, the GoP has decided to setup an RLNG based Combined Cycle Power Plant (CCPP) in Punjab. Government of Punjab (GoPb) has decided to setup the project in IPP mode and for that purpose, a company in the name of Punjab Thermal Power (Pvt.) Limited (PTPL) has been established. GoPb/PTPL has initiated a fast track Project to install a 1,100-1,400 MW RLNG based Combined Cycle Power Plant at Jhang to reduce the ongoing acute power crisis.

GoPb/PTPL has engaged M/s National Engineering Services Pakistan (NESPAK) Pvt. Limited for providing the consultancy services for project design and to conduct the Environmental Impact Assessment (EIA) Study of "1,100 -1,400 MW RLNG based Combined Cycle Power Plant at Jhang". The implementation phases of the project are planned to be executed through Engineering, Procurement and Construction (EPC) based contract involving NESPAK in supervisory role.

1.2 PURPOSE AND SCOPE OF THE STUDY

The purpose of the EIA study is to identify the beneficial as wella as adverse environmental impacts envisaged at feasibility stage and propose the practicable mitigation measures to be implemented during construction and Operation and Maintenance (O&M) phases of the Project. The Terms of Reference for EIA are attached as Annex-1. The specific stages of EIA Study are:

- Review of available documents;
- Overview of different Project Alternatives;
- Collection of baseline data related to physical, ecological and social domains of environment;
- Evaluation of Project impacts on environment and social settings;

- Conducting, recording and reporting public consultation with stakeholders;
- Suggesting mitigation measures for adverse impacts;
- Preparation of Environmental Management Plan (EMP); and
- Preparation of EIA Report.

The EIA report has been prepared in accordance with the following regulations and guidelines:

- Punjab Environmental Protection Act, 1997 (Amended 2012);
- Pakistan Environmental Protection Agency (Pak-EPA) Regulations, 2000 for review of Initial Environmental Examination (IEE) and EIA;
- Pakistan EIA Procedures, 1997;
- Guidelines for Preparation and Review of Environmental Reports (Major Thermal Power Stations), 1997; and
- International Standards, Convention and Safeguards.

Considering the prime importance of the Project and its urgency, the present EIA study has been prepared in parallel to the feasibility study on a very fast track in a very short period of time to meet the targets.

1.3 PROJECT PROPONENT

The Proponent for this Project is Punjab Thermal Power (Pvt.) Limited (PTPL), a company wholly-owned by Energy Department, GoPb. PTPL is responsible for the execution of proposed Project on IPP mode in Punjab Province, Pakistan.

Chief Executive Officer:	Mr. Ahad Khan Cheema
Address:	1st Floor, 7-C-1, Gulberg-III, Lahore, Pakistan
Telephone:	+92-42-35750936-38
Facsimile number:	+92-42-35750939
Electronic mail address:	compsec@punjabthermal.com

1.4 EIA TEAM

The consortium of power plant experts and EIA team worked in close collaboration for this EIA. The Project design data which was used by EIA team was provided by the design experts. EIA team comprised the following experienced experts:

- Akhtar Hussain Mayo — Project Manager/General Manager Power Plants
- Irfan-ul-Haq — GM/Head (Environment & Resettlement)
- Imran-ul-Haq — Chief Engineer-Safeguards
- Haseeb Saqib — Chief Engineer Mechanical/Power Plants Expert
- Aman Ahmad — Senior Environmental Engineer – Team Leader
- Makhdoom Ali — Ecologist (Adviser)
- Ibadullah Khan — Ecologist
- Waqar Saleem — Sociologist
- Fahad Saleem — Environmental Engineer
- Shoaib Aziz — Environmental Engineer
- Syed Badar-ul-Husnain — Geographic Information System (GIS) Expert

1.5 NATURE, SIZE AND LOCATION OF THE PROJECT

The proposed Project is essentially an RLNG based Combined Cycle Power Plant (CCPP). The Power Plant has a capacity of producing 1,100-1,400 MW (Gross) of electricity. The Power Plant will operate on imported RLNG to be transported from Karachi through pipelines. The Power Plant is located near Jhang as shown in **Figure 1.2**.

1.6 STRUCTURE OF THE REPORT

The EIA report is divided into ten chapters as follows:

- **Chapter-1** covers introduction to the proposed Project;
- **Chapter-2** methodology to conduct the study;
- **Chapter-3** provides the country's environmental legislative requirements, guidelines, frameworks and international laws and regulations applicable to the proposed Project;
- **Chapter-4** provides the analysis of Project alternatives;
- **Chapter-5** presents the description of the Project including project components, nature, size, location, design parameters, work activities, detail of infrastructure, facilities, implementation schedule, proposed Project cost, etc.;
- **Chapter-6** describes in detail the existing environmental baseline conditions of the AOI related to the physical, ecological and social domains of environment;
- **Chapter-7** explains the stakeholders consultation mechanism, findings and public consolation and disclosure framework;
- **Chapter-8** exhibits the impacts assessment at construction and operational phases of the proposed Project along with their mitigation measures;
- **Chapter-9** outlines EMP along with proposed institutional framework required for effective implementation and monitoring; and
- **Chapter-10** gives the conclusions and recommendations.

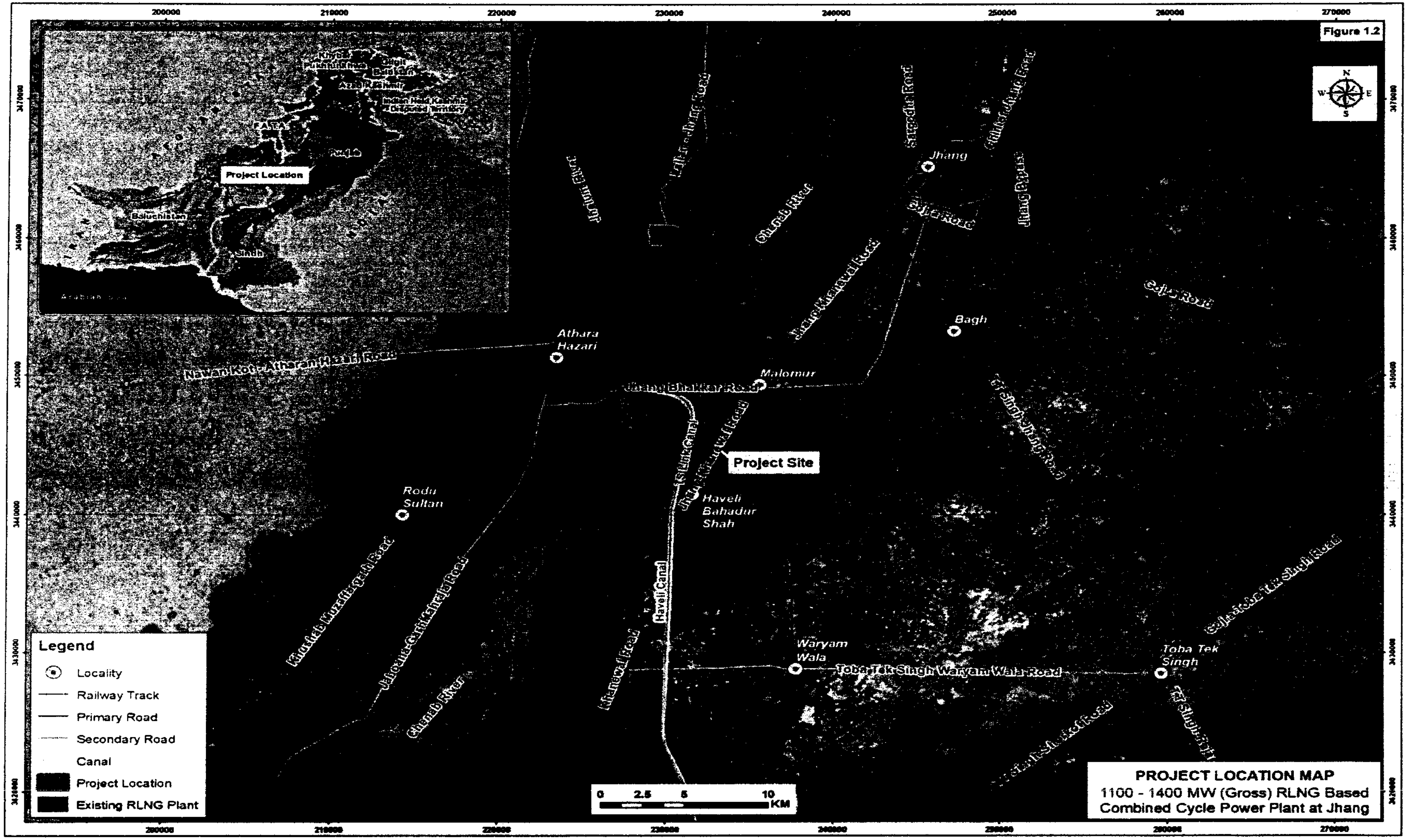


Figure 1.2: Project Location Map

CHAPTER–2: EIA METHODOLOGY

2.1 GENERAL

This chapter presents the approach and methodology adopted for conducting EIA study for proposed Project.

2.2 DESKTOP STUDY

Consultant carried out a detailed desktop study through collection and review of guidelines, data and reports related to the Project that included:

- Review of National Environmental Legislations and international best practices related to Environmental and Social Assessment Guidelines/Safeguards;
- Google Earth Satellite Imagery;
- Relevant design information and drawings;
- Project Design and Fesibility Data provided by design team;
- EIAs of other RLNG ongoing projects i.e. 1000-1200 MW (Gross) RLNG based CCPP at Haveli Bahadur Shah, District Jhang, Pakistan; 1000-1500 MW (Gross) RLNG based CCPP at Bhikki, District Sheikhupura, Pakistan; 1000-1200 MW (Gross) RLNG based CCPP at Balloki, District Kasur, Pakistan; and
- Other related documents.

2.3 ANALYSIS OF ALTERNATIVES

The analysis of various alternatives was carried out during the selection of the most feasible project site in consultation with design team and PTPL officials in order to select the most viable option keeping in view the environmental, economic and social constraints.

It is an international practice for the preparation of EIA that the proposed Project should be compared with other alternative arrangements that could be developed to meet the objectives for which the proposed Project has been planned.

An analysis was carried out in consideration of technical and environmental aspects. Moreover, No Project Option (NPO) was also considered with reference to the effect on the country's economics. This exercise provides justification for the need of the proposed Project.

The following alternatives were considered for the Project:

- NPO;
- Power Generation Alternatives;
- Site Alternatives;
- Fuel Alternatives;
- Technology Alternatives;
- Pollution Control Alternatives;
- Cooling System Alternatives; and
- Wastewater Discharge Alternatives.

2.4 DELINEATION OF AREA OF INFLUENCE

For an EIA study, it is imperative to delineate the area where the potential significant impacts of the proposed Project are envisaged. The AOI is the area within which the potentially significant adverse environmental and social impacts of the proposed intervention are envisaged. In the light of this, potential impacts on the existing environment have to be considered in a larger geographical area than the proposed Project Area depending upon the extent of direct/indirect impacts.

Based on the experience of the Consultant, the available secondary information of the proposed Project Area, and technical details of the Power Plant, criteria was developed to delineate the AOI for the proposed Project. In the criteria, critical parameters of physical (wind direction and speed, topography), ecological and social (location of settlements, other receptors and existing land use resources) domains of the environment for the RLNG-Based Power Plant have been considered. The AOI was marked using the GT sheets and Google Earth Image during desk studies which was later finalized during the field visit.

AOI includes the actual proposed Project boundary or the area which is considered to be acquired for the Project, as well as the area in the surroundings in which potential adverse impacts may be foreseen due to the implementation of the proposed Project like location of construction camp, residential and non-residential buildings, workshops etc.

Hence, the AOI includes the Project Area, nearby land having settlements, agriculture fields, canal, existing RLNG Power Plant and other infrastructure as shown in the Photolog on which the proposed Power Plant is likely to have any impact. Tentative AOI is shown in Figure 2.1.

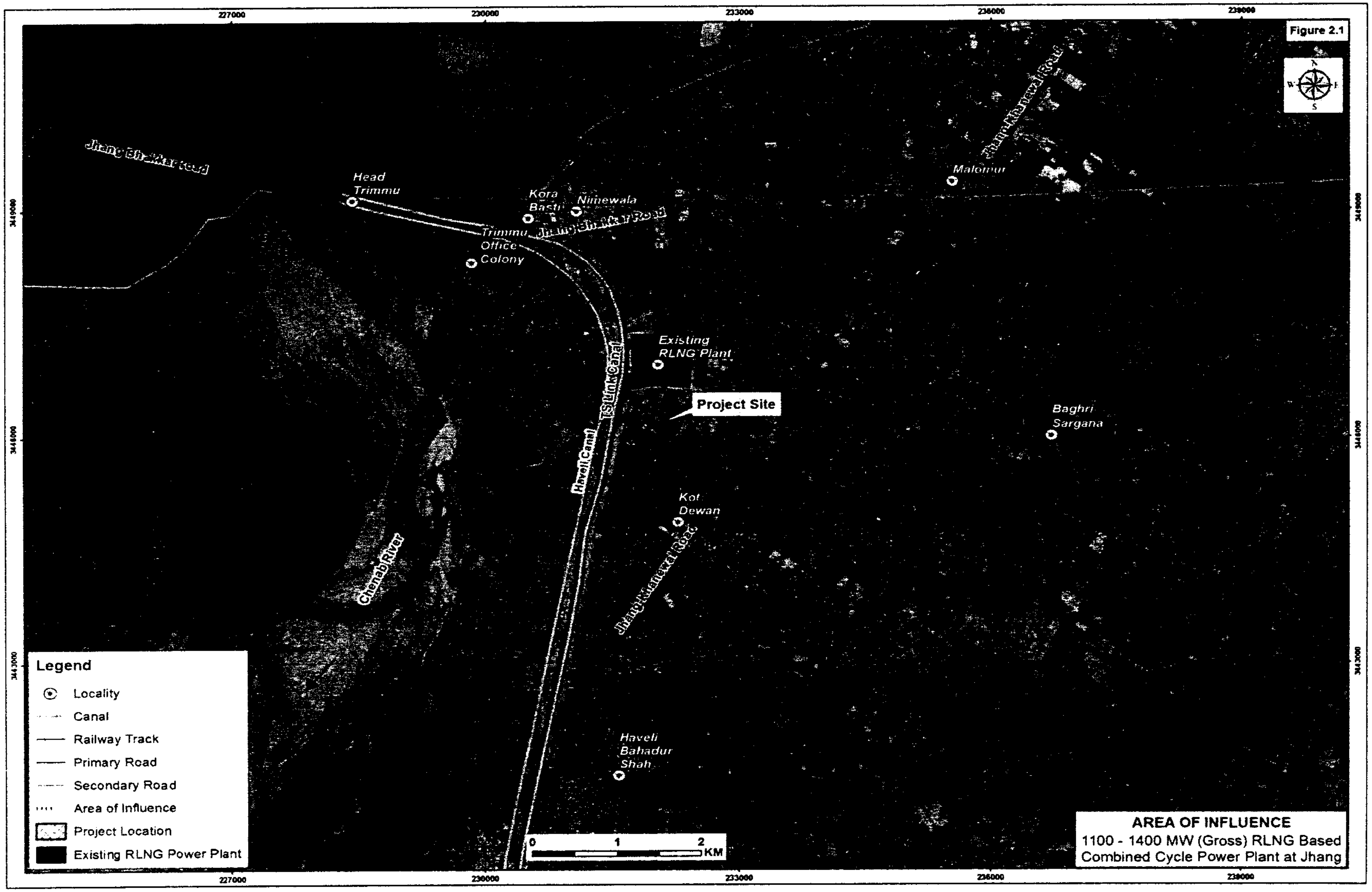


Figure 2.1: Area of Influence

2.5 BASELINE SURVEY OF AOI

After the selection of the most feasible option and the delineation of AOI, detailed environmental survey/investigations were carried out in Project AOI for identification of adverse or positive impacts due to implementation of the Project. Baseline surveys were carried out in the month of July, 2017.

Prior to the start of field activities, comprehensive checklists, proformas and maps were developed covering the following main parameters:

- Physical environment (physiography, soil, climate, surface water, ground water, hydrology, noise, air, etc.);
- Ecological environment (natural flora, invasive species, critical habitat, natural fauna, reserved forest, wildlife sanctuaries, ecosystem services, aquatic diversity, etc.); and
- Socio-economic environment (demography, infrastructure and other facilities, historical / archaeological / cultural heritage, women empowerment, Non-Government Organizations (NGOs), etc.).

For collection of baseline data on environmental parameters, one time instrumental monitoring was also carried out. The collected baseline data was computerized and analyzed using softwares such Microsoft Office, Statistical Package for Social Sciences (SPSS), GIS, Computer Aided Design etc.

2.6 STAKEHOLDERS AND PUBLIC CONSULTATIONS

Stakeholder's identification was carried out in parallel to baseline surveys to ascertain which group(s) of people will be affected by the Project, and the extent of that impact, based on the Project activities. The stakeholders consultation with provincial and district level department was also conducted to gather secondary information about project AOI.

The consultations with local communities and Project Affected People (PAP) were conducted in the Project AOI. The objectives of this process are as follows:

- To share information with stakeholders about the proposed Project interventions and expected positive and adverse impacts on the physical, ecological and socio-economic environment of the Project Area; and
- To understand stakeholders' concerns regarding various aspects of the project, including the existing condition and the potential impact of construction and operation of the proposed Project.

2.7 ASSESSMENT OF SIGNIFICANT ENVIRONMENTAL AND SOCIAL IMPACTS AND THEIR MITIGATION MEASURES

A logical and systematic approach was adopted for impact identification and assessment. The process began during the screening and continued through scoping which identified the key issues and classified them into different categories. The tools, which were used for impact assessment, are:

- Checklists;
- Matrices;
- Overlays;
- Air Dispersion Modeling; and
- SPSS etc.

Identification of potential/significant environmental and social impacts in terms of their nature, magnitude, extent, location, timing and duration were carried out. The impacts were correlated to the Project location, construction and O&M phases of Project. Based on the impacts prediction methods and as a result of public/stakeholder consultations, the Consultants screened the adverse environmental impacts for inclusion in the mitigation measures and environmental management plan. The same process was followed for the identification of social impacts. Public consultations (which provided feedback of the impacts from the stakeholder's viewpoint) were used to screen out the insignificant impacts. Matrices and overlays were used for the evaluation of temporal and spatial impacts respectively.

Keeping in view the existence of another RLNG based CCPP in near vicinity, which is under construction at the time of writing this EIA, the cumulative impact assessment of both RLNG project was also conducted.

The Consultants proposed practicable, economically feasible and socially acceptable mitigation measures for the significant adverse environmental and social impacts. These measures were based on exploring the ways to achieve the Project objectives causing least disturbance to the existing environment by proposing alternatives, changes in the Project design (if applicable), and through improved monitoring and management practices.

2.8 ENVIRONMENTAL MANAGEMENT PLAN

An EMP has been prepared to ensure the adequacy and effectiveness of the proposed measures by clearly identifying the roles and responsibilities of the agencies responsible for implementation, monitoring and auditing of EMP activities. A comprehensive EMP addresses the following:

- Regulatory Requirements and Applicable Standards;
- Mitigation Management Matrix (MMM);
- Planning for the Implementation of EMP;
- Institutional Arrangements for the Implementation of EMP;
- Roles and Responsibilities of the Implementing entities;
- Environmental Monitoring Plan;
- Waste Management Framework;
- Emergency Preparedness and Response Framework (EPRF);
- Evacuation Framework;
- Health and Safety Management Framework (HSMF);
- Site Restoration Framework;
- Change Management Plan (CMP);
- Construction Material Transportation Framework;
- Traffic Management Framework;
- Training Program;
- Communication and Documentation;
- Conservation and Management Framework;
- Plantation Plan; and
- Environmental Cost.

2.9 CONCLUSIONS AND RECOMMENDATIONS

Conclusion of EIA has been prepared based on the existing baseline conditions, identified impacts and suggested mitigation measures and proposed Environmental Management Plan. Considering the conclusion and best environmental management practices, firm recommendations regarding the future plan of action were provided to prove the proposed Project more sustainable and environmental friendly.

2.10 REPORT PREPARATION AND DOCUMENTATION

The draft EIA report has been prepared on the basis of Pakistan's environmental legislations/guidelines/standards. The final EIA report will prepared after receiving and incorporating the comments from Proponent and EPA on draft EIA.

CHAPTER-3: ENVIRONMENTAL LEGISLATION AND STANDARDS

3.1 INTRODUCTION

This chapter presents the legal and regulatory requirements that the EIA must comply with. It presents a summary of (a) the current Pakistan environmental legislation, regulations and policies, (b) international treaties and conventions that Pakistan is signatory to. Particular reference is made to the process to be followed for obtaining Environmental Approvals from the concerned EPA.

After the approval of 18th amendment, powers have been delegated to the provincial Environmental Protection Agencies/Departments (EPAs/EPDs). For the subject Project, EPD-GoPb is the concerned authority.

3.2 PAKISTAN ENVIRONNEMENTAL LEGISLATION, REGULATIONS AND POLICIES

3.2.1 Strategies and Polices

The main environmental policies and strategies are summarized in Table 3.1:

Table 3.1: Main Strategies/Policies Related to Environment and their Relevance to the Project

Sr. No.	Policy/Strategy	Key Information	Relevance to Project
1.	**National Conservation Strategy, 1992**	Pakistan National Conservation Strategy (NCS), approved by the federal cabinet in March 1992, is the principle policy document on environment. The NCS outlines the primary approach towards encouraging sustainable development, conserving natural resources and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment.	The core areas that are relevant in the context of the proposed Project are pollution prevention and abatement, increasing energy efficiency, conserving biodiversity and supporting forestry and plantation.
2.	**National Environmental Policy, 2005**	In March 2005, GoP launched its National Environmental Policy, which provides a framework for addressing environmental issues. Section 5 commits to integrating environmental issues into development planning with the aim of achieving the objectives of National Environmental Policy. It also provides broad guidelines to the Federal Government, Provincial Governments, Federally Administered Territories and Local Governments to address their environmental concerns and to provide effective management of their environmental resources.	Clause (b) of sub-section 5.1 states that EIA related provisions in Environmental Protection Act, 1997, will be diligently enforced for all developmental Projects.
3.	**Pakistan Labour Policy, 2010**	The Labour Policy, 2010 pertains to the social and economic well-being of the labour of Pakistan. The four parts are: i) Legal Framework; ii) Advocacy: rights of workers and employers; iii) Skill development and employment;	The policy will apply to the labour employed (skilled and unskilled) on the proposed Project for construction and operational phases.

Sr. No.	Policy/Strategy	Key Information	Relevance to Project
		and iv) Manpower export.	

3.2.2 Laws, Regulations, Guidelines and Standards

The laws, regulations, guidelines and standards related to the environmental and social aspects of the project are summarized in Table 3.2:

Table 3.2: Main Act/Regulation/Standard and their Relevance to the Project

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
1	**Punjab Environmental Protection Act, 1997 (Amended, 2012)** The Punjab Environmental Protection Act, 1997 (Amended, 2012) is comprehensive legislation and provides the legislative framework for protection, conservation, rehabilitation and improvement of the environment. The 'environment' has been defined in the Act as: (a) air, water and land; (b) all layers of the atmosphere; (c) all organic and inorganic matter and living organisms; (d) the ecosystem and ecological relationships; (e) buildings, structures, roads, facilities and works; (f) all social and economic conditions affecting community life; and (g) the interrelationships between any of the factors specified in sub-clauses 'a' to 'f'. The notable points of the law are: • No Proponent of a Project shall commence construction or operation unless he has filed with the Provincial Agency designated by the Provincial EPAs an EIA, and has obtained an approval; • Establishment and formation of the Punjab Environmental Protection Council; • Prohibition of certain discharges or emissions; • Punjab Environmental Quality Standards (PEQS) for wastewater, air emissions and noise; and • Provincial Government can issue notices and enforce them to protect the environment. In the recent amendment of 2012, legislatives powers related to environment and ecology are given to provincial governments from the Federal government. The provinces are required to enact their own legislation for environmental protection. Other amendments include increasing the penalties for violations. For the proposed RLNG Project, Environmental Protection Department (EPD) Punjab/Environmental Protection Agency (EPA) Punjab is the concerned authority. The capability of regulatory institutions for environmental management is ultimately responsible for the	Environment	The provision section-12 of the act is applicable to RLNG power plants for conducting an EIA according to section 12 and to obtain environmental approval from the concerned EPD/EPA.

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
	success of environmental assessments and that development projects are environmentally sound and sustainable.		
2	**Punjab Plantation and Maintenance of Trees Act, 1974** The Punjab Plantation and Maintenance of Trees Act, (1974) regulates tree plantations and enforces measures for their protection.	Trees	The requirements to plant trees and their maintenance by the occupier of the land are given in this act and will be applicable to this RLNG project.
3	**Cutting of Trees Act, 1975** This Act prohibits cutting or chopping of trees without permission of the Forest Department. The act presents fine or imprisonment or both, for illegal cutting of tree but has not mentioned any compensatory afforestation. However, it's a common practice to plant 7-10 trees for compensation of 1 tree to be rooted up.	Trees	The provisions of compensation of this act are applicable if any project activity will cause cutting of trees otherwise, fine or imprisonment or both should be enforced for illegal cutting of tree (if happen during construction or O&M phase of proposed Project).
4	**Pakistan Environmental Protection Agency, Review of IEE and EIA Regulations, 2000** These regulations sets out: • Key policy and procedural requirements for filing an EIA; • The purpose of environmental assessment; • The goals of sustainable development; • The requirement that environmental assessment be integrated with feasibility studies; • The jurisdiction of the Federal and Provincial EPA's and Planning & Development (P&D) Departments; • The responsibilities of Proponents; • Duties of responsible authorities; • Provides schedules of proposals that the Project requires either IEE or an EIA; • The environmental screening process of the projects under schedule I, II and III; and • The procedure for the environmental approval for filing the case with the concerned EPA/EPD for granting the Environmental Approvals.	Environment	The provisions of these regulations are applicable for environmental screening of the Project which implies that an EIA is required.
5	**Land Acquisition Act, 1894** The Pakistani law governing land acquisition is the Land Acquisition Act (LAA) of 1894 and successive amendments. The LAA regulates the land acquisition process and enables the provincial government to acquire private land for public purposes. Land acquisition is a provincial responsibility and provinces have also their own province specific implementation rules like Punjab and Sindh Land Acquisition Rules, 1983. The LAA and its Implementation Rules require that, following an impact identification and valuation	Land Acquisition	This Act is applicable to provide compensation for any loss of land related to agricultural, commercial and residential due to siting of the proposed RLNG Project.

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
	exercise, land and crops are compensated in cash at the current market rate to titled landowners. The LAA mandates that land valuation is to be based on the last 3 to 5 years average registered land-sale rates. However, in several recent cases, the median rate over the past 1 year, or even the current rates, have been applied with an added 15% Compulsory Acquisition Surcharge (CAS) according to the provision of the law. The Affected Persons (APs), if not satisfied, can go to the Court of Law to contest the compensation.		
6	**Punjab Katchi Abadis Act, 1992** Amendment Ordinance No. XVIII of 2007 updated the Punjab Katchi Abadis Act, 1986. It made provisions for the regularization of Katchi Abadis and outlined the provision for giving assistance. The ordinance stated that the Director General (DG) shall be appointed by the Government and will be responsible to implement the Act. Subject to the provisions of sub-sections (2), (3), (4) and (5) and the directions, if any, of the government the DG can regularize any settlement of more than 40 dwelling units that was occupied before March 23, 2010.	Katchi Abadis	This Act is applicable in combination with LAA to provide compensation to Katchi Abadis.
7	**Explosive Act, 1884** This Explosives Act, (1884) regulates handling and storage of explosive substances. It will be applicable to any explosive, petroleum, and any other explosive material that may be used throughout the life of the Project.	Safety and Environment	The provision of this act is applicable for handling and storage of explosive substance.
8	**The Factories Act, 1934** The Factories Act, 1934 concerns: • Regulation of labour in factories; • Issues regarding labour, wages, working hours and health and safety; • Briefly refer to environmental issues; and • Section 14 deals with the disposal of industrial wastewater.	Employment, health and safety	This act will be applicable for regulating labor, wages, working hours and health and safety issues of the workers employed for the proposed Project during construction and O&M phases of Project.
9	**Pakistan Penal Code, 1860** The Code deals with the offences where public or private property or human lives are affected due to intentional or accidental misconduct of an individual or organization. The Code also addresses control of noise, noxious emissions and disposal of effluents.	Environment	This Code of law will be applicable to the construction, O&M and decommissioning works to be carried out during the proposed Project.
10	**Canal and Drainage Act amended 2016** The Canal and Drainage Act amended 2016, prohibits fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses), or obstruction of drainage.	Water	This Act will be applicable to the construction and O&M works to be carried out during the proposed RLNG Project.
11	**Pakistan Clean Air Program** The Pakistan Clean Air Program (PCAP) is an initiative of the Pak-EPA to comprehensively	Air	The PCAP would be applicable to enhance the air quality of the surroundings of the project

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
	address the air quality issue in the country. Key elements of the PCAP include an Air Quality Monitoring Program, Air Quality Indicators, Research Program, Air Quality Resource Center, Regulatory Measures, Economic Instruments, Emissions Inventory, Air Dispersion Models and Air Quality Abatement Technology Clearing House. The objectives of the program are to: • Protect and enhance the quality of the country's air resources; • Protect public health and welfare against any actual or potential adverse effects that may reasonably be anticipated to accrue from air pollution; • Preserve, protect, and enhance the air quality in urban areas and the countryside and in areas of natural, recreational, scenic, cultural, or historic value, in particular, the protected areas of the country, i.e. national parks, wildlife sanctuaries, game reserves, and national monuments; • Ensure that economic growth will occur in a manner consistent with the preservation of existing clean air resources; • Assure that emissions from any source in any province do not interfere with pollution prevention programs in any other province; and • Assure that Pakistan's international obligations regarding the trans-boundary effects of air pollution are met.		area with the help of monitoring, modeling and management techniques (if required incase of any worst emission).
12	**The Protection Against Harassment of Women at the Workplace Act, 2010** The Protection Against Harassment of Women at the Workplace Act (2010) refers to sexual harassment at the workplace.	Social	This Act will be applicable to the proposed RLNG Project if women are employed during construction and O&M phases.
13	**The Punjab Restriction On Employment Of Children Ordinance, 2016** Article 11(3) of the Constitution of Pakistan prohibits employment of child (below the age of 15 years) in any factory or any other hazardous employment. The ordinance includes legal obligations of work duration, weekly holidays and penalties on employer in case of child employment.	Employment	The relevance of this ordinance to the project will be to prohibit the child employment.
14	**Labour Laws** The Constitution of Pakistan contains a range of provisions with regards to labour rights, in particular: • Article 11 of the Constitution prohibits all forms of slavery, forced labour and child labour; • Article 17 provides a fundamental right to exercise the freedom of association and the right to form unions;	Employment	The labour laws will be relevant as it would deal with employment of labour for the proposed Project.

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
	• Article 25 lays down the right to equality before the law and prohibition of discrimination on the grounds of sex alone; and • Article 37(e) makes provision for securing just and human conditions of work, ensuring that children and women are not employed in vocations unsuited to their age or sex, and for maternity benefits for women in employment. Labour law is controlled at both provincial and national levels with compulsory employment agreements containing the terms set out by the labour laws. The labour laws are a comprehensive set of laws in Pakistan dealing with the following aspects: • Contract of Employment • Termination of Contract • Working Time and Rest Time • Working hours • Paid Leave • Maternity Leave and Maternity Protection • Other Leave Entitlements • Minimum Age and Protection of Young Workers • Equality • Pay Issues • Workers' Representation in the Enterprise • Trade Union and Employers Association Regulation • Other Laws.		
15	**Guidelines for Public Consultation, 1997** The guidelines for public consultation are issued by the Pak-EPA and are presented in "Pakistan Environmental Protection Act, 1997 and policy and procedure for filling, review and approval of environmental assessment"	Environment	The guidelines imply for stakeholder consultations that were conducted during EIA study.
16	**Guidelines for the Preparation and Review of Environmental Reports, 1997** These guidelines describe the format and content of IEE/EIA reports to be submitted to Provincial EPA/EPD for obtaining Environmental Approvals. The guidelines present: • The environmental assessment report format; • Assessing impacts; • Mitigation and impact management and preparing an environmental management plan; • Reporting; • Review and decision making; • Monitoring and auditing; and • Project Management.	Environment	The provision is applicable in term of conducting detailed EIA by following these rules and procedures during the detailed feasibility stage.
17	**Guideline for Solid Waste Management, 2005 (Draft)** Guidelines for Solid Waste Management (2005) are in draft form Park-EPA in cooperation with	Solid Waste Management	The provision of these guidelines is applicable for waste generation during construction, operation and decommissioning phases

Sr. No.	Act/Regulation/Standard	Topic Covered	Relevance to the Project
	JICA and UNDP).		of proposed RLNG power plant Project.
18	**Sectorial Guidelines for Environmental Reports, Major Thermal Power Plants, October 1997** These guidelines deal with major thermal Power Plants, which will be defined as those producing electrical energy from fossil fuels (coal, oil or gas). These guidelines identify the key environmental issues that need to be assessed as well as mitigation measures and Project alternatives to be considered in the actual EIA. These guidelines include: • A sector overview of the industry and the processes; • Potential impacts on the environment; • Mitigation measures (abatement technologies); • Monitoring and reporting; • Management and training; and • Checklist of likely environmental impacts and mitigation measure.	Thermal Power Plants	The provision of these guidelines is applicable for construction and operation phases of Thermal Power Plant (RLNG plant).
19	**Punjab Environmental Quality Standards (PEQS)** The Punjab Environmental Quality Standards (PEQS) were promulgated in 2016. Specified standards include those for: • Municipal and liquid industrial effluents; • Industrial gaseous emission; • Motor vehicle exhaust and noise; • National drinking water quality standards; and • Ambient air and noise standards.	Compliance Standards	All projects in Punjab must conform to PEQS. The full list is attached as an Annex-2.

3.2.3 Legal Procedures for Approval of Environmental Reports and Obtaining NOC from EPA-Punjab

The IEE-EIA Regulations (2000) provide details on the preparation, submission, and review of the IEE and the EIA. Projects are classified on the basis of adverse potential environmental impacts:

- Schedule I projects have potentially less adverse effects and require an IEE; and
- Schedule II have potentially irreversible adverse impacts and require EIA.

As per Punjab EPA Act, 2012 (as amended) and sectoral guidelines for major thermal power plants, the proposed Project requires to file a full EIA as all power plants projects of 200 MW or more capacity are classified under Schedule II projects (likely to have potentially significant and adverse environmental impacts).

The prescribed procedure for review of EIA by the EPA is described in sections 9–14 of the Regulations (Figure 3.1).

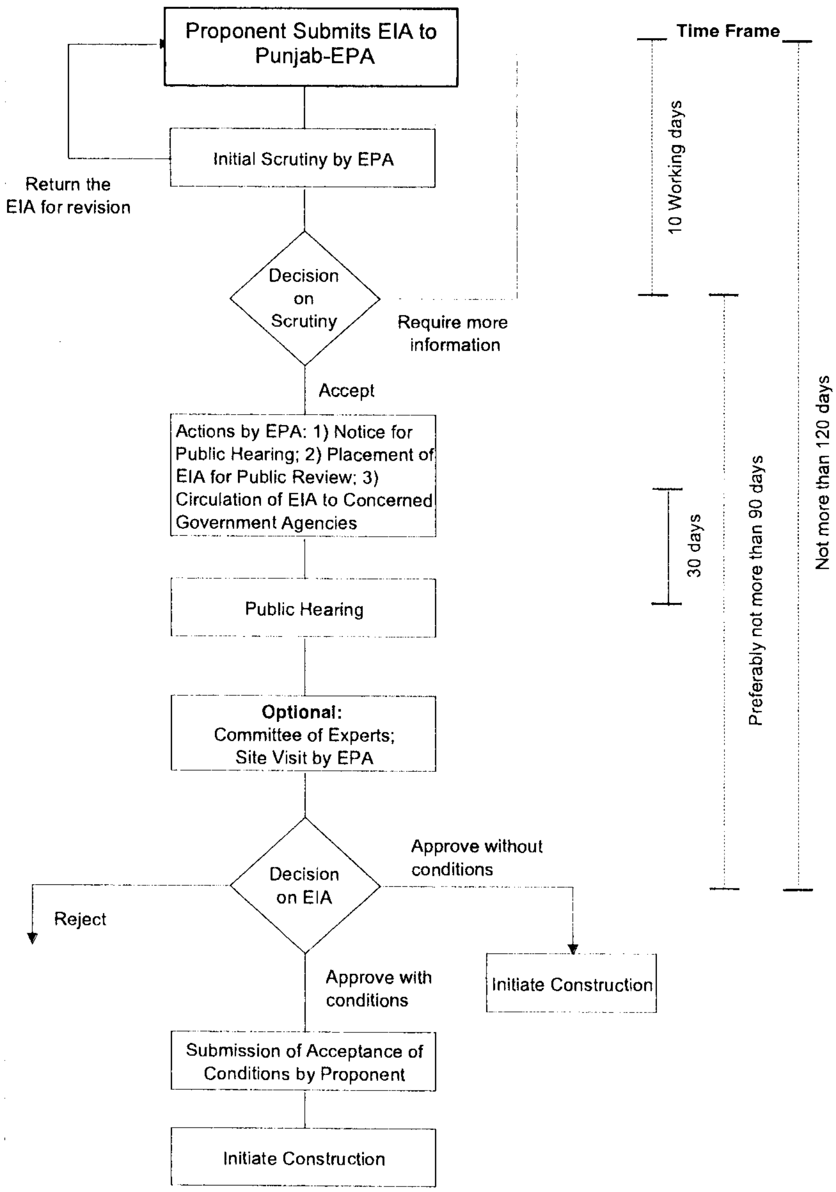


Figure 3.1: Pakistan EIA Procedure

The key features are:

- Submission of EIA to EPA-Punjab;
- On acceptance of the EIA for review, EPA will place a public notice in national English-language and Urdu newspapers, and in local language newspapers. The notice will inform the public about the project and where its EIA can be accessed. It will also set a date for public hearing which shall be at least 30 days after the publication of the notice; and
- If it considers necessary, the EPA can form a committee of experts to assist the EPA in the review of the EIA. The EPA may also decide to inspect the project site.

Article 12(4) of PEPA 1997 (amended, 2012) binds the EPA to communicate its approval or otherwise within a period of four months from the date the initial environmental examination or EIA is filed complete in all respects in accordance with the prescribed procedure, failing which the initial environmental examination or, as the case may be, the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations made thereunder.' Rule 11 of the IEE-EIA Regulations 2000, states that the EPA shall make every effort to carry out its review of the EIA within ninety days, of issue of confirmation of completeness'.

3.3 INTERNATIONAL CONVENTIONS, AGREEMENTS AND TREATIES

Pakistan is a member of several international organizations such as United Nations Organization (UNO), Organization of the Islamic Conference (OIC), South Asian Association for Regional Cooperation (SAARC), and the Economic Cooperation Organization (ECO). The conventions, ratification dates and obligations related to the proposed Project are given in Table 3.4:

Table 3.4: International Agreements/Conventions Relevant to the Project

Sr. No.	Agreement / Convention	Ratification	Description	Relevance
1	Convention on Biological Diversity, 1994 **Web Link:** https://www.cbd.int/	Signed in 1992 and ratified in 1994.	The Convention on Biological Diversity (CBD) has three main goals: conservation of biological diversity (or biodiversity); sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources.	This is applicable to the project for conservation of biological diversity and restoring habitats during the project life.
2	The Rio Declaration, 1992 **Web Link:** http://www.unep.org/documents. multilingual /default.asp? documented =78 & articled = 1163	Signed on 13th June 1992, and ratified on 1st June, 1994	The Rio Declaration comprises 27 principles which address important issues such as; sustainable development to integrate environmental protection into the development process; common but differentiated responsibilities to conserve, protect and restore the earth's ecosystems; public participation and information access at the national level, reduce and eliminate unsustainable patterns of production and consumption.	The provision of the declaration is applicable for environmental protection during the project life.
3	Kyoto Protocol, 1992 **Web Link:** http://unfccc.int/kyoto_protocol/items/2830.php	Ratified in 2005	The Kyoto Protocol is a protocol to reduce greenhouse gasses that cause climate change. It was agreed on 11th December, 1997 at the 3rd Conference of the countries to the treaty when they met in Kyoto, and entered into force on 16th February, 2005. As of November 2007, 175 countries have ratified the protocol. One hundred and thirty seven (137) developing countries have ratified the protocol, including Brazil, China, India and Pakistan but have no obligation beyond monitoring and	The protocol is applicable to reduce the emissions from project activities during its construction and operational phases and for Cleaner Development Mechanism.

Sr. No.	Agreement / Convention	Ratification	Description	Relevance
			reporting emissions.	
4	The Rotterdam Convention on Chemicals, 1998 **Web Link:** http://www.pic.int/	Pakistan signed this convention on 9th September, 1999 and ratified on 14th July, 2005	The convention promotes shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labeling, include directions on safe handling, and inform purchasers of any unknown restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that procedures within their jurisdiction are complied.	The convention is applicable with reference to proper labeling and safe handling of hazardous chemical if used during the project implementation.

CHAPTER–4: ANALYSIS OF ALTERNATIVES

4.1 GENERAL

This chapter deals with an analytical overview of the different alternatives that have been considered for the proposed Project. The analysis has been carried out critically so as to select the most suitable alternative for the Project. Seven different types of the alternatives have been considered as listed below:

- No Project Option (NPO);
- Power Generation Alternatives;
- Site Alternatives;
- Fuel Alternatives;
- Technology Alternatives;
- Pollution Control Alternatives;
- Cooling System Alternatives; and
- Wastewater Discharge Alternatives.

The details of the alternatives considered and the final selection are discussed in the following sections.

4.2 NO PROJECT OPTION

Electricity accounts for one of the most important component of infrastructure and economic growth and plays a key role in national ballooning and development. The growing pace of urbanization and industrialization also puts a premium on demand for electricity.

According to the available data (refer Figure 1.1), the installed power generation capacity in Pakistan is estimated to be about 25,794 MW including 9,129 MW and 8,830 MW from thermal private and public generating units respectively, 7,115 MW from hydropower, 414 MW from nuclear and 306 MW from wind.

It has been reported that the shortfall in power generation has increased to 5,000-7,000 MW per day. The total average demand of country is 19,000 MW. Power shortages are estimated to cost the economy 2% of the GDP each year. This is slowing the pace of economic activity and causing public unrest with prolonged outages of electricity and gas. For that reason, to attain self-sufficiency, alternative energy resources are being explored at a very high priority.

Another important issue related to power generation in Pakistan is the higher cost of generating electricity due to reliance on imported fuels such as oil. The difference between the power generation and supply cost is quite high which is one of the major causes to create circular debt in addition to other reasons like delay in tariff determination, fuel price adjustments, revenue collection problems etc. Therefore, there is a dire need not only to increase the generating capacity but also to reduce the generation cost.

Natural gas is a cleaner fuel for generating electricity and fuels about 24%[5] of global electricity production. Table 4.1 shows the list of countries producing a major chunk of their power through natural gas. The list also includes some natural gas importing countries like Japan, Turkey etc. Natural gas is likely to remain a key component of the fuel mix for power generation to meet electricity demand, especially the growing demand in developing countries.

[5] Source: British Petroleum-statistical-review-of-world-energy-2016

Table 4.1: Power Generation by Natural Gas in Various Countries

Sr. No.	Country	Power Share Produced by NG (%)
1	Belgium	31.8
2	Ireland	45.0
3	Italy	38.3
4	Japan	39.2
5	Mexico	59.8
6	Netherlands	44.1
7	Turkey	38.6
8	United Kingdome	29.8
9	United States	32.0
10	Spain	18.5

Source: Electricity production from natural gas sources (2015), The World Bank

According to the GoP and the World Bank, in year 2014 Pakistan produced 25.1%[6] of energy from natural gas. Bearing in mind the country's depleting natural gas resources and drastically increasing energy demands, it is need of the hour to import Liquefied Natural Gas (LNG) for the purpose of regasification and power generation.

1,400 MW of maximum electricity to be produced by the proposed project makes up 24 % of the present gap between demand and supply. Therefore, the project can play an effective role to bridge up the widening gap between demand and supply. Considering the above scenario, if the 1,200 MW power plant is not run on RLNG, then Pakistan will be deprived of this cleaner electricity generation option, which can help to fill in the contemporary demand and supply gap. In view of above scenario and justification, the NPO is not viable for this project.

4.3 POWER GENERATION OPTIONS

Two major potential power generation options available in Pakistan are hydel power and thermal power generation by use of natural gas, coal and oil.

In Pakistan, energy generation by various fuels is shown in Figure 4.1. The figure clearly indicates that major chunks of energy are produced by hydro, gas and oil.

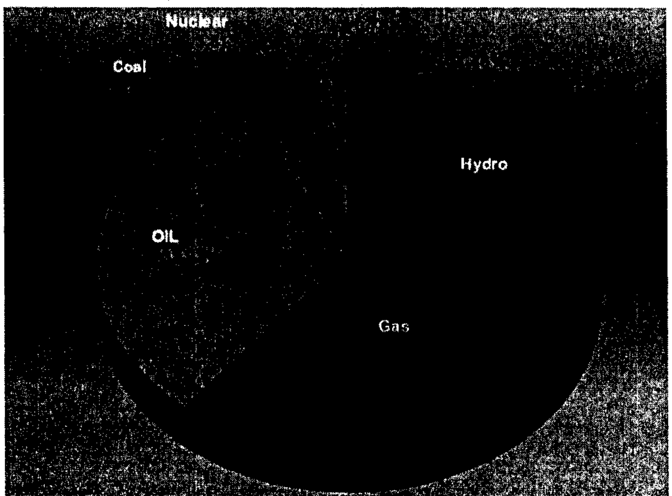


Figure 4.1: Energy Generation by Fuel Type 2016[7]

As a first option, Hydel power was considered being friendlier to natural environment during operational phase. Various feasibilities are available or in progress for various hydel power generation projects in Pakistan like Basha Diamer Dam and other small Hydel projects. Dasu

[6] *Electricity production from natural gas sources (2014, Pakistan), The World Bank*
[7] *Power System Statistic 2015-2016 (41st Edition Planning Power, NTDC)*

Hydropower Project has already been initiated. As per Water and Power Development Authority (WAPDA) Vision 2025 program, these projects are required to be implemented as soon as possible but will take long time to be completed. The construction of any big dam, even if initiated now will take 10 years to come into operation.

In view of the long-lead-time required to bring large hydel projects online, GoP's intention is to solicit bids for thermal projects, for which feasibility studies are already available or can be prepared on a very fast track basis. The immediate solution to the power shortage in Pakistan is the implementation of thermal power projects based on fossil fuels.

In this regard, GoP took an initiative to generate electricity in order to reduce load shedding. Therefore, 1,100-1,400 MW RLNG based CCPP at Jhang initiated by PTPL under the umbrella of GoPb based on imported LNG and its regasification near Karachi, was considered as a feasible option as it will reduce the overall power shortages in Pakistan. The Project will be connected with national grid to reduce the power shortages in national grid.

4.4 SITE ALTERNATIVES

4.4.1 Option-1: Land Adjacent to North Boundary of Existing RLNG Plant in Moza Dhueen Muhammad, Jhang

This site is located almost 25 km away from Jhang, almost 1.6 km off Jhang-Shorkot Road. The land is on the bank of Trimmu-Sidhnai (TS) Link Canal near Moza Dhueen Muhammad and Moza Mansoor Sial. This land is adjacent to northern boundary of existing RLNG CCPP Haveli Bahadur Shah. Nearest railway line is approximately 7.0 km from the site while nearest main road is Multan road (N-5) which passes 80 km from the site. Three 500 KV lines are passing: (i) Muzaffargarh-Gatti transmission line passes approximately 3 km away; (ii) Multan-Gatti transmission line passes approximately 25 km away; and (iii) RLNG CCPP Haveli Bahadur Shah (HBS) transmission line passes approximately at 1.23 km. This segment of land comprises private owned land only (majorly agriculture).

4.4.2 Option-2: Land About 200 m Away from West Boundary of Existing RLNG Plant in Moza Kot Dewan, Jhang

This site falls within the area of Moza Kot Dewan at about 0.9 km off Jhang-Shorkot Road. This land is about 200 m away from west boundary of existing RLNG CCPP HBS, on the bank of TS link canal. Railway line is approximately 6.6 km from the site. Nearest main road is Multan road (N-5) which passes 80 km from the site. Three 500 KV lines are passing near to the proposed site. (i) Muzaffargarh-Gatti transmission line passes approx. 3 km; (ii) Multan-Gatti transmission line passes approx. 25 km; and (iii) RLNG CCPP transmission line passes approx. 50 m. The proposed site includes Government owned land (i.e. Auqaf Land and Irrigation Department owned land) majorly i.e. more than half of total land required for project.

4.4.3 Option-3: Land About 1.13 km Away from West Boundary of Existing RLNG Plant in Moza Kot Dewan, Jhang

This segment of land also falls within the area of Moza Kot Dewan at a distance of 0.4 km from Jhang-Shorkot Road on the bank of TS Link Canal. This land is about 1.13 km away from west boundary of existing RLNG CCPP HBS. Nearest railway line is approximately 6.5 km from the site and nearest main road is Multan road (N-5) which passes 78 km from the site. Three 500 KV lines are passing near to the proposed site. (i) Muzaffargarh-Gatti transmission line passes approx. 3 km; (ii) Multan-Gatti transmission line passes approx. 25 km; and (iii) RLNG CCPP transmission line passes approx. 1 km away. The proposed site contains privately owned land (Majorly agriculture) only.

All these options considered for the proposed project are shown in Figure 4.2 and comparison of these three options is given in Table 4.2 below.

Table 4.2: Comparison of Alternate Site Options

Features	Option 1	Option 2	Option 3
Location	Moza Dhueen Muhammad, Moza Mansoor Sial	Moza Kot Dewan	Moza Kot Dewan
Distance From Canal (m)	100	100	100
Distance from Jhang-Shorkot Road (km)	1.6	0.9	0.4
Distance from Railway Line (km)	7.0	6.6	6.5
Total Land (Acres)	104.68	168.22	108.76
Private Land Area (Acres)	104.68	73.71	108.76
Government Land Area (Acres)	No	94.51	No
Easting (m)	232,052.76	231,830.47	231,638.44
Northing (m)	3,447,660.34	3,445,743.90	3,444,906.86

4.4.4 Site Suitability of Option-2 for the Proposed Project

After due consideration of load flow, availability of grid station, transmission lines and in view of the requirements of cooling water intakes , less private land, minimum tree cut and distance from main settlements, Option-2 is feasible. Option-2 contains more Auqaf land which can be utilized for colony or plantation purposes. The option-2 is also prefferable in terms of power evacuation and spur[8] pipeline's connectivity.

From a power evacuation standpoint, the site posts an advantage because CPPA/NTDC will not have to add significant transmission infrastructure to the area. As per the current power evacuation plan the project will feed net generation of to the nearest Toba Tek Singh (TTS) 220 KV grid station and the proposed dispersal is 220KV Quad bundle in the existing lines. The power will be evacuated from the Project through 220 KV transmission lines that will connect it to national grid through Grid Station.

For the gas supply, SNGPL shall construct the Spur pipeline and allied facilities at PTPL cost. Keeping in view of above situation and land ownership status, the option-2 (land of Kot Dewan situated at about 200 m away from west boundary of existing RLNG CCPP) seems to be most feasible for the proposed RLNG Project.

[8] Spur pipeline is the small pipeline connected to Trunk pipeline carrying natural gas.

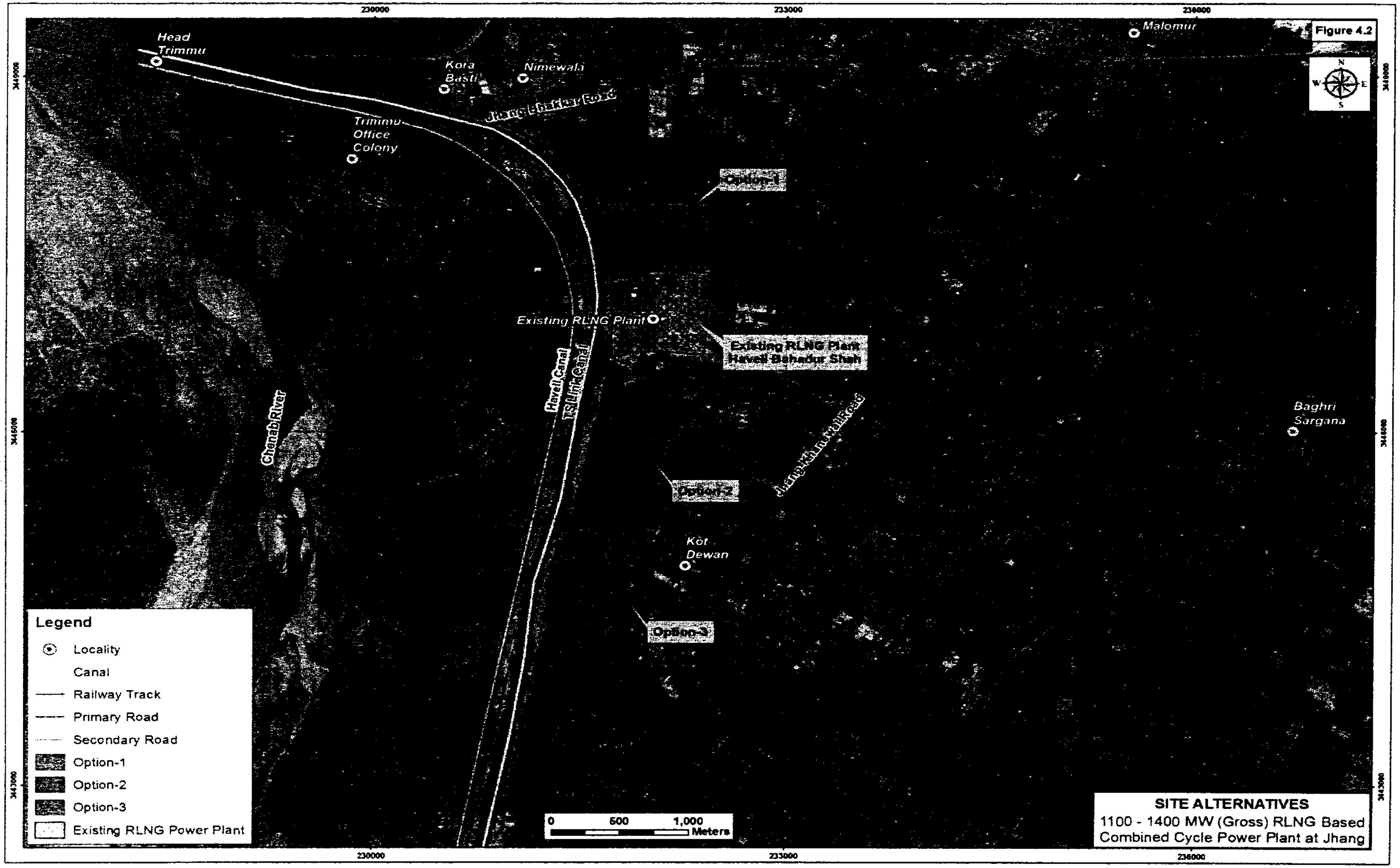


Figure 4.2: Site Alternative Map

4.5 FUEL ALTERNATIVES

Main fuels which are considered for power generation include the Natural Gas, Heavy Furnace Oil (HFO), High Speed Diesel and Coal.

However HFO is mostly used for thermal power generation. The main issues with this fuel include high SO_2, NO_2 and Particulate Matter (PM) emissions. Imported HFO is expensive and cost of the power generation with this fuel is higher as compared to any other indigenous fuel in Pakistan.

There are technologies available to burn coal but coal combustion through any technology may result in toxic emissions. Some of the coal combustion technologies are pulverized fuel combustion, Fluidized Bed Combustion (FBC) and coal gasification. All the processes involve coal burning and air pollutant emissions. In order to control air and wastewater emissions from the burning coal, Clean Coal Technologies (CCT) are used. However, use of these technologies involves higher capital and operation & maintenance cost which may result in higher electricity generation cost.

Therefore, considering the above mentioned limitations in the supply of local natural gas, coal combustion and high price of the imported HFO, imported LNG has been selected as the most feasible source.

4.6 TECHNOLOGY ALTERNATIVES

4.6.1 Single-Shaft v/s Multi-Shaft CCPP

A CCPP consists of one or more Gas Turbine (GT) generator sets equipped with HRSGs. Heat produced in the GTs is utilized to run HRSGs. Steam produced in the HRSGs is guided to a Steam Turbine (ST) and expanded there. The ST drives a generator which produces additional electrical energy.

A single-shaft CCPP comprises a GT and a ST driving a common generator. In a multi-shaft CCPP, each gas turbine and each steam turbine has its own generator. The single-shaft configuration is more suitable with regards to performance, simplified control and operation, lower capital cost as compared to multi shaft and minimum space requirement. The disadvantages of single-shaft CCPP are slightly lower efficiency in case of 2 blocks of 1-1-1 single-shaft configuration vs. 2-2-1 multi-shaft configuration, lower redundancy and large starting device requirement. Also its phased construction and operation of GT in simple cycle is not possible.

The multi-shaft configuration is more suitable with regards to space limitations, steam turbine shaft power, availability, reliability, flexibility for phased construction, slightly higher efficiency in case of 2-2-1 multi-shaft configuration compared to 2 blocks of 1-1-1 single-shaft configuration, better part load efficiency, higher redundancy, higher operational flexibility and smaller starting device requirement. However some of the disadvantages of multi-shaft CCPP are higher capital cost and more space requirement as compared to single shaft.

4.6.2 CCPP Configurations

There are several CCPP configurations possible. For example one GT with one HRSG feeds one ST. This configuration is also called 1-1-1. A very common configuration is the 2-2-1 (two GTs feed two HRSGs, drive one common ST).

Different configurations for combined cycle power plants entail distinct advantages and disadvantages depending upon a number of factors e.g. power plant rating, operation mode etc.

It is, therefore, imperative that the basis for comparing different configuration options should be the same.

Different configuration options as shown in Figure 4.3 compared herein are for gas fired CCPP of 1,000-1,200 MW rating which is to be operated as a base load plant. The plant is assumed to be constructed in two phases i.e. simple cycle operation before completion of combined cycle as well as having flexibility of operation in simple cycle after commercial operation date. Comparison of three CCPP Configurations is summarized in Table 4.3.

Table 4.3: Comparison of 1-1-1, 2-2-1 and 3-3-1 Configurations

Items	1-1-1 Configuration (1 GT, 1 HRSG, 1 ST)	2-2-1 Configuration (2 GT, 2 HRSGs, 1 ST)	3-3-1 Configuration (3 GT, 3 HRSGs, 1 ST)
Salient Information	• Due to limitation on available gas turbine maximum ratings, 1,100-1,400 MW plant requires 2 blocks with 1-1-1 configuration comprising large heavy duty gas turbines.	• Gas turbines in both 1-1-1 and 2-2-1 configurations could be same for 1100-1400 MW.	• With 3-3-1 configuration, 1,000-1,200 MW plant would require smaller gas turbines as compared to other two configurations.
Advantages	• Higher based load efficiency compared to 3-3-1 configuration due to larger gas turbines • Minimum space requirement • Lowest capital cost	• Highest base load efficiency compared to other two options • Less space requirement than 3-3-1 configuration • Lower capital cost than 3-3-1 configuration	• Higher operational flexibility due to 3 gas turbines • Higher part load efficiency than other two options
Disadvantages	• Higher minimum load • Lower base load efficiency compared to 2-2-1 configuration • Lower part load efficiency than 3-3-1 configuration	• More space requirement than 1-1-1 configuration • Higher capital cost than 1-1-1 configuration • Lower part load efficiency than 3-3-1 configuration	• Lower base load efficiency compared to other two options • Higher capital cost compared to other two options • Maximum space requirement compared to other two options • Longer erection time

Conclusion: HRSGs are more environment friendly as excess heat loss is avoided. Single Shaft configuration is more suitable for combined cycle power plants employing single gas turbine which is to be operated in combined cycle mode only. This configuration is also preferred where there are space constraints. Multi Shaft configuration is more suitable for combined cycle power plants employing two or more gas turbines which are to be constructed in phases and operated in simple cycle as well.

Based on above comparison both 1-1-1 and 2-2-1 configurations have clear advantages compared to 3-3-1 configuration for a combined cycle power plant of around 1,000-1,200 MW rating. 2-2-1 configuration is more suitable in terms of efficiency and if the flexibility for phased construction where simple cycle operation is desired. However, final configuration will be chosen by EPC contractor.

4.7 POLLUTION CONTROL ALTERNATIVES

There are two primary control techniques considered for the control of NO_x: (1) combustion modifications to suppress the formation of NO_x, and (2) add-on controls to reduce NO_x to molecular nitrogen.

4.7.1 Combustion Modifications

Most of these techniques involve a reduction in the peak gas temperatures, a reduction in the oxygen concentrations in the high temperature areas of the burner flames, and/or a reduction in the residence time of combustion products in the high temperature areas of the burner flame. A partial list of the combustion modifications to reduce NO_x formation is provided below:

- Low excess air operation;
- Off-stoichiometric combustion (Low NO_x Burners, Over fire Air and Burners out of Service); and
- Flue gas recirculation.

4.8 POST COMBUSTION CONTROL

Due to the limitations of combustion modifications, add-on control systems are being developed to decrease NO_x emissions below the levels possible by means of combustion modifications alone. There are two categories of add-on control systems that are applicable to boilers and other combustion processes.

- Selective Non Catalytic Reduction (SNCR); and
- Selective Catalytic Reduction (SCR).

Both types of systems inject ammonia or urea into the gas stream to reduce nitrogen oxides to molecular nitrogen and water.

For this Project, low NO_X burners has been selected as the most easily adoptable option in Gas Turbines which can result of about 50% of NO_X. However, control of NO_X during the use of HSD, water will be injected to control the NO_x emissions.

4.9 ALTERNATIVES CONSIDERED FOR THE SELECTION OF COOLING SYSTEM

Water use and conservation at Power Plants have been an important siting issue in Pakistan and anywhere else. The requirement of water for condensing exhaust steam from steam turbines, generally known as Power Plant cooling, is the largest use of water at the most of the plants. For Power Plant thermal discharge, there are different cooling methods which include once-through cooling water system, recirculation water cooling system and air cooling.

Due to availability of TS Link Canal, the once through cooling system is prefferd which means that after pass through the turbine condenser, the water will be returned to the Canal. For this, the allocation of water has been consented by the Irrigation Department. However, during canal closure period of six weeks, the alternative method of recirculating ground water from deep wells is suggested. Provisions of wet/dry cooling tower have also been made in the project to be operated during the canal closure periods.

4.10 WASTEWATER DISCHARGE ALTERNATIVES

During operation of CCPP, there will be three types of discharges mainly process wastewater, cooling wastewater and sanitary wastewater. Different alternatives considered for the disposal of plant wastewater after the treatment include the following:

4.10.1 Option-1: Discharge of Treated Wastewater in TS-Link Canal

The treated wastewater can be discharged into TS-Link Canal. However, following are the major consideration while selecting this alternative:

- Approval from Irrigation Department will be required for discharge of treated effluent into main canal;
- The treatment should be decided carefully to prevent health hazard as canal water is also being used for recreation purpose such as bathing by locals; and
- It may also affect the livestock and animals which consume the canal water for drinking purpose.

4.10.2 Option-2: Recycling and Reuse of Treated Wastewater

Recycling and reuse of the treated wastewater was also considered in which wastewater after treatment can be used in-house for the plantation within the plant boundary and in the surrounding agricultural areas. Mainly three types of wastewater will be generated from the proposed Power Plant. The industrial wastewater can be reused and can be consumed in the system after treatment however the sewerage wastewater can be used for watering vegetation within the colony and the surroundings of the Power Plant. However, 100% water cannot be recycled.

4.10.3 Option-3: Construction of Seepage Pits

The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case treated water discharge is not permitted during this time by the canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided.

All the above options will be adopted for the disposal of all kind of treated wastewater from the Power Plant in different scenarios i.e. during canal closure seepage pits would be the feasible option.

CHAPTER–5: PROJECT DESCRIPTION

5.1 GENERAL

This chapter describes the Project, site features, impetus of the project, components of the project, technical data, fuel (quality, quantity and transportation), back-up fuel, transmission and distribution system, water requirements and cooling system, wastewater generation and treatment, air emission controls, load flow studies, maintenance facilities, project implementation schedule and project cost.

5.2 THE PROJECT

The proposed Project is essentially an RLNG based Combined Cycle Power Plant (CCPP). The Power Plant shall be of producing 1,100-1,400 MW (Gross) electricity. The Power Plant will operate on imported RLNG to be transported from Karachi through pipelines. However, HSD will be used as back-up fuel.

5.3 SITE FEATURES

The site is located about 30 km from Jhang and is adjacent to TS (Trimmu-Sidhnai) Link Canal (100 m) on downstream of Trimmu Barrage. Railway line is approximately 5.5 km from the site. The main access roads to the project site are Bhakkar-Jhang Road and Jhang-Shorkot Road which passes approximately 1.5 km and 1 km from the Project site.

5.4 BENEFITS OF THE PROJECT

The project is aimed to provide power share to the National Grid by using RLNG Based CCPP in view of the higher price of other resources like RFO, HFO etc. for production of affordable electric power and to help narrowing the gap in the supply and demand. The main objectives of the Project are as follow:

- To provide adequate power generation capacity at the least cost;
- To encourage and ensure exploitation of imported LNG for development of Thermal Power Generation projects in the country;
- To encourage the local engineering industry to form joint ventures with foreign companies for participation in the development of the Power Generation projects.
- To protect the environment;
- To achieve energy generation self-sufficiency in order to support economic growth and reduce poverty;
- To provide affordable electricity to the main load centers through National Grid;
- To reduce the load shedding in the country; and
- To provide energy security to the country.

5.5 COMPONENTS OF THE PROJECT

The combined cycle power plants utilizing large sized heavy duty Gas Turbines (GT) have several advantages and are known for their reliable long term trouble free operation, high thermal efficiency and are the best choice for base load operation. The application of large GT in CCPPs results in lowest possible cost per kWh on Net Present Value (NPV) basis for 30 year life-time. Plant power production efficiency at Reference Site Conditions (RSC) is given in Table 5.1 below:

Table 5.1: Plant's Power Production Efficiency

Mode	Fuel	Guaranteed Net Power Output (kW at ISO)		Minimum Net Thermal Efficiency corresponding to quoted Guaranteed Net Heat Rate (kJ/kWh at ISO) at LHV
		Min.	Max.	
Complex	RLNG	1100	1400	60.0%
	HSD	85% of output with RLNG	-	
Gas Turbine	RLNG	-	-	39.5%

The open cycle operation of the power plant generates the electricity by using gas turbine only without the recovery to waste heat to generate additional electricity by running a steam turbine.

To increase the overall efficiency of thermal power plants, multiple processes can be combined to recover and utilize the residual heat energy in hot exhaust gases. The term "combined cycle" refers to the combining of multiple thermodynamic cycles to generate power. Combined cycle operation employs a HRSG that captures heat from high temperature exhaust gases to produce steam, which is then supplied to a steam turbine to generate additional electric power. The combined cycle operation of the power plant increases the efficiency as compared to the single cycle operation.

The design shall provide maximum levels of reliability and availability, convenience of operation and maintenance, neat and orderly arrangement, which shall take into account the functional requirements of various systems and pleasing physical appearance of the completed power station. The CCPP shall be designed for base load operation. A Simplified Conceptual Diagram of a CCPP is shown in Figure 5.1 and the Plant Layout Plan is shown in Figure 5.2.

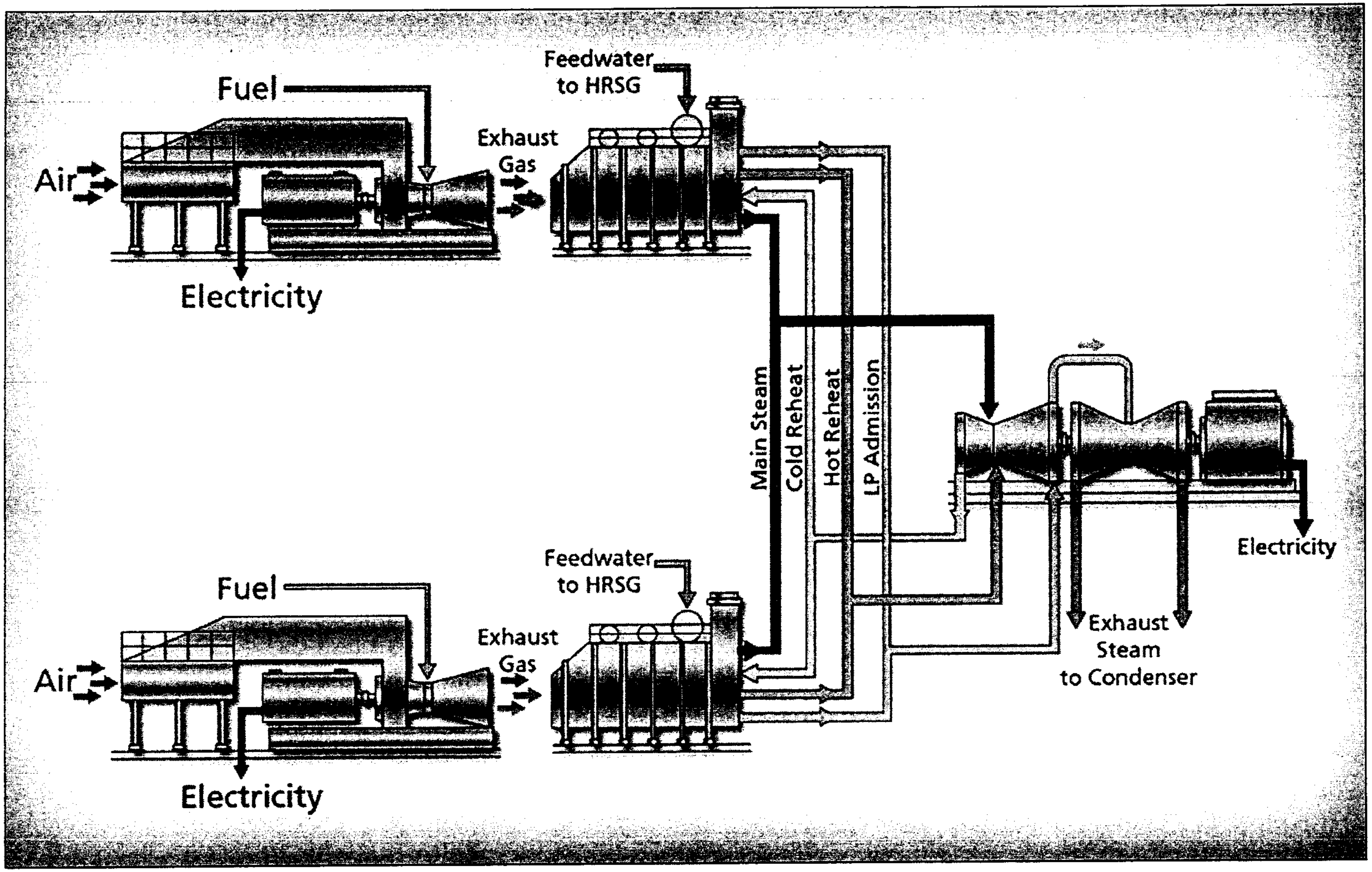


Figure 5.1: Conceptual Diagram of CCPP

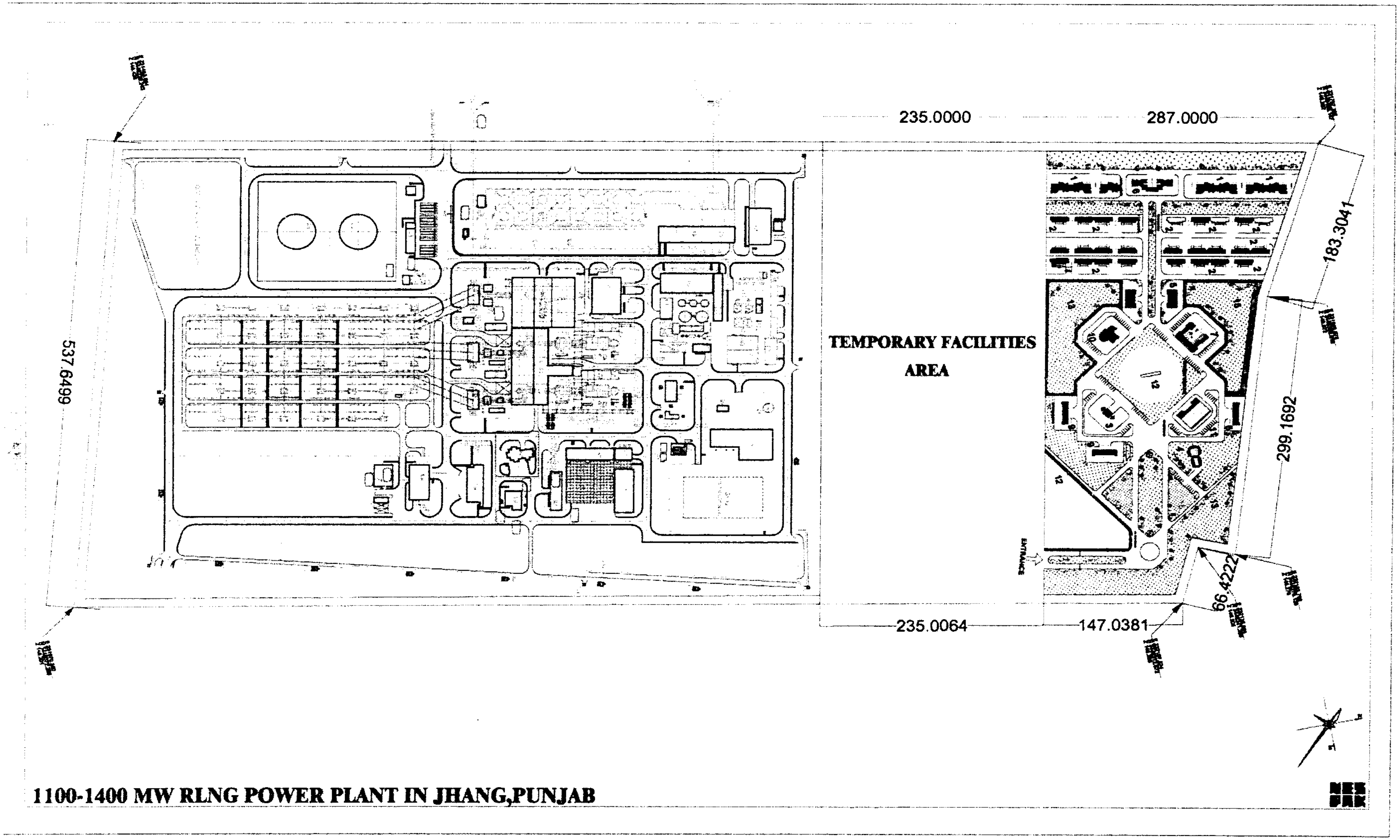


Figure 5.2: Layout Plan

5.5.1 Scope of EPC Work

The Scope of Work for the Plant comprises, but shall not be limited to, the complete engineering, supply of drawings, diagrams and other required information, construction, manufacture, shop testing, packing and marking, delivery, insurance, transport from shop to site, loading and unloading, storing at site, checking on completeness, erection, connection to existing equipment and facilities, functional testing, start-up, commissioning, optimization, reliability testing, acceptance testing; handing over in satisfactory condition for commercial operation, training of operation and maintenance personnel during the warrantee period until acceptance of the complete work of the Facility with all auxiliaries, ancillaries and appurtenances so that the plants are completely ready for commercial operation.

This includes as a minimum:

- Civil works as required for the project;
- Gas turbines and generators;
- Steam turbines with water cooled condenser;
- Once through cooling system fed from canal water, and a cooling tower for backup when canal water is not available during at least one month every year;
- Gas booster compressor station;
- Step-up transformers;
- Unit and station transformers;
- Heat recovery steam generators;
- Primary fuel system;
- Balance of plant equipment;
- Auxiliary systems;
- Electrical systems;
- Control and instrumentation systems;
- Fire alarm, protection system, and firefighting equipment;
- Field equipment;
- Continuous emission monitoring system;
- Metering and quality monitoring equipment (power and fuel);
- Communication facilities;
- Closed circuit television (CCTV) system; and
- A GPS Clock synchronized time system for the common time basis of all the equipment.

5.5.2 Civil Works

The major civil works for the Project include:

- Civil works for GT foundations;
- Civil works for HRSGs foundations;
- Civil works for Steam turbine foundations;
- Power house building including workshops, labs and warehouse;
- Cooling Water Intake House;
- Water treatment plant, pre-treatment plant, effluent treatment plant storage tanks;
- Transformer yard;
- 220 kV Switchyard;
- Plant buildings, pump houses and storage sheds;
- Administration building, security office, parking shed;

- Pipe rack, cable rack and pipe sleepers;
- Green belt development; and
- General civil works including residential buildings.

5.5.3 Equipment and Machinery

The major equipment and machinery include:

- Heavy Duty GT, generators and auxiliaries;
- Heat recovery steam generators with ancillaries;
- ST, generator and ancillaries;
- Main step up transformers;
- Main auxiliary transformers;
- Station services transformers;
- MV/ LV unit & station auxiliaries power supply system;
- Protection and control panels;
- Distributed Control System (DCS);
- Emergency diesel generator;
- Cooling water systems;
- Cooling water pump House;
- Water treatment plant;
- Clarifier plant;
- Firefighting pump house;
- Demineralised water storage tank;
- Clarified water storage tanks;
- Fire-fighting water tanks;
- Workshop;
- Spare parts store;
- Fuel oil storage tanks; and
- Gas booster compressor(s).

5.5.4 Other Physical Facilities

Other physical facilities are:

- Supervisory Control and Data Acquisition (SCADA) System;
- Telecommunication system including fibre optic cable and satellite links;
- Security system for all installations;
- Fire and gas detection and alarm system;
- Central Control Room (CCR);
- Control equipment room (s);
- Relay room;
- Battery room;
- Interconnection arrangements;
- Labs;
- Warehouse;
- Residential / Non-residential buildings; and
- Transportation.

5.5.5 GT and Auxiliaries

The GT generator units shall be of the indoor type for installation in a machine hall suitable for operating suitable for operation under severe tropical conditions with extremely high air temperatures, humid and highly corrosive atmosphere. The GT generator units shall be operating on the simple open cycle as well as in connection with a HRSG in combined cycle mode, suitable for operation under specified conditions.

The unit shall be designed for operation to manufacturer's practice burning natural gas as specified to be the main fuel and diesel oil as stand by fuel. Automatic and manual change over from gas fuel operation to diesel oil operation shall be incorporated in case of low gas supply pressure.

All accessories, cables, piping, protection and safety equipment, auxiliary and ancillary equipment normally belonging to a unit required for safe and continuous operation, even if not especially mentioned in the Specification, shall be included, and shall be subject to approval by the Engineer. Walkways respectively elevated platforms shall be provided for all access areas, which are elevated from the floor of the turbine hall respectively from the ground level.

Heavy duty GT preferably in a 2xGT+ 2xHRSG + 1xST CCPP Configuration with a minimum CCPP thermal efficiency of 60 % are envisaged. The conceptual Diagram of GT and Auxiliaries is shown in Figure 5.3.

The gas turbines will be equipped with Static Frequency Converters (SFC) utilizing their own generators during GT starting.

A fire detection and carbon dioxide/clean gas protection system as per GT manufacturer's standard practice (which will be generally compliant to recommendations of National Fire Protection Association (NFPA)), will be provided to protect the gas turbine and its auxiliaries against fire hazard.

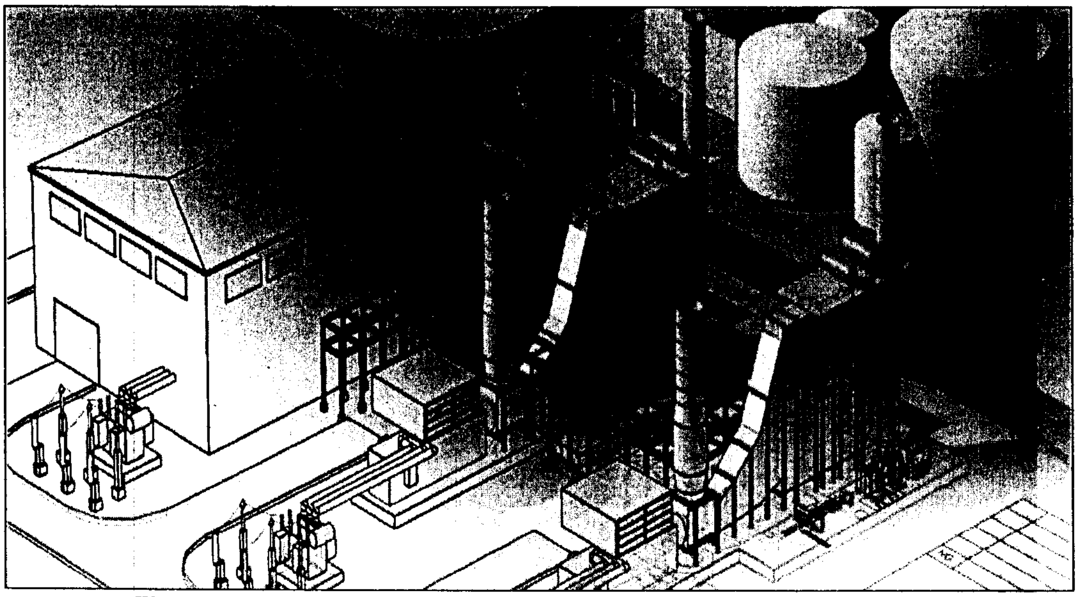


Figure 5.3: Conceptual Diagram of Gas Turbines and Auxiliaries

The following design features shall be considered for the gas turbine package:

- Gas turbine set for indoor arrangement;
- Package type with acoustic, ventilated enclosure assembled;

- Dry low NO_X combustion system for RLNG;
- Dual fuel capability including water injection system for NOx control;
- On-load fuel changeover capability;
- Annular combustor design / a number of combustors arranged circumferential;
- Variable inlet guide vanes to maximise the efficiency over a broad operation range while obtaining optimal firing temperature;
- Complete oil system;
  - Lube oil system with 2x100% a.c. motor driven, d.c. motor driven oil pump, coolers (2x100%), tank, lube oil filters (duplex), oil vapour extraction fans, and purification plant including all the accessories required;
  - Jacking oil system with (2 x100%) a.c. pumps, filters;
- State-of-the-art control system, including the hydraulic system with hydraulic oil pumps (2x100%), filters (duplex), coolers (2x100%), accumulators, etc.;
- State-of-the-art control system;
- On-line and off-line compressor washing system for each GT. For wash water feeding one water wash tank for both GTs may be sufficient;
- CO_2 firefighting system with nozzles inside GT enclosure, and CO_2 storage outside of enclosure;
- Air-cooled or hydrogen cooled electrical generator;
- Fuel gas control station;
- Distillate fuel package;
- Demin water package for NO_X-control;
- Inlet filter system with ducts and stairs, at least 2 meter wide galvanised steel maintenance platform;
- Inlet filtration for local ambient conditions including pollution in surrounding of site;
- Two stage filters, consisting of pre-filter and fine-filter;
- Low air inlet pressure loss;
- Rain hoods at first filter stage to prevent water intrusion during severe rain;
- Electrical hoist for filter change;
- Positive and negative pressure relief protection for inlet air filtration system;
- Exhaust ducting system including all necessary equipment for simple cycle operation of the gas turbine;
- for simple cycle operation Diverter Damper details should be provided;
- Hot Gas Bypass and Stack;
- Instrument air system (tanks, air compressors, accessories, etc);
- Cooling systems (with separate fin fan coolers);
- Air dryer (dehumidifier) to keep the unit in dry condition during long outage of the unit;
- Turning gear;
- All instruments, test connections, associated piping, valves, thermo-wells, thermocouples and, appurtenances, etc. required to operate the gas turbines and auxiliaries and to conduct the performance test;
- Fire protection and detection system;
- Spare parts;
- Special tools: all tools required for inspection and service, special tools including borescope parts for inspection of stationary vanes and rotating blades, appliances and measuring equipment shall be included; and

- Any other equipment/devices/works related to gas turbines required for safe and reliable operation and maintenance and not listed above.

The GT unit generator packages shall be provided complete in every respect including all components required for safe and reliable operation, whether mentioned or not mentioned in this Employer's Requirements.

It shall be possible to inspect all gas turbine stator and rotor blades by means of borescope equipment. Relevant borescope inspection access holes and the borescope equipment including camera for coloured pictures and digital a tape recorder shall be provided.

The blading shall be designed to withstand all vibration, thermal shock, gas and mechanical loads that may be experienced during all operational conditions. The blading materials shall be suitable for long term operation on the fuels specified in the operating environment.

Any material which is applied to the blading to improve anti-corrosion and erosion and heat resistant properties shall be fully described in the Tender. The expected life of these coating and the extent of deterioration of these coatings permitted before re-coating shall be defined.

The compressor and turbine rotor shall be statically and dynamically balanced in the factory. In addition, before assembly, the complete rotors must be tested at least with over speed of 15 % for duration of at minimum 2 minutes or with higher speeds according to Contractor's practice. The vibration of the gas turbine rotor, measured by proximity systems, shall not exceed the "A" Zone of the relevant ISO Standard respectively the "good"-range of the VDI recommendation.

Ports shall be provided for the installation of balancing weights during field balancing.

The operating range of the compressor shall allow 0 - 100% base load operation without any surge or unsuitable flow at specified maximum ambient temperature and minimum frequency operation.

The inlet shall have an access opening, which allows to enter the inlet and to inspect the first blades of the compressor.

Special lifting tackles, slings, rotor lifting and turn attachments/devices are included in the supply, as far as required for turbine/compressor assembly/disassembly and repair.

Turning Gear System shall be furnished to provide sufficient cooling of the gas turbine rotor after regular shut down or emergency trip and shall include a.c. and or d.c. motor (as per manufacturer's practice) and automatic control. Additionally, emergency manual turning equipment, which can also be used for maintenance works (e.g. replacement of blading) shall be provided.

The design of the combustion system shall permit mixed fuel operation for fuel change over purposes in all proportions at all loads for a limited period of time. The combustion system shall be free of any pulsation/humming.

5.5.6 Heat Recovery Steam Generators

The HRSGs shall comprise once-trough or natural circulating HRSG with economizer and superheater complete in all respects with all necessary ancillary equipment, integral pipework, feed water system, and steam mains to / from turbine. The HRSG units shall be of three pressure reheat design without duct firing. A By-Pass system for each pressure level shall be provided.

The HRSGs shall be in an enclosure with cladding, and a heating to keep the temperature above 5°C.

In case of 2-2-1 configuration, the steam shall be generated in two (2) HRSGs and delivered to one (1) condensing steam turbine. Each HRSG shall be assigned to one (1) gas turbine and arranged downstream of the corresponding GT.

All steam and water systems shall be designed so that their design pressures and temperatures shall not be exceeded. Pressure and temperature shall be controlled by suitable equipment.

The HRSG high pressure (HP) evaporator circulation systems shall be natural circulation with drum or forced circulation according to Contractors standard design.

The boiler evaporator circulation systems shall be natural circulation with drum or forced circulation. Contractor shall offer his standard HRSG type for maximum efficiency. However, as far as this Employer's Requirements state specific design requirements, these requirements shall be adhered to.

Unless otherwise specified, the data indicated below refer to one HRSG but apply to both HRSGs.

The HRSGs shall be provided complete in every respect including all components required for safe and reliable operation, for a high service life time whether mentioned or not mentioned in these Employer's Requirements.

5.5.6.1 Basic Design and Operating Data of the HRSG

The plant shall be designed such that it requires the minimum operator intervention for routine tests and maintenance.

The HRSG shall be of proven design, at least three (3) references shall be provided.

In any case, the steam conditions shall meet the requirements of the Steam Turbine.

In order not to exceed the maximum permissible steam temperature at any load and or transient conditions, steam attemperators shall be foreseen. The attemperator design shall provide full evaporation of spray water into steam especially when water to steam ratio is high.

Dosing systems shall be provided for HRSG feed water conditioning.

For full preservation of the HRSG a complete nitrogen gas injection system has to be provided with one injection point per pressure level at the highest point to ensure good preservation of HRSG and associated pipework.

5.5.6.2 Start-Up, Operating and Shut-Down Procedure Requirements

Continuous operation at base and part load shall be possible at all possible ambient conditions, and all gas turbine loads.

Gas turbine and HRSG shall be separated by diverter damper. The gas turbine exhaust gas at start-up is directly led to the by-pass stack.

The HRSG shall be shut down in accordance with the normal gas turbine shut-down.

5.5.6.3 HRSG Pressure Parts

The HRSG shall be in compliance with ASME Boiler and Pressure Vessel Code regulations. The expression "in compliance with ASME" means engineering and construction in the work shop and at site comprising: materials, design, fabrication, examination, inspection, testing, certification, and pressure relief (overpressure protection). For the final HRSG an ASME certificate with an ASME stamp is requested.

A minimum corrosion allowance of 2.0 mm shall be provided for the drums and headers, including nipples and nozzles. A minimum corrosion allowance of 5% of tube thickness or 0.8 mm whichever is higher shall be provided for the tubes above the code requirements.

5.5.6.4 Steam Drum in Case of Using a Natural Circulation System

The HRSG shall be provided as once through boiler and/or with adequately dimensioned steam drums to ensure stable operation under all load conditions.

The HP / IP (as applicable) steam drums shall be sized sufficient to provide a minimum of three (3) minutes storage capacity between its normal operating water level and the low-low unit trip point when operating at MCR conditions and to optimize water retention during start-up and load transients. The LP drum shall be designed & sized for at least five (5) minutes storage between normal water level and trip level at the design point.

Thermocouples, to measure the differential metal temperature of the boiler drums shall be provided.

5.5.6.5 Steam Headers

Headers shall be fabricated from seamless steel pipes and shall be provided with removable butt-welded end caps to facilitate internal cleaning and inspection.
Suitable means of access shall be provided between all tube banks for inspection and cleaning purposes.

5.5.6.6 Economiser

In order to avoid low temperature corrosion in any part of the economizer or the stack, the feed water temperature shall not drop below a certain limit depending on the sulphur content of the fuel.

5.5.6.7 Evaporator

The evaporator systems shall be designed to operate over the full load range without drumming or vibration and the design shall ensure an even distribution of water through the tubes.

In case of using a natural circulation system, the down comers shall be designed to achieve a uniform circulation ratio to the individual evaporator tubes over the full load range.

5.5.6.8 Superheaters

Each superheater shall be of the self-draining type.

Means of steam temperature control shall be employed for the high steam pressure systems to enable a constant steam outlet temperature to be obtained over the range of 70% 110% base load steam flow.

A superheated steam sampling point shall be provided, complete with CCW cooling and all necessary pipework.
All superheater drain valves shall be motor operated if the valves are required to be operated during start-up, shut-down or normal operation of plant.

A reasonable number of thermocouples shall be provided for measuring and recording the tube metal temperatures during the commissioning period i.e. on temporary basis as well as for normal operation i.e. as permanent installations.

5.5.6.9 Desuperheaters

The desuperheaters shall be of the variable spray nozzle type, to ensure proper atomisation over the whole range of operation. Steam downstream of the superheaters shall be conditioned to meet the steam turbine manufacturer's requirements at all times. The desuperheaters shall be sized for the full continuous operating range and 110% of the maximum steam mass flow rate over all continuous operating pressures of the HRSG. The last attemperator shall be installed upstream of the last superheater section i.e. water injection into the live steam line upstream of the steam turbine is not permitted.

Feed water shall be used for spray water, which shall be branched off, upstream of the control valves. Injection water flow measurements shall be provided on the main line as well as on all branch lines.

The desuperheating pipework and all valves shall be designed to withstand the maximum pressure of the feed pump and the final feed water temperature.

5.5.6.10 Safety Valves and Silencers

The number and capacity of the safety valves, if and where applicable, shall be in accordance with the applied standard of the HRSG.

The safety valves shall be of the direct spring loaded type with springs exposed to the open air, i.e. with open bonnets. They shall be provided with a lifting gear.

Hydraulic oil assisted safety valves with triple steam pressure sensors are also acceptable in special cases which shall be approved by the Engineer.

5.5.6.11 Feed water Control Valve Stations

Feed water control stations shall achieve the required feed water flow to the HRSG. The feed water control stations shall be installed downstream of the economisers in order to avoid evaporation in the same.

5.5.6.12 Spray Water Control Valve Stations

Spray water control station(s) shall achieve feed water flow to the attemperator(s) to control the temperature of the main steam.

5.5.6.13 Steam and Feed water Valves

The materials used for valve casings shall be of the same composition as for the related pipes.
Feed water stop valves and steam stop valves shall close perfectly tight in both directions so that it shall be possible to perform the hydraulic tests for the HRSG and the feed water and steam pipes independently.

All high pressure steam valves shall be fitted with by-pass valves for pressure equalisation.

5.5.6.14 Steam Stop Valves and Non-Return Valves

Stop valves for shutting off the HRSG and non-return valves shall be installed in the steam lines leaving the boiler. The number of shut off valves shall be in accordance with the pressure levels. Double shut off valves with a drain valve in between shall be provided for pressure levels equal to or above 65 bar or temperatures above 400°C in order to allow maintenance of one boiler while the other one remains in service.

By-passes of the valves shall be provided for pressure equalisation.

5.5.6.15 Drain and Vent Valves

Drain and vent valves shall be combined in groups, connected to common collectors and discharged to the blowdown vessel respectively the vent line of the blowdown vessel. Vents shall discharge in separate silencers (not common with safety valves).

5.5.6.16 Blowdown Equipment

Each HRSG shall be fitted with a blow-down system.

The sizing of the blow-down valve shall be adequate to prevent blockages, deposits or corrosion.

If necessary appropriate valves shall be provided to prevent any water carry over into the superheater.

5.5.6.17 HRSG Steel Structure

The supporting structure shall be designed considering the internal forces and expansions, as well as forces from wind, earthquake, etc.

The HRSG shall be arranged with its total pressure parts comprising of steam drums, superheaters, evaporators, economisers, headers, integral pipework, etc. in the form of a self-contained unit supported by its own steel structure.

The following shall be included but not be limited to:

- HRSG main columns and girders
- Supporting structure for platforms, stairs and galleries
- Pipe racks for pipes located in HRSG area
- Supporting structure for the HRSG stack
- Supporting structure for goods hoist
- Girders to fix lifting appliances above all components having a weight of more than 50 kg shall be provided for dismantling and assembling the equipment during maintenance and overhaul.
- Access platforms and galleries for inspection, maintenance and operation of all equipment (drum manholes, water columns, gauge glasses and their shut off valves, safety valves, all other valves associated with the operation of the unit, access doors, inspection ports, for the entire unit including economisers, evaporators, superheaters, attemperators, ducts etc.). All valves and instruments shall be accessible from fixed installed platforms, wherever possible. Mobile facilities will not be accepted.
- One set of full height stairs from grade to top of unit, shall be furnished and installed for the HRSG.

- HRSG structure lift (electrical, passenger & freight) shall be furnished and installed for each HRSG
- Ladders will not be accepted as means of main access to places where maintenance, checking and inspection have to be performed. Ladders shall be used only in special cases.
- All platforms, walkways, galleries shall be covered with galvanised steel gratings with a minimum height of 30 mm. Covering of platforms with chequered steel plates shall be done only if required to avoid or reduce natural draft.
- All main areas shall have sufficient emergency exits, i.e. at least 2 (two) exits. At least one of the two must be via stairs, the other one can be a ladder, if it is not frequently used for operation or maintenance purpose.

5.5.6.18 HRSG Roof and Wall Cladding

For the protection of the equipment and maintenance personnel against adverse weather conditions, a roof deck with side wall panels shall be provided of each HRSG. This arrangement shall cover all top mounted drums, valves and instrumentation.

Provisions shall be taken for adequate ventilation and heating, so that excessive temperature built up and freezing of any equipment shall not be experienced.

5.5.6.19 HRSG Stack

Each HRSG shall have a stack with a height of at least 60 m (to be confirmed after clearance and approval with the EIA). Additionally a bypass stack with a height of at least 45 m (to be confirmed after clearance and approval with the EIA) for temporary usage during the initial simple cycle operation and during the recurrent performance tests as part of the Long Term Service Agreement (LTSA) contract shall be provided. Exchangeable flanged connection pieces (GT-bypass stack and GT-HRSG) shall be provided.

The HRSG stack shall be of carbon steel construction and to comply with the environmental requirements. It shall be inside and outside corrosion protected.

The design and manufacturing shall be in compliance with international standards or equivalent standard. When designing the HRSG stack, the maximum wind speed, earthquake factor, etc., as stated elsewhere in this document shall be taken into consideration.

The HRSG-stack shall be provided with an access door located conveniently in the base section. It shall also be provided with a platform at the top level around the full circumference, complete with safety rail.

The HRSG stack shall be equipped with stack damper incl. drainage for rain protection and prevention of excessive heat loss. For this purpose the stack shall be insulated until the stack damper.

HRSG stack (bypass and main) stack should be provided with continuous monitoring of flue gas emission (e.g NOx, SOx, CO, O_2, Particulate Matter and SO_2. All the emission real time data should be available in DCS.

Expansion joints shall be of bellows or other approved type and shall be provided with internal plates to prevent eddies.

5.5.6.20 Preservation System

The Contractor shall provide a preservation system with all components and controls to provide a state-of-the-art wet and dry preservation for the water steam part as well as preservation for the flue gas side for the HRSG during a non-service period.

5.5.6.21 Cleaning of water Steam System

The contractor shall provide acid cleaning and steam blowing of the HRSG during commissioning. All temporary equipment necessary for completion of this work shall be provided in the scope of the Contract. All orifice plate assemblies and thermocouple pockets shall be installed after completion of steam blowing.

All piping connections and components used in chemical cleaning shall be handed over to the Employer once chemical cleaning is successfully completed. The Contractor shall be responsible for the safe disposal of HRSG cleaning waste water and chemicals. If steam is required for chemical cleaning this shall be provided by the Contractor.

5.5.7 Steam Turbine and Auxiliaries

The following general requirements shall be considered:

- STG unit, adapted to the 3 pressure level HRSGs, with reheat, condensing type,
- STG of proven design
- Modified sliding pressure operation (fixed pressure at low ST loads and sliding pressure at higher ST loads)

The scope of works shall comprise the respective components of steam turbine including all the equipment necessary for a safe and reliable operation of the unit, and shall mainly consist of, but shall not be limited, to the following items:

- High pressure, intermediate re-heating, and low pressure steam turbine, condensing type;
- HP Emergency stop and control valves, reheat stop and control valves, LP stop and control valves and steam strainers, also including piping and the necessary chemical cleaning and blow-out provisions;
- LP section release diaphragms;
- Bearings;
- Couplings;
- Anchor, sole plates, base plate, pedestals, foundation and all associated components;
- Complete lubrication oil system with shaft driven, a.c. motor driven, d.c. motor driven oil pumps, coolers (2x100%), tank, lube oil filters (duplex), oil vapour extraction fans, supports and purification plant;
- Complete jacking oil system including 2x100% jacking oil pumps (one a.c. motor driven, one d.c. motor driven), filters;
- Electro-hydraulic governing and protection system with high pressure electro-hydraulic actuators and associated equipment; hydraulic oil pumps (2x100%), filters (duplex), coolers (2x100%), accumulators, tank including heater, etc.;
- Clean and dirty oil tanks for lube oil and control oil, including oil pumps;
- Turbine turning gear and associated equipment; including provision for manual turning;
- Gland seal system including gland steam condenser with 2x100% exhauster fans and associated equipment;

- Turbine integral draining system and all associated equipment (flash tank, pumps, etc.);
- Turbine exhaust hood spray system;
- Thermal insulation as required for steam turbine and auxiliaries' equipment, piping and valves;
- All interconnecting pipes related to above mentioned systems;
- All valves related to above mentioned systems and not mentioned specifically;
- Instrumentation and control items as specified in corresponding section containing essentially:
  - Turbine control and governor system
  - Turbine supervisory system
  - Fail safe turbine protection system
  - Automatic turbine start-up/shutdown system including the full automatic warming up and draining control system
  - Turbine logic control system
  - Thermal stress evaluator (TSE)
- All instruments, test connections, associated piping, valves, thermo-wells, thermocouples and, appurtenances, etc. required to operate the steam turbines and auxiliaries and to conduct the performance test,
- Seal oil system required for generator oil/H2 sealing and all the accessories required;
- Complete heat and sound insulation;
- Painting and corrosion protection;
- Fire protection and fire detection equipment;
- Electrical earthing of the equipment;
- Necessary supporting steelworks, access walkways, ladders, service platforms for the complete steam turbine generators area, covering also all auxiliary equipment;
- Any other equipment/devices/works related to steam turbines required for safe and reliable operation and maintenance and not listed above;
- Standstill positive ventilation (Hot air drying system);
- Special tools as required for maintenance, inspection and repair; and
- Spare parts.

5.5.7.1 Design / Construction Features

The ST and the respective associated equipment shall be able to be operated without any restrictions and any time limitations at each load between no-load and maximum load.

The ST shall also be capable of operating with one condenser half shut down.

The maximum overspeed shall be limited by three independent electronic overspeed trip devices. The capability to withstand the overspeed shall be proven in a workshop test performed at 120% of the nominal speed at least for 3 minutes on the fully bladed ST rotor.

Balancing shall be carried out in accordance with ISO 11342.

The rotors shall be statically and dynamically balanced in the factory so that the maximum effective vibration magnitudes do not exceed the recommended values under steady running conditions at all loads according to ISO 7919, Zone A for newly commissioned machines.
The maximum vibration velocities at the bearings shall not exceed the requirements of ISO 10816 for Zone A.

The rotor design shall provide for in-situ site balancing of rotors to be carried out, if necessary. Pro-visions shall be included for rotor dynamic balancing without removing the casing after installation on site.

The sound pressure level inside the ST building shall not exceed 85 dB(A), measured as spatially averaged sound pressure level, when all equipment is running at MCR. This level will be measured in one (1) meter distance from the equipment and at 1.5 meter height above ground floor level.

The following design features shall be also considered:

- Package type assembled and tested (no-load test) in the workshop,
- Lateral or axial LP exhaust steam direction.

The casing of the HP ST should be of double-shell construction design with inner and outer casing.

The turbine design shall be such that at no point in the steam path the steam conditions reach a state, which can cause water particle erosion to the turbine components. Hence, the LP steam turbine blades shall be designed for droplets removal.

The blading material shall have good creep and fatigue strength properties, as necessary, with small elongation at fracture and resistance to cracking, scaling and erosion at the operating conditions. The composition, heat treatment and surface treatment of the blade material shall give maximum resonant strength. In addition, the material shall be resistant to pitting, corrosion and erosion. The material shall be inspected for chemical and physical properties.

All roots and fixing of the ST blading shall be of highest quality and proven in tests as well as in such a manner that the blades may be easily removed in case of repair, without disturbing other blade rows.

The blading shall preferably be assembled without the use of lacing wires or brazing.

The design and construction of turbine blading shall be suitable for continuous operation at maximum output capacity with turbine speed ranging from 6% below to 4% above rated speed to prevent the possibility of damage from vibration due to natural frequency of blading, etc..

The blades including root and integral shroud shall be either forged or machined from a single piece.

Stationary blading and associated nozzle chambers, diaphragms and carrier rings shall be designed for minimum deflection under maximum steam load conditions adequate to the clearances in the ST. The blading shall be designed to minimise blade end leakage.

The outer sealing glands between the outer casing and the rotor shall be horizontally divided and preferably of spring–backed metallic labyrinth type of well proven design. The inner sealing glands between the rotor and the inner casing, interstage diaphragm packing in impulse type STs and the glands at balance pistons shall be horizontally split and of the labyrinth type. Sealing strips in the rotor shall be caulked into the shaft in order to allow easy replacement in the event of damage. If fins are employed, the material shall be soft and the fins shall be very thin at their ends where accidental rubbing may occur.

The emergency stop valves shall be provided with hydraulic actuators to hold the valves open against spring load. The steam flow shall assist the valve closing action. In response to one of the protective devices, e.g. overspeed, or by manual operation of trip circuit the valves shall be closed instantaneously and close tightly in their closed positions.

They shall be provided with an internal pilot valve, as necessary, enabling them to be opened against full steam pressure.

All control valves shall be designed to eliminate hunting and provide smooth operation over the entire speed and load range of the turbine.

The actuators of the control valves shall be of the double acting type or single action type with strong closing spring to ensure close control and to avoid sticking of the valve spindles.

Actuators mounted directly on the valve casings, thus avoiding any connection levers, shall be provided.

The ST Governor shall be provided with high-pressure hydraulic fast response control valves actuators. The governor equipment shall be complete in all respects. The governor shall be capable to carry out the following control tasks:

- Speed regulation
- Electrical power regulation
- Live steam pressure limitation
- Condenser pressure limitation.

All features of the governing system shall be demonstrated during commissioning.

5.5.8 Fuel Oil Supply System

The fuel oil system shall be designed by EPC Contractor in accordance with the relevant international standards. Applicable Codes and Standards including National Fire Protection Association, American Petroleum Institute, British Standards, other internationally recognised Codes and Standards as approved by the Purchaser/Consultant, requirements of the gas turbine manufacturer and local rules and regulations shall be adhered to.

The EPC Contractor shall collect fuel samples if are necessary in order to produce proper fuel oil composition analysis and shall check fuel oil heating value ranges, oil contaminants, etc.

The fuel oil supply system shall be optimized and should have sufficient redundancy to ensure the maximum availability of fuel at the plant including during a changeover between fuel types.

5.5.8.1 Scope of Fuel Supply

The fuel oil system shall be provided complete in every respect for reliable, efficient and safe operation whether mentioned or not mentioned in this specification for a high service life time.

The scope of supply shall include but not be limited to the following main equipment / installations:

- One (1) HSD Oil truck unloading station, designed for simultaneous unloading of at least six (06) trucks including all auxiliaries (truck weighing facility, underground receiving tank(if required), unloading pumps, filters, metering stations etc.) and supply lines (including motorised valves) to the HSD storage tanks;
- Road tanker unloading facilities shall include all required equipment and installations in order to refill tanks within 6-7 days;
- Common fuel oil flow meter;
- At least Six (06) road tankers unloading arms with sufficient space in between, for easy manoeuvring of the road tankers;

- Separate parking space inside the area for at least four (04) oil road tankers, waiting for unloading;
- Provision of facility to remove left over oil from the road tankers;
- Weigh bridge with a separate sampling platform;
- Fuel oil storage tank(s) with a total capacity for 7 days full load operation of the plant, including the tank equipment such as valves, instrumentation and control equipment, floating suction, level indication, etc.;
- One (1) day tank with a capacity of 24 hours for full load operation of the emergency diesel generator, complete with tank equipment e.g. valves, instrumentation and control equipment;
- Fuel oil forwarding pump station including two (2) x 100% fuel oil forwarding pumps and two (2) pump suction strainers for each gas turbine and related equipment;
- Oily drains collecting facility for the oil storage tanks, forwarding pumps has to be provided;
- Metering and sampling equipment for the fuel oil supply;
- Piping, valves and instruments;
- local instrumentation;
- set of special tools and equipment for maintenance, inspection and repair;
- Fire Fighting and indication system;
- Cathodic protection for the pipes below underground; and
- Any other equipment/devices/works necessary for safe and reliable operation and maintenance of the system are provided.

5.5.8.2 Fuel Oil Pumps

Alternate Current motor driven distillate fuel oil pumps (2X100%) with suction duplex strainers and accumulator (if required) shall be provided. The equipment shall be weather protected, provided within a building or a shed. Local and remote operation/control indication shall be provided.

In the event of a trip of the pump should not cause a successive trip of the gas turbine. The standby pump shall start automatically on failure of the duty pump. The fuel oil pressure pipe work shall be provided with an accumulator to ensure buffer capacity during the automatic switch over to the standby pump. The buffer capacity shall be selected to compensate the missing pump capacity during the switch over time.

The pumps shall be of centrifugal type. The pump casing shall be made of cast/forged steel. The fuel pumps shall provide a constant pressure. Pressure relief valves shall be provided on the discharge lines from the pumps to provide a return flow at part load condition, or to work as minimum flow protection.

5.5.8.3 Strainers and Filters

Generally, all strainers/filters shall be provided with a differential pressure gauge for local and a remote alarm in case of high differential pressure. Each duplex filter shall be provided with an inlet and outlet pressure gauge.

In the suction line of the pumps a duplex strainer with max. 200 micron shall be provided.

Duplex type discharge filters with maximum 80 microns or less as per manufacturer standard and the GT requirements shall be arranged in the pump pressure piping. The strainers/ filters shall be equipped with a changeover device which allows change over while on operation. The pipeline strainers shall be designed such that they do not require cleaning more than once per loading. All strainers shall have pressure ratings appropriate for the service intended, but in no case, not less than 1.5 times the maximum service pressure.

5.5.9 Generator and Excitation System

The Generator will be capable of continuous safe operation at rated output and power factor under any of the following conditions for system compatibility:

- Terminal voltage variation of +/- 5% of the rated value;
- Frequency variation within 47.5 to 51.5 Hz; and
- Absolute sum of combined voltage & frequency variation of not beyond 5%.

Additionally, the generators must comply with the National Electric Power Regulatory Authority (NEPRA) Grid Code.

The Generator winding will be star connected with the phase & neutral terminals brought out for connection to isolated phase bus duct. The star neutral point will be grounded through a neutral grounding transformer with a resister in the secondary circuit. The Generator will generally comply with the requirements specified in International Electro-technical Commission (IEC) 60034.

5.5.10 220 kV Substation

A 220 kV substation will be built within boundary wall of the project. For the power evacuation from the CCPP, an associated 220 KV Switchyard with its bays arranged in breaker and a half scheme is foreseen. A state of the art Substation Automation System (SAS) is envisaged for control, protection and monitoring purpose.

5.5.11 Distributed Control System

The CCPP will be equipped with a State-of-the-Art DCS.

Description of the plant design and operation procedures as per Feasibility Study, including flue gas cleaning and waste water treatment (WWT) facilities is given below:

5.6 TECHNICAL DATA

Technical parameters of the CCPP are shown in Table 5.2:

Table 5.2: Key Technical Data

Sr. No	Description	Data
1.	Combined Cycle Power Plant at Site	1,100 -1,400 MW (Gross) – RSC
2.	Type of gas turbines	Heavy duty
3.	Preferred Configuration: 1 x 2xGT-2xHRSG-1xST However final configuration will be chosen by the EPC contractor	-
4.	Basic fuel	natural gas (RLNG)
5.	Back-up fuel	HSD
6.	Minimum Net Efficiency (LHV) in Combined cycle operation	60% - RSC
7.	Single cycle mode operation required, with bypass stacks/damper behind GTs	-
8.	Indoor installation	-
9.	Once-through cooling system with water from adjacent canal plus wet/dry cooling tower for 1 month (January) outage period of canal per year	-

Sr. No	Description	Data
10.	The plant shall be complete in all respect with auxiliaries and Balance of Plant (BoP) and all other facilities required	-
11.	Potentially, evaporative cooling for GT air intakes	-
12.	Spare parts for 2 years operation	-
13.	LTSA from GT-OEM for 48,000 OH (6 years) and for 96,000 OH (optional)	-
14.	AIS 220 kV switchyard in 1 ½ breaker type	-

5.7 RLNG SOURCE, QUALITY, QUANTITY AND CONVEYANCE TO POJECT SITE

The location of the Project falls in the operating region of Sui Northern Gas Pipelines Limited (SNGPL) that supplies the natural gas supply to domestic and industrial consumers. SNGPL receives natural gas in bulk quantity from various gas fields and injects in to its pipeline network. Gas quantities to various consumers are allocated generally by Ministry of Petroleum and Natural Resources.

RLNG for the Project will be supplied and installed by the gas supplier (SNGPL) inside the plant boundary (the commitment letter is attached as Annex-3). The planned supply for the Project is up to 200 Million Cubic Feet/Day (MMCFD) (236,000 Sm^3/h). The maximum content of total Sulphur and Hydrogen Sulphide will be 3.5 grains / 100 SCF and 0.24 grains / 100 SCF respectively. There will be no storage facility of RLNG at the power plant site.

Reference Gas Composition provided by SNGPL is given in Table 5.3.

Table 5.3: Reference Gas Composition

No.	Component	Composition (Mole - %)
1.	Methane (C1)	90 +/- 08
2.	Ethane (C2)	Not more than 15
3.	Propane (C3)	Not more than 05
4.	Butane and Heavier (C4+)	Not more than 03
5.	Nitrogen (N_2)	Not more than 10
6.	Carbon Dioxide (CO_2)	Not more than 03
7.	Total Sulfur, max	3.5 grains/100 SCF (max)
8.	Hydrogen Sulfide, max	0.24 grain/100 SCF (max)
9.	Solid particle size, max	10 micron (max)
10.	Hydrocarbon Dew Point, max	0^oC (max)
11.	Water content, max	7 lbs/MMSCF (max)
12.	Gross Calorific Value	950 to 1170 Btu/SCF
± 5%" with composition for component no. 1 to 6		
Gas pressure at interface: 550-600 psig		
Gas temperature at interface: 35 °F - 90 °F		
Note: However, in case the gas temperature falls below 35 °F due to any unforeseen variation in the gas supplier's system, the design of equipment to be supplied by the EPC Contractor shall ensure safe, reliable and continuous operation of the power plant.		

Flue gas cleaning is not required due to the low sulphur content of the fuel. A maximum content of total sulphur of 20 grains/100 SCF will lead to 28.45 mg/Nm³ SO_2 emissions at 15 % O_2.

5.8 BACK-UP FUEL

As a back-up fuel, HSD could be used whenever the primary fuel (RLNG) is not available. Composition for HSD is shown in the Table 5.4 below:

Table 5.4: Composition of Back-up Fuel (HSD)

Component	Composition (%)
Carbon	85.99
Hydrogen	12.7
Oxygen	0.1
Nitrogen	0.1
Sulphur	1.0
Ash	0.01
Moisture	0.1

5.9 TRANSMISSION AND DISTRIBUTION SYSTEM

Power will be evacuated by National Transmission & Despatch Company (NTDC). 220 KV step-up transformers will be required and 220 KV AIS in 1 ½ breaker type will be included in EPC scope. 220 kV Substation will be built by the EPC Contractor within the boundary wall of the Project.

5.10 WATER REQUIREMENT AND COOLING SYSTEM

The water requirement for the Project will be about 22 m^3/sec (770 Cusecs) for cooling purposes. This required quantity of raw water will be taken from TS-Link Canal with a maximum discharge of 325.9 m^3/sec (11500 ft^3/s or Cusecs) running parallel to the Project Site. The water during the plant operation will be used for sanitary, plant uses and cooling purposes. The cooling system will be once through type which means that after pass through the turbine condenser, the water will be returned to the Canal. The allocation of water has been consented by the Irrigation Department. During a yearly period of canal closure (6-8 weeks) the cooling demands of the power plant will be met using cooling towers. The underground water is also available for use as make up water. The deep wells will also be installed at the Site. During this period, water will be taken from underground wells that have to be developed as part of the EPC Contract. The cooling water requirements are given in Table 5.5 below:

Table 5.5: Cooling Water Requirements

Sr. No.	Component	Once Through	Wet Cooling Tower
1.	Cooling Water Intake Flow Rate (kg/s)	21,820	--
2.	Cooling Water Outfall Flow Rate (kg/s)	21,820	--
3.	Cooling Water Temperature Rise (K)	8	8
4.	Cooling Water Intake Temperature (°C)	25	--
5.	Cooling Water Intake Salinity	--	--
6.	Cooling Water Intake pH	--	--
7.	Discharged Cooling Water Temperature (°C)	33	--
8.	Discharged Cooling Water Salinity	--	--
9.	Discharged Cooling Water pH	6 - 9 according to specification*	6 - 9 according to specification*

Sr. No.	Component	Once Through	Wet Cooling Tower
10.	Air Into Cooling Tower	--	25 °C / 70 % rH / 12,793 kg/s
11.	Air leaving Cooling Tower	--	33.6 °C / 100 % rH / 13,047 kg/s
12.	Makeup Water Flow Rate (incl. Blowdown) (kg/s)	--	381.49

* *In case of out of range values, discharge valve to be closed and neutralisation to be carried out.*

5.11 WASTEWATER GENERATION AND TREATMENT

The plant operation will generate Industrial as well as sanitary wastewater. It is estimated that about a maximum of 2 m^3/h (max 200 staff, 250 l/d/person) of sanitary, 4 m^3/h of industrial wastewater will be generated along with cooling tower blow down (expected concentration factor: 4 - 5) in canal closure period.

Sanitary and Industrial WWT plants will be designed to treat wastewaters to meet PEQS. Industrial wastewater will be treated by oily water treatment, clarifier, filter, sludge thickening. The treated wastewater will be monitored and disposed to outfall.

Sanitary WWT will be treated by screening, aeration, clarifier, chlorination, and sludge thickening. The treated wastewater will be monitored and disposed off in the outfall. The waste after treatment can also be used for fertilizing purposes.

5.12 WATER INTAKE AND DISCHARGE SYSTEM

Water shall be taken into the screened water bay via intake water pumps located inside the screened water bay. During the time of canal closure, water shall be taken from deep wells to provide a secondary main cooling system based on cell type wet cooling tower technology.

The outfall shall be located downstream of the intake in a sufficient distance to prevent any re-circulation. The structure shall be sufficient for the discharge of all waste waters, i.e. main cooling water, sanitary and industrial waste water treatment effluents, storm water drains, and any other drains that are suitable to be discharged without further treatment. During the time of canal closure, the drains shall be diverted into a seepage pit if necessary. The seepage pit shall be sufficiently sized for the maximum expected drain volume under normal conditions.

5.13 EMISSIONS FROM PLANT

For each emission source, worst case estimations scenarios have been considered for different mode of operation, e.g. combined cycle, single cycle, cooling via once through or cooling tower. The minimum height of the bypass stack and the main HRSG stack shall be maintained at about 45 m and 60 m above ground level, respectively. Emission concentrations for primary (RLNG) and secondary (HSD) fuels for both combine cycle and open cycle are given in Table 5.6 and Table 5.7 respectively.

Table 5.6: Emissions for Primary Fuel (RLNG)

Sr. No.	At T = 25 °C; rH = 70 %; p = 150 maSL	Combined Cycle	Open Cycle
1.	Exhaust Gas Mass Flow CCPP (kg/s)	2,116	2,116
2.	Exhaust Gas Temperature (°C)	93.4	600
3.	Exhaust Gas Density (kg/m³)	0.923	0.399
4.	Exhaust Gas Pressure (bar (a))	0.9954	1.043
6.	Gas Composition (mole-%)		
7.	N_2	73.55	73.55
8.	O_2	11.97	11.97

9.	CO_2	3.976	3.976
10.	H_2O	9.622	9.622
11.	Ar	0.8835	0.8835
12.	CO	As per environmental limits	
13.	NOx	As per environmental limits (less than 10 ppmvd at 15 % O2)	
14.	SO_2	28.45 mg/Nm³ at 15 % O2	
15.	PM	0	0

In case of using the back-up fuel, much higher SO_2 concentrations have to be expected. An example calculation using a 2+2+1 configuration was carried out. Since no exact fuel analysis of the expected fuel in Jhang was available, an example liquid fuel (HSD standard composition) was used.

Table 5.7: Emissions for Secondary Fuel (HSD)

Sr. No.	At T = 24 °C; rH = 70 %; p = 200 maSL	Combined Cycle	Open Cycle
1.	Exhaust Gas Mass Flow CCPP (kg/s)	2,184	2,184
2.	Exhaust Gas Temperature (°C)	150	595
3.	Exhaust Gas Density (kg/m³)	0.802	0.403
4.	Exhaust Gas Pressure (bar (a))	0.9954	1.046
6.	Gas Composition (mole-%)		
7.	N_2	71.203	71.203
8.	O_2	11.115	11.115
9.	CO_2	5.561	5.561
10.	H_2O	11.2408	11.2408
11.	Ar	0.857	0.857
12.	SO_2	0.0241	0.0241
13.	CO	As per environmental limits	
14.	NOx	As per environmental limits (less than 10 ppmvd at 15 % O2)	
15.	SO_2	546.6 mg/Nm³ at 15 % O2	
16.	PM	0	0

To reduce the NO_X emissions during HSD-operation, a water injection may be foreseen. Therefore, a water mass flow of approx. 60 kg/s in sum may be required.

5.14 AIR EMISSIONS CONTROL

The plant is not expected to generate high concentrations of air pollutants in case of Primary Fuel RLNG. The internal combustion temperature will be greater than 1,300 °C. Flue gas cleaning is not required due to the low Sulphur content of the fuel. A maximum content of total Sulphur of 20 grains/100 SCF will lead to 28.45 mg/Nm³ SO_2 emissions at 15% O_2. However, in case of back-up fuel HSD, relatively high SO_2 emissions such as 546.6 mg/Nm^3 @15% O_2 (dry) are expected for both Combined and Open-Cycle plants.

5.15 LOAD FLOW STUDIES

NTDC / Planning Department is in process of conducting the Load Flow studies for the optimum interconnection scheme; dispersing up to 1,400 MW (Gross) from Power Plant to existing 220 kV system.

5.16 MAINTENANCE FACILITIES

The Contractor shall develop an in house facility for scheduled maintenance, forced outages and emergency maintenance. Mechanical, electrical, Instrumentation and Control (I&C) workshops, chemical and industrial labs shall be developed too. The tools & plants required for chemical laboratory, electrical & electronic instruments for electrical laboratory and the workshop equipment and accessories as required will be identified and will be supplied to the plant by EPC Contractor. The major Tools and Plants (T&P) of the Workshop is Mechanical Equipment listed here under:

- Universal Grinding Machine
- Central Lathe Machine
- Universal Drilling Machine
- Milling Machine
- Metal Cutting Hacksaw
- Thread cutting Machine
- Electric Welding Sets

5.17 IMPLEMENTATION SCHEDULE

Considering implementation of the project through a single EPC contract, the EPC arrangements and O&M after Commercial Operation Date (COD) of the CCPP will take 26 months after Notice to Proceed.

- Date of starting of the project = Date of notice to proceed
- Date of completion of the project = 26 Months from the notice to proceed

The Project Implementation Schedule is given in Table 5.8:

Table 5.8: Implementation Schedule

Years	Physical Activities
1st Year (2017-2018)	Pre-Qualification of Contractors
	Tender Documents Preparation
	Invitation of Bids
	Submission of Bid & Bid Evaluation
	Contract Award and Notice to Proceed
	Handover Site
	Basic Engineering
	Finalize Basic Engineering
	Finalize Plant Layout
	Detailed Engineering
	Procurement
	Civil Works
	Mechanical BOP Supply + Contract
	Electrical Supply Contract
	I&C Supply Contract
	Delivery Completion of GT packages up to Site

Years	Physical Activities
	Erection of 1st & 2nd Gas Turbine Generators
2nd Year (2018-2019)	Delivery Completion of HRSG and Steam Turbine packages up to Site
	Successful Synchronization of gas Turbines 1 & 2
	Erection of HRSGs Units 1 & 2
	Erection of Steam Turbine Generator
	Completion of Hydro test 1st & 2nd HRSGs
	Successful Synchronization of Steam Turbine Generator
	Tests on Completion Units 1 & 2, ST and CCPP
	CCPP Ready For commercial operation

5.18 PROJECT COST

The total project capital cost has been estimated around US $898.169 Million i.e. PKR 94.3 Billion at reference exchange rate of 1 US $ = 105 PKR.

CHAPTER–6: BASELINE CONDITIONS

6.1 INTRODUCTION

This section provides the description of baseline conditions of the Project as well as the AOI. The existing environmental conditions of the proposed AOI will also be a benchmark to be used for a comparison of before and after construction phases of the Project. This baseline will also provide the datum for assessing the impacts and suggesting the mitigation measures, which will be implemented effectively at various phases of the Project activities.

6.1.1 Existing 1,230 MW RLNG CCPP HBS

Another RLNG based CCPP of 1,230 MW capacity is being operated at about 200 m away on northern side of proposed Jhang Project. National Power Park Management Company Limited (NPPMCL) under the umbrella of Ministry of Water and Power is Proponent of HBS. The EPC Contractor is Power Construction Cooperation of China (Power China) that is responsible for power plant design, equipment procurement and supervision, transportation, construction and commissioning of the Project. GoP has engaged NESPAK to provide supervisory consultancy during the construction phase of Project.

The total area of this plant is about 260,000 square meters along with an access road of 1.3 Km to connect the plant with Jhang-Shorkot Road. The main construction work of this power plant has been accomplished and plant has been inaugurated by Prime Minister of Pakistan on 7th July, 2017. This plant has started power generation which is being dispatched to the National Grid (Gatti Faisalabad Grid Station) through a 500 KV transmission line coming out of plant from its west boundary.

6.2 PROJECT AREA ACCESSIBILITY

The proposed Project Area falls within the territory of District Jhang and located on the downstream of Head Trimmu and 200 m away from existing HBS CCPP. The site is situated on the left bank of the TS-Link Canal in village "Kot Dewan" which is about 25 km from Jhang City. The Project Site is accessible through Bhakkar-Jhang Road which is at an offset of 0.9 km from the project site. Main railway line is approximately 6.6 km from the proposed site. The proposed project site is also accessible through an unpaved track connecting TS link Canal with Jhang-Shorkot road. The access road constructed for existing 1,000-1,200 MW RLNG CCPP HBS is also near the site. The specific location and access to the Project area is shown in Figure 6.1.

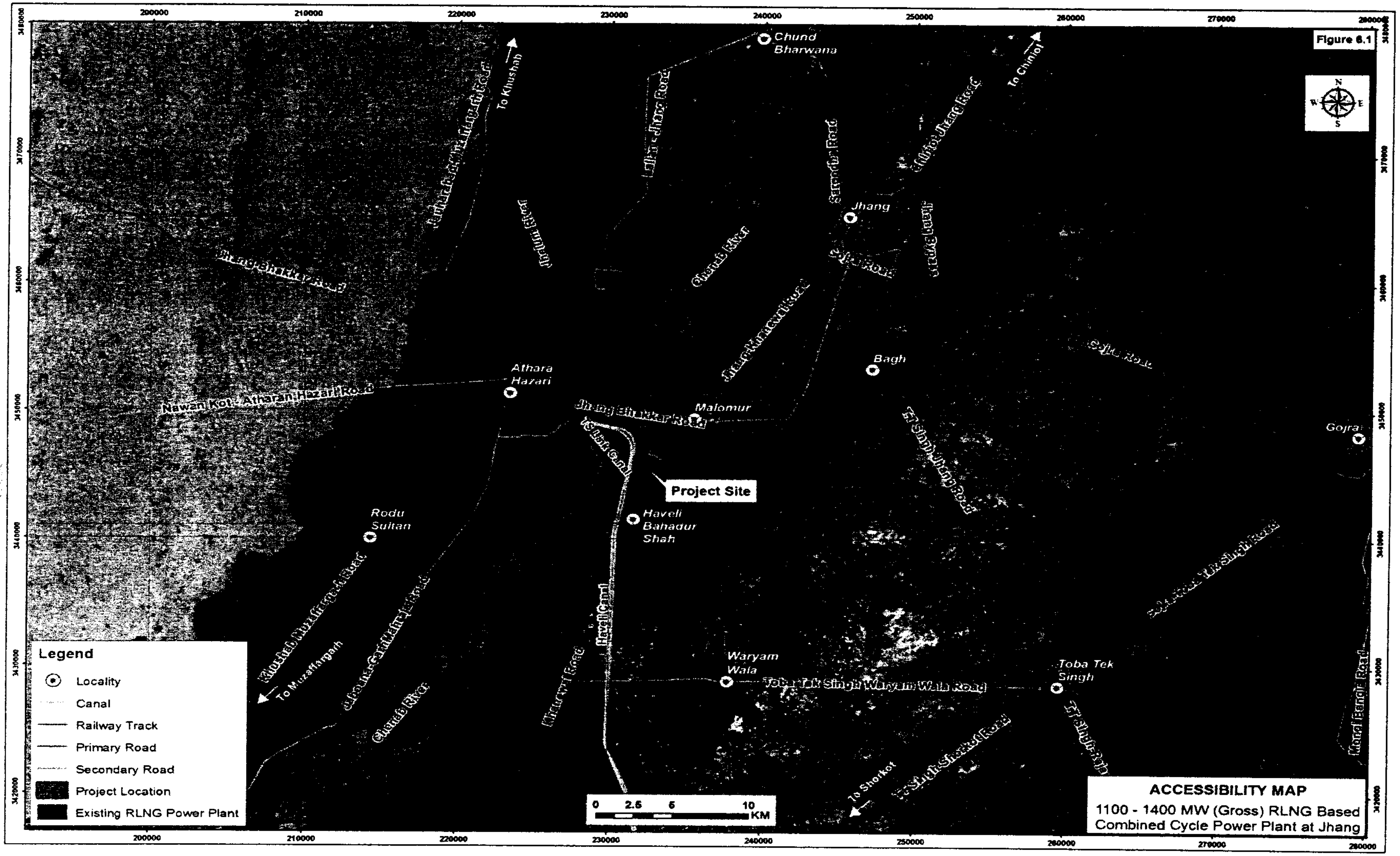


Figure 6.1: Project Access Map

6.3 BASELINE SURVEYS

EIA team carried out baseline surveys in Project AOI from July 07-11 & July 29 to August 02, 2017. The Project site located in Kot Dewan (Project and AOI) adjacent to TS-link canal and adjoining areas namely Dhueen Muhammad, Basti Kora Wala, Basti Shamme Wala, Moza Qadeemi, Kot Mehmood Wala, Malu Mor, Moza Mansoor Sial and existing RLNG CCPP HBS in order to collect the baseline data of physical, ecological and socio-economic conditions.

Primary data was collected from various sources. The people living around the proposed Power Plant area were interviewed to have their views about the plant installation and the perceived impacts on the natural environment around the Proposed Plant. This included information on land, surface water, groundwater, air, vegetation, animals and human. Photographs of the various environmental aspects both inside and outside the proposed plant area were also taken and are included as Photologs in this report. Stakeholder consultations were undertaken, details for which are provided in Chapter – 7 of this report.

Following is the description of baseline conditions of the AOI.

6.4 PHYSICAL ENVIRONMENT

6.4.1 Topography

Land allocated for the proposed RLNG CCPP is located in village Kot Dewan of Jhang adjacent to TS-Link Canal (about 100 m East). The topography of the proposed Project site is relatively flat as the area is located in plain terrain of Punjab near Jhang. The existing site is surrounded by cultivated/agriculture land (Private and government owned) and a few settlements. Average elevation of the site is 150 m (490 ft) approx. above mean sea level (amsl). Project Area requires minute leveling as the area is under agriculture practice.

6.4.2 Land-Use

The landuse of the Project Area is mainly agriculture i.e. 77%. Few patches of barren land (16%) are also present. There are 40 number of houses in the Project area having landuse cover of almost 5 acres. Katcha tracks and trees are other main components of landuse of Project area covering almost 6.5 acres. The featured quantification of land use of project site and access road is shown is in Table 6.1 and map shown in Figure 6.2.

Table 6.1: Land use of Proposed Project Area

Sr. No.	Description	Area (Acres)	Percentage of Total Area (%)
Proposed RLNG CCPP Project			
1	Agriculture	122.813	72.41
2	Barren	26.503	15.63
3	Built-up	5.067	2.99
4	Graveyard	0.099	0.06
5	Pond	0.251	0.15
6	Track	4.577	2.70
7	Tree Cover	1.261	0.74
Total		**160.57**	**94.68**
Proposed Access Road			
1	Agriculture	8.191	4.83
2	Barren	0.272	0.16
3	Track	0.261	0.15
4	Tree Cover	0.304	0.18
Total		**9.03**	**5.32**

Source: Google Earth Imagery, July 2017

6.4.3 Geology

The Project Area is a part of Punjab Plains. The area is dominantly composed of alluvial sediment spilled by the Chenab River. Alluvial deposits brought by the Chenab River and its surroundings are the products of the events that evolved during the Pleistocene and recent geological time. These alluvial deposits are more than 500 m thick. These deposits consist principally of fine to medium Sand, Silt and Clay. Below this alluvial cover, older sedimentary deposits either consolidated or unconsolidated overlies igneous/metamorphic rocks of Indo Pak shield/basement.

6.4.4 Soils

The land selected for the proposed Project is much fertile and under agriculture use by utilizing ground water. As per information provided by Geotechnical Investigation Survey team, total 75 points have been selected for soil investigation. On the basis of preliminary soil investigation done at site in July, 2017, there is generally brown silty clay available up to three meters depth of investigation and below 3 m upto 40 m, grey loose to dense fine sand / silty sand is present.

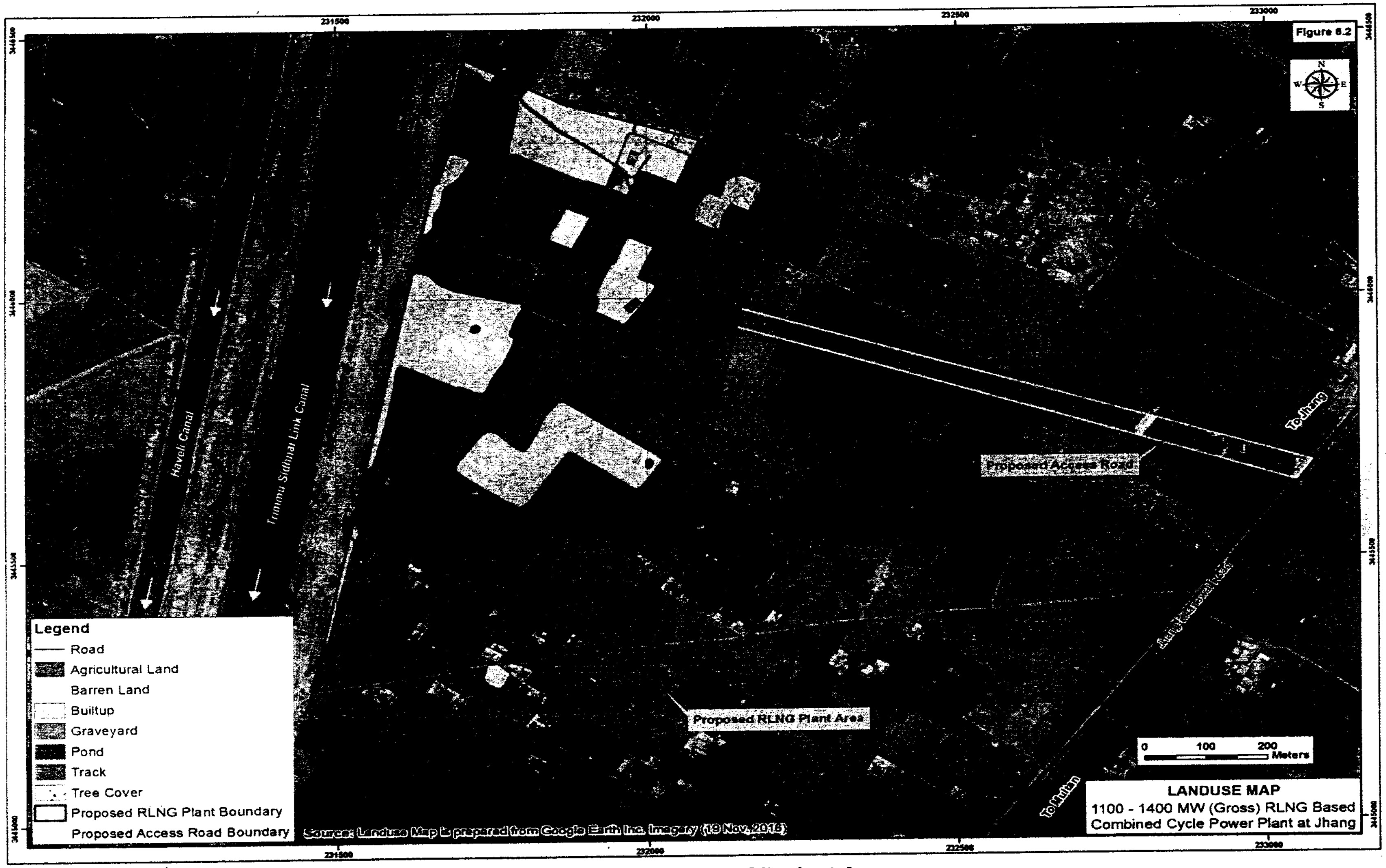


Figure 6.2: Landuse Map of Project Area

6.4.5 Seismology

Earthquake is generated by tectonic process in the upper part of the earth called lithosphere, which is divided into several rigid parts called "Plates". Due to the movements of these plates, stress build up takes place and result in the deformation of the crustal mass.

On the basis of Peak Ground Acceleration (PGA) values obtained through Pakistan Seismic Hazard Assessment (PSHA), Pakistan is divided into 5 seismic zones in line with the Uniform Building Code (UBC) 1997. The boundaries of these zones are defined on the basis as shown in Table 6.2.

Table 6.2: Probabilistic Ground Acceleration (PGA) Values of Seismic Zones of Pakistan

Horizontal Zone	PGA (g)
1	0.05 to 0.08
2A	0.08 to 0.16
2B	0.16 to 0.24
3	0.24 to 0.32
4	> 0.32

As per Building Code of Pakistan (BCP) 2007 (Seismic Provisions), the proposed Project falls entirely in the zone 2A, which is the regions of moderate seismic risk (Figure 6.3). Hence all the applicable provisions related to Soil and Foundations, Structural Design Requirements and with the Structural Concrete of BCP should be considered in the design of the structures[9].

[9] *Building Code of Pakistan (Seismic Provisions – 2007), Ministry of Housing and Works*

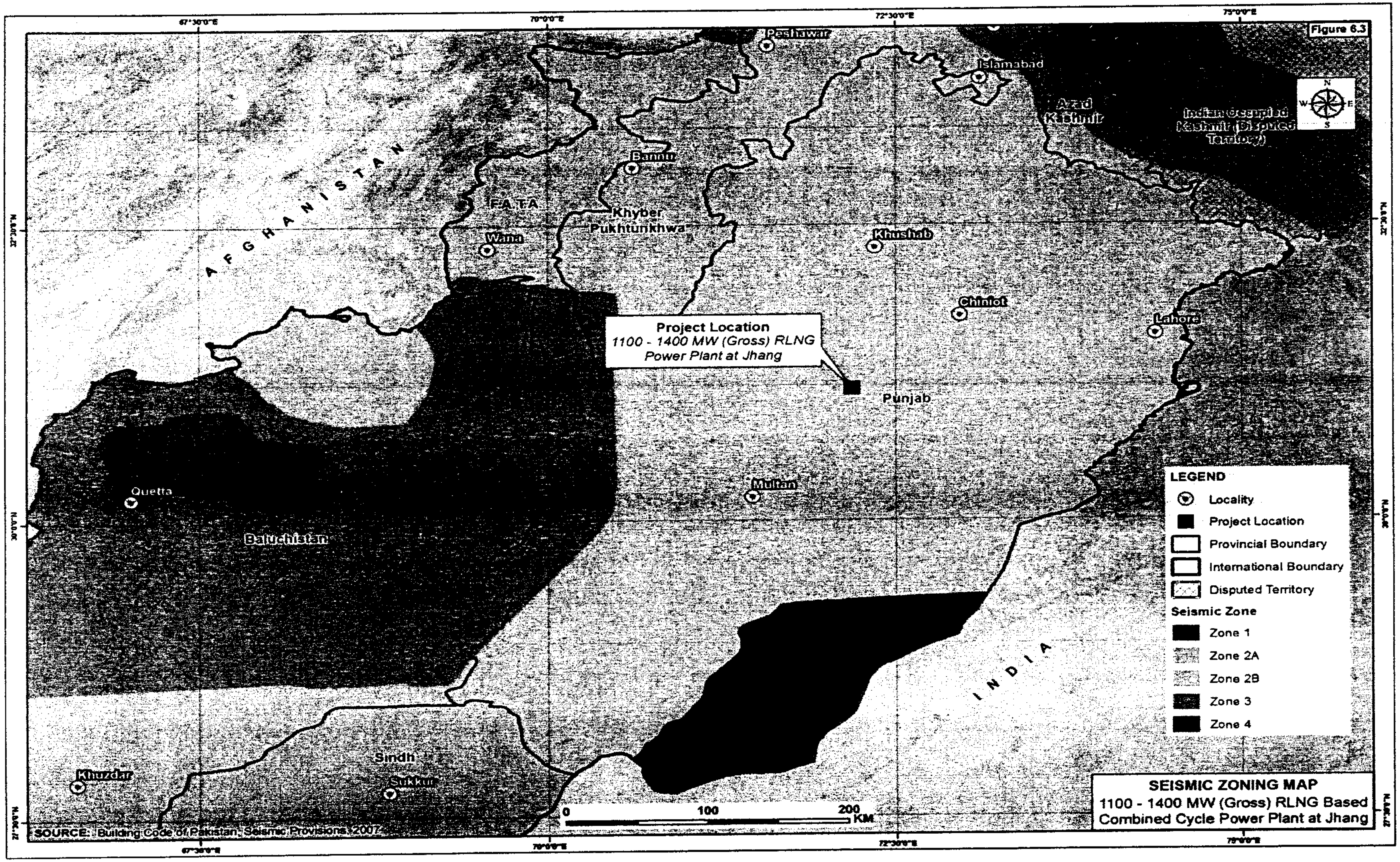


Figure 6.3: Seismic Zoning Map

6.4.6 Climate

The climate of the area is semi-arid, hot subtropical with foggy winter, pleasant spring, summer with dust and heat wave periods, rainy monsoon, and dry autumn. The climatic data has been obtained from Pakistan Meteorological Department. Jhang Weather Station is the nearest station from the Project Site. The data of Jhang region for the various climatic parameters such as temperature, rainfall, relative humidity, wind speed & direction has been acquired for the year 2015 to 2016 (2 years) which is being discussed as below:

6.4.6.1 Temperature

Mean monthly temperature data of the region for the years 2015 and 2016 is presented in Table 6.3. Based on this data, the coldest month is January in which the mean minimum temperature is 5.40°C and the mean maximum temperature is 18.15°C. June is the hottest month with the mean minimum temperature of 25.70°C and the mean maximum temperature as 40.40°C.

Table 6.3: Monthly Mean of Daily Temperatures

Sr. No.	Month	Minimum Temperature °C			Maximum Temperature °C		
		2015	2016	Mean	2015	2016	Mean
1	January	4.70	6.10	5.40	17.60	18.70	18.15
2	February	8.10	7.20	7.65	23.20	25.20	24.20
3	March	11.60	14.10	12.85	25.10	27.40	26.25
4	April	19.00	18.30	18.65	34.70	35.10	34.90
5	May	23.20	23.70	23.45	40.30	41.20	40.75
6	June	24.60	26.80	25.70	39.40	41.40	40.40
7	July	26.20	26.40	26.30	37.10	38.30	37.70
8	August	25.90	26.50	26.20	36.40	37.20	36.80
9	September	23.20	25.60	24.40	36.80	37.70	37.25
10	October	18.20	19.50	18.85	33.60	35.70	34.65
11	November	10.40	11.60	11.00	27.90	29.30	28.60
12	December	5.90	8.20	7.05	23.00	25.00	24.00
Annual		**16.75**	**17.83**	**17.29**	**31.26**	**32.68**	**31.97**

Source: Meteorological Department, Lahore (2017)

6.4.6.2 Rainfall

The maximum rainfall occurs during the monsoon season in the month of July with mean rainfall of about 143.9 mm. The variation of monthly rainfall for the two years 2015 and 2016 is given in Table 6.4:

Table 6.4: Mean Monthly Rainfall

Month	Mean Monthly Rainfall (mm)		
	2015	2016	Mean
January	14.2	9.8	12.0
February	12.0	16.6	14.3
March	85.5	147.2	116.4
April	31.0	11.2	21.1
May	4.4	13.8	9.1
June	37.2	64.0	50.6
July	123.6	164.1	143.9
August	90.6	145.0	117.8
September	41.8	4.2	23.0
October	18.4	-1.0	8.7

Month	Mean Monthly Rainfall (mm)		
	2015	2016	Mean
November	-1.0	0.0	-0.5
December	0.0	0.0	0.0
Annual	**38.1**	**47.9**	**43.0**

Source: *Meteorological Department, Lahore (2017)*

6.4.6.3 Relative Humidity

The data for relative humidity is being recorded on daily basis for 0500 GMT, 0800 GMT and 1700 GMT. The monthly mean, which is calculated for these timings for the years 2015 and 2016 is presented in Table 6.5:

Table 6.5: Relative Humidity

Month	Mean Monthly Relative Humidity (%)								Annual Mean
	2015				2016				
	0500 GMT	0800 GMT	1700 GMT	Mean	0500 GMT	0800 GMT	1700 GMT	Mean	
January	94.00	94.00	66.00	84.67	92.00	92.00	65.00	83.00	83.83
February	89.00	91.00	57.00	79.00	83.00	87.00	43.00	71.00	75.00
March	90.00	90.00	58.00	79.33	88.00	88.00	57.00	77.67	78.50
April	70.00	70.00	38.00	59.33	73.00	67.00	35.00	58.33	58.83
May	59.00	52.00	27.00	46.00	66.00	55.00	30.00	50.33	48.17
June	70.00	59.00	38.00	55.67	65.00	59.00	35.00	53.00	54.33
July	84.00	78.00	55.00	72.33	83.00	79.00	55.00	72.33	72.33
August	81.00	81.00	61.00	74.33	86.00	81.00	60.00	75.67	75.00
September	81.00	76.00	47.00	68.00	83.00	75.00	48.00	68.67	68.33
October	81.00	81.00	48.00	70.00	84.00	79.00	46.00	69.67	69.83
November	85.00	87.00	53.00	75.00	87.00	88.00	55.00	76.67	75.83
December	86.00	89.00	49.00	74.67	93.00	91.00	58.00	80.67	77.67
Annual	80.83	79.00	49.75	69.86	81.92	78.42	48.92	69.75	69.81

Source: *Meteorological Department, Lahore (2017)*

6.4.6.4 Wind Speed and Wind Direction

The wind data is being recorded on daily basis for 0500 GMT, 0800 GMT and 1700 GMT. The monthly mean for the wind speed is calculated and mentioned in Table 6.6 below for the years 2015 and 2016 in knots. It is observed that the wind speed is low in winter season, while in summer season, winds are blowing at a relatively higher speed than winter.

Table 6.6: Mean Wind at Synoptic Hours (Knots)

Months	Mean Monthly Wind Speed 2015						Mean Monthly Wind Speed 2016					
	0500 GMT	Wind Direction	0800 GMT	Wind Direction	1700 GMT	Wind Direction	0500 GMT	Wind Direction	0800 GMT	Wind Direction	1700 GMT	Wind Direction
January	0.10	S45E	0.30	S45W	0.30	S	0.10	E	0.10	S	0.30	S63E
February	0.20	S45E	0.40	S45W	0.80	S45W	0.10	N45W	0.00	C	0.10	S
March	0.10	C	0.20	S	0.60	S27E	0.10	C	0.10	N22E	0.10	N45W
April	0.50	S45E	1.30	S45E	0.80	S45E	0.10	N45W	0.70	W	0.10	S

Months	Mean Monthly Wind Speed 2015						Mean Monthly Wind Speed 2016					
	0500 GMT	Wind Direction	0800 GMT	Wind Direction	1700 GMT	Wind Direction	0500 GMT	Wind Direction	0800 GMT	Wind Direction	1700 GMT	Wind Direction
May	0.50	S45E	0.50	S36E	0.70	S02E	1.20	S62E	0.90	S67E	1.20	S36E
June	0.30	S31E	0.60	S37E	1.30	S38E	0.80	S40E	1.00	S03E	1.00	S13E
July	0.40	S31E	0.80	S37E	1.50	S36E	1.50	S45E	2.10	S49E	1.50	S48E
August	0.30	S31E	0.30	S45E	0.50	S27W	0.70	S32E	0.80	S55E	1.70	S
September	0.00	C	0.50	S45E	0.10	S45E	0.30	S45E	1.40	S26E	1.60	S06E
October	0.10	S45E	0.00	C	0.20	S45E	0.10	S45E	0.30	S22E	0.50	S67W
November	0.00	C	0.00	S45E	0.10	S45E	0.00	C	0.10	S24E	0.20	N80W
December	0.00	C	0.10	S45E	0.10	C	0.10	N	0.10	E	0.80	N06E
Annual	0.21		0.42		0.58		0.43		0.63		0.76	

Source: Meteorological Department, Lahore (2017)

6.4.7 Water Resources

The major surface water sources in the AOI are the TS-Link Canal and Haveli Main Line. The other water bodies in the AOI include natural storm water ponds and fish ponds. As per Irrigation Department, the area is prone to floods as Left Marginal Bund is breached in case of high floods in River Chenab. The Ground water in the AOI is extracted through tube wells and hand pumps installed in nearby villages and along the banks of both canals.

6.4.7.1 Surface Water

The TS-Link canal is being off taken from Trimmu Barrage. Trimmu Barrage is a barrage on the River Chenab in the Jhang District of the Punjab province. It is situated downstream of the confluence of the River Jhelum and River Chenab near Atharan Hazari. This link canal was constructed in 1939 to transfer River supplies of Jhelum and Chenab from Trimmu Barrage to River Ravi at Sidhnai Barrage. Length of the canal is 66768 m (219,000 ft.) with a design discharge of 326 Cumecs (11,500 Cusecs). The other benefit of the Link Canal is to enhance drainage of the area by intercepting a number of drains and conveying their discharge to the Ravi River. The TS-Link Canal flows in Cusecs are shown in the Table 6.7 below:

Table 6.7: TS-Link Canal Monthly Flows (Year 2012)

Month	TS-Link Flow in Cusecs	
	Max	Min
January	4627	0
February	5000	0
March	4500	1364
April	6000	0
May	8000	6000
June	11000	7500
July	11500	9807
August	11500	5000
September	10500	1500
October	11500	4951
November	6545	1904
December	7300	1364

Haveli Main Line is another canal which flows in parallel to TS-Link canal and passes near Dhueen Muhammad village. Length of this canal is 66464 m (218,000 ft.) with a design discharge of 147 Cumecs (5,178 cusecs).

Apart of these canals, a major natural storm water pond is located at about one (01) km west side of proposed Project site in the territory of Moza Kot Dewan and Moza Dhueen Muhammad. This water pond is being filled by storm water coming from River Chenab. This pond has much importance in context of its ecological features.

Natural wastewater drains in the AOI are open to the agricultural fields which collect all the sewerage including the wastewater from surrounding villages and discharge it to depression area lands available in the vicinity of these villages.

6.4.7.2 Groundwater

The groundwater table was encountered at shallow depth of about 3 m (10 ft.) during the soil investigations. It was reported by the local residents that tube wells are installed in the Project Area with an approximate depth of 15-22 m (50-70 ft.). The water is mostly used to meet the agriculture and drinking water demands of the area.

6.4.8 Solid Waste and Wastewater Drainage

In the AOI, no conventional solid waste management system exists. Most of the solid waste was found to be stored in the forms of heaps at various locations near the villages. Similarly, there is no proper sewerage system in the AOI, only some open drains are constructed in the vicinity for the discharge of wastewater. In general, each village drains its sewage through small open drains which discharge the sewage into the depression area near each village. This depression area/pond is called "village chappar" in local language.

6.4.9 Instrumental Environmental Monitoring and Testing

Purpose of instrumental environmental monitoring is to collect baseline quantitative data of ambient air, background noise levels and water (groundwater, surface water and wastewater) quality in the AOI. The baseline quantitative data of the Project AOI was acquired through instrumental monitoring in March, 2015 at EIA stage of existing HBS CCPP. The monitoring was carried out by M/s Apex/Ectech (an EPA approved Laboratory). The summary of baseline monitoring is given in Tables 6.8-6.13. Based on the available information at the feasibility stage of existing HBS, a base map was prepared on which the points for the monitoring of ambient air, noise levels and water sampling were marked. Map showing the monitoring and sampling points is attached as Figure 6.4.

Detail of the monitoring, sampling and testing parameters are given in the Table 6.8 below:

Table 6.8: Environmental Monitoring, Sampling and Testing Parameters Details

Sr. No	Parameter	No. of Points	Critical Parameters Tested during 1st Round
1	Ambient Air (AA)	04	SO_x, NO_x, PM_{10}, $PM_{2.5}$, Volatile Organic Compound (VOC), CO_2
2	Noise Levels (NL)	08	In dB Scale (A)
3	Surface Water (SW) Samples	05	Color, pH, Temperature (at site), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), TSS, TDS Grease & Oil, Phenolic Compound as Phenols, Chloride as Cl^-, Fluoride as F^-, Cyanide total as CN-, An-Ionic Detergents as MBAs, Sulphate as SO_4^{2-}, Sulphide as S-, Ammonia Pesticides, Cadmium, Chromium trivalent and hexavalent, Copper, Lead, Mercury, Selenium, Nickel, Silver, Total toxic metals, Zinc, Arsenic, Barium, Iron, Manganese, Boron and Chlorine, Nutrients, Dissolved Oxygen, Turbidity
4	Wastewater (WW) Samples	05	Color, pH, Temperature (at site), Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), TSS, TDS Grease & Oil, Phenolic Compound as Phenols, Chloride as Cl^-, Fluoride as F^-, Cyanide total as CN-, An-Ionic Detergents as MBAs, Sulphate as SO_4^{2-}, Sulphide as S-, Ammonia Pesticides, Cadmium, Chromium trivalent and hexavalent, Copper, Lead, Mercury, Selenium, Nickel, Silver, Total toxic metals, Zinc, Arsenic, Barium, Iron, Manganese, Boron and Chlorine, Nutrients, Dissolved Oxygen, Turbidity
5	Ground Water (GW) Samples	05	pH, Temperature (at site), Color, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Taste , Odor, Total Hardness, Nitrate as NO_3, Ammonia, Arsenic, Turbidity, Chlorides as Cl^-, Fluoride as F^-, Sulphate as SO_4^{2-}, Iron as Fe^{3+}, Sodium, Iodine, Zinc as Zn^{2+}, Total Coliform, E-Coli

The summary of analysis, results and discussions for the ambient air, background noise levels, surface water/wastewater and groundwater are given below:

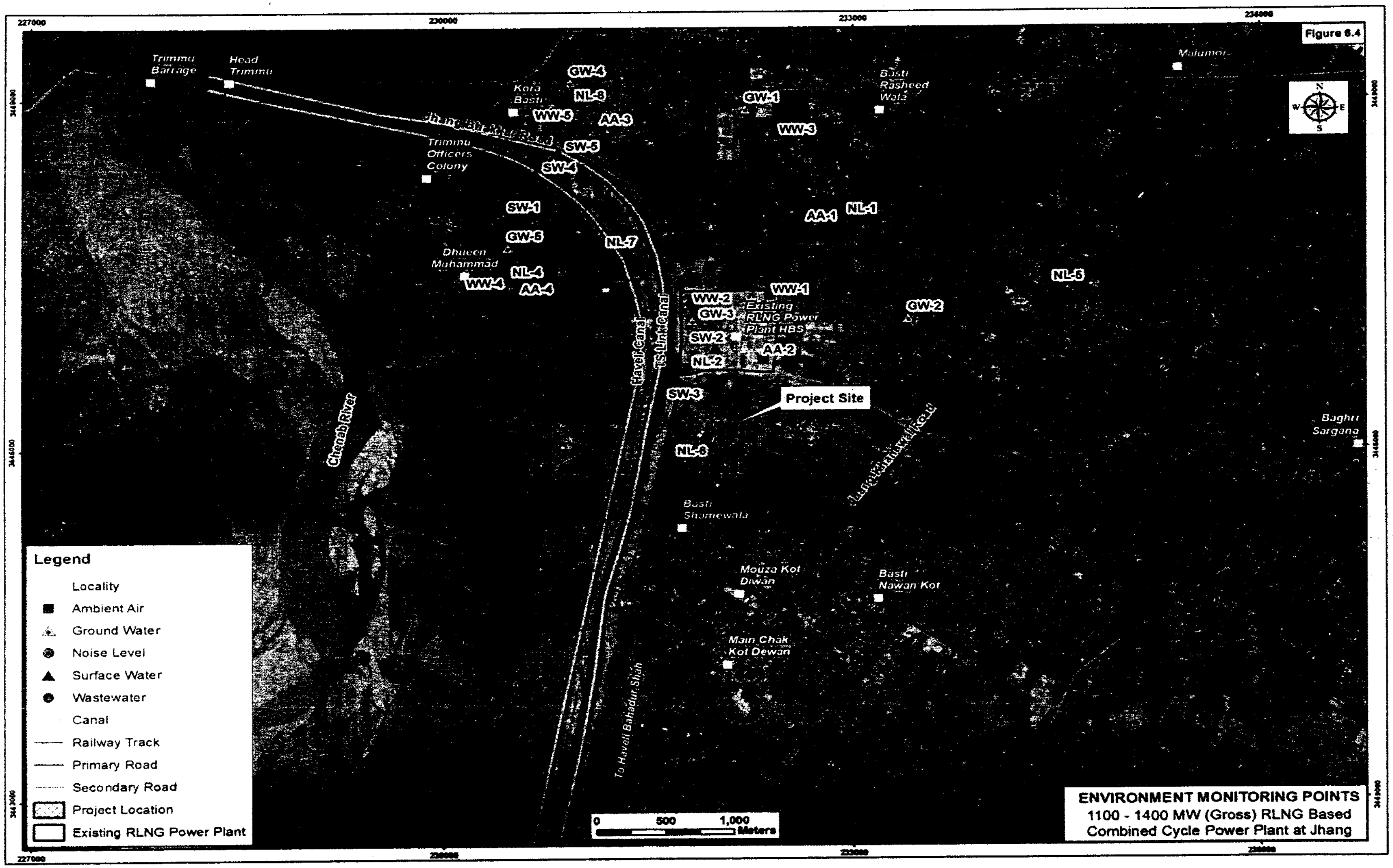


Figure 6.4: Environmental Monitoring Points

6.4.9.1 Ambient Air

Ambient air quality data for SO_2, NO, NO_2, CO_2, VOC, PM_{10} and $PM_{2.5}$ was monitored at four (04) points located in the AOI (Figure 6.4). These results were compared with the PEQS for ambient air 2016 (i.e. effective from August, 2016), limiting values of the corresponding parameters. The summary of ambient air monitoring points i.e. AA01 to AA04 along with averaging periods and monitoring location are provided in Table 6.9.

Table 6.9: Ambient Air 24-Hour Monitoring Results

Sr. No.	Monitoring Points	Location	Pollutants							
			Duration (Average)	CO_2 ppm	NO ug/m³	NO_2 ug/m³	SO_2 ug/m³	VOC ppm	PM_{10} ug/m³	$PM_{2.5}$ ug/m³
1	AA-01	Near Basti Raheed Wala	24 Hr.	256.9	0.017	23.06	29.5	0.62	79.4	12.7
2	AA-02	Existing RLNG HBS	24 Hr.	242.2	0.06	13.9	24.6	0.44	42.1	16.0
3	AA-03	Near Basti Kora Wala	24 Hr.	256.3	0.014	28.4	31.4	0.72	91.5	17.2
4	AA-04	Near Dhueen Muhammad	24Hr.	253.1	0.023	24.9	24.2	0.52	70.5	15.8
	PEQS		24 Hr	-	40	80	120	-	150	35

** 08 hour monitoring value*

All the parameters are well within the PEQS applicable limiting values.

6.4.9.2 Background Noise Levels

The background noise level monitoring was carried out in the AOI at eight (08) locations as shown in Figure 6.4. The results of Noise levels were compared with the PEQS for noise 2016 (i.e., effective from August, 2016). The PEQS has defined four categories of areas for noise level i.e., residential area (A), Commercial area (B), Industrial area (C) and Silence zone (D), with limiting values of 55 dB, 65 dB, 75 dB and 50 dB, respectively. All points from NL-01 to NL-08 fall into category A (Residential Area) because no major industry exists in the AOI expect rice mills (Zain and Sufi Rice mills). The summary of background noise monitoring points i.e. NL01 to NL08 along with averaging corresponding readings and monitoring location are provided in Table 6.10.

Table 6.10: Noise Level Monitoring Results

Sr.	Point	Location	Results Leq	PEQS Limits							
			24 Hr. Average	Residential Area (A)		Commercial Area (B)		Industrial Area (C)		Silence Zone (D)	
				Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time
1	NL-01	Near Basti Rasheed Wala	42.66	55	45	65	50	75	65	50	45
2	NL-02	Existing RLNG HBS	42.16	55	45	65	50	75	65	50	45
3	NL-03	Near Bhakhar-Jhang Road	66.20	55	45	65	50	75	65	50	45
4	NL-04	Near Dhueen Muhammad	43.81	55	45	65	50	75	65	50	45

Sr.	Point	Location	Results Leq 24 Hr. Average	PEQS Limits							
				Residential Area (A)		Commercial Area (B)		Industrial Area (C)		Silence Zone (D)	
				Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time
5	NL-05	Near Multan Road	65.72	55	45	65	50	75	65	50	45
6	NL-06	Near Basti Kot Dewan,	42.33	55	45	65	50	75	65	50	45
7	NL-07	Near Basti Qaim Pur	46.66	55	45	65	50	75	65	50	45
8	NL-08	Near Basti Kora Wala	50.89	55	45	65	50	75	65	50	45

Day Time hour: 06:00am to 10:00pm
Night Time hour: 10:00pm to 06:00am

All the monitoring points except NL-03 and NL-05 are in compliance with the PEQS Noise Level Category A. The points NL-03 and NL-05 exceed the PEQS Noise Level Category A because of heavy traffic on both roads.

6.4.9.3 Surface Water

In order to measure the baseline quality of surface water in the AOI, five (05) grab samples of water were collected from TS-Link Canal, Haveli Main line and fish ponds within AOI. All the samples collected as grab samples were preserved and transported to the laboratory for testing. The results were compared with available FAO standards. Location of all the sampling points is given in Figure 6.4.

Table 6.11: Surface Water Sampling Results

Sr. No	Parameter	Units	SW-01	SW-02	SW-03	SW-04	SW-05	FAO
Location			Dhueen Mohammad Fish Farm	Existing RLNG HBS	TS-Link Canal (Near North Side Project Boundary)	Haveli Main Line	TS-Link Canal	
1	pH	--	7.5	7.8	7.8	7.3	8.1	6.5-8.4
2	Temperature	^oC	22	23	23	24	22	--
3	Biochemical Oxygen Demand (BOD_5)	mg/l	142.8	169	129	128	126.4	--
4	Chemical Oxygen Demand (COD)	mg/l	200	237	181	180	177	--
5	Total Suspended Solids (TSS)	mg/l	5	163	13	34	16	--
6	Total dissolved Solids (TDS)	mg/l	236	243	145	156	904	2000
7	Grease & Oil	mg/l	1.29	1.48	0.1	0.3	N.D	--
8	Phenolic Compounds as Phenols	mg/l	N.D	N.D	N.D	N.D	N.D	--
9	Chloride	mg/l	248	321	126	120	233	355
10	Fluoride	mg/l	N.D	2.7	N.D	N.D	N.D	1.0
11	Cyanide	mg/l	0.001	0.07	0.004	0.001	0.001	--
12	An-Ionic	mg/l	N.D	N.D	N.D	0.6	N.D	--

Sr. No	Parameter	Units	SW-01	SW-02	SW-03	SW-04	SW-05	
	Location		Dhueen Mohammad Fish Farm	Existing RLNG HBS	TS-Link Canal (Near North Side Project Boundary)	Haveli Main Line	TS Link Canal	FAO
	Detergents							
13	Sulphate as SO_4^{2-}	mg/l	49	26.5	3.9	5.8	0.9	--
14	Sulphide	mg/l	0.03	0.05	N.D	N.D	0.07	--
15	Ammonia	mg/l	18.6	12.	6.32	9.9	1.0	--
16	Pesticides	mg/l	N.D	N.D	N.D	N.D	0.04	--
17	Cadmium	mg/l	0.046	N.D	N.D	0.01	N.D	0.01
18	Chromium trivalent and hexavalent	mg/l	N.D	0.1	N.D	N.D	N.D	0.1
19	Copper	mg/l	N.D	N.D	N.D	N.D	N.D	0.2
20	Lead	mg/l	0.004	0.14	0.011	0.012	0.10	0.05
21	Mercury	mg/l	N.D	N.D	N.D	N.D	N.D	<0.005
22	Selenium	mg/l	0.03	0.08	0.03	0.04	0.05	0.02
23	Nickel	mg/l	0.01	N.D	N.D	0.002	N.D	0.2
24	Silver	mg/l	N.D	N.D	N.D	N.D	0.75	--
25	Total toxic metals	mg/l	N.D	N.D	N.D	0.08	0.5	--
26	Zinc	mg/l	0.05	0.79	0.09	0.1	1.11	2.0
27	Arsenic	mg/l	0.05	0.025	0.01	0.25	0.03	0.1
28	Barium	mg/l	0.8	0.49	0.7	0.1	0.2	--
29	Iron	mg/l	2.6	2.40	1.2	0.7	1.5	5.0
30	Manganese	mg/l	N.D	0.81	0.3	N.D	0.61	0.2
31	Boron	mg/l	0.1	0.15	N.D	0.9	1.1	0.2
32	Chlorine	mg/l	N.D	N.D	N.D	N.D	N.D	--
33	Nitrogen as nutrients	mg/l	0.003	N.D	N.D	N.D	N.D	--
34	Phosphorus as nutrients	mg/l	0.01	N.D	N.D	N.D	N.D	--
35	Potassium as nutrients	mg/l	0.001	N.D	N.D	N.D	N.D	--
36	Turbidity	NTU	25	39	29	22	9.0	--
37	Dissolved oxygen	mg/l	7.5	9.3	9.3	9.4	19	--

NS: Not Specified ND: Not Detected

Based on the analysis, results of all the samples are within limits except few paraters such as Selenium, Lead and Arsenic. Selenium is exceeding limits in all the samples however, Arsenic is higher in Haveli main line, Lead is higher in TS-Link Canal and sample taken from RLNG HBS Project area.

6.4.9.4 Wastewater

In order to document the existing quality of wastewater being generated in the AOI, five (05) grab samples of wastewater were collected from rainwater ponds and natural storm water ponds within AOI. After being labeled and preserved, they were transported to the laboratory in Lahore for testing. Location of all the sampling points is given in Figure 6.4. The results of these monitoring points were compared with the PEQS for wastewater 2016 (i.e., effective from August, 2016) which are shown in Table 6.12.

Table 6.12: Wastewater Sampling Results

Sr. No	Parameter	Units	WW-01	WW-02	WW-03	WW-04	WW-05	PEQS
	Location		Rain Water Pond I, Kot Dewan	Rain Water Pond II Kot Dewan	Pond Near Rasheed Wala	Pond near Dhueen Muhammad	Pond near Basti Kora Wala	
1	pH	--	7.6	7.5	7.4	7.6	7.6	6-9
2	Temperature	^{o}C	24	22	24	23	22	40 ^{o}C
3	Biochemical Oxygen Demand (BOD_5)	mg/l	134.2	139.2	132.1	180	127	80
4	Chemical Oxygen Demand (COD)	mg/l	188	195	185	253	179	150
5	Total Suspended Solids (TSS)	mg/l	240	174	56	82	58	200
6	Total dissolved Solids (TDS)	mg/l	1885	139	288	876	312	3500
7	Grease & Oil	mg/l	N.D	N.D	N.D	1.79	0.6	10
8	Phenolic Compounds as Phenols	mg/l	N.D	N.D	N.D	N.D	N.D	0.1
9	Chloride	mg/l	428	139	206	406	205	1000
10	Fluoride	mg/l	2.22	N.D	N.D	N.D	N.D	10
11	Cyanide	mg/l	0.091	0.08	0.021	0.031	0.001	1.0
12	An-Ionic Detergents	mg/l	N.D	1.0	0.45	1.12	1.8	20
13	Sulphate as SO_4^{2-}		22	31.4	18.76	28	19	600
14	Sulphide	mg/l	0.1	0.02	N.D	N.D	N.D	1.0
15	Ammonia	mg/l	3.4	14.3	18.6	8.2	23.5	40
16	Pesticides	mg/l	N.D	N.D	N.D	N.D	N.D	0.15
17	Cadmium	mg/l	N.D	N.D	N.D	N.D	N.D	0.1
18	Chromium trivalent and hexavalent	mg/l	N.D	0.62	0.5	N.D	0.04	1.0
19	Copper	mg/l	N.D	0.25	N.D	N.D	N.D	1.0
20	Lead	mg/l	0.16	0.15	0.043	0.06	0.006	0.5
21	Mercury	mg/l	N.D	N.D	N.D	N.D	N.D	0.01
22	Selenium	mg/l	0.08	0.2	0.03	0.48	0.1	0.5
23	Nickel	mg/l	N.D	N.D	N.D	0.19	0.12	1.0
24	Silver	mg/l	0.65	N.D	0.04	N.D	N.D	1.0
25	Total toxic metals	mg/l	0.2	0.74	0.24	0.02	0.19	2.0
26	Zinc	mg/l	1.15	0.97	0.31	0.35	0.05	5.0
27	Arsenic	mg/l	0.05	0.05	0.01	N.D	0.10	1.0
28	Barium	mg/l	0.8	0.9	1.2	1.0	0.5	1.5
29	Iron	mg/l	2.5	3.26	2.74	3.2	1.62	8.0
30	Manganese	mg/l	0.91	0.87	N.D	N.D	0.14	1.5
31	Boron	mg/l	9.1	8.60	2.5	4.7	0.4	6.0
32	Chlorine	mg/l	N.D	0.63	0.07	N.D	N.D	1.0
33	Nitrogen as nutrients	mg/l	0.003	0.002	1.5	2.0	1.2	NS
34	Phosphorus	mg/l	N.D	N.D	0.3	0.9	0.09	NS

Sr. No	Parameter	Units	WW-01	WW-02	WW-03	WW-04	WW-05	PEQS
	Location		Rain Water Pond I, Kot Dewan	Rain Water Pond II Kot Dewan	Pond Near Rasheed Wala	Pond near Dhueen Muhammad	Pond near Basti Kora Wala	PEQS
	as nutrients							
35	Potassium as nutrients	mg/l	N.D	N.D	0.009	0.007	0.003	NS
36	Turbidity	NTU	9.1	21	51	17	26	NS
37	Dissolved oxygen	mg/l	39	9.2	9.4	9.2	9.0	NS

NS: Not Specified *ND: Not Detected*

Wastewater samples were tested for parameters specified in PEQS were compared with the PEQS limiting values for the inland discharge. Based on the analysis, all the samples are exceeding the limits of BOD_5 and COD. Total Suspended Solids of WW-01 also exceeding the PEQS limits.

6.4.9.5 Groundwater

In order to examine the existing groundwater quality, five (05) samples were collected from Basti Rasheed Wala, Moza Kot Dewan, Exisitng RLNG HBS, Basti Kora Wala, Moza Dhueen Mohammad. All the samples were collected as grab samples and after being labeled and preserved, they were transported to the laboratory in Lahore for testing. These samples were tested against all parameters as given in Table 6.8. Location of all the sampling points is given in Figure 6.4. Results of these samples along with the respective PEQS values are shown in Table 6.13.

Table 6.13: Drinking Water/Ground Water Sampling Results

Sr. No	Parameter	Units	GW 01	GW 02	GW 03	GW 04	GW 05	PEQS	WHO Standards
1	Temperature (During Sample Collection)	^oC	23	22	23	23	23	NS	NS
2	Color	Pt-Co	5	1	2	4	2	≤15TCU	<15TCU
3	pH	pH unit	7.3	7.0	7.1	6.9	7.4	6.5-8.5	6.5-8.5
4	Turbidity	NTU	N.D.	1.16	2.10	1.28	1.17	<5	<5
5	Total, Hardness	mg/l	116	165	126	190	98	<500.00	NS
6	Total Dissolved Solid (TDS)	mg/l	481	288	131	723	130	<1000.00	<1000.00
7	Total Suspended Solid (TSS)	mg/l	N.D.	02	03	03	N.D.	NS	NS
8	Ammonia	mg/l	N.D	N.D	N.D	N.D	N.D	NS	NS
9	Fluoride F^-	mg/l	0.03	0.009	0.32	0.6	0.85	≤1.50	1.50
10	Sulfate (SO_4^{-2})	mg/l	6.9	1.25	1.54	N.D	12	NS	NS
11	Chloride(Cl^-)	mg/l	24	38.5	60.3	49.7	52.4	<250.00	250
12	Nitrate (NO_3)$^-$	mg/l	4.8	5.9	2.27	1.6	3.1	≤50.00	50.00
13	Odor	-	OK	OK	OK	OK	OK	Non Objectionable / Acceptable	Non Objectionable / Acceptable
14	Taste	-	OK	OK	OK	OK	OK	Non Objectionable / Acceptable	Non Objectionable / Acceptable
15	Sodium	mg/l	27	33	29	23	35	NS	NS

Sr. No	Parameter	Units	GW 01	GW 02	GW 03	GW 04	GW 05	PEQS	WHO Standards
16	Iodine	ppm	N.D.	N.D.	N.D.	N.D.	N.D.	NS	NS
17	Arsenic (As)	mg/l	0.005	N.D.	N.D	0.01	0.005	< 0.05	0.01
18	Iron (Fe^{3+})	mg/l	0.01	N.D.	0.01	0.03	N.D.	NS	NS
19	Zinc (Zn^{2+})	mg/l	0.02	0.01	0.04	0.06	0.03	5.0	3.0
20	Total Coliforms	cfu/100 ml	N.D	N.D	N.D	N.D	N.D	0/100 ml	0/100 ml
21	Fecal Coli forms(E.Coli)	cfu/100ml	N.D	N.D	N.D	N.D	N.D	0/100 ml	0/100 ml

NS: Not Specified

Results were analyzed and compared with the PEQS values. Based on the analysis, all the tested parameters are in compliance with the PEQS for drinking water.

6.4.10 Latest Environmental Monitoring and Testing

Another round of monitoring was carried out in July and August 2017 at EIA stage of proposed Jhang CCPP adjacent to HBS CCPP. The purpose of latest monitoring was to check the exceedance in pollutant levels from baseline due to construction of existing HBS. In addition, operation of HBS CCPP has also been started in July 2017. M/s SEAL Environmental Laboratory (an EPA approved lab), was awarded the contract for the environmental monitoring, sampling and testing. The latest monitoring work was carried out for the direct instrumental monitoring for the ambient air and background noise levels while samples of the water (groundwater and surface water) were collected /preserved as per standard procedures and transported to the lab for testing. The monitoring points were selected on the basis of proximity to Project site, sensitive receptors, anticipated impacts during project implementation and Project operations.

Based on the available information, a base map was prepared on which the points for the monitoring of ambient air, noise levels and water sampling were marked. Map showing the monitoring and sampling points is attached as Figure 6.5.

Detail of the monitoring, sampling and testing parameters are given in the Table 6.14 below:

Table 6.14: Environmental Monitoring, Sampling and Testing Parameters Details

Sr. No	Parameter	No. of Points	Critical Parameters Tested during 2nd Round
1	Ambient Air	04	Same as above (Refer Table 6.8)
2	Noise Levels	04	Same as above (Refer Table 6.8)
3	Ground Water Samples	04	Same as above (Refer Table 6.8)
4	Surface Water/ Wastewater Samples	04	Same as above (Refer Table 6.8)

Based on the analysis, results and discussions for the ambient air, background noise levels, surface water/wastewater and groundwater are given below:

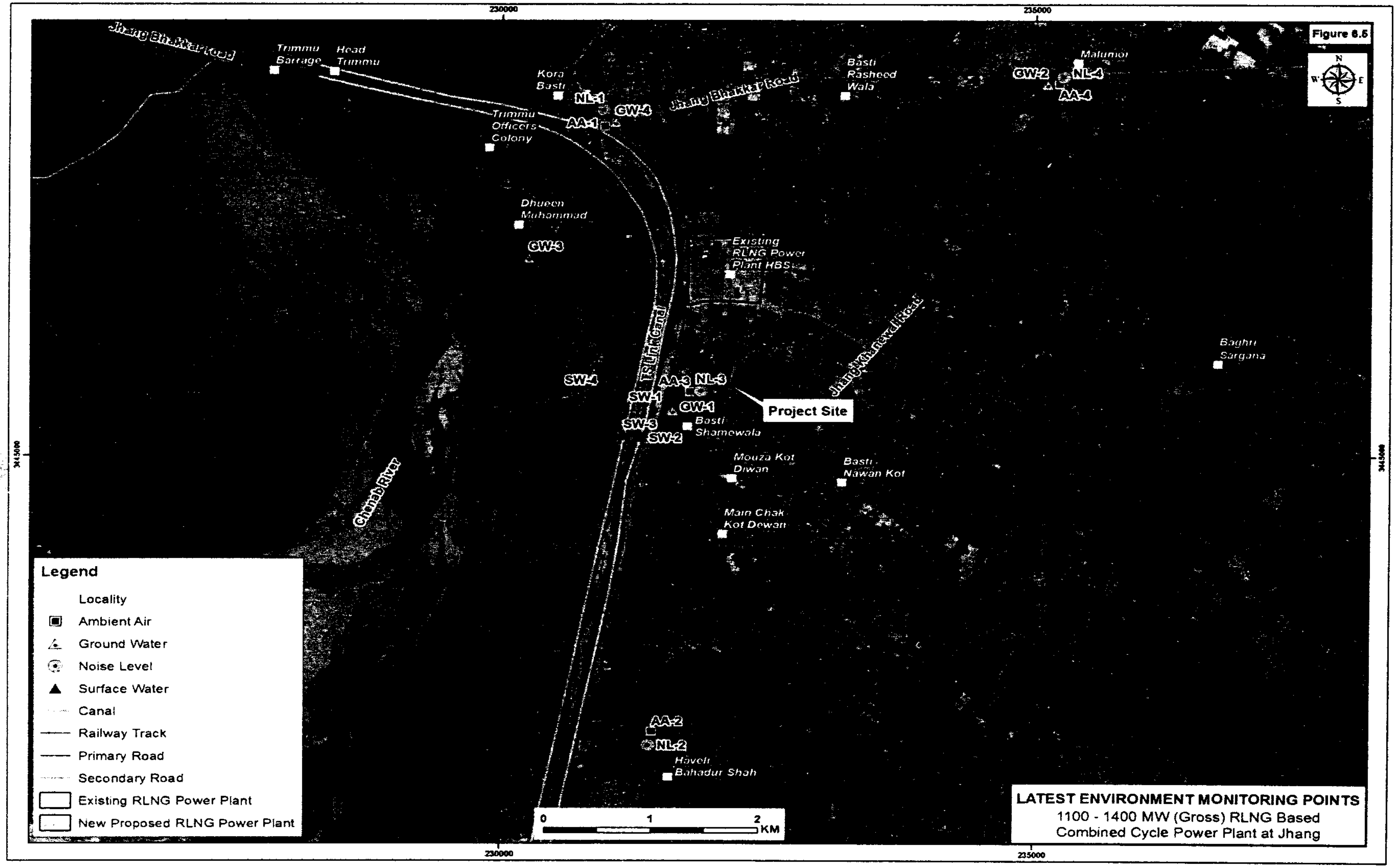


Figure 6.5: Latest Environmental Monitoring Points

6.6.10.1 Ambient Air

Ambient air quality data for NO, NO_2, CO_2, VOC, PM_{10} and $PM_{2.5}$ was monitored at four (04) points located in the AOI (Figure 6.5). The summary of ambient air monitoring points i.e. AA-01 to AA-04 along with averaging periods and monitoring location are provided in Table 6.15.

Table 6.15: Ambient Air Monitoring Results

Sr. No.	Monitoring Points	Location	Pollutants							
			Duration (Avg.)	CO_2 ppm	CO ug/m³	NO ug/m³	NO_2 ug/m³	VOC ppm	PM_{10} ug/m³	$PM_{2.5}$ ug/m³
1	AA-01	Kora Basti	24 Hr.	447.63	0.012	0.386	0.227	0	116.88	19.71
2	AA-02	Haveli Bahadur Shah	24 Hr.	461.85	0.029	0.545	0.200	0	121.17	17.13
3	AA-03	Project Site	24 Hr.	350.88	0.089	0.384	0.215	0	112.88	19.0
4	AA-04	Malu Mor	24Hr.	400.88	0.085	0.283	0.281	0	141.38	20.92
	PEQS		24 Hr	-	05*	40	80	-	150	35

** 08 hour monitoring value*

The parameters such as CO, NO, NO_2, VOCs, PM_{10}, and $PM_{2.5}$ are well within the PEQS applicable limits at all monitoring points. However, the values of all parameters have been increased due to construction and operation existing RLNG CCPP HBS.

6.6.10.2 Background Noise Levels

The background noise level monitoring was carried out in the AOI at four (04) locations as shown in Figure 6.5. The summary of background noise monitoring points i.e. NL-01 to NL-04 along with averaging corresponding readings and monitoring location are provided in Table 6.16.

Table 6.16: Noise Level Monitoring Results

Sr. No	Point	Location	Results Leq		PEQS							
			24 Hr. Average		Residential Area (A)		Commercial Area (B)		Industrial Area (C)		Silence Zone (D)	
			Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time
1	NL-01	Kora Basti	65.41	53.19	55	45	65	50	75	65	50	45
2	NL-02	Haveli Bahadur Shah	61.94	59.54	55	45	65	50	75	65	50	45
3	NL-03	Project Site	62.8	50.55	55	45	65	50	75	65	50	45
4	NL-04	Malu Mor	61.31	51.6	55	45	65	50	75	65	50	45

Day Time hour: 06:00am to 10:00pm; Night Time hour: 10:00pm to 06:00am

The average day time and night time noise level at NL-01 exceed the PEQS limits (Commercial Area (B)) extensive commercial activities. The average day time noise level at NL-02 and NL-04 are well within the PEQS applicable limits (Commercial Area (B) but the night time noise level exceed the PEQS applicable limits (Commercial Area (B)) due to high traffic volume on Jhang-Shorkot Road. The day and night time noise levels at NL-03 are well within the PEQS applicable limiting values (Industrial Area (C)).

6.6.10.3 Surface Water

Four (04) grab samples of surface water were collected from TS-Link Canal, Haveli Main line, fish ponds, natural storm water ponds within AOI. All the samples were collected as grab samples and after being labeled and preserved, they were transported to the laboratory in Lahore for testing. Location of all the sampling points is given in Figure 6.5. The results of these monitoring points were compared with the FAO standard limits for surface water as shown in Table 6.17.

Table 6.17: Surface Water Sampling Results

Sr. No.	Parameter	Units	Surface Water 01	Surface Water 02	Surface Water 03	Surface Water 04	FAO
Location			Water Pond within Project Area	TS-Link Canal	Haveli Main Line	Fish Pond in Dhueen Mohammad	
1	Temperature	^{0}C	26	26.5	25.5	25.0	--
2	pH	pH unit	6.6	6.84	7.21	7.35	6.5-8.4
3	COD	mg/l	12	14	10	10	--
4	(BOD_5)	mg/l	05	05	04	04	--
5	Solids, Total dissolved (TDS)	mg/l	428	238	210	549	2000
6	Solids, Total suspended (TSS)	mg/l	18	63	52	22	--
7	Chloride	mg/l	94	42	38	122	355
8	Fluoride (F^-)	mg/l	1.42	1.42	0.36	2.46	1.0
9	Oil & grease	mg/l	BDL	BDL	BDL	BDL	--
10	Phenols, Total (Phenolic Compounds)	mg/l	BDL	BDL	BDL	BDL	--
11	Cyanide(CN-)	mg/l	BDL	0.01	BDL	0.02	--
12	Anionic Detergents as MBAS	mg/l	BDL	BDL	BDL	BDL	--
13	Sulfate (SO_4^{-2})	mg/l	120	54	52	152	--
14	Sulfide (S)	mg/l	BDL	-	-	-	--
15	Ammonia NH_3	mg/l	15.4	8.4	9.5	17.5	--
16	Cadmium (Cd)	mg/l	0.01	BDL	BDL	0.01	0.01
17	Chromium (Cr) as Hexavalent & Trivalent	mg/l	0.18	0.08	0.12	0.36	0.1
18	Copper (Cu)	mg/l	0.25	0.28	0.23	0.52	0.2
19	Lead	mg/l	BDL	BDL	BDL	BDL	0.05
20	Nickel	mg/l	0.05	BDL	BDL	BDL	0.2
21	Zinc	mg/l	1.72	1.26	1.14	2.47	2.0
22	Iron	mg/l	0.84	0.61	0.52	1.36	5.0
23	Manganese	mg/l	BDL	BDL	BDL	BDL	0.2
24	Selenium	mg/l	BDL	BDL	BDL	BDL	0.02
25	Silver	mg/l	BDL	BDL	BDL	BDL	--
26	Arsenic	mg/l	0.09	0.06	0.08	0.17	0.1
27	Barium	mg/l	BDL	BDL	BDL	BDL	--
28	Boron	mg/l	BDL	BDL	BDL	BDL	0.2
29	Mercury	mg/l	BDL	BDL	BDL	BDL	<0.005
30	Chlorine	mg/l	0.12	0.05	0.01	0.12	--
31	Total Toxic Metals	mg/l	0.28	0.14	0.2	0.54	--
32	Turbidity	NTU	1.5	3.0	3.0	2.0	--
33	Oxygen, Dissolved	mg/l	2.5	1.5	1.0	1.5	--
34	Pesticides	µg/l	BDL	BDL	BDL	BDL	--
35	Nutrients as Potassium	mg/l	0.02	0.04	0.03	0.09	--

Sr. No.	Parameter	Units	Surface Water 01	Surface Water 02	Surface Water 03	Surface Water 04	FAO
36	Nutrients as Nitrogen	mg/l	0.005	0.02	0.02	0.10	--
37	Nutrients as Phosphorous	mg/l	0.015	0.01	0.004	0.02	--
38	Total Coliform	MPN/100ml	36	29	32	36	--
39	Fecal Coliform	MPN/100ml	12	12	16	16	--

NS: Not Specified BDL: Below Detection Limits

The results of all the tested parameters taken from sampling locations (SW-01 to SW-04) are in compliance with available FAO limiting values except Flouride, which is higher in samples taken from Dhueen Muhammad, TS-Link Canal and Project Area.

6.6.10.4 Groundwater

Groundwater in the AOI and nearby area is mostly being used as a main source of drinking water through hand pumps. Four samples were collected as grab samples and after being labeled and preserved, they were transported to the laboratory for testing. These samples were tested against all parameters as given in Table 6.14. Location of all the sampling points is given in Figure 6.5. Results of these samples along with the respective PEQS values and WHO standards are shown in Table 6.18.

Table 6.18: Drinking Water/Ground Water Sampling Results

Sr. No	Parameter	Units	GW 01	GW 02	GW 03	GW 04	PEQS	WHO Standards
Location			Tube Well within Project Area	Tube Well near Malu Mor	Tube Well in Dhueen Mohammad	Hand Pump in Kora Basti		
1	Temperature (During Sample Collection)	^{o}C	23.0	24.0	24.0	22.0	NS	NS
2	Color	Pt-Co	0	0	0	0	≤15TCU	<15TCU
3	pH	pH unit	7.21	7.48	7.51	7.28	6.5-8.5	6.5-8.5
4	Turbidity	NTU	0	0	0	0	<5	<5
5	Total, Hardness	mg/l	220	245	295	310	<500.00	NS
6	Total Dissolved Solid (TDS)	mg/l	584	548	674	714	<1000.00	<1000.00
7	Total Suspended Solid (TSS)	mg/l	BDL	06	BDL	12	NS	NS
8	Ammonia	mg/l	BDL	BDL	BDL	BDL	NS	NS
9	Fluoride F^-	mg/l	0.21	0.25	0.18	0.26	<1.50	1.50
10	Sulfate (SO_4^{-2})	mg/l	65	50	70	73	NS	NS
11	Chloride(Cl^-)	mg/l	75	62	92	115	<250.00	250
12	Nitrate (NO_3)$^-$	mg/l	5.8	6.1	7.2	9.5	<50.00	50.00
13	Odor	mg/l	Non Objectionable	Non Objectionable	Non Objectionable	Non Objectionable	Non Objectionable / Acceptable	Non Objectionable / Acceptable
14	Taste	mg/l	Non Objectionable	Non Objectionable	Non Objectionable	Non Objectionable	Non Objectionable /	Non Objectionable /

Sr. No	Parameter	Units	GW 01	GW 02	GW 03	GW 04	PEQS	WHO Standards
							Acceptable	Acceptable
15	Sodium	mg/l	42	58	62	85	NS	NS
16	Iodine	ppm	BDL	BDL	BDL	BDL	NS	NS
17	Arsenic (As)	mg/l	0.006	0.008	0.005	0.015	< 0.05	0.01
18	Iron (Fe^{3+})	mg/l	0.12	0.09	0.12	0.15	NS	NS
19	Zinc (Zn^{2+})	mg/l	0.38	0.28	0.46	0.35	5.0	3.0
20	Conductivity	µS/cm	835	780	963	1020	NS	NS
21	Bicarbonate	mg/l	120	110	152	158	NS	NS
22	Nitrite	mg/l	BDL	BDL	BDL	BDL	<3	3
23	Magnesium	mg/l	21	20	28	29	NS	NS
24	Calcium as Ca	mg/l	132	155	178	194	NS	NS
25	Phosphate	mg/l	BDL	BDL	BDL	BDL	NS	NS
26	Potassium	mg/l	3.4	3.7	4.8	7.2	NS	NS
27	Boron	mg/l	BDL	BDL	BDL	BDL	0.3(P)	0.3
28	SAR Iodine (I)	mg/l	1.26	2.14	2.65	2.12	NS	NS
29	Aluminum	mg/l	BDL	BDL	BDL	BDL	< 0.2	0.2
30	Antimony	mg/l	BDL	BDL	BDL	BDL	<0.005	0.02
31	Cadmium	mg/l	BDL	BDL	BDL	BDL	0.01	0.003
32	Mercury	mg/l	BDL	BDL	BDL	BDL	<0.001	0.001
33	Nickel	mg/l	BDL	BDL	BDL	BDL	<0.02	0.02
34	Selenium	mg/l	BDL	BDL	BDL	BDL	0.01(P)	0.01
35	Barium	mg/l	BDL	BDL	BDL	BDL	0.7	0.7
36	Total Chromium	mg/l	0.021	0.018	0.024	0.023	<0.05	0.05
37	Copper	mg/l	BDL	BDL	BDL	BDL	2	2
38	Lead	mg/l	BDL	BDL	BDL	BDL	<0.05	0.01
39	Cyanide (CN)	mg/l	BDL	BDL	BDL	BDL	<0.05	0.07
	Manganese	mg/l	BDL	BDL	BDL	BDL	<0.5	0.5
40	Total Coliforms	cfu/100ml	06	05	0	12	0/100 ml	0/100 ml
41	Fecal Coli forms(E.Coli)	cfu/100ml	0	0	0	03	0/100 ml	0/100 ml

NS: Not Specified *BDL: Below Detection Limits*

Results of all the tested parameters of samples GW-01, GW-02 and GW-03 indicate that the groundwater/ drinking water of these sites has bacterial contaminations. The groundwater sample taken from Dhueen Mohammad (GW-03) is 100% fit for drinking as all the tested parameters are well within the PEQS applicable limits.

6.4.11 Deduction on Instrumental Environmental Monitoring Results

The both rounds of instrumental environmental monitoring i.e. in March 2015 & July/August 2017, were carried out in same AOI. The results of both monitoring rounds are comparable for groundwater and surface water parameters. However, there have been an increase in noise levels and ambient air parameters such as CO_2, NO, $PM_{2.5}$, and PM_{10} in latest round of monitoring. This exceedance is due to construction and operation of HBS CCPP.

The latest round of monitoring do not represent the actual baseline quantitative data. Except short term construction emissions, there has been not that much contribution from HBS CCPP. In future, both HBS CCPP and proposed Project are supposed to run in parallel. Hence, it was deduced that first round of instrumental monitoring carried out in March 2015 would be considered as baseline for both existing HBS and proposed Jhang Project. On the basis of this conclusion, Air Dispersion Model was run and the results are given in Chapter 8.

6.5 ECOLOGICAL ENVIRONMENT

This section describes the biodiversity existing ecosystem and existing ecological conditions in the Project AOI. This section also enlists the fruit and non-fruit trees (forest trees), wildlife species and identifies those that need protection.

6.5.1 Habitat Evaluation

The Project Area is part of the Indus basin. It was once covered with thorn forests. The natural habitat of Project Area has been converted into agricultural area gradually in pat decades. However, trees still exist along the boundaries of the agricultural fields or at the residences or deras of the landowners.

The entire forest area has been degraded due to illicit cuttings, overgrazing, over exploitation, fires and other biotic factors. Forest has been lost at a substantially greater rate than regeneration. The AOI, in general is under significant biotic pressure and under retrogression due to various factors such as expanding human settlements, industrial activities and unsustainable practices which resulted in habitat loss, soil erosion and improper ecosystem functioning.

6.5.2 Flora

As the climate of the tract is arid sub-tropical, the flora found in the area is tropical thorn forest type, predominately thorny hard wooded species. Acacia species are distinctive in AOI. The trees in Project Area have usually short boles and low branching crowns, which rarely meet on exceptionally favorable spots. The usual height of trees is 6-9 meters. There is generally a mixture of species found in the tract. These trees have been raised mostly by the local farmers, along the boundaries of their agricultural fields.

Jhang District has hot semi-arid climate intermediating between desert climate and humid climate. The climate tends to have hot and sometimes extremely hot summers and mild warm winters. The soils are fertile and climate supports a variety of agricultural crops and vegetables, with scarce growth of indigenous flora and grasses.

The flora of the Project Area and AOI has been greatly affected by human interferences. The original vegetation of the tract consisted mainly Shamee (*Prosopis spicigera*) Karir (*Capparis aphylla*) and Vann (*Salvadora oleoides)*. With the advent of canal irrigation system in Punjab, the original vegetation of the tract was replaced by agricultural lands and settlements.

Natural forest cover has been significantly reduced in the past. Some of the older stands of trees, consisting of these species still survive in remote barren areas or in graveyards. There is probably now little natural vegetation left in tract.

The land owners have raised trees like Gum Arabic (*Acacia Arabica*), North Indian Rosewood (*Delbergia sissoo*), Chinese date (*Zizyphus jajuba)*, Mulberry (*Morus alba)*, Lebbek tree (*Albizzia lebbek)*, Chinaberry tree (*Melia azedarachta)*, etc., along the boundaries of their agricultural fields. Bodhi tree (*Ficus religiosa)* and Banyan Hindi *(Ficus bengalansis)* are grown for providing shade in their houses or deras.

6.5.2.1 Trees

Amongst trees the most common are Gum Arabic (*Acacia arbica*), North Indian Rosewood (*Dalbergia sissoo*), Chinese date (*Zizyphus jajuba)*, Mulberry (*Morus alba)*, Lebbek tree (*Albizzia lebbek*) Chinaberry tree (M*elia azerdarac)* and Indian lilac *(Azadirchata indica)*, which are planted for providing shade at the Deras. Farash (*Tamarix articulate*) are also found in the area, particularly along nullahs and rivers. Trees found in the area, are listed below:

Table 6.19: Trees in the AOI

S. No.	Local Name	Common Name (English)	Scientific Name	IUCN Status
1.	Kikar	Gum Arabic	*Acacia nilotica*	----
2.	Shisham/Tahli	North Indian Rosewood	*Dalbergia sissoo*	----
3.	Ber	Chinese date	*Zizyphus sp.*	----
4.	Sufeda	River red gum	*Eucalyptus camaldulensis*	----
5.	Toot	Mulberry	*Morus alba*	----
6.	Neem	Indian lilac	*Azadirachta indica*	----
7.	Sirris	Lebbek tree	*Albizia lebbek*	----
8.	Lasura	Assyrian plum	*Cordia myxa*	----
9.	Khajoor	Date Palm	*Phoenix dactylifera*	----
10.	Jaman	Jambul	*Syzygium cumini*	----
11.	Bakain	Chinaberry tree	*Melia azadirachta*	----
12	Aam	Mango	*Mangifera indica*	Data Deficient
13	Amrood	Guava	*Psidium guajava*	----

No compact plantation or woodlots exist in the Project Area or its vicinity but scattered trees are grown in the farm lands in linear pattern. These consist of Gum Arabic, Indian rosewood, Lebbek, Date Palm etc. species.

6.5.2.2 Shrubs and Herbs

Shrubs and herbs which are commonly found in the AOI include Camelthorn (*Alhaji maurorum*), Gokshura (*Tribulus terrestis*), Rubber bush (*Calatropis procera*), Seabligh (*Sueda fruticosa*), Phogs (*Calligonum polygonides*), Pers (*Sesbania aculeata*) and Bitter Apple (*Citrullus colocyntbus*). Salt cedar (*Tamarix gallio*) is found on moist sandy soil along the rivers and is used for wicker-work, basket making etc.

A list of Shrubs and Herbs found in the AOI is given in Table 6.20 below:

Table 6.20: Shrubs and Herbs in the AOI

Sr. No.	Local Name	Common Name (English)	Scientific Name	IUCN Status
1.	Jawan	Camelthorn	*Alhagi maurorum*	----
2.	Bhakra	Gokshura	*Tribulus terrestis*	----
3.	AK	Rubber bush	*Calotropis procera*	----
4.	Lana	Seabligh	*Suaeda fruticosa*	----
5.	Phog	Phog	*Calligonum polygonoides*	----
6.	Jantar	Pers	*Sesbania aculeata*	----
7.	Tumba	Bitter apple	*Citrullus colocynthis*	----
8.	Bathu	Jerusalem Oak	*Chenopodium botrys*	----
9.	Arind	Castorbean	*Ricinus communis*	----
10.	Pilchhi	Salt cedar	*Tamarix dioica*	----

Pers (*Sesbania bispinosa)*, Bitter Apple (*Citrullus colocynthis)* and Jerusalem Oak (*Chenopodium album*) are found mostly grown in left over agricultural fields, while Castorbean (*Ricinus communis)* is present mostly along the water channels. The remaining shrubs and herbs grow in open places.

6.5.2.3 Grasses

The most common grass of the tract is Bermuda Grass (*Cynodon dactylon)*. It is a useful fodder grass. Other grasses in the area are Lemongrass (*Cymbopogan jawarnica)*, Aini (*Elionorus hirsutus)*, Little Millet (*Panicum antidotale)*, Munja *(Saccharum munja)* and Halfa grass (*Typha angustata)*, which are found along the water courses or in moist places. Grasses found in the AOI are given in the below Table 6.21.

Table 6.21: Grasses in the AOI

Sr. No.	Local Name	Common Name (English)	Scientific Name	IUCN Status
1.	Khabbal	Bermuda grass	*Cynodon dactylon*	----
2.	Gam or Mali	Little Millet	*Panicum antidotale*	----
3.	Sinn or Gorkha	Aini	*Elionorus hirsutus*	----
4.	Khawi	Lemongrass	*Cymbopogan jawarnica*	----
5.	Dib	Lesser Bulrush	*Typha angustata*	----
6.	Kana	Munja	*Saccharum munja*	----
7.	Chhimber	Yard-grass	*Eleusine flagellifera*	----
8.	Kai	Wild Sugarcane	*Saccharum spontaneum*	Least Concern
9.	Dub	Halfa grass	*Desmostachya bipinnata*	Least Concern

6.5.2.4 Endangered Flora

No endangered flora was found in the tract during baseline survey. Original flora of the tract, which consisted of trees like Shamee tree (*Prosopis spicigera),* Vann *(Salvadora oleoides)* and Karir (*Capparis aphylla)* was cleared for raising crops at the advent of irrigation system through canals.

The above mentioned trees now exist only in graveyards or barren places. As their further plantation is discouraged, these trees need protection, since they are symbol of our culture and past history.

6.5.3 Fauna

As already mentioned, the AOI once covered with thorn forests, and now converted to agricultural land. Most of the natural fauna has also been eradicated with the removal of natural Tropical Thorn Forest.

6.5.3.1 Mammals

The AOI being agricultural land is not very rich in wildlife Mammals. However, common mammals are Jackal (*Canis aurecus*), Squirrel (*Sciuridae funambulus*), Fox (*Vulpus vulpus*), Rats (*Mus musculus*) and Mangoose (*Herpestes auropunctatus*). Wild bear (*Sus scrofa)* is also reported in the area, but its number has been reduced to a bare minimum due to extensive hunting and shooting.

Porcupine (*Hystrix indica*) is common and causes enough damage to young plants and crops.

Domestic animals include goats, sheep, camels, cows and buffaloes. Another important domestic draught animal in the area is donkey which is used for pulling carts etc. A list of Mammals and Reptiles found in the area is given in Table 6.22 below:

Table 6.22: Mammals in the AOI

S. No.	Common Name	Scientific Name	IUCN Status
1.	Jackal	*Canis aureus*	Least Concern
2.	Fox	*Vulpus bengalensis*	Least Concern
3.	Porcupine	*Hystrix indica*	Least Concern
4.	Squirrel	*Sciuridae funambulus*	----
5.	Mouse	*Funambulus pennanti*	----
6.	Mongoose	*Herpestes javanicus*	Least Concern
7.	Wild Boar	*Sus scrofa*	Least Concern
8.	Hog Deer	*Axis porcinus*	Endangered
9.	Wolf	*Canis lupus*	Least Concern

6.5.3.2 Reptiles

Common reptiles found in the AOI include snakes like Cobra (*Naja naja*), Rattle Snakes and Rat eater Snakes. Small and medium sized Lizards are also a common sight. These include Spiny Tailed Lizard (*Uromastix hardwickii*) and Finged Toed Lizard (*Acanthodactylus cantoris*). Turtles are common during short rainy season and along moist place. A list of Mammals and Reptiles found in the area is given in Table 6.23 below.

Table 6.23: Reptiles in the AOI

S. No.	Common Name	Scientific Name	IUCN Status
1.	Indian Cobra	*Naja naja*	----
2.	Spiny tailed Lizard	*Uromastyx hardwickii*	----
3.	Fringed Toed Lizard	*Acanthodactylus cantoris*	Least Concern
4.	Turtle	*Kachuga smithii*	Near Threatened
5.	Indian Krait	*Bungarus caeruleus*	----

6.5.3.3 Birds - Avifauna

Important bird species observed in the tract during baseline surveys are Common Crow (*Corvus splendens)*, Indian Myna (*Acridotheres tristis)*, House Sparrow (*Passer domesticus)* and Pigeon (*Columba livia*), which are abundant in the area and are frequently sighted. Red-vented Bulbul (*Pycnontus cafer)* and Old World Quail (*Coturnix coturnix)* were also seen in the Project Area and AOI. Grey and black partridges, though present in the area have been reduced to a minimum quantity due to excessive hunting. Other birds include Indian Roller (Chai) and Quail (*Coturnix ypsilophora)*.

Water fowls are seen in abundance during Kharif season, along the agricultural fields which remain full of water for rice cultivation, along the canal sides and the in nearby pond area of Head Trimmu. These waterfowls include little and medium sized Egrets, Mallard (*Anas platyrhynchos*) and White-Breasted Waterhen (*Amaurornis phoenicurus)*. Houbara Bustards (*Chlamydotis undulate*) and Falcon (*Falco peregrinus)* are also present in the area, but in a very limited number. Birds seen and reported in the tract are given in Table 6.24 below:

Table 6.24: Common Birds

Sr. No.	Common Name	Scientific Name	IUCN Status
1.	Indian myna	*Acridotheres tristis*	Least Concern
2.	House Crow	*Corvus splendens*	Least Concern
3.	House sparrow	*Passer domesticus*	Least Concern
4.	Asian koel	*Eudynamys scolopacea*	Least Concern
5.	Parrot	*Psittacula krameri*	Least Concern
6.	Pigeon	*Columba livia*	Least Concern
7.	Patridge Grey	*Francolinus pondicerianus*	Least Concern
8.	Patridge Black	*Francolinus francolinus*	Least Concern
9.	Old World quail	*Coturnix coturnix*	Least Concern
10.	Little Egret	*Egretta garzetta*	Least Concern
11.	Mallard	*Anas platyrhynchos*	Least Concern
12.	Jal Kookri	*Fulica atra*	Least Concern
13.	Red-vented Bulbul	*Pycnontus cafer*	Least Concern
14.	Hoo poe	*Upupa epops*	Least Concern
15.	Indian Roller or Blue Jay	*Coracias benghalensis*	Least Concern
16.	Falcon	*Falco peregrinus*	Least Concern

6.5.3.4 Migratory Birds at Trimmu Barrage

A study was carried out by Government College University Faisalabad during the year 2009 to identify the avifauna at Trimmu Barrage, which is part of AOI. The study revealed that among 89 bird species recorded in the area, 29 species were migratory and winter visitors while remaining

52 species are resident, which inhabit the area throughout the year for nesting, resting, feeding and breeding.

Different types of migratory waterfowls visit Trimmu Barrage wetland during winter. The most abundant are Jal Kookri *(Fulica atra)*, Common Teal (*Anas crecca)*, Common Duck (*A. acuta*) Duck Spp (*A. platyrhynchos*), Eurasian Wigeon (A. *penelope)* and Common Pochard *(Aythya ferina)*. Other species found in the area are Little Grebe (*Tachybaptus ruficollis)*, Little Cormorant (*Phalacrocorax niger)*, Heron (*Ardea cinerea*), Cattle Egret *(Bubulcus ibis*), Little Egret *(Egretta garzetta*), Paddy Bird (*Ardeola grayi*), White-breasted Waterhen (*Amaurornis phoenicurus*), Common Moorhen (*Gallinula chloropus)*, Swamp Hen *(Porphyrio porphyria)* and Bombay swamp eel (*Hoplopterus indicus)*. Waterfowls (*Anseriformes*) are important game species and are a great source of food for sport hunters.

As per study, little Ringed Plover (*Charadrius dubius*), Little Cormorant (*Microcarbo niger*), Common Teal (*Anas crecca*), Little Egret *(Egretta garzetta*), Common Coot (*Fulica arta*) and Mallard (*Anas platyrhynchos*) are populated species in area.

6.5.3.5 Endangered, Vulnerable and Near Threatened Fauna

a) Hog Deer

The Hog Deer *(Axis porcinus*), historically occurred in Pakistan, in grass lands along the banks of rivers and in manmade forest plantations raised during the British era, such as Changa Manga, Peerowal, Chicha Watni, Khanewal and nearby Shorkot Plantation. In the past, these species have been subjected to extensive hunting and shooting, resulting in their present small population, mostly confined to game sanctuaries, wild life parks and forests. Another reason for their reduction was habitat loss and degradation of suitable environments. Hog deer normally avoid cultivated areas and prefers uninhibited wilderness. Hog Deer, which were often seen in the AOI in the old times, are now have become almost non-existent in the area. Hog deer are now seen rarely in uncultivated wild areas i.e. in Shorkot plantation (which is approximately 20 km away from project site).

Hog Deer is categorized as Endangered by IUCN. In its native range, Hog Deer is associated with major river systems and floodplains. Hog deer are not generally found in steep or hilly terrains. Hog deer primarily inhabit grassland and riverine forests.

b) Houbara Bustard

Houbara Bustard (*Chalmydotis undulate*) is categorized as “Vulnerable” in the IUCN Red List. It is also listed in CITES Appendix I, pertaining to species that are vulnerable to hunting and poaching due to their economic value. Large number of Houbara Bustard are illegally hunted and trapped, mainly in Pakistan and Iran, and shipped to Arabia for use in training falcons to hunt. Houbaras are also hunted and killed for their meat. Habitat loss and degradation compound this problem.

The specie was noticed in the surroundings of Head Trimmu and River Chenab within AOI. As per District, Wildlife Officer Jhang, Houbara bustard is found in the wild and desert areas of district Jhang in Pir Sukhera area, located nearly 30 Kms away from the project area.

Houbara bustard utilises varied habitats for nesting and breeding. These habitats range from distinct vegetation to sandy and stony semi-desert areas. It typically lays 2-4 eggs in a scrape on the ground. Eggs and new born babies are susceptible to ground predators.

Between February and April the female lays two or three eggs in a small scrape. After hatching, the chicks follow the female for protection as it feeds. The chicks are vulnerable to predators, including Eagles, Falcons, Foxes, Wolves, Monitor Lizards, Snakes and Kestrels.

c) *Kachuga smithii* (Fresh Water Turtle)

It is fresh water turtle and is found in the AOI in TS link canal, Haveli Main Line, Head Trimmu and Chenab River. As per IUCN list, this species is designated as "Near Threatened".

Kachuga smithii commonly basks in aggregations. This species exists in nearly all the rivers of Pakistan and major canals, particularly link canals.

Freshwater turtles play a significant role in aquatic ecosystem being scavengers. These turtles are responsible for cleaning the aquatic environment by feeding upon dead organic material and diseased fish. Freshwater turtles being a keystone species also control the population of fish.

Nesting of *Kachuga smithii* is recorded in between late October and late November (or early December). Hatching season comes in May. The breeding cycle of turtles is so timed egg layings, egg hatching and birth of new ones are brought both at a time most favourable for their survival.

6.5.3.6 Fisheries

Several fish farms exist in the vicinity of Project Area, including the adjacent TS-Link canal and nearby pond area of Head Trimmu. Fisheries Department Jhang, leases out the area of TS-Link Canal, falling within their jurisdiction and pond area of Head Trimmu every year. As per Supervisor, Fisheries Department, Jhang, their revenue from these sources for the year 2016-2017 is shown in Table 6.25.

Table 6.25: Revenue of Fish Farms for the year 2016-17

Sr. No.	Site	Revenue for 2016-2017 (Pak Rupees)
1	Chenab River Upstream 1 Km (Trimmu HW)	6.5 million
2	Chenab River Downstream 1 Km (Trimmu HW)	1.6 million
3	Haveli Main Canal	0.6 million
4	T. S. Link Canal	0.95 million

Major carps found in pond area of Trimmu Head Works and Link Canal are Indian carps, such as Rahu/Labeo (*Labeo rohita*), Thela/Catla (*Catta catta*), Mrigal (*Cirrhinus mrigala*), Long-Whiskered catfish (*Aorichthys aor*), and Rita (*Rit rita*). Out of these varieties, Rahu/Labeo (*Labeo rohita*) and Long-whiskered catfish (*Aorichthys aor*) are the most delicious, but their catches are being reduced every year due to lesser water levels and enhanced pollution. All these species are commercially important, in particular the Rahu and Mori. Other aquatic fauna found in TS Link canal and pond areas are turtles, frogs etc.

6.5.4 Agriculture

Agriculture is the predominant land use in the area, where irrigation mainly depends upon tube wells installed in the Project Area. The agriculture is by far the main economic activity in the area.

6.5.4.1 Crops

The main crops during Rabi are Wheat, Gram, Rape, Mustard, Barley and Oil Seeds. In Kharif season, Sugarcane, Rice and Maize are grown. Wheat, Sugarcane and Rice are the major crops, whereas Guava, Mango and Citrus are the major fruits of the area.

6.5.4.2 Cropping Pattern

The crop pattern followed in the Project Area includes both Rabi and Kharif crops. Rabi crops are sown during the months of November to December, and harvested during April to May.

Kharif crops are sown during May to June and are harvested in the month of October and November. Major Rabi crop is wheat and major Kharif crops are sugarcane, Cotton and Rice.

6.5.4.3 Yield and Income

Per acre yield and income derived from production of main crops is given in Table 6.26 below. The information was obtained from Assistant Director, Extension, Agriculture Extension, Jhang.

Table 6.26: Yield from Crops

Sr. No.	Name of crop	Production/Acre	Income from one Acre (Rs.)
1	Wheat	1,800 Kg	60,750
2	Sugarcane	48,000 Kg	216,000
3	Rice	2,000 Kg	100,000
4	Cotton	1,000 Kg	75,000
5	Vegetables	--	10,5000

6.5.5 Eco-System Services in the Project Area

Ecosystem services include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other services. Ecosystem services are expanded rom the availability of adequate food, fuel and water, to disease regulation of vectors, pests, and pathogens. Moreover, human health benefits and maintenance of natural environment are also part of it.

In the power plant area provisional, regulatory, habitat, and ancillary ecosystem services are simultaneously exploited and least recognized.

The EIA team observed during field visit that the AOI is mainly agricultural. The agricultural ecosystem of the AOI provides the following types of services:

d) Provisioning services which are food (growing crops and livestock), fuel (wood, dung), wood for the construction of houses, grass / reeds for thatching, etc. and few species of herbs for treatment of various diseases;
e) Regulating services such as trees and other plants which consume CO_2, purify and maintain air quality. Trees also provide shade to the community of AOI;
f) Supply of required nutrients to soil for the growth of plants and hence positive influence on livestock's food (fodder); and
g) Rice paddies and ponds can provide feeding and resting habitat for water birds and amphibians.

6.6 SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

6.6.1 General

For acquisition of baseline data on socio-economic and cultural environment, social surveys in the Project Area were conducted. The basic objectives of the social surveys were to:

- Observe and document the existing socio-economic settings of the Project and AOI;
- Identify the potential impacts associated with the implementation of the proposed Project;
- Get feedback from community about existing power plant issues and potential social issues related to the new power plant; and
- Evaluate the possibilities of addressing the feedback/concetns/issues in the report.

Baseline information was collected from direct and indirect affectees during the field visit. The people whose land and houses or any other structure will be directly affected by the project implementation are called direct PAPs while indirectly affected are those people who will have to face impacts of proposed Project indirectly.

6.6.2 Tools Used for Social Data Collection

Socio-economic survey of the selected households in the Project area and villages in AOI (as listed in Table 6.27) was carried out. During the socio-economic survey, 99 respondents from the Project area and AOI were selected as sample size by calculation with 95% confidence level and 10% confidence interval. On the basis of information provided by respondents during social survey by EIA team, population of villages in AOI was estimated as 25,600.

For AOI, the respondents were selected by using systematic random sampling technique, however, in Project Area all the PAPs were considered. Questionnaires were developed to collect the baseline data, based on the demographic and socio-economic indicators. Interviewing technique was used as a tool for data collection. In order to quantify the existing baseline conditions of the AOI, collected data was analyzed digitally by using SPSS.

During the survey, people were informed about the objective and purpose of the Proposed Project. In particular, apprehensions of the locals regarding issues of existing power plant and the proposed plant were discussed. Public Consultations and Focus Group Discussions (FGDs) were held in the villages located in the AOI as well as within project boundary, to clarify the Project related works and activities in detail and also to record the concerns and suggestions of the people. The total number of houses in each village was identified either through observatory analysis and the figure quoted by the residents during the questionnaire survey.

Table 6.27: Villages Surveyed during Socio-economic Survey in the AOI

Sr. No.	Name of Village	Number of Houses
1	Basti Shammewala (Moza Kot Dewan)	41
2	Nava Kot	60
3	Kot Dewan	200
4	Dhueen Moza	200
5	Basti Arain	50
6	Dera Sahat	35
7	Basti Kora Wala	40
8	Basti Rasheedwala	65
9	Moza Qadeemi	800
10	Malu Mor	1500
11	Moza Mansoor Sial	800
12	Basti Mehmooda Abad	30
Total		**3821**
Average Household size as per socio-economic survey **(B)**		**6.7**
Estimated Population in all villages surveyed **(C=A x B)**		**25,600**

Sample proformas used during the survey are attached as Annex-4. The villages consulted during the socio economic survey are shown in Figure 6.6.

6.6.3 Political and Administrative Settings

The district Jhang is managed by the Deputy Commissioner who is District Magistrate as well as district Collector. District Magistrate is responsible for law & order and other allied matters in district Jhang. In this capacity, he is assisted by Additional District Magistrate (Additional Deputy Commissioner), Sub-Divisional Magistrates and Ilaqa Magistrates.

Jhang district is divided into three tehsils which are:

1. Jhang;
2. Shorkot; and
3. Ahmedpur Sial.

Proposed project falls under the jurisdiction of tehsil Jhang.

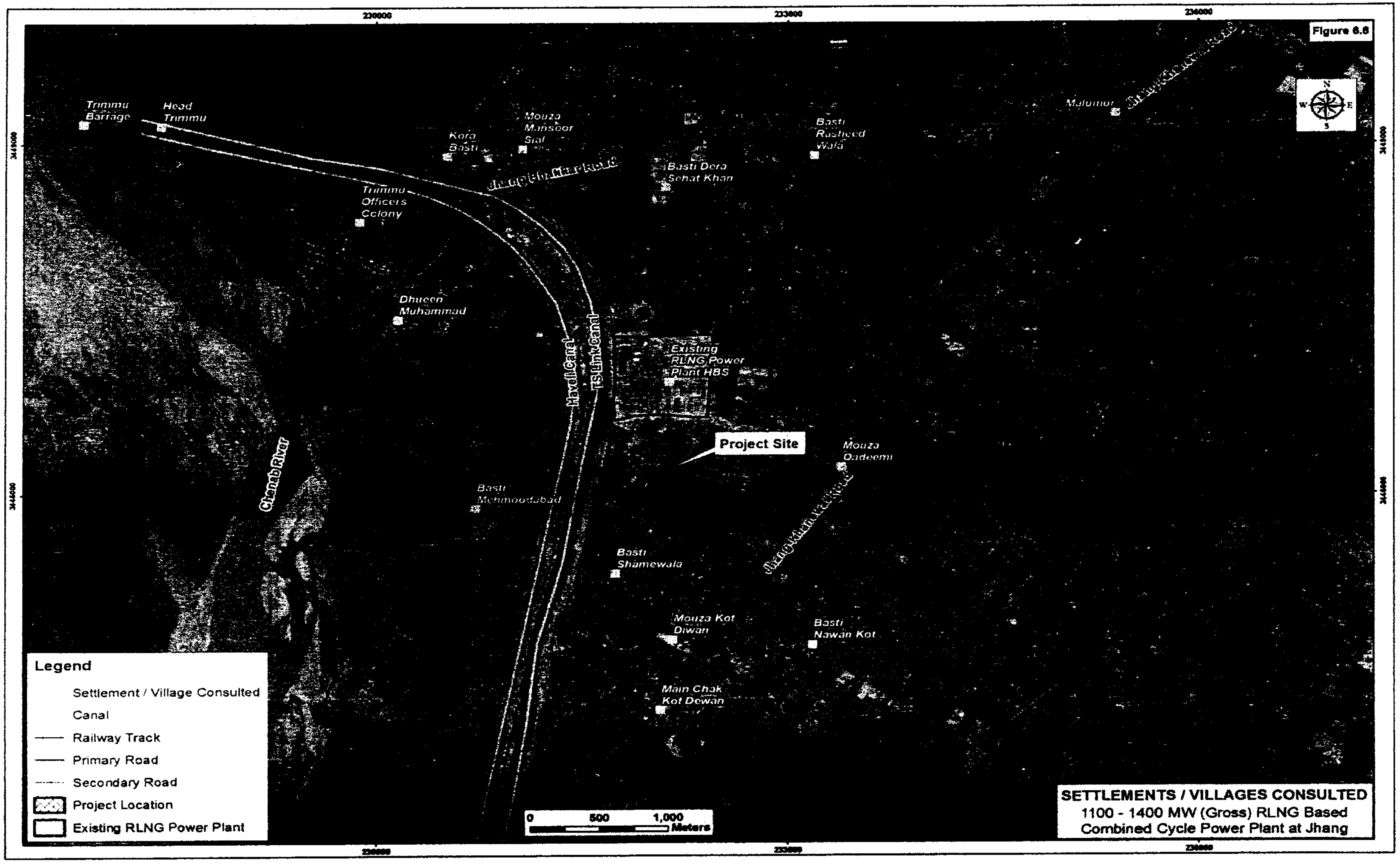


Figure 6.6: Settlement / Villages Consulted for Proposed Project

6.6.4 Demographic Characteristics of the AOI

6.6.4.1 Sample Population and Family Size

Based on the socio-economic survey of the selected households in the AOI, the overall population of 99 households was calculated as 663. Average household size was concluded as about 6.7. The sex ratio (males per 100 females) for the AOI is found to be 106.9. Detail is given in Table 6.28 below.

Table 6.28: Sample Population and Family Size

Sr. No	Age Group (Years)	Male		Female		Total	
		No.	Percentage	No.	Percentage	No.	Percentage
1	0-4	38	11.1	29	9.1	67	10.1
2	5-9	48	14.0	31	9.7	79	11.9
3	10-19	66	19.2	75	23.4	141	21.3
4	20-39	90	26.2	88	27.5	178	26.8
5	40-49	75	21.9	62	19.4	137	20.7
6	50-59	18	5.2	22	6.9	40	6.0
7	60 and above	8	2.3	13	4.1	21	3.2
	Total	**343**	**100**	**320**	**100**	**663**	**100**

* Men per 100 women

The sex ratio in district Jhang as computed in 1998 was 108.4 males per 100 females. The sex ratio based on the household size estimated during baseline surveys is 107 males per 100 females. The ratio depends on the factors such as the sex ratio at birth, differential mortality rates between the sexes at different ages, and losses and gains through migration. In rural areas of Pakistan, sons are preferred because (i) they have a higher wage-earning capacity, (ii) they continue the family line; and (iii) they are generally recipients of inheritance. Girls are often considered an economic burden because of the dowry system and after marriage they typically become members of the husband's family, ceasing to have responsibility for their parents in illness and old age.

6.6.4.2 Age and Marital Status of the Respondents

As per information provided by respondents, 98% were married. Almost 57% respondents were from age group of 36-50 years. Details of age of the respondents along percentage are shown in Figure 6.7.

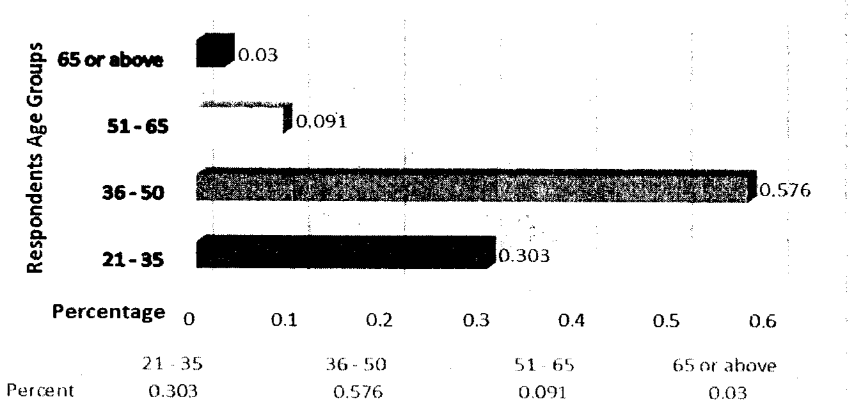


Figure 6.7: Age Distribution of Respondents in the AOI

Endogamy is the prevalent style of marriage. Most of the people are monogamous as second marriage is not affordable. Mothers have limited role in decision-making about marriages of their sons and daughters. Neither the groom nor the bride is allowed to choose his or her life partner in rural areas. The decision of the parents is considered final; however, in some scenarios the bridegroom is consulted before the final decision.

6.6.4.3 Languages Spoken

Punjabi is the predominant language being spoken in the AOI. However Urdu is also understood.

6.6.4.4 Ethnicity and Minority Groups

The population of the villages in AOI is predominantly Muslim and only few number of households were found Christians.

The core unit of social organization is the caste system ("biraderi" in local language) in which groups are either defined on the basis of specific occupation or lineage. Occupationally defined caste groups are considered as lower status in the social setup. For instance occupationally defined biraderi/caste groups are Mochi (cobbler), Machi (fisherman), Nai (barber), Gujjar (dairy and livestock farmers), Julahay (weavers) while lineage based biraderi/caste groups include Khokar, Sial, Malik, Rajput, Bhatti, Jutt, Kullah, Mian, Khurral, Syed, and Cheema. The social life of the local population is traditionally organized.

Based on the household survey, the population in the AOI has many castes. The major caste/ethnic groups are Arain, Sial, Sipra, Bharwana, Khurral, Bhutta, Sheikh, Khokar, Malik, Rehmani, Bhatti, Syed, Cheema, Mochi, Sindhu, Rana and Baloch. Among all the castes mentioned, Sial, Bharwana, Arain, Syed, Rahmani, Sheikh and Bhatti are the dominant castes in the AOI.

During the field survey, it became apparent that some castes were influential because they have a key role in decision-making regarding the resolution of social issues. For instance, landlords (locally named as Chaudry/Mahar) as well as the heads/or elders of the respective caste generally make decisions related to the social issues at village level and the social development works in their areas. Prior to any Project/ programme to be initiated, it is essential to involve these groups right from start of the Project i.e. planning, design and implementation of the power plant, to make the Project successful. In the AOI, local councilors, chairman and deputy chairman are the influential persons while in rural setup Numberdar and councilors have influence.

6.6.4.5 Migration in the AOI

Migration, especially internal migration in Pakistan, is an old phenomenon. It not only provides opportunities for employment but also improves the socio-economic conditions of migrant households. Lack of employment opportunities coupled with inadequate income from farming are considered the leading cause of migration. Similar is the case with the population residing in the AOI and their migration to other areas.

During the field visit, locals informed that they are forced to migrate due to lack of jobs and business opportunities. In the majority of the cases, male members usually migrate to other cities such as Faisalabad and Lahore. Faisalabad is an industrial city and has several job opportunities. Being the divisional headquarters, there are many educational institutions which also attract migrants (e.g., Government College University, Agriculture University, Science College, and Faisalabad University).

People move to big cities like Lahore for similar reasons. If a person moves to a big city, he prefers to retain his ties with his native village. His rights are still acknowledged even after his departure. Typically, the migrants send part of their earnings to the family members in villages. Mostly, residents return to their village for work at peak agricultural seasons. Sometimes married migrants leave their families in the village when they initially migrate. The decision to migrate wife and children to big cities has always been a difficult one. In some cases, if a man is away from his family, his wife often takes responsibility for day-to-day business dealings that are considered the responsibility of men.

6.6.5 Literacy

In villages such as Kot Dewan, Moza Dhueen, Moza Mansoor Khan, Malu Mor and Moza Qadeemi, primary schools for boys and girls are present while high schools are in Trimmu Colony and Malu Mor. However, no degree college and vocational institution were found in the AOI for boys and girls.

The majority of the respondents in the AOI were illiterate and their weightage is 27.3% followed by respondents having 23.3% primary, 17.2% middle and 13.1% secondary level education. Detail of the education level of the respondents is given in Figure 6.8 below.

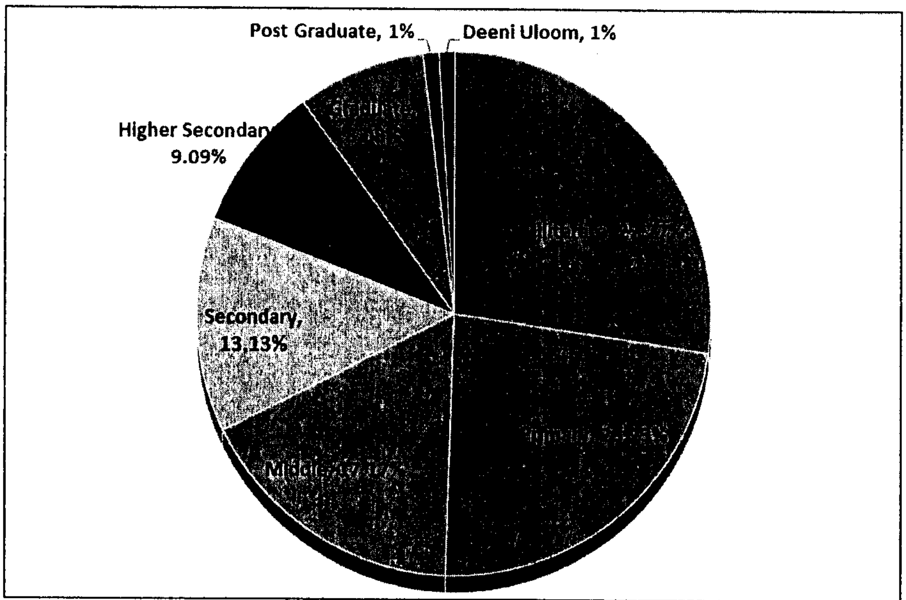


Figure 6.8: Literacy Level of Respondents

Most of the people in the AOI are poor and cost of education is another determinant factor for parents to decide whether to send their children to school or not. Therefore, poor people do not send their children to school.

Based on the field survey and discussion with the locals, it is noted that female literacy rate is lower as compared to males. Locals give least importance to female education. Few reasons of low literacy rate among women are discussed below:

- The major cause of women illiteracy is increase in population, which is playing a negative role in deprivation of female education. A family having more children and less income usually prefer to educate their boys only, while the girls are taught embroidery or sewing skills;
- The number of schools and colleges for females are few (one high school in Malu Mor). Girls have to travel a long distance to reach the schools or colleges in the AOI. For this reason most parents prefer to give them religious education at home.
- There is also misconception that females have to manage home after marriage whereas males have to earn for livelihood, so education matters only for males and not for females;

- Some families do not like their daughters to study in co-education institutes thus depriving them of higher education; and
- The social setup is male dominated and girls are restricted to homes and can not go out freely thus any male of the family has to take responsibility for grocery and other household supply etc. This sometimes seems difficult to them. There is also a sharp division between female oriented work and male oriented work. Females are not allowed to work in all sectors and females' education is not considered valuable for society.

6.6.6 Family System

Joint family system is dominant culture in the AOI. It was observed that the family structure in the area was very strong and elders play pivotal role in solving their social and cultural problems.

Many families are living in joint family system comprising grandparents, uncles, aunties and too many cousins, whereas only a small percentage of families are living separately (nuclear family system). Although the joint family system is generally undergoing a radical change, with a greater influence of media and education, people of the AOI are not in favor of this change. As joint family system contains rich emotional attachments, therefore such families feel that nuclear family system will weaken the family ties and may damage their relationships.

As per the locals, joint family system is like an organization having defined norms and values to which are followed religiously by all the members. All the members have their defined tasks and responsibilities to perform. Each member of the family equally shares the available resources such as money, food and other requirements. Locals feel better in joint family system as compared to nuclear family.

During the discussion with the locals, it was clarified that large family size is also treated as the strength of the family.

6.6.7 Occupations

The dominant source of income in the AOI is agriculture which is 78.8% (refer Figure 6.8). The second major source of income identified in the AOI was labour. Only few people were found who use to work in other occupations. However, majority of the respondents are small land holder, therefore they are forced to adopt other source of income such as labour in existing power plant, livestock, small level general stores etc. Detail about occupational distribution of the respondents is in Figure 6.9.

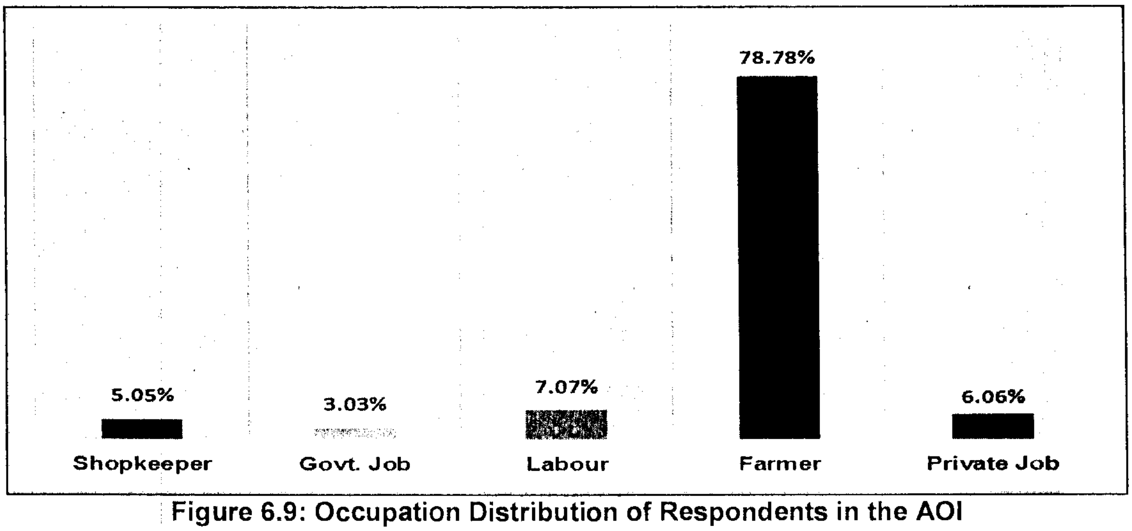


Figure 6.9: Occupation Distribution of Respondents in the AOI

6.6.7.1 Income Levels

The main sources of income in the entire AOI are agriculture and labor work. During the social survey, it was found that most of the respondents are working as labour in power plant and this is their second important source of income. In few cases two to three family members are doing job at existing HBS plant. Locals expect jop opportunities with the proposed Project with reasonable wages. In AOI, residents have no practice of borrowing money from any source to fulfill their needs.

The average monthly income of most of the respondents (mostly involved in agricultural works and labour) was found to be Rs. 15,001/- to 20,000/- i.e. 30.3%. Income levels of residents in AOI are shown in Figure 6.10.

As discussed most of the respondents are small land holders (less than 2 acres) having low income levels. However, income level has been improved due to job opportunities at existing Power Plant HBS. They will lose the job opportunities as construction would complete.

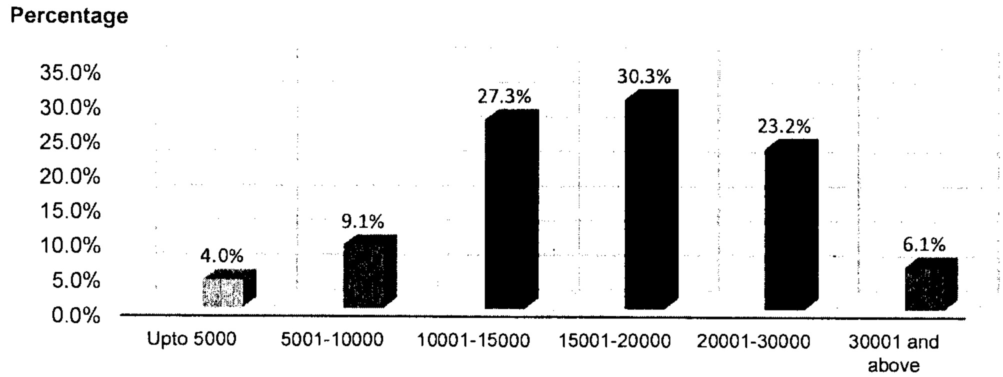


Figure 6.10: Income Level of Respondents in the AOI (in Pak Rs.)

6.6.7.2 Expenditures

In the Project Area, 33.3% people fall in the group, which spends Rs. 5001-10000 per month, while the lowest group i.e. 4% are those who spend Rs. 30,001 and above per month. Other categories of monthly expenditures along with their percentages are shown in Figure 6.11.

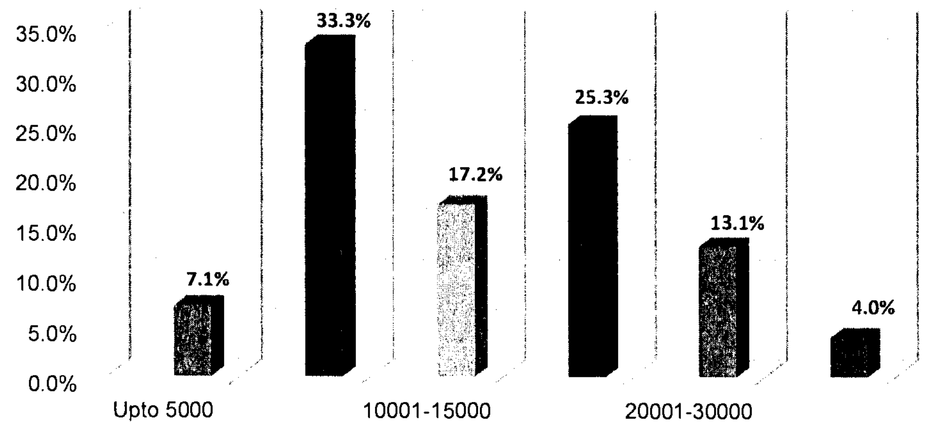


Figure 6.11: Average Monthly Expenditure of Households

6.6.8 Housing Characteristics

Housing characteristics is one of the major indicators for the assessment of the living standard of the population. Most of the houses are owned by dominant male in the house. However, joint ownership also exists in few houses. Most of the houses are ordinarily constructed, with moderate standard buildings made of cement and bricks.

Approximately 78.8% houses are pacca (made from brick, stone, and mortar) and 20.2% are semi-pacca (made of clay, inferior bricks and palstered with mortar). Types of housing structures in the area are given in Figure 6.12.

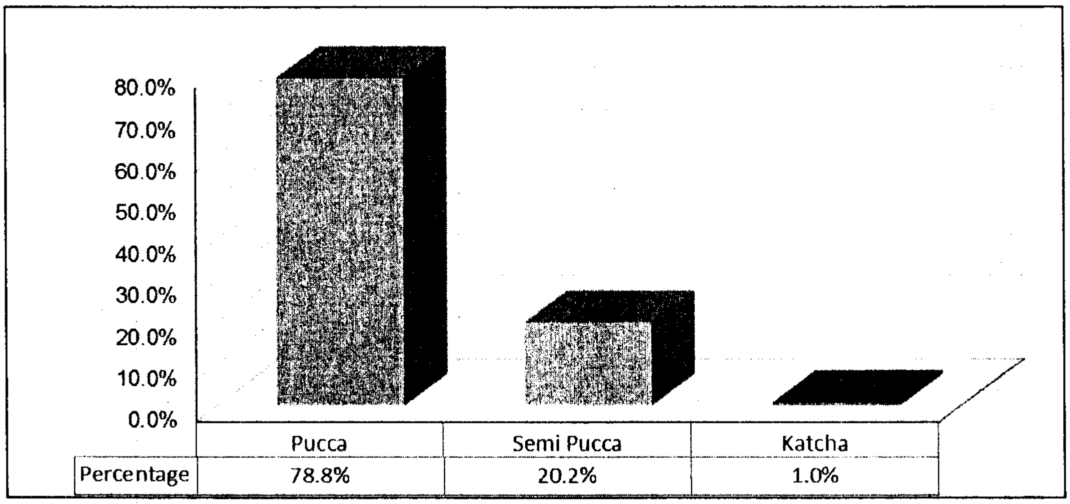


Figure 6.12: Type of Housing Structures

In the AOI, houses are generally owned by a single owner. None of the respondent was tenant of any house in AOI.

6.6.9 Amenities in the AOI

The availability of the basic infrastructure and social amenities, measures the development of the area and living standard of the people. During the social survey, data regarding the availability of village infrastructure including electricity, road, basic health unit/center, school, drinking water/water supply scheme, telephone, sewerage/drainage, fuel wood and sui gas were collected in order to identify the pressing infrastructural development needs of the villages located in the AOI.

The 'village profile' survey shows that out of 12 villages/settlement, only 60% of the villages/settlements in the AOI had access to roads, electricity, fuel wood and schools especially for boys; while the other facilities like health and education were not available as per requirement. Drinking water/ water supply schemes and sui gas were not available in a single village out of the 12 villages/settlements.

6.6.9.1 Health Facilities

Health facilities are generally inadequate in the AOI. People tend to get treatment from indigenous healers, due to the lack of suitable and sufficient health facilities. Poor sanitary conditions, insufficient medical facilities and meager parental care contribute to the prevalence of bad health and high rate of mortality in the area.

Most of the respondents reported that they were suffering from different diseases On the contrary, only one dispensary is available in Moza Kot Dewan which is not effective due to non-availability of MBBS doctor and lack of medicine. Small level hospitals with limited health facilities exist in Malu Mor and Haveli Bahadur Shah.

Nearby main city is Jhang where only one government level hospital is functioning but is in poor condition. Due to lack of staff and inadequate space it is overloaded and unable to accommodate the population. Therefore, locals have to cover long distances to reach health facilities in Faisalabad and Lahore Cities. The situation is worse for women in case of maternity issues. The majority of respondents informed that for childbirth cases, people have to move to Faisalabad (about 90 Km from AOI) due to lack of proper maternity facilities in the local hospital. In the AOI, private clinics are available and being run by dispensers with limited services.

6.6.9.2 Common Diseases

Diseases such as seasonal fever, cough, cold and flu are common amongst the people of the AOI. However, many people were found to be suffering from diarrhea as well.

6.6.9.3 Sewerage & Solid Waste Disposal

No public sewerage system was observed in Project AOI. Lined drainage channels were found in some villages which lead to a larger pond and sometimes drop into the nearby major drain passing near the Project Area. While most of the settlements drop their sewerage water into the nearby fields. Solid waste disposal is one of the major problems being faced by the residents of the area. People throw solid waste in the vicinity of their villages or burn it into a large pit. Most of the solid waste was found to be dumped in heaps near the villages in the AOI. Organic and livestock waste is collected in designated areas to prepare compost which farmers use in their fields as a soil conditioner.

6.6.9.4 Toilet Facilities

Type of the toilet used by the household indicates their living standard, health and hygienic conditions. Figure 6.13 depicts that 66.6% of the selected households in the AOI have flush type latrine, while 38.4% have open field toilet facilities. In Project area, open toilets are in practice.

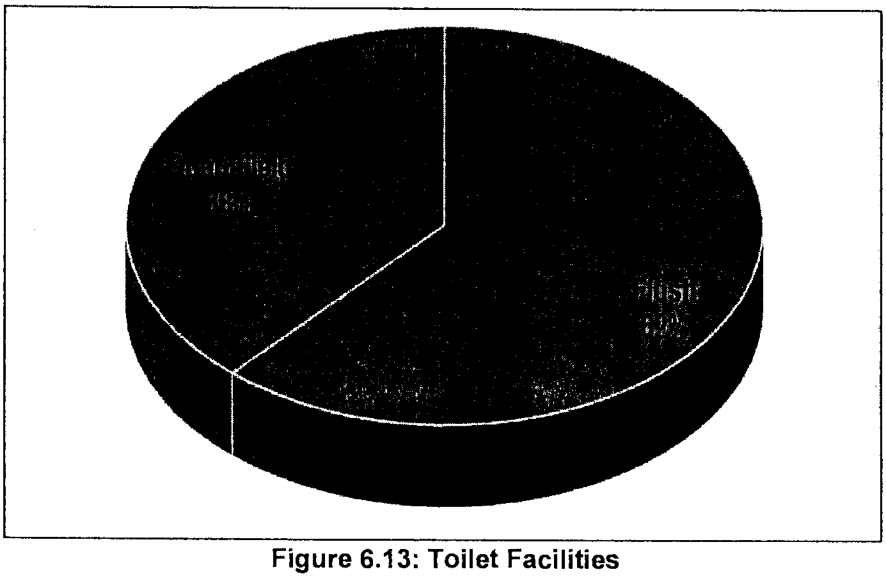


Figure 6.13: Toilet Facilities

6.6.10 Land Ownership and Tenure System

Agricultural work in the AOI is primarily performed by men but women and children are also involved in farming activities. Big land owners employ tenants for agricultural activities or give their land for cultivation on contract basis whereas small land owners cultivate their land by themselves with the help of their family members. The land owners in the AOI hire labor on a permanent basis. However, in the Project Area only small land holders exist and they cultivate their own land. Every farmer and landowner adopts a system according to his own will and resources. Generally landowners hire tenants on equal-share of crop basis. The laborers work throughout the season. After harvest, the crop is distributed as per agreed share between laborers and land owner. Some landowners hire the services of laborers on cash payment.

6.6.11 Livestock

A significant percentage of the workforce and households in the area is engaged in livestock rearing in addition to agricultural farming. The livestock farming is a traditional activity in the area; it comprises rearing of Cattle, Sheep and Goat and getting benefits from them in the form of dairy products and meat. Cattle constitute major portion of the livestock population within the area.

6.6.12 Commercial/Industrial Activities

Any noticeable commercial activity was not observed in the entire AOI except some grocery or general shops, godowns, workshops, markets etc. at Malu Mor and Kot dewan. There was only one textile industry (Sufi Textiles) situated on main road near Project Area. While already existing HBS Power Plant and one rice processing unit at Jhang-shorkot road are other main industries.

6.6.13 Crime & Conflict Resolution System

Crime and conflict resolution system mostly relied on the local culture. The local culture gives powers to elected chairman, vice chairman or Lumberdar of the villages. These persons are considered most influential to resolve the conflict issues of people as and when occurred in the area. The crime situation in the area is under-control as observed by EIA team and reported by respondents.

6.6.14 Security Situation and Movement of the Foreigners

At present, security & safety situation in the AOI is satisfactory. During the social survey, locals informed that there have been no incident of any threat to lives and there is no animosity towards foreigners. In the AOI there is a reasonable atmosphere for women. The local culture recommends modest dress for both men & women. Due to existing HBS power plant security of the area has already been improved.

6.6.15 Women Emancipation/Empowerment

Women in the AOI are mainly dependent on male members of their family for economic reasons. They have no opinion in the family matters and are not asked about their preference/acceptance for marriage.

The emancipation of women (i.e., their liberation from economic and sexual oppression, their access to higher education and their escape from narrow gender roles) is not easily achieved due to the traditional setup. In this rural society, males are dominant. Cultural tradition, social practices and low female literacy ratio have left women in a vulnerable position. Women are restricted to performing household work and are excluded from decision-making both on the domestic front and at the community level. Women's access to education and health care is limited because such services are not available close to home in the AOI. Women play their role in agricultural activities, collecting fuel wood and fetching water, in addition to household work and family duties.

Women in the AOI are also vulnerable through economic, social and psychological poverty. Economic poverty is due to lack of assets and low endowment of human capital. Social poverty derives from the inability of the society to accept women's equality and their economic, political and cultural rights, while psychological poverty is a product of the subjugation of women, under the dictates of customs and traditions, which deprives them even of control over their own lives.

Information which was collected through secondary sources and group discussion with locals shows that major problems faced by women in the area are lack of primary health care and education opportunities. Other problems include laborious work such as woods collection for cooking and heating, working in agricultural fields. These tasks not only affect their health but also take up major portion of their time.

6.6.16 Culture

The people of the area are found to be very humble, hospitable, gender sensitive and hardworkers. Decisions are mostly taken by head of the village but people also use to resolve their issues on their own first.

Religious monuments including mosques, shrines and graveyards are socially sensitive to deal with. Shrines and graveyards are regarded as sacred heritage and receive devoted attention from the people. The survey exposed that the people of the AOI were attached to their religion and culture.

As per information provided by the residents, one graveyard exists in the Project Area comprising 8 graves within the boundary line of the proposed power plant. However, during consultation with the Chief Resident Engineer-NESPAK at HBS power plant, he informed that graveyard will be excluded from the area.

6.6.17 Archaeological and Heritage Sites

A shrine of saint was also identified in Qadeemi village in AOI. One graveyard also exists within the Project Area boundary. However, no Archaeological site falls in the Project Area.

6.6.18 NGOs or CBOs

Non-Governmental Organizations (NGOs) and Community Based Organizations (CBOs) play a vital role in the socio-economic development of the area. For this project, no active NGO was found in the entire AOI.

CHAPTER–7: STAKEHOLDERS' CONSULTATION

7.1 GENERAL

Stakeholders' involvement especially the local population is an important feature of the environmental assessment and can lead to a better and more acceptable decision-making regarding the project design and its implementation. It gives the feeling of an ownership to the local population.

7.2 OBJECTIVES

The objectives of stakeholder consultation were to contribute openness, transparency and dialogue. The concerned stakeholder groups were identified to include in the assessment process.

The objectives of stakeholders' engagement include:

- Informing the stakeholders about the proposed project;
- Providing an opportunity to those who remained unable to present their views and values, therefore allowing more sensitive consideration of mitigation measures and trade-offs;
- Providing those involved with planning the proposal with an opportunity to ensure that the benefits of the proposal are maximized and that no major impacts have been overlooked;
- Providing an opportunity for the public to influence the project design in a positive manner;
- Increasing public confidence in front of Proponent, reviewers and decision makers;
- Providing better transparency and accountability in decision making;
- Reducing conflict through the early identification of contentious issues, and working through these to find acceptable solutions;
- Creating a sense of ownership of the proposal in the minds of the stakeholders; and
- Developing proposals which are truly sustainable.

7.3 STAKEHOLDERS' IDENTIFICATION

Stakeholders were identified, categorized and consulted at provincial level (EPD, Irrigation Department, Agriculture Department, Wildlife Department, Archaeology Department etc.), district level (EPD, Agriculture Department, Fisheries Department, Wildlife Department, Forest Department etc.) and at village level (Direct and Indirect Affectees and Locals from AOI).

Consultation with the provincial and district level departments were carried out through meetings and presentations while consultations with locals, village people, directly affected people, local NGOs etc. were undertaken during the baseline survey of the AOI. The consultation is an on-going process which should be continued during the project life cycle i.e. even after submission of EIA.

At EIA stage of Project, consultations were done with the following;

7.3.1 Provincial Level Stakeholders

1. Environmental Protection Department, Punjab;
2. Archaeology Department;
3. Agriculture Department, Punjab;
4. Forest Department, Punjab;
5. Wildlife Department, Punjab;
6. Irrigation Department, Punjab; and
7. Fisheries Department, Punjab.

7.3.2 District Level Stakeholders

1. Environment Protection Department, Jhang;
2. Agriculture Department, Jhang;
3. Forest Department, Jhang;
4. Wild life Department, Jhang;
5. Irrigation Department, Head Trimmu;
6. Fisheries Department Jhang;
7. Communication and Works Department; Jhang;
8. Revenue Department;
9. Local Government;
10. WAPDA, Jhang Office; and
11. Municipal Committee, Jhang Office.

7.3.3 Village Level Stakeholders

1. Project Affected Persons (PAPs);
2. Basti Shammewala (Moza Kot Dewan);
3. Nava Kot;
4. Kot Dewan;
5. Dhueen Moza;
6. Basti Arain;
7. Dera Sahat;
8. Basti Kora Wala;
9. Basti Rasheedwala;
10. Moza Qadeemi;
11. Malu Mor;
12. Moza Mansoor Sial; and
13. Basti Mehmooda Abad.

7.4 DEPARTMENTAL CONSULTATION

Details of Provincial and District Levels officials contacted are given in Table 7.1 below:

Table 7.1: List of Government Officials Consulted

Sr. No.	Name of Person	Designation	Name of Department/ Office	Department Level
1	Rana Shabir Ahmad	Chief Conservator	Forest Department	Provincial
2	Zafar Haider	Director General	Agriculture Department	Provincial
3	Ijaz Ahmad	Director General	Archaeology Department	Provincial
4	Sajid iftikha	Deputy Director	Irrigation Department	Provincial
5	Iftikhar Ahmad & M.Sikandar	Director General & Deputy Director	Fisheries Department	Provincial
6	Asim Rehman	Deputy Director	Environmental Protection Agency	Provincial
7	Khalid Ayaz khan	Director General	Wildlife Department	Provincial
8	Dr.Waseem Iqbal	Divisional Forest officer	Forest Department	District
9	Azmat Hayat	Executive Engineer	Communication and Works Department	District
10	Shahid Joya	Assistant commissioner	Revenue Department	District
11	Anwar Baig	Chief Municipal officer	Local Govt. Department	District
12	Meher Afzal Khathia	Executive Engineer	Water & Power Development Authority	District

13	M.Ajmal	Sub-Divisional officer	Irrigation Department	District
14	M.Asghar	Deputy	Agriculture Department	District
15	M.Nawaz Khan	Assistant Director	EPD	District
16	Riaz Ali	Fisheries Supervisor	Fisheries Department	District
17	Amir Khan	District Wildlife Officer	Wildlife Department	District

7.4.1 Provincial Level Departments' Concerns/Feedback

A series of consultations were held with various Provincial level departments to get their feedbacks regarding environmental issues and other project related concerns. Below are the points or issues that were discussed during the course of the consultation process. NESPAK experts explained the proposed Power Plant project and its impacts on Natural environment, to the Govt. officials in Lahore. Following is the summary of the concerns given by the different Heads of Govt. Departments.

The following Table 7.2 shows the details of issues/points raised/discussed during the consultation:

Table 7.2: Issues/Points Raised/Discussed during Provincial Level Consultation

Sr. No.	Department	Concerns/Observations	Response
1	**Punjab Forest Department, Chief Conservator of Forests (CCF)** Mr. Shabir Ahmad Rana Contact: 042-99200784	CCF Lahore commented that tree cutting should be avoided as far as possible and minimum possible number of trees should be cut, if necessary.	NESPAK agreed and assured him tree cutting will be minimum.
		He was of the opinion that as per Governments policy, not only 10 times number of plants should be raised, but the area of plantation should be increased 10 times.	NESPAK Ecologist responded that as per law only ten number of plants to be raised for every tree cut, but CCF insisted on his statement.
		He further suggested that a proper plantation plan should be prepared and if required land is not available near the project site, forest department can be of help in providing the land for plantation. He also recommended that in this regard a meeting may be held with CF Faisalabad.	NESPAK team told him that a proper tree plantation plan would be part of the report with a recommendation that plantation should be carried out through Forest Department.
		CCF inquired about the possible emissions from the plant and requested for sharing the report with him, so that he can see that his suggestions have been incorporated in the report or not.	NESPAK team informed the CCF that emissions shall be kept below the PEQS and

Sr. No.	Department	Concerns/Observations	Response
			EIA shall be made public.
2	**Punjab Agriculture Department, Director General Extension Punjab, Lahore** Zafar Haider Contact: 0300-8770085	DG highlighted that loss of agricultural land shall be a setback to agriculture, but this sacrifice would be in the larger interest of the country and in view of acute shortage of electricity in the country.	NESPAK team appreciated the views of DG and thanked him.
		Compensation to the affected farmers must be according market rates, so that farmers can purchase agricultural lands, somewhere else.	NESPAK team informed the DG that this suggestion shall be made part of EIA report.
3	**Archaeology Department, Pakistan Designation: Director General** Mr. Ijaz Ahmad Contact: 03004211855	Director General, after a careful examination of the map of the area, informed the NESPAK team that as per map, there is no archaeological site within or in the vicinity of the proposed area for the project. He however suggested that an official letter should be written to him by concerned authorities in NESPAK, after which he will give a detailed reply inclusive of feedback from his staff.	The letter has been sent to Archaeology Department and attached as Annex-5.
4	**Irrigation Department Punjab. Deputy Director (Superintendent Engineer)** Sajid Iftikhar Contact: 042-99250343	The Proposed Power Plant site must have proper flood inundation Plan as the project site is vulnerable. At RD5 critical gauge is located. In case of high flood, Left Marginal Bund can be breached.	NESPAK team noted down the valuable observation and told the Deputy Director that his suggestions shall be incorporated in the report. The suggestions should be considered by Power Plant authorities.
		He mentioned if the value of water rises from 4000 cusecs, then damages are highly expected and Spur would not be the solution. He strongly recommended the construction of low level embankment/ stone pitched earthen bund for Power Plant to avoid any damage to site during floods seasons.	
		The breach scenario studies are also given the importance by the officer, that all the aspects should be studied technically and in detail.	
		Annual closure of canal, supply fluctuations and non-operation of TS link canal must be kept in mind by the concerned authorities of Power Plant.	
5	**Environmental Protection Agency Deputy Director** Asim Rehman. Contact: 042-9923282	Deputy Director appreciated that NESPAK team has visited EPA office. He further advised that the EIA report must conform to the sectoral guidelines as already prescribed.	NESPAK team noted down his suggestions and thanked him.

Sr. No.	Department	Concerns/Observations	Response
6	**Fisheries Department Punjab, Director Extension, Fisheries** Dr.Sikandar Hayat Contact: 0300-2444621	Dr. Sikander had apprehensions that discharge of heated up water will cause damage to aquatic life present in TS Link Canal.	NESPAK team replied that water shall pass through a cooling process, before it is discharged back into the canal and its temperature will not exceed the permissible limits.
		He highlighted that toxic waste water emission from Power Plant must not be disposed off in canal and other water bodies unless or until treated.	NESPAK team replied that his valuable opinion has been noted down and care shall be taken that composition /chemistry of water is not changed.
7	**Wildlife Department Punjab, Director General** Khalid Ayaz Khan. Contact: 042-99212367	The officer informed the NESPAK team that he is not in a position to give his comments or concerns as he has not visited the site. He will give his concerns only in reply to an official letter from Client.	NESPAK team noted down his reply and informed him that EIA will be made public.

7.4.2 District Level Consultations

A series of consultations were held with various district level officers to get their feedbacks regarding environmental issues and other project related concerns. Below are the points or issues that were discussed during the course of the consultation process. NESPAK experts explained the proposed Power Plant project and its impacts on ecological environments, to the Govt. officials in district Jhang. Following is the summary of the concerns given by the different representatives of Govt. departments. The points raised/discussed during the consultation meeting are summarized in Table 7.3:

Table 7.3: Issues/Points Raised/Discussed during District level Consultations

Sr. No.	Department	Concerns/Observations	Response
1	**Construction & Works Department. Executive Engineer,** Mehar Azmat Hayat. Contact: 0300-5526962	During meeting with C & W official, he Cleary mentioned that the Proper road must be constructed to proposed Plant site as to avoid inconvenience for general Public on Multan road and for project construction team too.	The Proponent should consider this concern.
2	**District Administration, Assistant Commissioner** Mr. Shahid joya Contact: 0301-8665636	AC being well aware of the project informed the NESPAK team that for HBS power plant project, excess land is being acquired for residential colony and for raising a protection bund around the Project Area to protect Plant from flood, as the Project area is part of the flood zone.	NESPAK team appreciated AC for his keen interest in the affairs of the project and noted down the information given by the AC to incorporate the

Sr. No.	Department	Concerns/Observations	Response
		He further informed the team that proper market rates have been recommended for compensation of land, crops and fruit trees.	same in the report.
		He also informed the team that no compensation shall be given for forest trees and the land owners have been allowed to cut or sell their trees.	
3	**Municipal committee Jhang. Chief Officer,** Mr. Anwar Baig Contact No: 0324-6881695	Chief Officer was of the view that the Project is need of the hour due to shortage of electricity in the country.	NESPAK team noted down his suggestions and informed him that his suggestions shall be incorporated in the report.
		He suggested that existing power plant and the proposed power plant should have their own arrangements for disposal of liquid and solid waste as the Project Areas are out of their jurisdiction as per new set up. Therefore, they will not be in a position to continue disposal works.	
4	**WAPDA. Executive Engineer District Jhang,** Mehar Afzal Kathia Contact No: 0345-15000397	XEN appreciated that another power plant is being set up in Jhang District. He commented that PTPL is actually helping WAPDA in overcoming the electricity shortage.	NESPAK team thanked him for his appreciation.
		He also informed the NESPAK team that as a high voltage transmission line passes close to the site of Power Plant, Wapda is studying its cross effects.	NESPAK team requested the XEN to share the results of such study.
5	**Irrigation Department. Sun-Divisional Officer.** M. Ajmal Contact No: 0300-6624698	SDO Irrigation also told the NESPAK team that subjected power plant is located in flood zone and some protective measures must be adopted. He further suggested that a protective stone pitched earthen bund may be constructed around the power plant.	NESPAK team noted down his valuable suggestions
		SDO further stressed that canal water after its use must be discharged back into the canal, keeping the water temperature at the level of the canal water temperature.	NESPAK team informed the SDO that water is to pass through a cooling process, before it is discharged back in the canal.
		He also informed the NESPAK team that measuring gauges are to be installed at the points of off take and intake to measure the quantity of water, taken out of the canal and then discharged in the canal.	NESPAK team thanked him for his views.
6	**Forest Department Divisional Forest Officer,** Mr. Waseem Iqbal Butt Contact No.: 0300-6184623	DFO appreciated the proposed project and commented that such projects are highle welcomed as they are need of the time to overcome the power shortage in the country As this project is LNG based, there will be possibly no harmful impact on account of its emissions.	NESPAK team thanked the DFO for his positive views and also apprised him that emissions from the plant shall remain below the permissible PEQS limits.
		He, however, emphasised that as quite a significant number of trees shall be affected during construction, the loss of trees should be compensated by planting at least 10 times more trees.	NESPAK Ecologist told the DFO that a plantation plan shall be part of the report and it shall be mandatory for the Proponents to plant 10 tress (at least) as compensation for every single tree.
7	**Agriculture**	DD Agriculture Extension emphasised that as	Ensured to provide th

Sr. No.	Department	Concerns/Observations	Response
	Department: Deputy Director, Agriculture,, Extension, Jhang Mohammad Asghar Contact No.: 0334-5682598	sizeable fertile agricultural land is to be acquired, handsome compensation should be paid to the landowners, for their land and existing crops, so that they can purchase alternate lands.	reasonable compensatior framework for the affectec crops as per policy o department
		DD, Ext. was of the view that implementation of the project shall cause a negative impact on the agriculture of the area, but this sacrifice has to be given in view of the acute shortage of electricity in the country.	Noted down.
8	**Environmental Protection Department District Officer, EPD, Jhang** Mr. Nawaz Khan Sial Contact No.: 047-9200376	Asstt. Director favored the project in view of the sufferings of the people on account of acute shortage of electricity in the country.	Noted down
		He however cautioned the NESPAK team, that adequate mitigation measures should be made part of the report especially regarding disposal of solid waste and liquid waste. He stressed that all the liquids must pass through a filtration process before they are discharged into drains or canals.	He was iformed that the impacts and their comprehensive mitigations shall be incorporated in the report along with detailed EMP.
	Fisheries Department Supervisor, Fisheries, Mr. Riaz Ali Contact No.: 0307-2895638	As the Assistant Director Fisheries was on some training course at Lahore, so the NESPAK team conducted consultation with the Supervisor, Fisheries Jhang	Noted Down
		He was of the view that the project will have a minor negative impact on fisheries in TS Link, due to raised temperature.	NESPAK team explained to him that water temperature at its disposal point shall be controlled and water shall be discharged into canal, after going through a cooling process.
		He also gave us very useful information, regarding kind of fishery in Chenab River, Head Trimmu and TS Link canal.	NESPAK team thanked him for his useful information.
9	**Wildlife Department District Wildlife Officer** Mr. Mohammad Aamir Khan Contact No.: 0333-6835763	DWO was of the view that as the area to be acquired is comparatively small i.e. 136 acres. Therefore, the project implementation will not have any significant impact on wildlife	Noted down.
		He however, suggested that suitable mitigation measures should be undertaken to compensate for the loss of trees, as the flora and fauna are inter related for instance trees are used for resting, nesting and roosting by tha avifauna.	DWO was informed that, a plantation plan is part of the report and 10 times more trees shall be planted in lieu of effected trees.
		He also gave very useful information regarding the baseline conditions of the fauna in and around Project Area.	Noted down
10	**Social Welfare Department, Jhang** i. Mr. Azhar, DO Social Welfare; ii. Mr. Riaz Hussain Bhatti, Chairman Bait-ul-Mall;	No technical and vocational institute is available nearby the project site, therefore, Government should add exclusive budget for this within the project cost.	The Proponent should consider this concern.
		The official emphasized that implementation of proper mitigation measures to control environment must be taken during the Project activities.	Incorporated in the EIA.

Sr. No.	Department	Concerns/Observations	Response
	iii. Dr. M. Riaz, President Amina Welfare Society; and iv. Ms. Qurrat-ul-Aein, Women Welfare Department.	Local norms and cultural values, especially women's privacy should not be disregarded by any contractors or foreigners during the course of the Project;	
		Employment preference should be given to the locals as people in and around the area are mostly poor;	
		Employment for minorities like Christians should also be provided in the existing and proposed power plant;	
		Occupational health and safety should be taken care with respect during construction of the power plant;	
		Settlements such as Shamme wala in Moza Kot Dewan should be avoided and available Auqaf land can be utilized for proposed plant;	The Proponent should consider these concerns/ suggestions.
		If it is not possible then compensation should be given at fair rates and livelihoods should be restored to the PAPs;	
		Government should develop housing society for affectees nearby current residence;	
		Livelihood restoration of the affectees is the primary responsibility of the government;	
		Government and contractor(s) can involve themselves in social welfare activities by providing free ambulance service in the area, free transportation facility for school/college especially for female students.	
		Education and health facilities should be provided free of cost to the PAPs.	
		Government should involve social welfare department for wellbeing of PAPs in different programs.	
11	**Revenue Department, Patwari Halqa Moza Kot Dewan,** Muhammad Yar Contact No: 0345-7601210 **Tehseel Dar,** Ghulam Abbas Contact No: 0301-3963725	Land is being acquired as per market price and section-IV has been implemented. Land which is being acquired is much fertile than other land in nearby area.	The Proponent should pay due compensation and assistance in relocation/displacement to equally valuable area.
		Special arrangements should be made to establish a colony to transfer the PAPs in nearby area of the Kot Dewan.	
		Proponent has shifted the proposed project land at about 200 meter west side from existing plant to shield the 500 KV transmission line which will increase the resettlement issues;	
		Government should also consider the compensation of tube well and non-fruit trees along with other items;	
		Government and contractor should provide permanent employment opportunities to the PAPs in power plant;	
		Shifting and livelihood allowance should be provided to the PAPs;	
		Government should also consider the lease agreement between PAPs and Auqaf department which they had made earlier for acquisition of government land. The compensation should be given accordingly.	

7.5 CONSULTATIONS AT EXISTING RLNG POWER PLANT HBS

NESPAK team consulted contractor staff/laborers working at existing HBS RLNG. The concerns of labor force along with remarks are shown in Table 7.4 below.

Table 7.4: Issues/Points Raised/Discussed with Existing RLNG HBS Labor

Company Name And Contact Persons	Concerns/Observations	Remarks
Chief Resident Engineer, HBS RLNG Site, NESPAK Mr. Waqar Hussain, Contact: 03335802293	The proposed site is about 200 m away from the south boundary of existing plant to shield the existing 500 KV transmission line laid for dispatching power from existing plant;	Information was noted down by EIA team
	The total area of new plant is about 168 acres which includes all the temporary facilities, residential colony and other associated structures;	
	For the new plant more than 50% of the requisite area is government owned (Auqaf and Irrigation Department); and	
	The design of the proposed project is almost same as that of existing 1,236 MW RLNG CCPP HBS.	
Power China HSE Manager, Iftikhar Contact: 0300-7953185 **SAPCO HSE Engineer,** Nauman Contact: 0341-9446661 **SAPCO HSE Engineer,** Asim Hussain Contact: 0333-5598290	No proper rest area facility for local labor has been given by EPC contractor/sub-contractor(s) during the break time (1100 hr to 1400 hr).	I. The Proponent should consider these concerns and ensure their addressal by EPC contractor/ sub-contractor(s). II. Special provision should be incorporated in contract regarding site restoration, occupational and community health and safety, first aid facility, salary/wages, wastewater treatment, clean drinking water, balanced housing facility to all labor; better quality food and rest area facility during break time. III. Recreational facilities should be provided to the labour at site.
	Insufficient sanitation and washroom facility (i.e. one wash room for almost 50 staff during Plant's construction) has been provided to the laborers.	
	Collection of sanitary waste from septic tanks installed near the contractor's labour camps which is hygienically inappropriate.	
	Discrimination between Foreign (Chinese) and local labor is also a pronounced concern. The condition of housing camp, cafeterias/mess hall, wash room facilities provided to local staff is much poor as compare to the Chinese labor.	
	Availability of clinical facility at site is insufficient with respect to the staff quantity.	
	Provision of wastewater treatment plant especially for municipal waste.	
	Health problems such as malaria, dengue and histoplasmosis (a lung infection caused by a common soil fungus)	
	Currently, there are no recreational facilities. The heavy workload, work place violence or community violence and limited social support are the factors associated with increase stress in the work force.	

7.6 VILLAGE LEVEL CONSULTATIONS

A series of public consultations were conducted to get the feedback/concerns of the different categories of stakeholders including potential PAPs, local community and other general public residing in the AOI. Total five (05) consultative meetings were held with about 99 participants in the AOI. The major categories participated in these meetings were local population, community groups, landowners, tenants and potential PAPs. Majority of the people who participated in these consultations are mature/elderly persons because as per the local culture, elders do have the right for any decision. However, young people also participated in the consultations.

These consultations were conducted with the direct and indirect affectees in July 2017. Major consultation with the PAPs/local community and general public were carried out in Dhueen Muhammad, Basti Kora Wala, Nava Kot, Moza Kot Dewan, Shamme Wala, Malu Mor and Nai Abadi. The list of PAPs who were consulted during survey, is given in Table 7.5 below:

Table 7.5: List of PAPs Consulted during Social Survey

Sr. No.	Name	Father's Name	Contact Number
1.	Sardar Ali	Mian Pathana	0345-6334562
2.	Haji Mahmood	Rehan	0349-8794634
3.	Muhammad Aslam	Lahna	0300-7501147
4.	Muhammad Iqbal	Shamand Khan	0340-8388852
5.	Ghulam Muhammad	Lahna	0347-8733857
6.	Shaukat Hayat	Sikander Hayat	0341-6764029
7.	Liaqat Hayat	Sikander Hayat	0342-7900452
8.	Zafar Ahmad	Makhan	0343-0813690
9.	Haq Nawaz	Makhan	0343-0813690
10.	Sultan	Makhan	0343-0813690
11.	Sister	Makhan	0343-0813690
12.	Habib-ur-Rehman	Abdul Rehman	0343-0812601
13.	Manzoor Hussain	Shamand	0346-2307629
14.	Nasir Abbas	Shamand	0348-1787062
15.	Raheel Hussain	Zawer Hussain	--
16.	Muhammad Munir	Shamand Khan	0301-2704846
17.	Ghulam Shabir	Shamand Khan	--
18.	Muhammad Ramzan	Shamand Khan	--
19.	Muhammad Iqbal	Shamand Khan	0340-8388822
20.	Khurshid Saqin	Husband/ Ghana, Zawar Hussain	Presently in Karachi
21.	Zulfqar Ali	Ghama	0343-1795474
22.	Ali Haider	Muhammad Ramzan	--
23.	Mubzan Hussain	Ghama	--
24.	Ghulam Abbas	Ghama	--
25.	Nadeem Iqbal	Ghama	--
26.	Zafar Iqbal	Ghulam Muhammad	0345-0337031
27.	Ghulam Yassin	Ghulam Muhammad	--
28.	Muhammad Ramzan	Ghulam Muhammad	--
29.	Jumma Khan	Ghulam Muhammad	--
30.	Abdul Ghafoor	Ghulam Muhammad	--
31.	Marriam Bibi	Ghulam Muhammad	--
32.	Muhammad Iqbal	Shabaigh	0345-1717843
33.	Muhammad Bux (late)	Shabaigh	--
34.	Muhammad Riaz (late)	Shabaigh	--
35.	Qaiser Abbas	Noor Muhammad	0344-7789611
36.	Falak Shair	--	0341-7781125
37.	Allah Bux	Maghi	0302-3797484
38.	Umar Hayat	Haq Nawaz	--
39.	Muhammad Sidique	--	0341-7725575
40.	Abdul Khalid	--	--
41.	Satta Mai	Mother / Haq Nawaz	0344-7959749
42.	Muhammad Ramzan	Pehalwan	--
43.	Karam Ali	Barhiyam	0347-7926958
44.	Rehana	Ahmad Bux	--

The following points, summarized in Table 7.6, were raised/discussed during the consultation:

Table 7.6: Issues/Points Raised/Discussed during Village Level Consultations

Sr. No.	Stakeholder Observations/ Concerns	Responses with addressal
1	Locals of the Nava Kot, Moza Kot Dewan and Nai Abadi said that during the construction phase of the Project, noise, dust and traffic problems on Jhang-Shorkot Road will adversely affect their health as well as business. Similarly, their mobility will be disturbed specially during the construction phase. At Kot Dewan and Malu Mor shopkeeper raised concern that during the operation phase, accidents may occur due to the traffic load.	Power Plant Authorities/ Govt. should pay due attention on improvement of Jhang-Shorkot Road.
2	Locals of the Moza Kot Dewan, Malu Mar and Nava Kot suggested that the government should consider nearby Auqaf land fully as site alternatives for this proposed project instead of acquiring partial private land.	The Auqaaf land was not enough to meet the design requirements.
3	Basti Shamme Wala (Moza Kot Dewan), Nava Kot and Basti Mehmooda Abad said that this should also be ensured by the government that the locals will get free electricity or subsidy from this Projet on priority basis.	This concern has been noted down. .
4	Dhueen Moza, Basti Arain, Basti Kora Wala, Moza Qadeemi and Moza Monsoor Sial recommended that locals should be given preference for skilled and unskilled jobs at existing HBS and proposed Jhang power plants.	The concern has been noted down.
5	Locals demanded permission for cultivation of seasonal crops till the construction phase commencement	The Proponent should consider this concern.
6	Dhueen Moza, Basti Arain, Basti Kora Wala, Moza Qadeemi, Moza Monsoor Sial Basti Shamme Wala (Moza Kot Dewan) and Nava Kot expressed that this area lacks basic health and education facilities. There is no degree college for boys and girls, If this project starts, we are expecting that the authorities will also take care of this aspect, therefore, at least degree college for women should be provided to the local community in Haveli Bahadur Shah or Malu Mor.	The comment has been incorporated in the report and it has been recommended that Govt. should pay due attention to this aspect. It is also recommended that Proponent should improve some social infrastructure as Confidence Building Measures (CBM) and measures such as Corporate Social Responsibility.
7	Moza Qadeemi, Moza Monsoor Sial Basti Shamme Wala (Moza Kot Dewan) and Nava Kot stated, PAPs must not only be compensated with land for land or money for land but they should also be compensated by the government in re-establishing their livelihood in the resettled area.	The Govt./Proponent should do more consultation with the PAPs and proper compensation should be given, and their concerns should be addressed. The Govt. should provide livelihood assistance to the PAPS in the form of loan, training etc. This has been recommended in EIA Report.
8	PAPs of Shamme Wala settlement showed unwillingness to sell their property as land is highly fertile and sweet ground water is easily available as compared to other lands in the nearby area of this district. Few PAPs demanded about Rs 3.5 to 4.0 million per acre for their land.	The compensation process should be fair and must cover infrastructure, displacement and livelihood restoration costs.
9	Shamme Wala (Moza Kot Dewan), Nai Abadi people requested that a committee should be framed at Govt. level to address land acquisition issues involving locals as well.	The concern has been noted down.
10	Nava Kot people told that one graveyard comprising 8 graves will be falling in the proposed project. They raised concerns to avoid these graves.	Every possible measure would be taken to avoid the damage to graves.
11	The PAPs must not only be compensated in cash or in land but they should also be compensated by the government in re-establishing their livelihood in the	The govt. should provide livelihood assistance to the PAPS like loan, training etc. If possible, RAP should

Sr. No.	Stakeholder Observations/ Concerns	Responses with addressal
	relocated area.	be done.
12	Some locals demanded that alternate land instead of market price will be acceptable to them. Some showed concerns that cash compensation should be given to the PAPs directly and political/patwari interference should be avoided. PAPs informed that price of land in nearby area have been increased to about Rs. 100,000 per Marla which is too costly for them; therefore, government should facilitate them in purchasing land as per market price.	The Govt./Proponent should do more consultations with the PAPs and proper compensation should be given and their concerns should be addressed. The Govt. should provide livelihood assistance to the PAPs like loans, trainings etc. This has been recommended in report.
13	PAPs of Shamme Wala settlement (Moza Kot Dewan) said that due to the acquisition of land for proposed power plant, their livelihood will be lost; farming on agricultural land is their sole source of income and they do not possess any technical or vocational skills. They will not be able to fulfill the basic needs of their family. Therefore, locals demanded fair compensation to be provided so that they can purchase alternate land easily.	The Govt./Proponent should conduct more round of consultations with PAPs and their concerns should be addressed.
14	PAPs of Shemewala told that no one wants to sell their lands in vicinity of this area, therefore, they are forced to purchase land far away. PAPs said that shifting from this area is very costly and difficult for them as maximum civic amenities such as availability of good drinking water, education, health and primary school Kot Dewan are near to their houses.	The Govt./Proponent should improve amenities/civic facilities in area where PAPs will ultimately be displaced.
15	Locals from Dhueen Moza, Basti Arain, Basti Kora Wala, Moza Qadeemi, Moza Monsoor Sial Basti Shamme Wala (Moza Kot Dewan) and Nava Kot said that they should be given employment opportunities during the construction phase of the proposed plan.	The Proponent should consider this concern.
16	Some PAPs demanded that the compensation should be adequate and acceptable to affectees. The compensation should cover all the structures, trees, tubewells etc.	This has been recommended in EIA \report and Power Plant authorities should consider this.
17	People of the Dhueen village said that the installation of Tower should be placed at the edge of the field rather than in the center of field. So that the disturbance to farming activities is minimized. During the installation of towers compensation should be paid, which was not paid to PAPs in case of HBS Power Plant.	The Proponent should consider this concern.

Majority of respondents supported the project subject to the payment of demanded compensation, livelihood assistance and addressal of their concerns.

7.6.1 PAP's Concerns/Feedback

7.6.1.1 People's willingness

The country is overall suffering from energy crisis. Continuous Power shutdown is badly affecting daily life of the people. People in the AOI are hopeful with this Project. According to respondents of the AOI, such projects are important for the prosperity of people and country. People even demanded that construction of the new Power plant should be started as soon as possible. As per consulted communities this Project has more beneficial aspects in longer run. Few respondents showed willingness to bear minor losses in the wake of these benefits.

7.6.1.2 Livelihood

In the AOI, farming, labour and small businesses are the main sources of livelihood. Most of the respondents are poor and they informed the EIA team that there are very few employment opportunities for locals. About 90% population in AOI are using tube-well for irrigation purposes as canal water is not available due to river Chenab in near vicinity. Tube-wells are mostly being run on electricity and load shedding has affected agriculture activities in these areas. Locals also informed that many people are becoming jobless as small cottage industries are shutting down due to load shedding issues. Few locals have closed down their private small businesses due to the same reason. People in the AOI are hopeful that employment opportunities during implementation phase of the Project would be given to them especially to poor people residing in the Project Area.

7.6.1.3 Electricity

Electricity is not available in some of the nearby small settlements such as Nava Kot. It was suggested by the locals that free electricity should be provided to all the settlements existing in vicinity of proposed Project. According to locals, provision of electricity will reduce many constraints of daily life. It will initiate development in the area and increase the living standard of locals.

7.6.1.4 Other Concerns/Feedback

Basic amenities of life are not available in most of the villages in the AOI. Medical facilities, proper education system and road infrastructure are not present in the area.

7.6.1.5 Sewerage System

There is no proper sewerage system in the villages of AOI. Absence of proper sewerage system results in epidemic health problems. Locals from Kot dewan and Dhueen Muhammad demanded that sewerage system should be installed as first priority to improve sanitation condition.

7.6.1.6 Health/Medical Facilities

As per survey, diseases such as jaundice, hepatitis, fever, tuberculosis and stomach disorders etc. are common in the area. Hospital is far away from the AOI. Only one dispensary is working in Kot Dewan which is not fully furnished. Maternity homes are not available in AOI. Due to inadequate health facilities, most of the patients couldn't get proper treatment and have to go Jhang or Faisalabad cities. People have to travel long distances to get health facilities.

Livestock rearing is common practice in the AOI. But, there are no veterinary hospitals near settlements. Any disease outbreak among livestock directly affects the households. Therefore, veterinary centers should be provided in area.

7.6.1.7 Public Infrastructures/ Roads

Transportation and road infrastructure is very poor in the AOI. Most of the settlements have Katcha tracks. People have to travel longer distances by foot. During rainy season, travelling on Katcha tracks becomes difficult. It was demanded that roads should be constructed and free transport for students should be provided to the local people from power plant to Jhang and Shorkot.

7.6.1.8 Education

Proper education facilities are not available in the AOI. Schools are not present in the villages and boys/girls have to travel long for schools which are situated far away and devoid of proper infrastructure and learning aids. Many students are unable to continue their education to high schools due to non-availability of college in vicinity. It was suggested by locals that Degree College for both males and females should be built on urgent basis in the area. Degree College is available in Jhang and Shorkot cities which are about 20-30 km away and locals do not send their daughters there.

7.6.2 Project Related Concerns and Feedback by Women

7.6.2.1 Willingness

Women have also shown positive approach towards the proposed Project, as it will help in the development of the country by providing more electricity.

7.6.2.2 Privacy

While performing gender surveys, EIA team was informed that local women would have privacy issues as outsiders/foreigners will come into their area during construction phase causing restrictions to females' mobility. Although no major incident occured during the construction of existing HBS power plant but it may happen and locals need to remain cautious all the time. They also showed their concern that Project should not be implemented during the harvesting season of crops as during that season women would have to go out to help male members in the fields.

7.6.2.3 Employment

It was demanded by the locals that Govt. should provide job opportunities to literate people especially women in education and health sectors. Women demanded that during construction phase of the power plant their male member should be provided skilled and unskilled job opportunities.

7.6.2.4 Awareness

Most of the women expressed a desire to expand the magnitude of their work and responsibilities; due to illiteracy, poverty and restrictions. Though, women have access to agricultural information and knowledge about farrning and livestock activities which has come to them through word of mouth and over time. However, their main obstacle has been their exclusion from using their experience and knowledge for making decisions.

7.7 STAKEHOLDER CONSULTATIONS FRAMEWORK FOR CONSTRUCTION AND OPERATION PHASE

Key stakeholders of the Project include provincial and district level government departments such as EPD, Agriculture Department, Forest Department, Wildlife Department, Irrigation Department, Fisheries Department and Project directly affected people, land owners and local people. The community members will be compensated by project Proponent and they will be encouraged to participate in project activities during construction and operation phases. The consultations will be made in future to facilitate the communities at the local level.

Consultations will be carried out during the construction and operation phases of project. Efforts will be made to maximize consultations during the project implementation. The consultations will be carried out with the objectives to develop and maintain communication linkages between the project promoters and stakeholders, provide key project information to the stakeholders, and to solicit their views on the project and its potential or perceived impacts, and ensure that views and concerns of the stakeholders are incorporated during the implementation to reduce or offset negative impacts and to maximize benefits of the proposed project. The framework for the future consultations is elaborated in Table 7.7 below:

Table 7.7: Future Consultations Framework

Sr. No.	Stakeholders	Project Phase	Frequency of Consultation
1	Provincial Government Departments	• Pre-Implementation • During the Project Implementation	• One round of consultations before the start of implementation of project. • Monthly during construction phase and bi-annually during O&M phase of the project.
2	District Level Government Officials	• Pre-Implementation • During Project Implementation	• One round of consultations before the start of implementation of project. • Monthly during construction phase and bi-annually during O&M phase of the project.
3	PAPs	• Pre-Implementation • During the Project Implementation	• One round of consultations before the start of implementation. • Fortnightly during construction phase and bi-annually during O&M phase of the project.
4	Surrounding Villages	• Pre-Implementation • During Project Implementation	• One round of consultations before the start of implementation. • Quarterly during construction phase and bi-annually during O&M phase of the project.
5	Local Elders	• Pre-Implementation • During Project Implementation	• One round of consultations before the start of implementation of project. • Monthly during construction phase and bi-annually during O&M phase of the project.
6	Women	• Pre-Implementation • During Project Implementation	• One round of consultations before start of implementation. • Fortnightly during construction phase and bi-annually during O&M phase of the project.

CHAPTER–8: POTENTIAL IMPACTS AND MITIGATION MEASURES

This chapter identifies the potentially significant beneficial as well as adverse environmental and social impacts during the design/pre-construction, construction and O&M phases of the proposed Power Plant. The impacts have been assessed for the physical, ecological and socio-economic domains of the environment. A project impact evaluation matrix has been developed to evaluate the potential impacts of the proposed project.

8.1 IMPACT EVALUATION

The methodology adopted for the evaluation of the impacts includes the following assessment tools, (i) project impact evaluation matrix and (ii) overlays. These tools have been used to identify the significance and magnitude of the impact as well as the nature, reversibility, extent etc.

8.1.1 Project Impact Evaluation Matrix

The Impact Evaluation Matrix was developed by placing project activities along one axis (i.e. Y-axis), and on the other axis (i.e., X-axis) the different environmental parameters likely to be affected by the proposed project actions are grouped into categories i.e. physical, ecological and socio-economic environment. The significance of impacts was analyzed and presented in matrix. For the impact assessment, project impact evaluation matrix is used by dividing the project actions into different phases (design/pre-construction, construction and operational phases). A Project Impact Evaluation Matrix is attached as Annex-6.

8.1.2 Overlays

In order to identify the spatial based (location based) impacts, overlays are used. An overlay is based on a set of transparent maps, each of which represents the spatial distribution of environmental characteristics. Information for an array of variables is collected for the standard geographical units within the Project Area and recorded in a series of maps typically one for each parameter. These maps are overlaid to produce a composite map. The resulting composite map characterizes the area's physical, ecological, socio-economic and other relevant characteristics relative to the location of the proposed Project. Software used for the overlays are Arc View and AUTOCAD. For the subject Project available Google Earth Imageries and ARC GIS was used to prepare overlay maps. Land-use map prepared for overlays of the Project Area is attached as Figure 6.2.

8.2 POTENTIAL POSITIVE IMPACTS

The Project is envisaged to have the following major positive impacts.

8.2.1 Electricity Generation

The power plant is expected to generate 1,100-1,400 MW of electricity. Given that Pakistan currently faces a shortfall of about 5,000 to 7,000 MW per day, the generation capacity of this power plant will help towards meeting a portion of the shortfall, thus providing some measure of relief to the people of Pakistan. The generation of electricity will not only help the industrial sector and its outputs but will also help to raise the standard of living as it will reduce load shedding.

8.2.2 Employment Opportunities

Electricity generation will help industry in producing more output and work more efficiently, which in turn will have a ripple effect of increasing skilled and unskilled employment. Even during the construction phase of the project, the requirement of engineers, workers, laborers, technicians, para-professionals etc. will help to generate employment opportunities. Apart from this, opportunities of small businesses (for example, shop keepers etc.) will also be increased resulting more income for local inhabitants. Locals will also have the opportunity to diversify their incomes by being employed during the construction period of the project. It is estimated that about 2500 to 3500 staff will be deployed during the construction phase and about 150-200 staff will be employed during the operation phase of proposed project. Hence, there will be a large number of employment opportunities mainly for the local people, during the construction and O&M phase of the project.

8.2.3 Increase in Businesses

With the influx of laborers for the proposed project, there will be more opportunities for small scale businesses such as small grocery shops, small cafes (khokas), and vehicle tuning, tire-repair shops etc. Additionally the generation of electricity will reduce load shedding and contribute towards more business in the country.

8.2.4 Increased Accessibility

Construction of the access road for the construction of Power Plant and up gradation of existing tracks to the Project Area will result in improved accessibility.

8.2.5 Increase in Land Value

Construction of new RLNG CCPP Project is expected to increase the land value, due to the increased accessibility, especially in villages where little or no road infrastructure is present. Land owners will have an opportunity to sell their land at increased prices and start new businesses.

8.2.6 Indirect Benefits

In addition to the power production and other benefits described above, there will be other economic benefits associated with the project implementation. These are known as secondary or indirect benefits, which are as follows:

- The generation of 1,100-1,400 MW of electricity and its augmentation with national grid. This will help in reducing the current crisis of the electricity. The availability of electricity will boost the industrial sector of Pakistan. This will have a huge impact on the economy of the country;
- The proposed Project will have positive impacts on the areas due to the development of quarry sites. In this regard, construction of new roads to the quarry sites will also benefit the local population apart from job opportunities;
- The construction and operation of the proposed Project will stimulate business and indirect employment opportunities for the labor in the form of handling, transportation, business etc.;
- The project will also provide direct employment opportunities to unskilled labor in the Project AOI;
- In addition to all these benefits, the project will result in the general economic and social uplift of the people particularly in areas of the Punjab Province and will provide basic infrastructure and raw material for other projects in the region.
- The benefit of decrease in electricity load shedding will facilitate other services, such as health facilities, schools, water supply, and expansion of the industrial activities etc., which are dependent on electricity, resulting in the improvement of the socio-economic conditions of the locals.

8.3 POTENTIAL ADVERSE IMPACTS AND MITIGATION MEASURES DURING DESIGN / PRE-CONSTRUCTION PHASE

This section identifies the potentially significant adverse environmental and social impacts anticipated during the pre-construction phase of the project. Mitigation measures, where applicable have also been suggested.

8.3.1 Impact of Land Acquisition

The project will be constructed over a land area of 649,804 square meters (160.57 acres) which includes the permanent as well as temporary area requirement for construction camp and other construction related activities. The access road will have a total area of 36,543 square meters (9.03 acres). More than 50% of the land acquired for this project is government owned (Auqaf and Irrigation Departments) land which will be acquired as per the policy of GoPb. However, remaining private land will be acquired as per provision of LAA 1894. The land acquisition process has already been started. PAPs residing in 40 houses and those having landholdings in Project area have been notified to vacate their lands. The Sections IV and V are attached as Annex-7. The revenue map of this area is shown in Figure 8.1 and the details of land are provided in Table 8.1.

8.3.2 Mitigation Measures for Impact of Land Acquisition

The plant construction mostly involves the government land which will be acquired according to the policy of GoPb. On the other hand, private land is being acquired according to the provision of the LAA 1894. The LAA is broadly grouped into eight (8) parts comprising 55 Sections dealing with the details of land acquisition and compensation. The main relevant Sections of LAA, 1894 are shown in Figure 8.2. Apart from other relevant sections, the sections describing the aspects to be considered and not to be included during the determination of compensation are as summarized below:

Section-23 (Matters to be considered in Determining Compensation): Section-23 testifies that in determining the amount of compensation to be paid for land acquired under this Act, the Collector shall take into account the followings:

- Market value of land at the date of publication of notification under Section-4;
- Damage sustained, by reason of the taking of any standing crops or trees at the time of the Collector's taking possession thereof;
- Damage (if any) sustained, at the time of taking possession of the land, by reason of severing such land from his other land;
- Damage (if any) sustained, at the time of taking possession of the land, by reason of the acquisition injuriously affecting his other property or his earnings;
- If in consequence of the acquisition of the land, the person interested is compelled to change his residence or place of business, the reasonable expenses (if any) incidental to such change;
- The damage sustained by diminution of the profits of the land between the time of the publication of the declaration under Section-6 and the time of taking possession of the land; and
- 15% over and above the cost of the land determined by the Collector as charges for acquisition.

Section-24 (Matters to be neglected in Determining Compensation): In accordance with Section-24, following matters shall not be taken into consideration in determining:

- The degree of urgency which has led to the acquisition;
- Any disinclination of the person interested to part with land acquired;

- Any damage sustained by him which, if caused by a private person, would not render such person liable to a suit;
- Any damage which is likely to be caused to the land acquired after the date of publication under Section 6, by or in consequence of the use to which it will be put;
- Any increase to the value of the land acquired likely to accrue from the use to which it will be put when acquired;
- Any increase to the value of the other land of the person interested likely to accrue from the use to which the land will be put; and
- Any outlay or improvements made without the sanction of the Collector after the date of the publication of the notification under Section-4.

EIA team has recommended the strict compliance with above Sections 23 nd 24 and inclusion of compensation for household materials and livelihood restoration. Accordingly, due compensation should be given by district government/Proponent along with livelihood assistance.

Sr. No.	Description	Area (Acres)	Area (%age)
1	Private Land	75.50	44.62
2	Land of Auqaf Department	83.24	49.20
3	Land of Irrigation Department	9.30	5.50
4	Track	1.15	0.68
Total		169.19	100.00

Figure 8.1: Land Acquisition Map

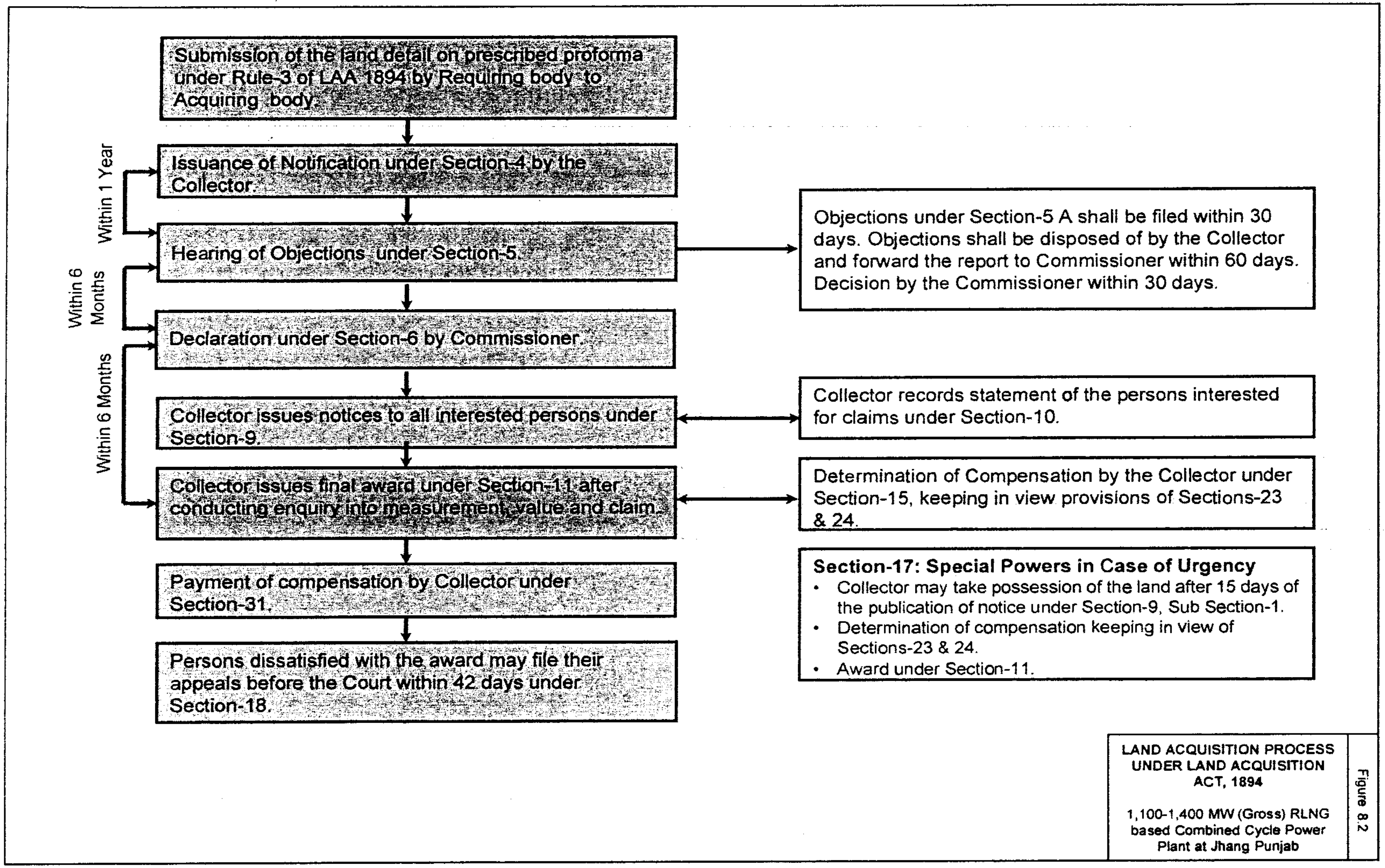


Figure 8.2: Land Acquistion Process under LAA, 1894

The above provision will be strictly complied with during the determination and payment of compensation. Proper measures need to be taken to safeguard the livelihoods of the affectees apart from the compensation.

8.3.3 Impact on Water Quality & Quantity

It is expected that the requirement of water during pre-construction phase will be fulfilled from ground water source i.e. tube wells. The preconstruction activities include construction of new access tracks and improvement of existing track, clearing and leveling of Project Areas etc. Water extraction from ground will negatively affect the existing water quantity.

8.3.4 Mitigation Measures for Impacts on Water Quality and Quantity

This impact on groundwater needs to be addressed carefully by considering the recommendations of hydrogeological study and Electrical Resistivity Survey (ERS). Contractor should consult with the concerned department and obtain permit for extraction of water during pre-construction phase.

8.3.5 Loss of Livelihood

Due to the acquisition of the private land i.e. about 75.5 acres for proposed new power plant, about 40 families have direct impact and will lose their livelihood. Based on the field survey most of the farmers belonging to the village Shamme Wala, Moza Kot Dewan have small land holdings i.e. less than 2 acres. The bread and butter of these families rely on the agricultural yield of these lands. With the acquisition of these lands livelihood of these families will be lost. As per the LAA these families will get the compensation of these lands however, loss of livelihood is a significant adverse social impact of the proposed Project.

8.3.6 Mitigation Measures for Loss of Livelihood

As per LAA, no provisions for the loss of livelihoods exist. Other compensation should be provided to the adversely affected population who may have usufruct or customary rights to the land or other resources taken for the project. A Resettlement Action Plan (RAP) is strongly recommended. It is strongly recommended that the Proponent should provide livelihood assistance to the affectees like loans, trainings, employment in unskilled work etc. Government should also promote the social welfare facilities such as free health and education facility, subsidize food purchasing facility, etc. to compensate the effect of loss of livelihood of PAPs. Affectees along with their children losing their agricultural land in proposed new power plant should be given employment opportunities on preferential basis during the construction and O&M phases of project.

8.3.7 Impacts on Built Up Areas, Infrastructure and Crops

The implementation of the Project will affect built up area (about 40 houses), crops, katcha track, tube wells (about 20 nos.) and hand pumps that will mainly come under Project Area. The detail of the Project Area land quantification is elaborated in Table 8.1.

Table 8.1: Landuse Quantification in Project Area

Sr. No.	Description	Measurement	Percentage of Total
Area Distribution of Proposed RLNG CCPP Project			
1	Agricultural land (acres)	122.81	72.41
2	Barren land (acres)	26.50	15.63
3	Built-up land (acres)	5.07	2.99
4	Graveyard (acres)	0.1	0.06
5	Pond (acres)	0.25	0.15
6	Tracks (acres)	4.58	2.70
7	Tree Cover (acres)	1.26	0.74
Total Land for CCPP (acres)		**160.57**	**94.68**
8	Track Length (m)	4050	94.40

Sr. No.	Description	Measurement	Percentage of Total
9	Tree Count (no.)	409	91.1
Area Distribution of Proposed Access Road			
1	Agriculture (acres)	8.19	4.83
2	Barren (acres)	0.27	0.16
3	Track (acres)	0.26	0.15
4	Tree Cover (acres)	0.30	0.18
Total Land for Access Road (acres)		**9.03**	**5.32**
5	Track Length (m)	240	5.60
6	Tree Count (no.)	40	8.9
Total Land for Project (acres)		**169.6**	**100**
Total Track Length in Project Area (m)		**4290**	**100**
Total Trees in Project Area (no.)		**449**	**100**

Residents of 40 houses which will be affected are practicing agricultural activities since last thirty years. Over the years, they have put huge efforts to convert barren part of land into fertile and productive one.

8.3.8 Mitigation Measures for Impact on Infrastructure

The loss of private land, built-up area, infrastructure and crops should be compensated according to the provisions of the LAA 1894. Other government infrastructure should be relocated by the concerned department in consultation with the project Proponent. Affected trees should be compensated by planting more trees as per the provisions of Forest Department. The planting of new trees should be carried out as per the Tree Plantation Plan (Refer Chapter 9).

8.3.9 Loss of Agricultural Land

The proposed project will result in the conversion of agriculture land in to built-up area that will decrease the gross agriculture yield of this area. The EPC activities may also affect surrounding agricultural lands.

8.3.10 Mitigation Measures for Loss of Agricultural Land

The Proponent should consult with the locals and take guidance from the agriculture department and facilitate farmers in converting barren lands into agricultural land. The provision of high tech agricultural machinery, water and and soil conservation approaches and micronutrients with efficient use of safe fertilizers would help to mitigate the loss. Proponent, Agriculture Department and Farmers should also promote such practices and techniques that will increase the yield and soil fertility. Following steps are recommended for yield increase in the nearby surrounding area.

- Promote and adopt new irrigation techniques like drip irrigation, sprinkle irrigation, etc. and other prevailing modern scientific methods that will improve the crop yield;
- Use of Effective Microorganisms (EM) technology for crop yield enhancement;
- Agricultural inputs should be offered on subsidized prices to farmers of small land holdings relating to electricity tariff, supply of seeds, fertilizers, machinery and other agricultural tools so as to attract the farmers zeal to work hard in increasing the crop yield;
- Soil microbial inoculants as an alternative biological approach should be used to improve the soil quality;
- Integrated use of green manure, farmland manure and inorganic fertilizers may be promoted;
- Improving agronomic performance of crops, particularly wheat and rice, by controlling insect pests;
- Use of modern machines for cultivation and harvesting will increase yield of the crops;
- Government may evolve a system to offer credit facilities to farmers of small holdings to purchase certified seeds, pesticides, fertilizers, etc. and

- Lack of guidance to small farmers about new agricultural techniques and allied sciences may be overcome by means of communication through Radio and TV in rural areas to air the programs in regional and local languages for better understanding and field adoption.

8.3.11 Impact on Mosques and Graveyards

As per baseline survey, two small mosques in Shamme Wala village and one graveyard comprising 8 graves will be coming within project boundary.

8.3.12 Mitigation Measures for Saving Mosques and Graveyard

Mosques are privately constructed by the local persons, therefore, compensation should be paid to the locals. For graveyard maximum efforts should be done to avoid this graveyard from being affected through making necessary design changes. If impact on graveyard is unavoidable then shift these graves to nearby graveyard of Basti Waisaan.

8.4 IMPACTS AND MITIGATION MEASURES DURING CONSTRUCTION PHASE

8.4.1 Impacts on Land Resources

8.4.1.1 Soil Erosion

In the Project Area, soil erosion may be occurred as a result of improper runoff drawn from the equipment washing-yards, accidental spills from batching plants and improper management of construction activities. Soil erosion may also occur at quarry and borrow areas due to the non-engineered and inappropriate material extraction activities.

Most of the construction works of the proposed project such as surface leveling, grading, filling etc., will cause temporary change in the natural ground surfaces due to which instability of top soil surface and soil erosion may occur.

Operation and movement of construction machinery such as excavators, bulldozers, cranes, batching plants and crushers may cause soil erosion.

8.4.1.2 Soil Contamination

All the carbon and sulfur based compounds are toxic to varying degrees. Hydro Cabrons (HCs), petrol, diesel etc. are toxic in nature. The insulation on electric wires and cables are made from hydrocarbon compounds, which are also toxic in nature. Paints and varnishes are also toxic in nature, which are used during construction phase. If proper care is not taken for handling, storing and transportation of these toxic substances these may cause damage to the health of the workers as well as their spills will contaminate the soil. The other waste generated is mostly composed of rubbish, ashes and residues, demolition materials and hazardous wastes which will be generated from batching plant activities, construction camps, offices, borrow/quarry areas, stockpile and fabrication areas and other related construction activities. Indiscriminate disposal of these wastes will contaminate the soil.

Improper storage of construction materials such as bricks, cement, crushes, lubricant, chemicals and deployment of project machinery such as bulldozers, cranes, excavators will also contaminate the soil. Another source of soil contamination is the discarded construction materials which include chemicals, wires, plastics, cut pieces of pipes, pieces of empty fuel and lubricants tins and cardboard packing and other discarded materials/solid waste.

Construction camps and offices are one of the most important sources of solid waste during construction phase. The major components of the camp's waste are garbage, putrescible wastes. The construction camp will be located over reasonable area, and therefore there is significant area that is potentially susceptible to soil contamination. Immediate attention is required for such type of wastes as these are degradable and those that produce odor. It is expected that approximately 0.5 kg/capita/day waste will be generated from the camps. The total expected labor force will vary between 2500 to 3500 nos. during the peak course of the construction phase of the project. Table 8.2 shows an average estimate of the number of workers during the construction phase and estimated solid waste generated.

Table 8.2: Estimated Solid Waste Generated by Workers

No. of Workers	Estimated Solid Waste Generated per day
3000	1,500 kg/day (3,307 lb/day)

8.4.1.3 Water Ponding

The excavated material will be generated from the excavations of trenches for foundations, laying of water supply pipelines, underground electricity wiring and other structures. These excavated materials will be used for filling works as much as possible. However, a bulk of the excavated material will not be reused. If this material is left at places of excavation, it will remain there in loose form and may promote development of temporary water ponding within the Project Area and its vicinity.

8.4.2 Proposed Mitigation of Impacts on Land Resources

8.4.2.1 Soil Erosion

Good engineering practices will help in controlling soil erosion at the construction site areas. Controlled excavations at quarry or borrow areas will reduce the soil erosion. Contractor should make proper arrangements for drainage of water through channels in the washing yards and quarry areas.

Removal of vegetation and trees will be avoided to the extent possible. In case of unavoidable circumstances the exposed soil will be re-vegetated quickly and compensatory plantation, (as per Tree Plantation Plan presented in Chapter 9), will be carried out after construction is over. If construction work is divided among the sub-contractors then they all should have close coordination to accomplish their work without much damage to land/soil.

It is recommended that a properly developed quarry management plan should be prepared for each quarry site. The Waste Management Framework (WMF) and Site Restoration Framework described in Chapter 9 of this report should also be adhered to by the EPC contractor to develop plans and overcome soil contamination issues.

8.4.2.2 Soil Contamination

Oil leakages, chemicals and other hazardous / non-hazardous liquids spills should be avoided (to extent possible) or minimized by providing appropriate storage places depending on the type of stored material. Oil and other lubrication material should be stored in water proof tanks especially built for oil storage. These tanks should be built away from the main road and residential areas for public and workers safety purposes. Access to these tanks should only be allowed to the authorized personnel with specific work permit. Safety equipment and personal protective equipment along with firefighting system should be provided near these places along with identification signs and Standard Operating Procedures (SOPs).

Workers must be familiar with the Material Safety Data Sheets (MSDS) of each chemical used at site. MSDS are provided with each chemical storage box. Chemicals will be stored as per the instructions of MSDS. Utmost care should be taken during the handling of these chemicals. Precautions should be taken to prevent spills and all workers should be trained in proper handling, storage and disposal of hazardous or toxic materials.

Contractor should consult with the Proponent and the Tehsil Municipal Administration (TMA) for final disposal of solid waste which is the one of the major source of soil contamination. Segregated solid waste collection and disposal strategy should be adopted with adequate number of collection containers. The location of these containers should be easily approachable to workers/staff working within the Project site. Contractor shall also manage the disposal of waste to the designated places after consultation with TMA.

Separate primary collection of organic and in-organic waste arrangements need to be provided. In this regard, workers should be made well aware of the solid waste management system being adopted at the site. Hazardous, Non-hazardous, inert and municipal waste such as garbage, refuse, etc. produced during the construction, pre-commissioning and commissioning phases shall be disposed in compliance with the National guidelines and government ordinances. All hazardous wastes shall be clearly labeled. Other waste shall be placed in designated containers.

Regular clean-up of scrap material, saw dust, rags, oil, paint, grease, flammable solvents and other residue of construction operation shall not only remove or reduce the fire hazard, but shall promote general safety at the same time. Impermeable sheets should be placed at chemical/lubricant storage areas to avoid contamination.

Left over construction materials and excavated soil will be disposed off in designated areas to avoid soil contamination/land degradation.

Contractor will arrange adequate waste disposal and toilet facilities, potable water for use of its employees. In addition, Contractor shall comply with all laws, standards, codes and regulations relating to sanitation at the work-site, including company's requirements as to waste disposal and toilet facilities and potable water.

All the above measures should be implemented as part of a Waste Management Plan to be prepared by the contractor under the guidelines presented in the WMF in Chapter 9 of this report. The contractor should prepare Construction Camp Management Plan (CCMP) for Project implementation prior to deputing on site and submit to Consultant for approval.

8.4.2.3 Water Ponding

Proper storage place for each type of material should be built to avoid the development of water ponds. Left over material should be disposed off immediately at appropriate places designated by concerned department (TMA). Employees/workers should also be trained enough to reduce the excessive wastage of water on land or depression areas to minimize this impact.

8.4.3 Impact on Water Resources

8.4.3.1 Water Utilization for Construction

Large amount of water will be required especially during batching process of construction. Annually two (02) months closure has been recorded for TS Link Canal. During this period, the water requirement will be fulfilled by installation of deep wells for the supply of makeup water during construction phase. If the overall quantity of water required during construction phase will be extracted from groundwater then it may have negative effect on water domestic demand and may raise conflict between local communities and workforce.

Apart of this, relatively less amount of water will be utilized for drinking and domestic purpose of employees or workers at Project site. Ground water will be the only source utilized for this purpose. Estimation of this water usage for about 3000 no. of workers has been carried out based on the per capita demand of 100 liters per day. This estimate is shown in Table 8.3 below:

Table 8.3: Estimated Water (Ground Water) Utilization by Workers

No. of Workers	Estimated Total Water Demand (litres/day)
3000	300,000

8.4.3.2 Contamination of Water Resources

Sewage and wastewater will be generated at the construction camps, offices, stockyard areas and from various construction activities. If the generated sewage is not properly treated or disposed off, this may contaminate the water quality of the T-S link Canal and might affect the groundwater resources apart from soil contamination due to percolation. Water from dewatering activities (during rainy season) has the potential to contain suspended solids, oil & grease and if disposed off untreated may affect the quality of surface water bodies. Furthermore, spills of oils and hazardous chemicals if in large quantities can drain into the nearby water channels that are a source of irrigation water to the agricultural fields. This is a potentially significant adverse impact as the wastewater will directly drain from the Project Area into the Canal. Such contamination of canal water can have adverse impacts on the water quality. The Table 8.4 below shows an estimate of the wastewater to be generated during the course of the construction phase of the project assuming that 80% of the water demand will become wastewater.

Table 8.4: Estimated Wastewater Generated by Workers

No. of Workers	Estimated Total Water Demand (litres/day)	Estimated Wastewater Generated (litres/day)
3000	300,000	240,000

The groundwater can also be contaminated by sewage from the septic tanks, seepage of contaminated water in ground and leakage of underground fuel storage tanks.

8.4.4 Mitigation Measures for Impacts on Water Resources

8.4.4.1 Water Utilization for Construction

Efforts should be made to draw water from deep aquifer which does not influence the top unconfined aquifer which is being exploited by the local community. The location of these deep well should be finalized considering the drawdown phenomena of existing tube wells. Recommendations of hydrogeological study and ERS should be considered carefully. It will be EPC contractor's responsibility to ensure safe supply of water for construction purposes, to train workers on minimum use of water and to not disturb the proposed water scheme, tube wells etc.

8.4.4.2 Contamination of Water Resources

To avoid sewage, untreated wastewater, and chemicals and oil spillage from draining into the canal during construction activities, measures should be taken to collect, store and dispose off the chemicals, sewage and untreated wastewater. Contractor should not in any case dispose off the hazardous chemicals into the nearby Canal.

Similarly utmost care should be taken to avoid any spills of oils and hazardous chemicals by adopting best management practices, good house-keeping and following the MSDS. In case of accidental spill, SOPs should be developed and strictly followed by contractor. The chemicals and other oils shall be disposed off at designated places or supplied to other industries as raw material (considering its reuse) to avoid contamination. Measures should also be taken to remove settle-able solids prior to discharging of wastewater from the site which include the use of sediment sumps. Any visible oil and grease can be skimmed off the surface by using absorbent pads or oil scrapers.

For Sanitary drainage, installation of proper temporary sanitary sewage disposal facilities for the entire site should be considered. These include provisions for the construction offices and living area. The number of comfort rooms/portables shall correspond to the number of workers, as required by law, and the sanitary sewage facilities should be adequately sized.

Sewage from construction camps, offices, etc. should be disposed off by development of on-site sanitation systems i.e. septic tanks along with soakage pits. On-site sanitation system can be operated well as long as the difference from the bottom of the soakage pit is 2 m (6.56 ft) from the groundwater. Therefore, this system will minimize the negative effect on groundwater quality. During the construction work of existing HBS CCPP, overall 2000 to 3000 labor (800-1000 nos. local labor) were involved which are now reduced to 1000-1200 nos. of labor. All the temporary facilities such as offices, construction camps, batching plant facility, stockpile area etc. are located within the boundary of this RLNG CCPP. The photographs of HBS CCPP are shown in Photolog. The contractor should prepare Construction Camp Management Plan (CCMP) for Project implementation prior to deputing on site and submit to Consultant for approval.

8.4.5 Impacts on Ambient Air and Noise

8.4.5.1 Air Quality

Air quality is likely to be adversely affected by the construction of the Power Plant. Following types of emissions are expected, including:

- Gaseous emissions (SO_x, NO_x, CO_x, etc.) due to movement of construction machinery such as cranes, excavators, crushers, batching plants, bulldozers, vehicles and operations of equipment;
- Fugitive dust emissions due to movement of machinery on dirt tracks, construction of roads and excavation of borrow areas; and
- Particulate Matters (PM) such as PM_{10} and $PM_{2.5}$ emissions during the operation of concrete batching plants, asphalt mixing plants and other construction equipment.

These emissions are described in the following sections.

a) Gaseous and Fugitive Dust Emissions

Various types of machinery will be required for the construction activities. Machinery will consist of gantry cranes, tower cranes, crawler cranes, loaders, trailer pumps, mixers, excavators, dumpers, concrete rollers, etc. Since most of the machinery will use diesel as fuel, emissions will mainly consist of carbon monoxide (CO), sulfur dioxide (SO_2), PM, nitrogen oxides (NO_x) and HC. Most of the above machinery (excluding the batching plants) will move around during the construction period.

Fugitive dust will be produced by earth moving activities, excavation, haulage, heavy machinery movement and construction of access roads outside and within the power plant area. Fugitive dust emissions are a function of silt content of dirt tracks, vehicle speed and the mean annual number of days with 0.01 inches (0.254 mm) or more of rainfall.

Gaseous and fugitive dust emissions will result in an impact of medium significance, due to their moderate magnitude, relatively small duration (less than five years), and localized geographic impact area. Gaseous and fugitive dust emissions will affect the environmental components especially inhabitants living in the nearby settlements. Moderate levels of vehicular emissions tend to cause lung irritation, shortness of breath and increase a person's susceptibility to asthma. This impact is classified as moderately significant.

b) Particulate Matter Emissions from Concrete Batching

Concrete batching plants will be a major source of PM emissions. These emissions accumulate in the respiratory system and can lead to decreased lung function, and respiratory disease. Direct impacts will be encountered by the construction workers working in close proximity to the batching plants as well as those residents in nearby settlements.

The critical sources of air pollution during the construction phase are:

- Quarry or borrow areas that generate fugitive dust during the excavation and related activities; and
- Construction material haulage trucks that generate dust, particularly during the loading and unloading processes.

8.4.5.2 Noise and Vibration

Various activities during construction such as batching and asphalt plants operation, vehicular movement, clearing activities and other associated works etc. are the main source of noise and vibration. These activities might affect the nearby receptors such as villages, schools and especially labor working at Project site if noise crosses the PEQS limit as mentioned in Table 8.5 below:

Table 8.5: Noise Levels for Different Zones

Sr. No.	Zone	Noise Levels (dBA)	
		Day Time*	Night Time**
1	Residential (A)	55	45
2	Commercial (B)	65	55
3	Industrial (C)	75	65
4	Silence (D)	50	45

* *Day Time Hour: 06:00AM to 10:00PM*
** *Night Time Hour: 10:00PM to 06:00AM*

8.4.6 Mitigations of Impacts on Ambient Air and Noise

- Tuning of vehicles should be mandatory to reduce the emissions of NO_x, SO_2, CO, HC and PM to ensure that these emissions do not exceed PEQS limits of Motor Vehicle Exhaust and Noise. All vehicles will be required to carry a fitness certificate;
- Emissions points from batching plants, asphalt plants and other equipments can be controlled efficiently by the installation of cyclone. It is also recommended that during the operations of the machines labor shall wear Personal Protective Equipment (PPEs) in order to save their health. Diesel operated equipment and vehicles should be well maintained to minimize particulate emissions. Maintenance will include changing of lubricating oil, changing of air and fuel filter, cleaning of fuel system, draining the water separators and proper tuning;
- Haulage trucks carrying soil, sand, aggregate and other materials will be kept covered with tarpaulin to contain the construction materials being transported within the body of each carrier. Moreover, slightly wet material controls air pollution;
- Dust emissions will be reduced by regular sprinkling of water. Sprinkling will take place at an interval of three hours during daylight hours and six hours during night time throughout the construction period in the summer and during the winter the frequency can be reduced as per the requirement. Sprinkling will be done on access roads, tracks which are frequently used by vehicles, project site, construction material such as soil, sand etc. storage area;
- Noisy construction activities will be avoided during the night times and silencers should be provided in all vehicles. Noise complaints should be logged and kept onsite by the construction contractor. Noise producing machinery should be properly examined to reduce noise;
- All the provisions of PEQS, 2016 based on the zone classification should be strictly enforced;
- The proposed Project Area site should be fenced and noise barriers must be installed;
- Vibrational affects should be minimized by installing shock abosrbers with allproject machinery.

8.4.7 Impacts on Flora

Following are the impacts on flora due to project construction:

- The initial construction works at the project site, involving land clearance, cutting, filling and leveling will cause loss of potential productive agricultural land and loss of vegetation. Vegetation which shall be impacted are Gum Arabic (*Accacia nilotica*), Shisham (*Dalbergia sisso*), Date Palm (*Phoenix Dactylifirra*), and Lebbek (*Albizia lebbek*) etc. Agriculture Crops such as Wheat, Rice, and Cotton and grasses i.e. Bermuda (*Cynodon dactylon*), Gam or Mall (*panicum antidotale*), Khawi (*Cymbopogan jawarnica*) and Dib (*Typha angustata*) will be impacted.
- Construction of the Power Plant in any case shall involve cutting and removal of trees, which shall have a negative effect on the flora of the tract.
- Establishment of Contractor's camp and warehouses for storage of equipment, material etc. shall involve clearing of vegetation from the area causing a negative impact;
- Soil erosion shall enhance due to processes of digging of earth for building construction and for road construction. Loose earth is likely to be eroded and washed away along slopes;
- During the entire construction period dust laden polluted air will form a dust film on leaves thus blocking sunshine and stomata consequently hindering photosynthesis processes causing detrimental effect on the plant health;
- Exhaust of noxious gases from movement of heavy machinery will pollute air which will adversely affect health and vigor of plants; and
- During construction activities the Contractor's workers may damage the vegetation and trees (for use as fire-wood to fulfill the camps requirements.

8.4.8 Trees in the Project Area

Based on physical observation at site of the project site, total number of trees existing in the Project Area is approximately 409 (including all forest trees having a girth of 1 ft or above and fruit trees). These trees are mostly Gum Arabic (*Acacia Nilotic),* Indian rosewood *(Dalbergia sissoo)* and Date palm *(Phoenix dactylifera),* which form nearly 70 % of the total number of trees, followed by Lebbek tree *(Albizzia lebbe), Cordia myx,* Indian lilac *(Azadrachta indica)* Mulberry *(Morus alba)* and other species. Girth size of the trees existing within the power plant area is predominantly 0.6-1.22 m (2 feet to 4 feet). In addition to Date Palm (*Phoenix dactylifera* other fruit trees found in the Project Area are Mango *(Mangifera indica)*, Jambul (*Syzygium cumini*), Citrus (*Citrus lemon)* and Guava *(Psidium guajava*) plants. These fruit trees are mostly raised at the Deras or residences of the few landowners, existing within the Project Area. Detailed description of trees existing in the Project Area is given below in Table 8.6.

Table 8.6: Girth Size of Trees in the Project Area

Sr. No	Tree Name	Less than 1' Girth Size Class	Girth Size 1'-11" Class V	Girth Size 2'-3'11" Class IV	Girth Size 4'-5'11" Class III	Girth Size 6' And Above Class II	Total
1	*Acacia nilotica*	--	75	56	4	--	135
2	*Zizyphus sp.*	--	3	1	--		4
3	*Vitis vinifera*	--	10	6	--	--	16
4	*Date Palm*	--	4	77	2	--	83
5	*Dalbergia sissoo*	--	36	34	--	--	70
6	*Albizia lebbek*	--	6	14	--	--	14
7	*Azadirachta indica*	--	1	7	1	--	9
8	*Cordia myxa*	--	1	5			6
9	*Eucalyptus Camaldulrnsis*	--	1	2	--	--	3
10	*Morus Alba*	--	10	3			13
11	*Leucaena leucocephala*	--	2	--	--	--	2
12	*Poplus Ciliata*	--	1	--	--	--	1
13	*Tamarix aphyla*	--	--	3	--	--	3
14	*Bombax ciba*	--	3	1	--	--	4
15	*Ficus Religiousa*	--	--	--	--	2	2

Sr. No.	Tree Name	Less than 1' Girth Size Class	Girth Size 1'-11" Class V	Girth Size 2'-3'11" Class IV	Girth Size 4'-5'11'" Class III	Girth Size 6' And Above Class II	Total
16	*Syzygium cumini*	--	2	2	2	--	6
17	*Mangifera indica*	--	--	--	6	--	6
18	*Psidium guajava*	7	10	--	--	--	17
19	*Citrus lemon*	1	3				4
20	*Punica granatum*		2				2
21	*Citrus paradis*		3				3
							409

Girth Size Class Less than 1" Class V 1' to 1'-11"; Class IV 2' to 3'-11"; Class III 4' to 5'-11"; Class II 6' to 7-11"; Class I 8'and above.

There are 40 similar trees on access road for new RLNG Power Plant. However, it is not necessary that all the 449 trees are to be removed. Most of these trees along the drains, need not to be cut and they will remain as such, as they will be useful in stabilizing the banks of these drains.

8.4.9 Mitigation of Impacts on Flora

To minimize the impacts on flora, following measures should be adopted during construction:

- Only trees coming within the various structures to be constructed on the site, shall be removed and every possible effort shall be made to save the remaining trees, which fall in open spaces or those which can be adjusted in the future landscape of the Power Plant;
- Campsites and asphalt plants will be established on vacant land rather than on green areas. However, if such type of land is not available, it will be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to trees and undergrowth;
- Nearly 4500 trees (10 times more trees than trees to be cut/affected) of suitable species shall be raised in accordance with the Tree Plantation Plan to improve aesthetic value and offset the effect of removal of vegetation. About 3,000 along the Plant boundary and remaining 1100 plants in the open spaces within the boundary of the power plant and along the adjoining T S Link canal and Haveli canal, where open spaces are available.
- Construction vehicles, machinery and equipment will remain confined within their designated areas of movement;
- The Contractor's staff and labor will be strictly directed not to damage any vegetation such as trees or bushes;
- Contractor will provide gas cylinders at the camps for cooking purposes and cutting of trees/bushes for fuel should be strictly prohibited; and
- Such impacts would, however, be confined mostly to the initial periods of the construction phase and would be minimized through adoption of control measure as already mentioned. The impact would be restricted within the plant boundary. Thus, the impacts of construction activities will be marginal in scale.

8.4.10 Impact on Fauna

Following are the impacts on fauna during construction phase of project:

- The increase in vehicular traffic due to construction coupled with higher noise level due to various construction activities may drive away the local fauna from project site to neighboring area. However project site/area does not harbour fauna of significant importance. Hence, the impact on fauna is expected to be minimal;
- The trees provide nesting and resting places to the fauna. The cutting of these trees will have a negative impact on the fauna as well;

- During the construction phase, there will be negative impacts on the mammals and reptiles of the area, due to construction activities involving excavation, access roads, movement of labor, carriage of goods and machinery to various sites along the project corridor. Mammals, such as dogs, cats, jackals etc. will avoid these areas for fear of being persecuted. Same will be the case with reptiles such as snakes and lizards which might be killed during construction activities such as digging and movement of construction machinery and vehicles. Birds like House Sparrow, crows, myna, parrots, pigeons etc shall move away from the area, due to project activities and find shelter in nearby agricultural lands or barren areas;
- Eatable and refuse goods of the Contractor's camps may attract wildlife that might be hunted by the workers;
- Due to establishment of labor camp, food storage, setting up of kitchens, production of sewage and waste water may result in multiplication of rodents like rats, mice and shrew etc. and vectors like mosquitoes, bugs and flies which will have a negative impact; and
- Birds will try to find shelter and food somewhere else and will tend to move away from the Project Area due to the activities mentioned above for fear of being hunted/caught.

8.4.11 Mitigations of Impacts on Fauna

To minimize the impacts on fauna, following measures should be adopted during construction:

- Noise control measures should be enforced during the construction phase such as provision of silencers on heavy construction vehicles. It is further recommended that activities, which are expected to generate more noise should be executed during the daytime only;
- Moreover, over speeding shall be prohibited and construction machinery, vehicles and equipment will remain confined within their designated areas of movement to avoid and minimize any accidental killing of Fauna;
- The camps will be properly fenced and gated to check the entry of wild animals in search of eatable goods. Similarly wastes of the camps will be properly disposed off to prevent the chances of its eating by wild animals, which may prove hazardous for them;
- Hunting, poaching and harassing of wild animals and birds will be strictly prohibited and contractor shall be held responsible for any such act of his men;
- The impact on species like Brown Roofed Turtle (*Kachuga smithii*) and Houbara Bustard (*Chalmydotis undulate*) will be minimized and managed by taking following precautionary steps to preserve these endangered and vulnerable species.
- A complete survey of the area of Chenab River Bank, near Head Trimmu and portion of TS link canal, should be carried out by Wildlife Department to know the existing number of this species in the surrounding areas of power plants. After their existence is verified and their number is known, suitable steps can be undertaken for their protection like declaring the conservation areas for the preservation of these species;
- Hunting of the species must be restricted and controlled through existing regulations and if necessary, more stringent laws should be enacted for preservation of brown roofed turtles and Houbara bustard as these are valuable species;
- People should be given awareness for protection of wildlife as wildlife has also right to live and it makes the surroundings more attractive and colourful. Wildlife is an important ecological component and it adds to the beauty of the area. Promotion of awareness to individuals shall accelerate the process of wildlife preservation;
- All construction activities must be in coherence with the behaviour and habits of threatened species in the area;
- EPC Contractor should make close liaison with the Wildlife Department and Game inspectors to develop strategies for protection and conservation of species;
- During construction, fencing of area is mandatory to confine and protect the species; and
- During the hunting season, a framework should be developed in order to record the number of birds killed in a specific area. This is an essential component because it helps in generating necessary information in order to show not only the number of birds killed in

each year from a specific area but the annual population estimates can also support the sustainable use concept.

8.4.12 Impacts on Aquatic Ecology

Following are the impacts on aquatic environment:

- Construction works in the TS Link canal for constructing the intake and outfall channels of the Project may result in direct physical damage to aquatic habitat present in the creek. Construction works may also result in turbidity which may also impact aquatic habitats adversely. These may lead to changes in abundance and diversity number of aquatic species in the area. The brine released by the Project is likely to disturb the aquatic ecosystem in the TS Link, at the point of discharge.
- Increased temperature of discharged water in the TS Link canal might harm the aquatic life in the canal.

8.4.13 Mitigation Measures for Impact on Aquatic Ecology

To mitigate the impacts on aquatic environment during construction, following measures to be taken:

- During fish capturing operations by local peoples turtles are also captured and occasionally killed. Turtle hatcheries should be established and protection of nesting sites should be ensued. Surveys should be conducted to identify suitable places for establishing hatcheries for freshwater turtles. Protection of nesting sites of turtles is necessary for their survival. Nest protection during breeding season can be promoted through Community Based Organizations (CBO); and
- The surface run off originating from various construction activities should be collected and treated. Sanitation facility should be provided to construction labourers at the site.

8.4.14 Impacts on Social Environment during Construction

8.4.14.1 Impacts on Public Health

Following are the impacts on public health:

- Local community in the AOI may be affected by solid waste and wastewater emissions, noise, dust and vibration during the construction activities, which may have adverse impact on the health of the locals. These impacts are expected to be high in nearby settlements such as Kot Dewan, Nava Kot and Basti Vaisan;
- There is one primary school near the new Power Plant about 300 meters in adda Kot Dewan in which about 200 to 300 students are studying. Students and staff in this school will be adversely affected during construction activities due to noise, air pollution and vibration. During the construction activities of the power plant, elevated air and noise levels may create short term and long term health issues such as respiratory diseases by air pollution and hearing impairment, hypertension, annoyance, and sleep disturbance by noise pollution for the students and staff as well as local population residing in the AOI such as Kot Dewan, Korewala, Nai Abadi, Basti Arain, Nava Kot and Basti Vaisan; and
- Local community of Kot Dewan, Dhueen and Malu Mor may face accidents/incidents due to construction.

8.4.14.2 Mitigations for Impacts on Public Health

Following are the mitigation measures:

- Proper disposal and treatment of solidwaste and wastewater;
- Installation of noise barriers;
- Water sprinkling, encasement/provision of silencer and mini stacks of generators would be helpful to avoid inconvenience to the locals due to noise, smoke and fugitive dust; and

- Large noise generating activity will be carried out during the fixed hours (preferably during the mid-day). The timing will be made known to all the people within 500 m (1640 ft) radius of the site;
- Effective construction controls by the Contractor to avoid inconvenience to the school children, staff and locals due to noise, smoke and fugitive dust should be provided; and
- Training of workers in construction safety procedures, environmental awareness, equipping all construction workers with PPEs, safety boots, helmets, gloves, and protective masks, and monitoring their proper and sustained usage will be carried out. In case of accidents, contractor will provide free medical treatment to the community.

8.4.14.3 Impacts on Local Communities

Local communities will be affected during the construction phase as follows:

- During the construction phase, the general mobility of the locals and their livestock in and around the AOI will be affected temporarily on specific locations. The movement of the plant machinery and Towers and conductors from the stocking area to the construction site may cause traffic problems on the Jhang-Shorkot road for the locals. This may affect their mobility at times. This will have low adverse impact on the locals on temporarily basis;
- Induction of outside workers by the Contractor may cause conflicts with the locals on the cultural issues related to social and gender due to the unawareness of the local customs and norms. These issues may adversely affect the construction phase of the Project. This is a medium adverse social impact of temporary nature; and
- Theft problems to the community by the Contractor's workers and vice versa may also create social issues if outside labour is used by the Contractor.

8.4.14.4 Mitigation Measures for Impact on Local Community

Following are mitigation measures for impacts on local communities

- The Contractor have to provide alternative routes to the locals for their smooth mobility and select timing at late night and early mornings for the movements of heavy machinery, plant equipment and towers;
- During the construction phase, mobility of the workers in the nearby areas should be strictly restricted by the Contractor to avoid any inconvenience to the local communities. However, during the construction of existing power plant labor are using local tracks and cross the local populated areas but no complaint was done by the community. However, the Contractor should select specific timings so as to cause least disturbance to the local population considering their peak movement hours;
- Some Confidence Building Measures (CBMs) in the form of general improvement of the social infrastructure in the villages should be planned and implemented by the Proponent to lessen the loss of the local community and to build trust and confidence;
- The Contractor will be responsible for the sensitivity towards the local customs and traditions;
- The Contractor will be required to maintain close liaison with the local communities to ensure that any potential conflicts related to the common resource utilization for the project purposes are resolved quickly;
- The Contractor will warn the workers not to indulge in any theft activities and if anyone gets involved in such activities, he will have to pay heavy penalty and would be handed over to the police. Similarly at the time of employing, the Contractor has to take care that the workers should be of good repute. The Contractor camp should be fenced properly and main gate will be locked at night with a security guard at guard to avoid any theft incidence;
- The Contractor will keep all the copies of Computerized National Identity Card (CNIC) of his employees and will warn the workers not to involve in any theft activities and if anyone would involve in prohibited/criminal activities, the concerned police station will deal with it and he will have to pay heavy penalty;

- Similarly, at the time of employment, Contractor has to take care that the workers should be of good repute. The Contractor camp will be properly fenced and main gate will be locked at night with a security guard to check the theft issues; and
- Good relations with the local communities should be maintained by EPC Contractor to provide opportunities for skilled and unskilled employment to the locals, as well as on-job training for workers. Contractor will restrict his permanent staff to mix with the locals to avoid any social issues.

8.4.14.5 Indigenous people

No indigenous group fall in the AOI of the proposed Project. Hence there will be no impact on indigenous people.

8.4.14.6 Socio-economic Impacts

Following are the socio-economic impacts in general:

- Usage of the Community's common resources like potable water, fuel wood, etc. by the Contractor workforce may create conflicts between the community and the Contractor;
- Improper arrangement of the disposal of construction materials may create problems for the local residents during the construction of the Project;
- Relocation/disturbance to the existing utilities like electric poles, telephone poles, etc. may affect the routine life and mobility of the community;
- During the construction period, the movement of construction vehicles from the main highway into the proposed plant boundary may affect traffic on Shorkot-Jhang road and may create minor annoyances to the residents and traffic on the road. Transportation of heavy construction equipment and material is likely to damage the road
- In the proposed power plant area Moza Kot Dewan, Basti Arain, and Basti Waisaan few houses have no latrine facility therefore; some women living in these areas have to use the open field latrines. The privacy of women in Project AOI may suffer due to the Project activities

8.4.14.7 Mitigation Measures of Impacts on Socio-economic Environment

The following are the mitigation measures for impacts on social environment:

- The Contractor will take care of the local communities water needs and will not exploit, contaminate or damage community's water sources;
- Construction camp will be located at least 500 m (1640 ft) away from the local settlements to prevent the contamination of community-owned water resources;
- Approval from the locals (elders and leaders of nearby population) will be obtained before using the local water resources;
- In construction camps, amenities of life including clean food, water and sanitation facilities should be provided to these camps. The Contractor should arrange first aid boxes at camps;
- The Contractor will take due care in disposal of construction materials as well as solid waste to the proper places, not in the fields of the farmers, so that the nearby communities will not suffer;
- Proper arrangements in the form of alternative routes should be made to ensure that the mobility of locals should not be disturbed;
- Efforts should also be made to discuss traffic conditions with the National Highway Authority (NHA) so that regular traffic is not disturbed. Transporters engaged by the plant would be forced to adhere to the load specifications of the access road. No overloading would be allowed in any case;
- During the construction, accessibility of vehicles to the populated areas should be limited so that the business of shopkeepers will not be disturbed;
- Haul-trucks carrying concrete, aggregate and sand fill materials will be kept covered with tarpaulin to help contain construction materials being transported between the sites, thus preventing environmental pollution.

8.4.14.8 Gender Issues

Following are the main gender issues during construction:

- In the AOI few houses of Basti Vaisan, Shamme Wala and Kore wala near the near the Project area have no latrine facility therefore; some women living in these areas have to use the open field latrines. The privacy of women in AOI may suffer due to the Project activities.
- The houses in the surroundings of proposed Project Area may face privacy issues due to high towers and structures to be built.

8.4.14.9 Mitigation Measures for Gender Issues

To mitigate gender issues, following measures to be taken:

- The Contractor has to carry out the construction activities in such a way that the open field latrine usage timings by the local community particularly women, should not be affected. The normal timings to use the toilet facilities by the rural women are early in the morning and at evening so the Contractor will have to take care of these timings;
- Contractor should warn the staff strictly not to involve in any un-ethical activities such as theft, prostitution, harassment of working women as well as college students and to obey the local norms and cultural restrictions particularly with reference to the women; and
- If privacy of the nearby houses will be affected and the Project activities are unavoidable, the Plant management should take steps to not affect the privacy.

8.5 IMPACTS AND MITIGATION MEASURES DURING O&M PHASE

8.5.1 Impacts on Land Resources

8.5.1.1 Fire Breaking

For the proposed power plant there is also a risk of fire breaking out that may become a serious risk for residents living in allied residential facilities and/or nearby in the vicinity of the proposed power plant.

8.5.1.2 Solid Waste from Office Building and Other allied facilities

The project operation will result into generation of organic as well as in-organic waste from the power plant. This waste may have significant impact on soil, ambient air, residents living in proximity to the Power Plant, as well as on the aesthetic values if improper systems are adopted. In order to assess the impacts and proper designing of collection, transportation and disposal system, it is imperative to quantify the solid waste generation and assess its characterization.

It is estimated that maximum of 200 staff will be employed during O&M phase. In case of solid waste generation from office building and other facilities, the following range has been worked out as shown in the Table 8.7 below. Using a solid waste generation rate of about 0.8 kg/day (1.7 lb/day), about 160 kg/day (352.64 lb/day) of solid waste will be generated from 200 persons working during O&M phase.

Table 8.7: Typical Solid Waste Generation Rates

Sr. No	Source	Range
1	Office Buildings	0.5 – 1.1 kg/employee/day (1.1-2.4 lb/ employee/day)
2	Residential Colony(ies)	0.2 – 0.8 kg/employee/day (0.4-1.7 lb/employee/day)

8.5.1.3 Soil Contamination

The soil can be contaminated during the O&M phase due to the many chemicals used in the power plant processes. If proper care is not taken for handling, storing and transportation of these toxic substances, they may cause damage to the health of the workers as well as their spills which will also contaminate the soil. Even solid waste generated from the power plant, residential buildings, offices and other allied facilities can contaminate the soil.

8.5.2 Mitigations of Impacts on Land Resources

8.5.2.1 Fire Breaking

Fire protection and detection systems shall be provided to protect life, property, equipment, and operation of the power plant. The detection and fire alarm, fire protection and fire-fighting systems shall include, but not be limited to the following:

- Firefighting water storage, may be combined with raw water tank, as per the regulations;
- Firefighting pumps;
- Fire water ring main system, including hydrants;
- Fire protection systems; and
- Fire alarm and detection system.

All systems shall be subject to the approval of insurance company. The system shall be completed with all necessary piping, pumps, safety valves, mobile equipment, vehicles, etc.

8.5.2.2 Solid Waste from Residential Colony and Office Building

Provisions should be made for proper solid waste management as per the guidelines of the WMF in Chapter 9 of this report, which will involve the following major operations:

- Storage at source;
- Component separation at source;
- Segregated collection of waste;
- Storage;
- Transportation;
- Resource recovery for recycle and reuse items; and
- Environment friendly disposal of waste (sanitary landfill).

Proponent should make final disposal arrangements in consultation with the concerned government department (TMA) and should take approvals for final disposal of the waste at the designated disposal site.

A separate solid waste management system for waste from the office building and other allied facilities will be required. During the collection of solid waste, recyclable and reusable waste will be separated for resource recovery and reuse of the generated material.

8.5.2.3 Soil Contamination

SOPs should be followed to avoid spilling of oil and other hazardous chemicals to prevent soil contamination. Floors with impervious surface should be designated to avoid the contamination of soils. However, in case soil contamination due to spillage of oil occurs, the contaminated soil should be removed to avoid further spread of pollution in environment.

8.5.3 Impacts on Water Resources

8.5.3.1 Impact on Water Requirements

Cooling water for main cooling cycle will be taken from TS-Link irrigation canal next to project site. During a yearly period of canal closure (6-8 weeks) the cooling demands of the power plant will be met using cooling towers. During this period, water will be taken from underground wells that have to be developed as part of the EPC Contract. Since the wells will be used only for up to 8 weeks per year, a permanent impact is not expected. Tube wells near the project boundary might be impacted due to the drawdown phenomena of groundwater extraction carried out through the deep well installed for this purpose during canal closure period.

8.5.3.2 Wastewater Produced from Plant Operations

The plant operation will generate industrial as well as sanitary wastewater. It is estimated that about a maximum of 2 m^3/h of sanitary, 4 m^3/h of industrial wastewater will be generated along with cooling tower blow down (expected concentration factor: 4 - 5) in canal closure period. The release of hot water from new CCPP and existing RLNG HBS may have cumulative impact on canal water temperature rise.

8.5.3.3 Raw Water Reservoir

If raw water reservoir will be constructed during the canal closure to store ground water, the water quality of this reservoir (if uncovered) can be impacted by solid waste, sewage or other contaminated material. Furthermore, there is risk of vector borne diseases like malaria or dengue if the reservoir is uncovered or not properly monitored.

8.5.4 Mitigation Measures for Impacts on Water Resources

8.5.4.1 Water Requirements

The water requirement for power plant will be about 22 Cumecs (770 Cusecs). The impact is not expected to be significant. The impact of the extraction of the water on the aquifer should be determined on the basis of recommendations of Hydrogeological and ERS study.

8.5.4.2 Treatment and Disposal of Wastewater Produced from Plant Operations

Wastewater treatment system needs to be selected carefully considering the characteristics of wastewater generated from the power plant. The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case, if treated water discharge is not permitted during this time by the canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided. The location of seepage pit will be finalized by EPC Contractor during the design with consultation concerned department (TMA).

It is highly recommended that a separate water quality modeling study be conducted to monitor water quality along a stretch of the TS- Link Canal from the point of discharge of hot water into canal. The canal water intake for new RLNG project and HBS intake point should be same for cooling purposes. Else the intake should be before temperature influence zone of the discharge from HBS to minimize the effect of temperature rise. The consent from Irrigation Department must be taken in this regard.

Sanitary wastewater from the plant area shall be treated in biological treatment plant where all sanitary effluents will be reduced from organic matter to stable sediment. The water discharged from this plant shall be conveyed to the cooling water outfall. Separated sludge shall be collected in a sludge collector pond and suitably disposed off. The system shall have a sufficient treatment capacity and will be divided into several components which will be performing a specific phase of the treatment (retention basin, aeration basin, clarifier, sludge pit). The chlorination of separated clear water shall be performed by hypochlorite solution generated in the chlorination plant. The plant shall be designed to meet the following discharge limits (Table 8.8):

Table 8.8: Characteristics of Treated Effluent

Sr. No	Component	Value
1.	BOD_5	25 mg/l
2.	COD	125 mg/l
3.	TSS	35 mg/l
4.	Total Nitrogen Compounds (as N)	15 mg/l

The treated effluent from the sanitary wastewater treatment plant shall be transferred through piping to the treated water monitoring basin by gravity or dedicated pump station.

The industrial waste water treatment plant shall be constructed to treat all wastewater occurring during O&M of the power plant. The facilities have to be capable to achieve discharge limits for discharge into surface waters, stipulated in the most recent issue of the PEQS.

In industrial wastewater treatment plant, all oil contaminated drains and wash waters from the plant area shall be collected and treated by oil separators. The oil separators shall have two stages and shall be designed to meet the applicable wastewater discharge standards for residual oil and grease.

In case of accidents, large amounts of oil may lead to a blocking of the oil separators. Therefore, the de-watering of transformer areas shall be equipped with a retention basin with sufficient capacity to hold up the maximum possible oil discharge plus the firefighting water in case of fire NFPA Standard.

The oil free water from the oil separators and all other industrial drains shall be directed to the wastewater retention basin. The wastewater will be treated by the following steps: clarifier, secondary oily cleaning stage, and mechanical filters. The effluent from the mechanical filters and the boiler blow down shall also be directed to the treated wastewater basin for regular sampling and analyses in the plant chemical laboratory. From there, all plant effluents shall be finally discharged through the cooling water outfall pipes to the canal.

Only Sodium Hypochlorite (NaClO) will be used in the cooling water, the level will be closely monitored to keep it at the specified value which is evaluated as acceptable for the environment. Chemical drains from the water demineralisation plant, electrochlorination plant, battery room, etc. shall be collected in a separate drainage system, stored in a chemical waste water pit and treated on demand in a waste water treatment tank by means of precipitation and neutralisation chemicals. The treated effluent from the chemical waste water treatment tank shall be discharged into treated waste water monitoring basin and from there to the cooling water outfall.

Separated sludge from waste water and oily water treatment, as well as effluents from boiler acid cleaning and GT compressor washing shall be disposed off externally by a certified waste disposal contractor.

The GT wash waters and effluents boiler acid cleaning shall be collected during the washing procedure in dedicated tanks (to be provided) and disposed off externally by a certified waste disposal contractor.

8.5.4.3 Raw Water Reservoir

The raw water reservoir must be managed properly by the Project Proponent with a plan to ensure that it is not contaminated. Preferably, it should be covered.

8.5.5 Impacts on Air

Air quality can be reduced by emissions of typical pollutants such as SO_2, NO_x, and PM. Oxides of Nitrogen (NOx) are formed when combustion temperatures exceed 1,300 degree Celsius. Oxides of sulphur (SO_2 mainly), and PM are emitted depending upon the fuel characteristics.

The proposed power plant Jhang will utilize the RLNG as main fuel and HSD as a backup fuel. There exists another RLNG based CCPP HBS which is near completion. HBS power plant will also utilize RLNG as main fuel and HSD as a backup fuel. The side-by-side operation of both power plants is expected to pose cumulative impact on air quality. The impact on air quality is not expected to be significant if plants are run on RLNG (main fuel) which is a clean fuel with less air emissions. The emission estimates for the RLNG[10] and HSD provided by the designers of both RLNG power plants are given in Table 8.9 below:

Table 8.9: Pollutant Concentrations and Compliance Status with PEQS

Parameter	Units	Combined Cycle	Single Cycle	PEQS
MAIN FUEL - RLNG				
NO_x Concentrations	mg/Nm^3	50*	50*	400
PM concentration total @ 15% O_2	mg/Nm^3	5	5	-
PM concentrations (PM_{10})	mg/Nm^3	3	3	-
PM concentrations ($PM_{2.5}$)	mg/Nm^3	2.5	2.5	-
SO_2 concentrations	mg/Nm^3	28.46	28.46	1700
BACKUP FUEL - HSD				
NO_x Concentrations	mg/Nm^3	100*	100*	600
PM concentration total @ 15% O_2	mg/Nm^3	5	5	300
PM concentrations (PM_{10})	mg/Nm^3	3	3	-
PM concentrations ($PM_{2.5}$)	mg/Nm^3	2.5	2.5	-
SO_2 concentrations	mg/Nm^3	546	546	1700

As shown in the Table above, the pollutant's concentration to be emitted from stacks of both power plants, are within the thresholds of PEQS.

PEQS also lays down the compliance criteria for maximum allowable ground level increment to ambient and maximum SO_2 emissions in tons/day/plant. These criteria are required to be met on the basis of classification of the airshed as unpolluted, moderately polluted and much polluted, which is based on the measurement of SO_2 as annual average and maximum 24 hrs interval as shown in Table 8.10 below.

Table 8.10: SO_2 Ambient Air Criteria

Sr. No.	Background Air Quality (SO_2 Basis)	Annual Average ($\mu g/m^3$)	Max. 24 hrs Interval ($\mu g/m^3$)	Standards	
				Max. SO_2 Emission (tons/day/plant)	Max. Allowable ground level increment to ambient ($\mu g/m^3$) (One year average)
1	Unpolluted	< 50	< 200	500	50
2	Moderately Polluted*				

[10] Data provided by the designer to the best of their knowledge. NO_x values have been based on limits, which can be achieved and guaranteed, while the PM values are taken from similar projects on diesel fuel with a typical split between $PM_{2.5}$ and PM_{10}.

Sr. No.	Background Air Quality (SO_2 Basis)	Annual Average (µg/m³)	Max. 24 hrs Interval (µg/m³)	Standards	
				Max. SO_2 Emission (tons/day/plant)	Max. Allowable ground level increment to ambient (µg/m³) (One year average)
3	Low	50	200	500	50
4	High	100	400	100	10
5	Very Polluted**	> 100	> 400	100	10

* For intermediate values between 50 and 100 ug/m³ linear interpolations should be used.
** No project with sulphur dioxide emissions will be recommended.

The above criteria cannot be precisely adopted as the annual average values of SO_2 are not available. The data can only be obtained once the EPA starts continuous monitoring under national program. However, 24-hour monitoring was done at EIA stage of HBS power plant indicated a maximum 24-hour concentration of about 31.4 µg/m³ for SO_2. Considering this concentration, it is likely that the airshed would be classified as Unpolluted. Furthermore, the SO_2 emissions in tons/day/plant are calculated as 130.8 tons/day for a maximum capacity of 1,230 MW for single cycle operation on HSD which is less than value of 500 tons/day/plant specified in PEQS, therefore the plant meets the maximum SO_2 emission requirements laid down in PEQS.

8.5.6 Air Dispersion Modeling (ADM)

Air dispersion modeling is an important tool used to predict ambient air quality concentrations based on air pollutant emissions from stacks of power plant. It utilizes the mathematical formulation to describe the atmospheric process that disperse the pollutant and determine the ground level concentrations to assess the impacts on different receptors. In impact assessment studies, the models are typically used to determine whether proposed facilities will be in compliance with national ambient air quality standards and offer the advantage of bringing about necessary changes in the proposed industrial facilities so that plans can be fine-tuned to minimize environmental impacts.

Air dispersion modeling was done for this project with an objective to determine the ground level concentrations of SO_2, NO_x, and PM in order to check the compliance with the standards and assess the impacts on receptors.

8.5.6.1 ISC-AERMOD

The air dispersion modeling software ISC-AERMOD View, a replacement of ISC models (Industrial Source Complex) for predicting ground level concentrations of the pollutants and estimating the air quality impacts of sources, was used in this study. It also includes necessary user-friendly options such as complete AERMET meteorological data pre-processing and multiple pollutant utilities for modeling multiple pollutants in AERMOD run.

ISC-AERMOD is Gaussian steady-state plume dispersion model. It can be successfully applied for air quality assessments of inert pollutants that are directly emitted from a variety of sources.

The model assumes that the plume disperses in the horizontal and vertical direction, resulting in Gaussian (bell- shaped) concentration distributions. For the steady-state assumption, emission rates are assumed to be constant and continuous. The model is typically used to assess ambient concentrations of various pollutants in regulatory applications for a near-field modeling analysis.

This model uses the hourly sequential meteorological data to take account of complex turbulence and atmospheric stability effects and incorporate terrain affects. The model allows pollutant concentrations to be calculated at specific receptors or gridded locations for both long and short term averaging periods for emissions from a number of specified sources.

8.5.6.2 Working of ISC-AERMOD View Software

The ISC-AERMOD View interface uses six pathways that compose the run stream file as the basis for its functional organization. These pathways include:

- **Control Pathway (CO)**: Where the modeling scenario is specified, and control the overall modeling run.
- **Source Pathway (SO):** It is used to define the sources of pollutant emissions. The model is capable of handling multiple sources, including point, volume, and area source types.
- **Receptor Pathway (RE):** This pathway is used to specify and define the location, type and the number of receptors.
- **Meteorological Pathway (ME):** Here the atmospheric conditions of the area being modeled are defined; which will be useful while determining the distribution of air pollution impacts for the area.
- **Terrain Grid Pathway (TGP):** Here the terrain type to be used for modeling is specified. The option of complex terrain is also available in addition to simple terrain.
- **Output Pathway (OP):** The types of output required are specified in this pathway.

8.5.6.3 ADM Setup

The modeling setup based on the data provided by the designers of both RLNG Power Plants (i.e. Existing 1230 MW RLNG based CCPP Haveli Bahadur Shah and proposed 1,100-1,400 MW RLNG based CCPP Jhang Project) is given in Tables 8.11 & 8.12 below:

Table 8.11: Air Dispersion Modeling Setup for RLNG CCPP HBS

Description	Units	Value	
		Combined Cycle	Single Cycle
Source (Stacks)	No.	2	2
Stack Height	m	60	45
Stack Diameter	m	7	6.1
MAIN FUEL-RLNG			
Flue gas flow rate (each stack)	(m^3/sec)	766.66	1773.33
Flue gas temperature	^{0}K	366	872
Velocity of flue gas	m/s	19.7	62.2
Emission rate SO_2	g/s	18.56	18.63
Emission rate NO_x	g/s	28.60	27.76
Emission rate total PM	g/s	2.86	2.76
Emission rate PM (PM_{10})	g/s	1.7	1.66
Emission rate PM ($PM_{2.5}$)	g/s	1.43	1.4
Anemometer Height	m	10.24	10.24
Terrain	Simple and Flat		
Meteorology	Two years meteorological data used for ADM (2013-2014)		
Pollutant Averaging Periods	Annual and 24 Hours		
BACKUP FUEL – HIGH SPEED DIESEL			
Flue gas flow rate (each stack)	(m^3/sec)	912	1810.66
Flue gas temperature	^{0}K	423	866
Velocity of flue gas	m/s	23.4	63.7
Emission rate SO_2	g/s	397.33	366
Emission rate NO_x	g/s	58.86	57.06
Emission rate total PM	g/s	2.93	2.86
Emission rate PM (PM_{10})	g/s	1.76	1.7
Emission rate PM ($PM_{2.5}$)	g/s	1.46	1.43
Terrain	Simple and Flat		
Meteorology	Two years meteorological data used for ADM (2013-2014)		
Pollutant Averaging Periods	Annual and 24 Hours		

Table 8.12: Air Dispersion Modeling Setup for RLNG CCPP Jhang

Description	Units	Value	
		Combined Cycle	Single Cycle
Source (Stacks)	No.	2	2
Stack Height	m	60	45
Stack Diameter	m	7	6.1
MAIN FUEL-RLNG			
Flue gas flow rate (each stack)	(m^3/sec)	766.66	1773.33
Flue gas temperature	^{0}K	366	872
Velocity of flue gas	m/s	19.7	62.2
Emission rate SO_2	g/s	18.56	18.63
Emission rate NO_x	g/s	28.60	27.76
Emission rate total PM	g/s	2.86	2.76
Emission rate PM (PM_{10})	g/s	1.7	1.66
Emission rate PM ($PM_{2.5}$)	g/s	1.43	1.4
Anemometer Height	m	10.24	10.24
Terrain	Simple and Flat		
Meteorology	Two years meteorological data used for ADM (2013-2014)		
Pollutant Averaging Periods	Annual and 24 Hours		
BACKUP FUEL – HIGH SPEED DIESEL			
Flue gas flow rate (each stack)	(m^3/sec)	912	1810.66
Flue gas temperature	^{0}K	423	866
Velocity of flue gas	m/s	23.4	63.7
Emission rate SO_2	g/s	397.33	366
Emission rate NO_x	g/s	58.86	57.06
Emission rate total PM	g/s	2.93	2.86
Emission rate PM (PM_{10})	g/s	1.76	1.7
Emission rate PM ($PM_{2.5}$)	g/s	1.46	1.43
Terrain	Simple and Flat		
Meteorology	Two years meteorological data used for ADM (2013-2014)		
Pollutant Averaging Periods	Annual and 24 Hours		

8.5.6.4 Modeling Scenarios

Based on the both power plants' main and backup fuels characteristics and operation modes, following four scenarios were selected for the ADM:

1. Plants Operation on RLNG in a Single Cycle Mode (RLNG+SC)
2. Plants Operation on RLNG in a Combined Cycle Mode (RLNG+CC)
3. Plants Operation on HSD in a Single Cycle Mode (HSD+SC)
4. Plants Operation on HSD in a Combined Cycle Mode (HSD+CC)

The ADM was done for SO_2, NO_X, and PM for all the above scenarios for annual and 24 hours averaging periods considering the side-by-side operation of both RLNG power plants. Results and analysis of all the scenarios for each typical pollutant are given below:

8.5.6.5 Oxides of Sulphur (SO_2)

The dispersion isopleths of SO_2 emissions (annual as well as 24 hours averaging periods) from both plants' operation on all four scenarios are shown in Figure 8.3 to 8.10.

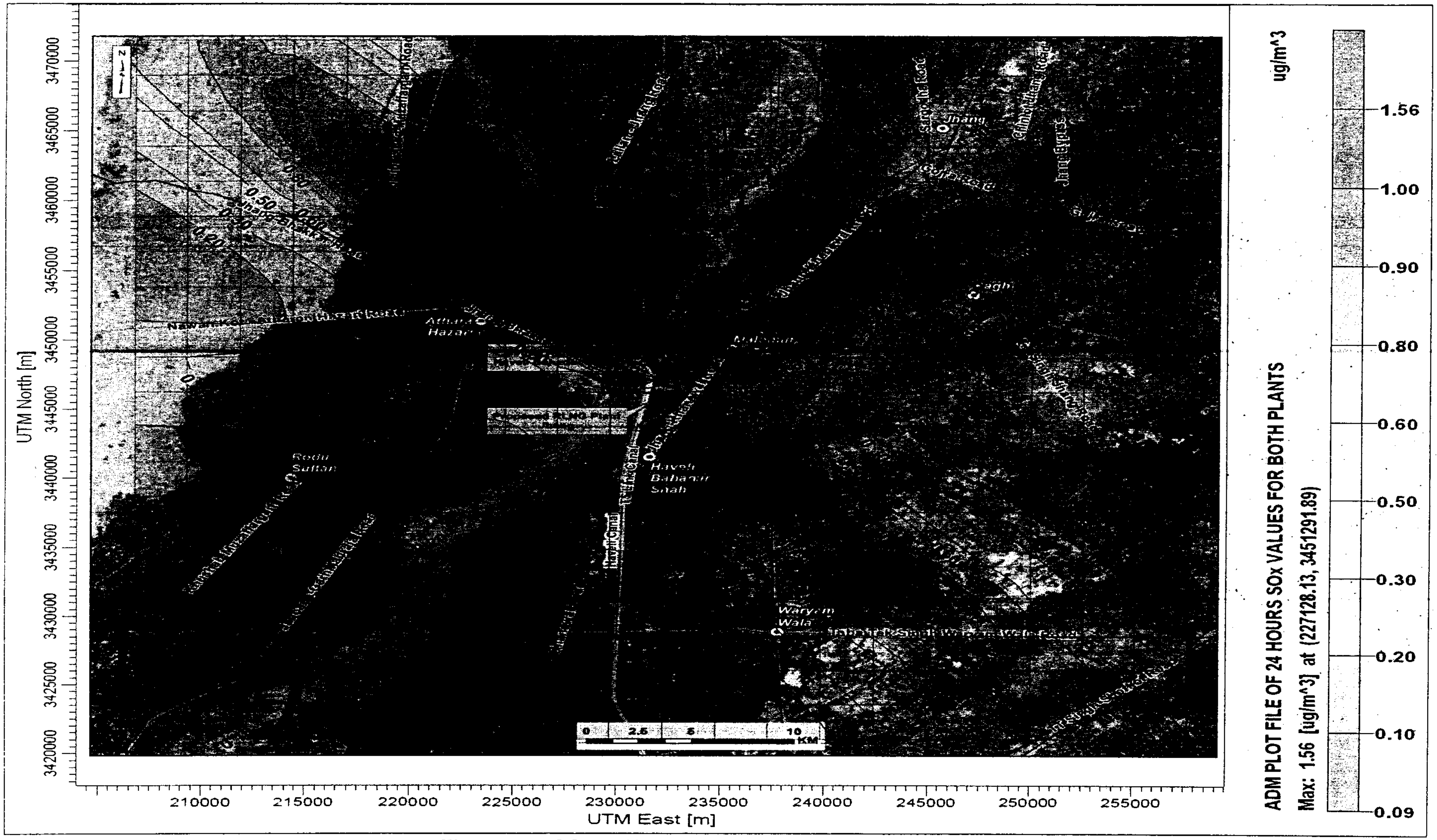


Figure 8.3: SO_2 24 Hours Average Isopleth RLNG+SC

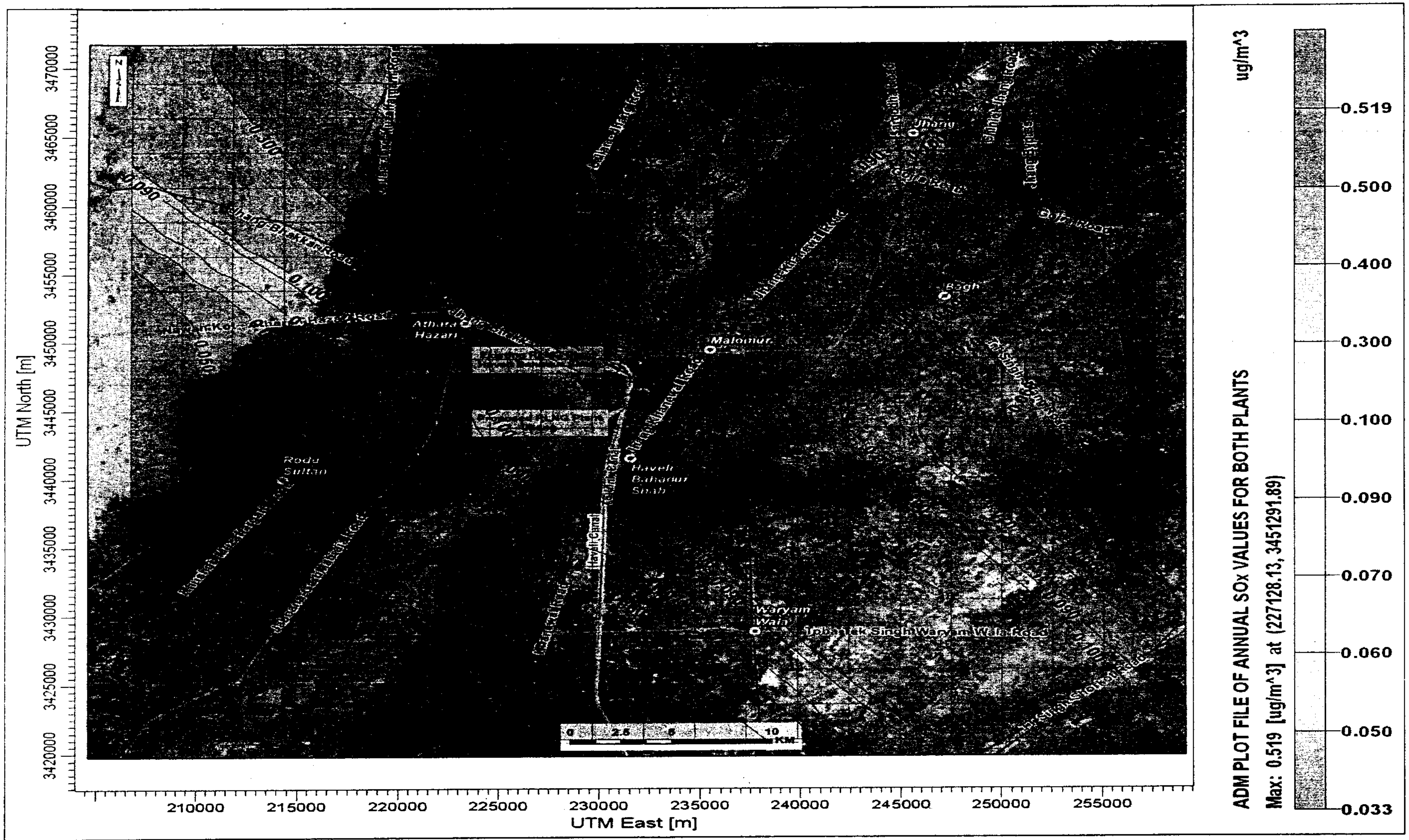


Figure 8.4: SO_2 Average Annual Isopleth RLNG+SC

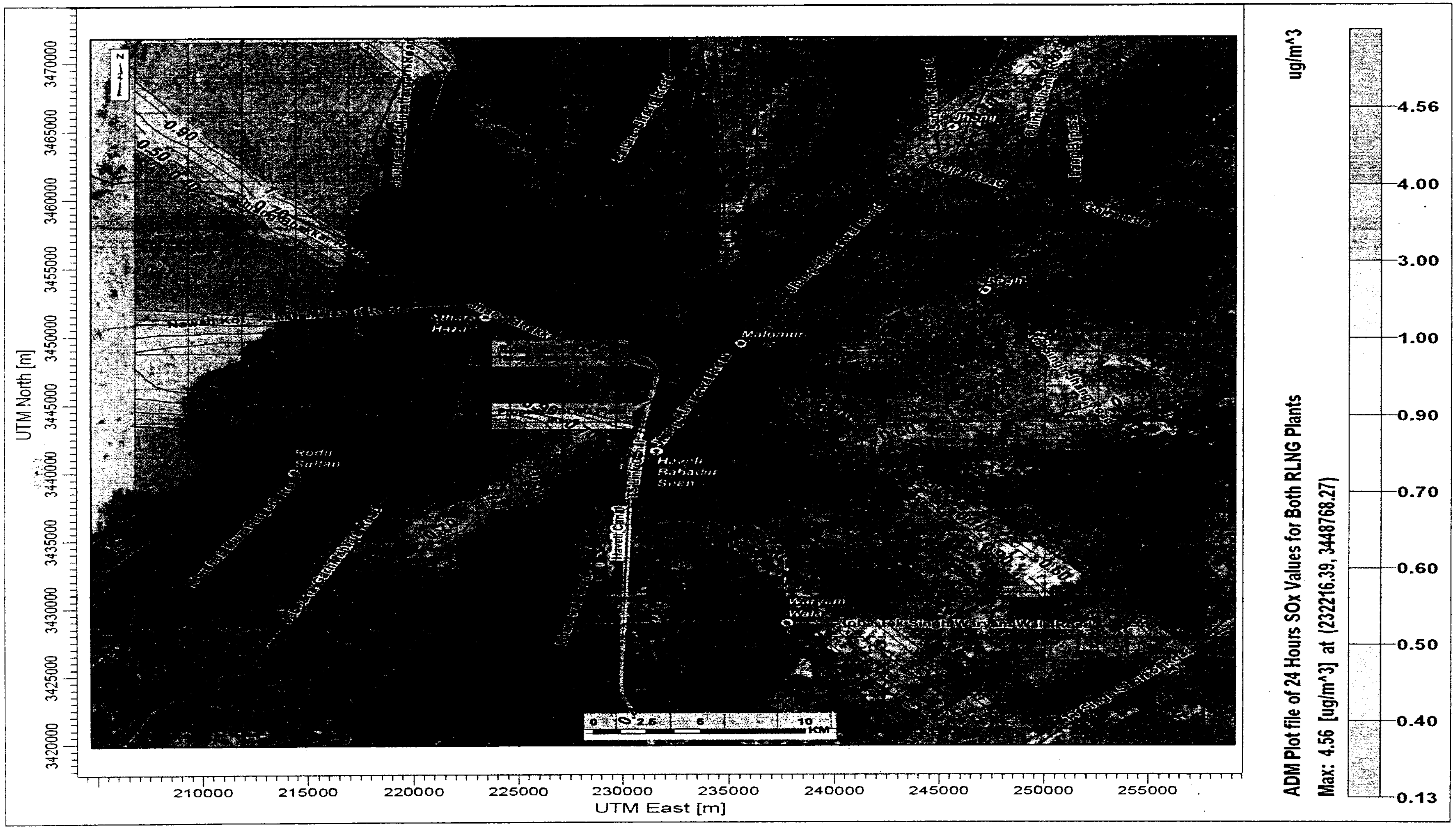


Figure 8.5: SO_2 24 Hours Average Isopleth RLNG+CC

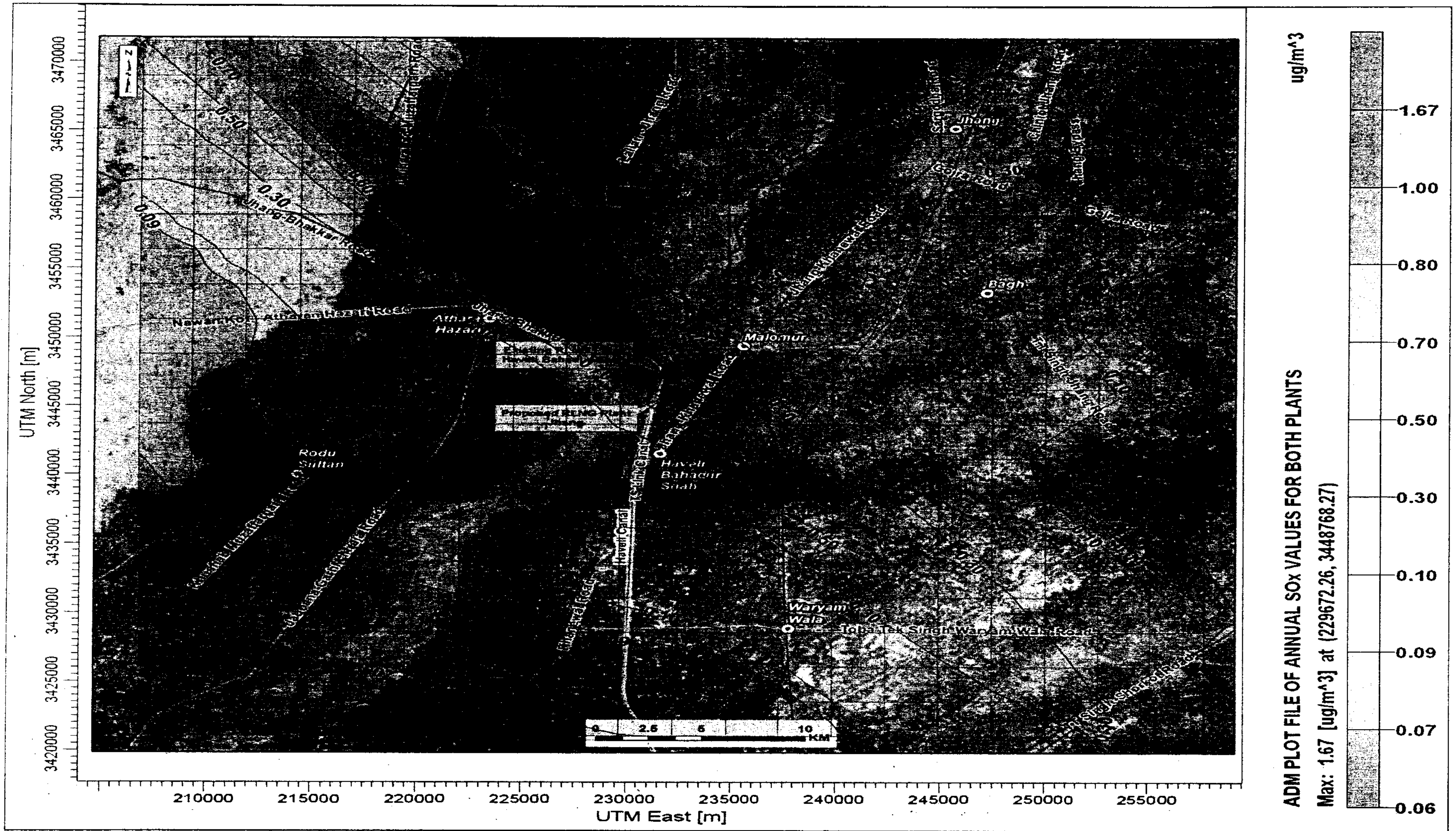


Figure 8.6: SO_2 Average Annual Isopleth RLNG+CC

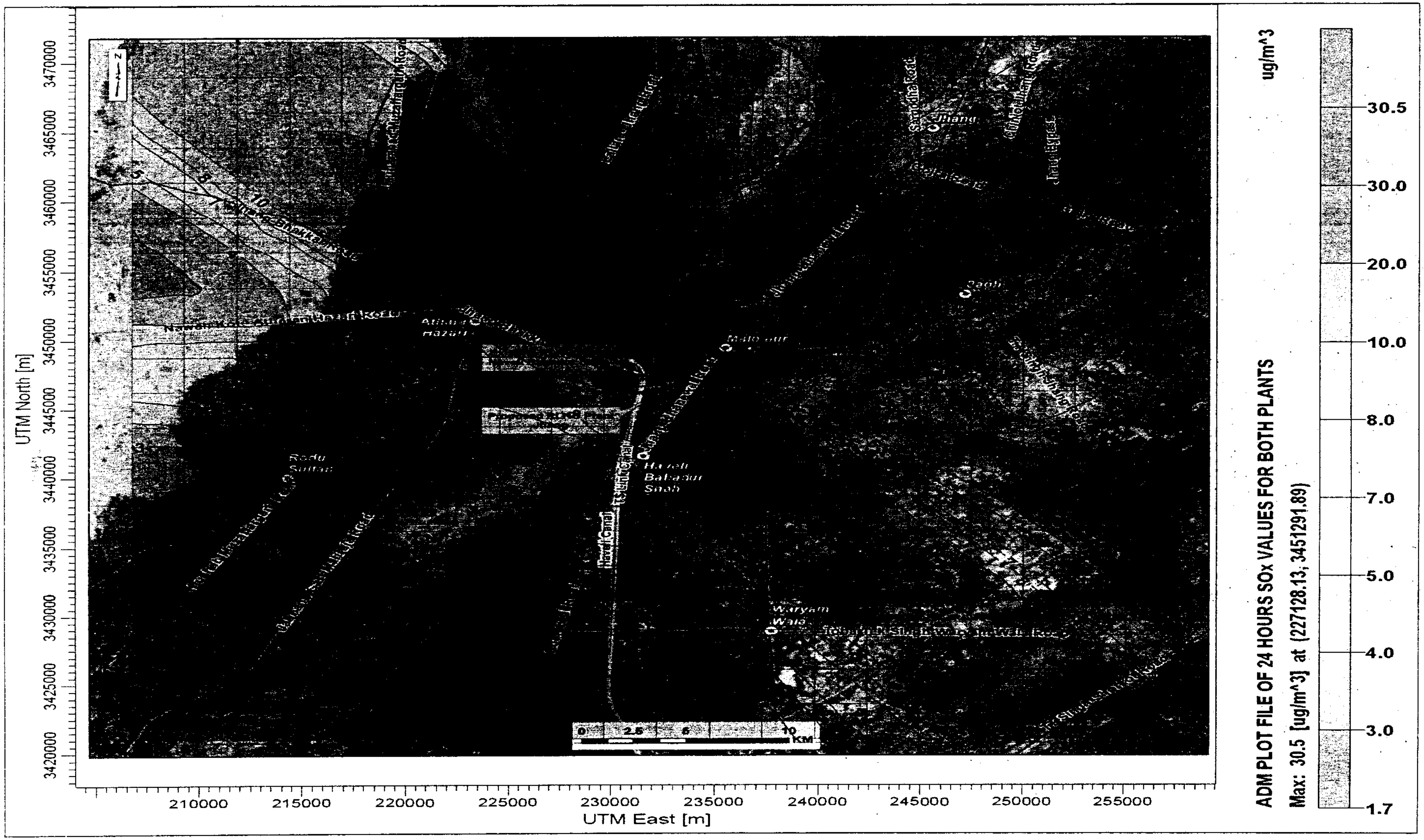


Figure 8.7: SO_2 24 Hours Average Isopleth HSD+SC

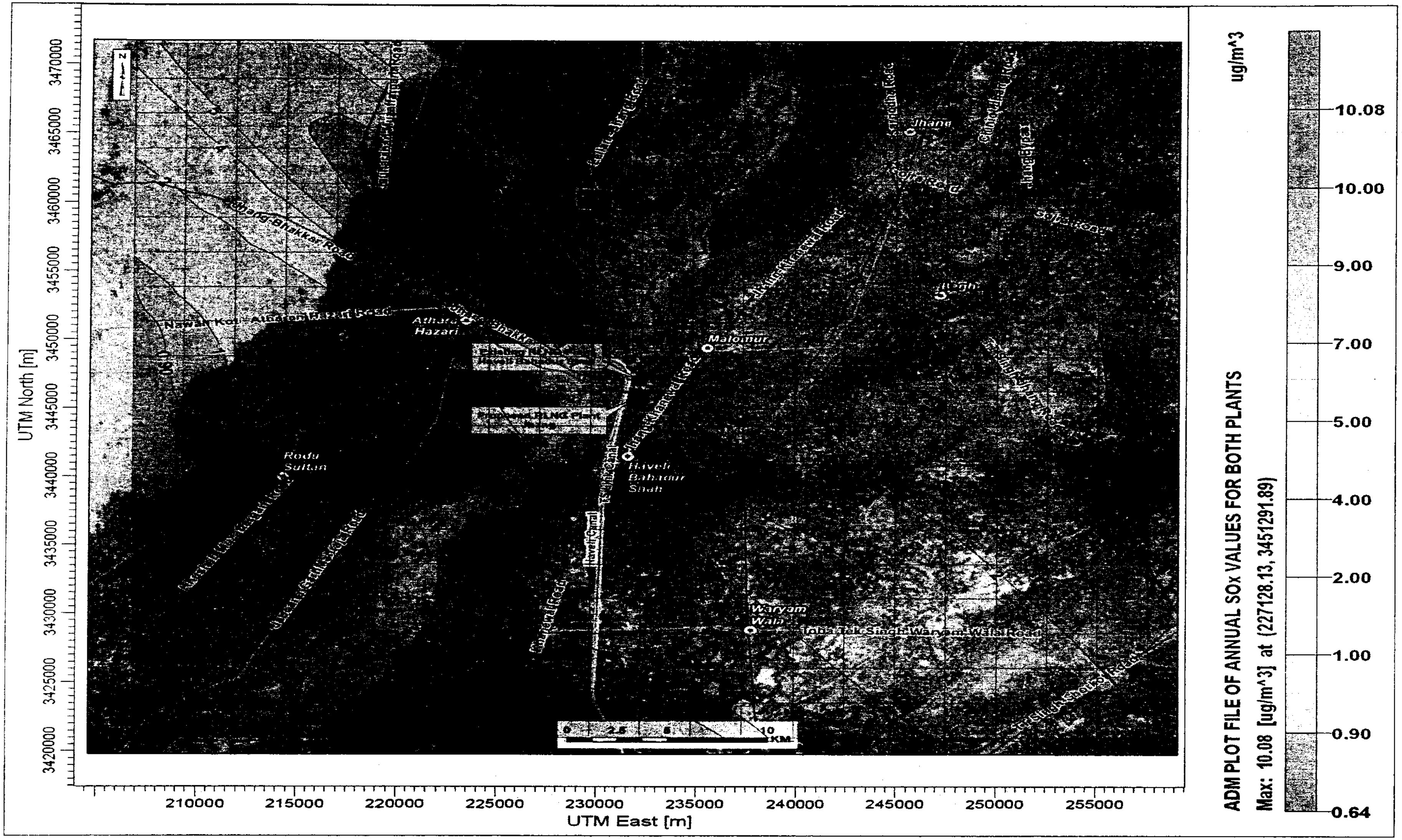


Figure 8.8: SO_2 Average Annual Isopleth HSD+SC

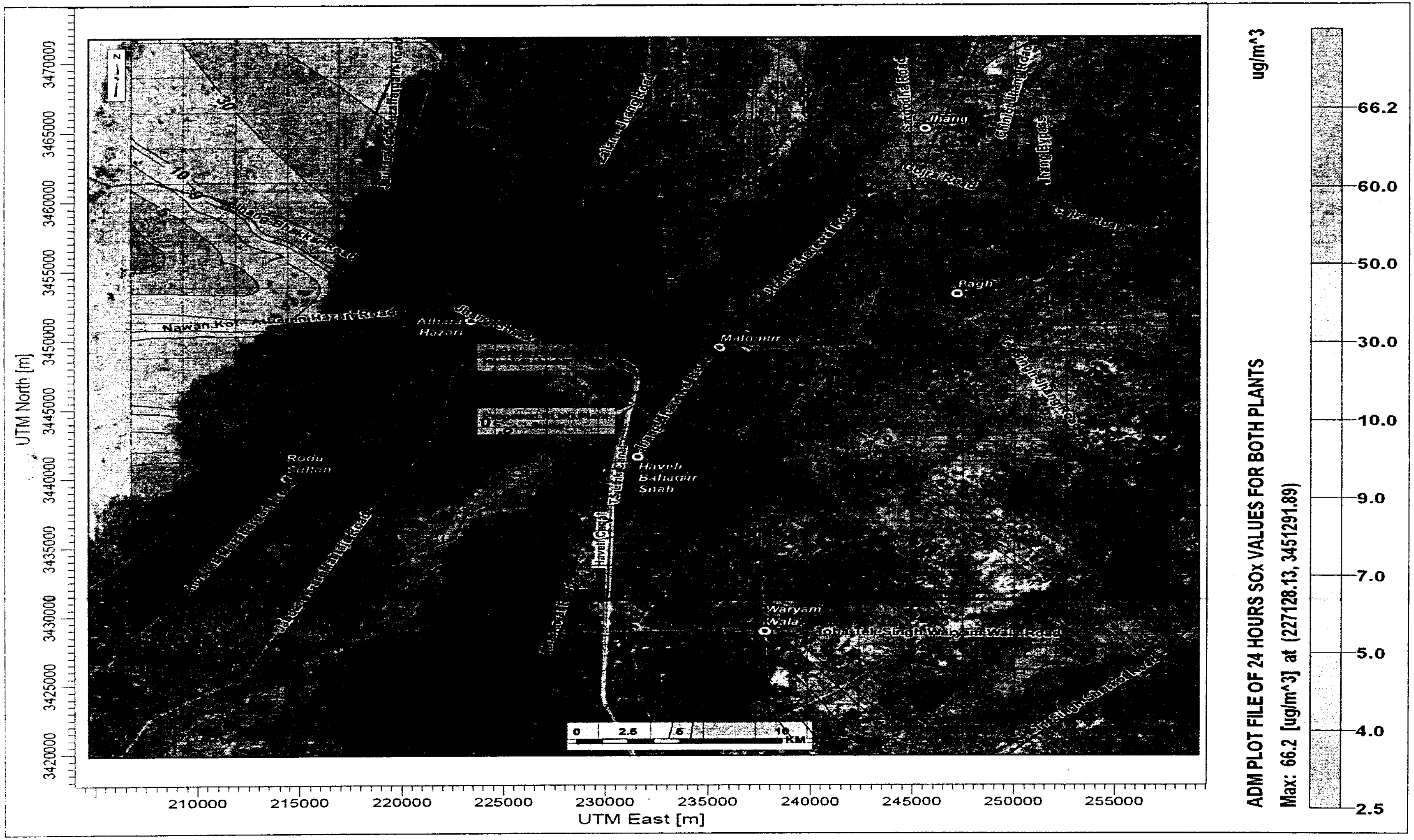


Figure 8.9: SO_2 24 Hours Average Isopleth HSD+CC

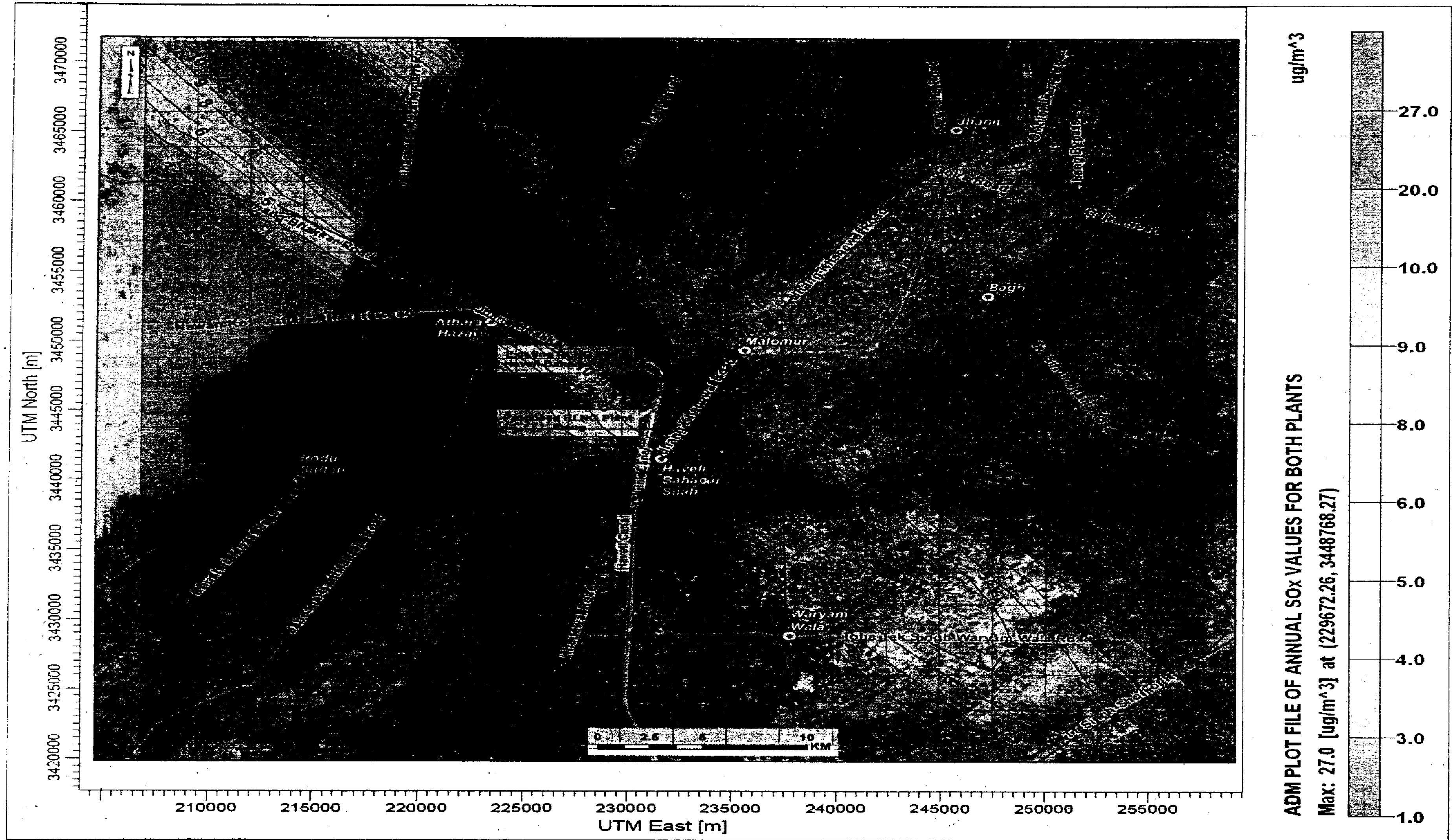


Figure 8.10: SO_2 Average Annual Isopleth HSD+CC

The Table 8.13 below shows the maximum concentration of SO_2 for all the four scenarios. Among the four scenarios, ADM has shown the maximum concentration for SO_2 for both power plants' operation on HSD in a Combined Cycle Mode for 24 hours as well as annual averaging periods. The resulting maximum concentrations for 24 hours and annual average by utilizing HSD are 66.2 μg/m^3 and 27 μg/m^3 respectively.

Table 8.13: Maximum SO_2 Concentrations for 24 Hours and Annual Averaging Periods

Sr. No	Scenarios	Maximum SO_2 Concentration	
		24 Hours	Annual
1	RLNG +SC	1.56	0.519
2	RLNG+CC	4.56	1.67
3	HSD+SC	30.5	10.08
4	HSD+CC	66.2	27

The maximum value of background SO_2 measured at site is 31.40 μg/m^3 for 24 hours averaging period. The values if measured for the annual averaging periods would be much lower than these concentrations. However, due to unavailability of average annual concentrations, the 24 hours averaging values are taken as baseline concentrations. The maximum concentration of SO_2 for 24 hours averaging period is less than the thresholds of 120 μg/m^{3}and 80 μg/m^3 for 24 hours and average annual periods respectively as specified by the PEQS.

The above table shows that the maximum average annual contribution of SO_2 from side-by-side operation of both power plants (if both are run on HSD) will be 66.2 μg/m^3 for 24 hours averaging and 27 μg/m^3 for average annual period. The contribution of both plants for 24 hours averaging when added in maximum baseline concentration would result in a total value of 131.0 μg/m^3 for 24 hours averaging which exceeds 24 hours average ambient air quality threshold of 120 μg/m^3 as specified by PEQS. However, the maximum mutual contribution of power plants for average annual when added in maximum baseline concentration would result in a total value of 71.8 μg/m^3 for annual averaging which is less than annual average ambient air quality threshold of 80 μg/m^3 as specified by PEQS.

8.5.6.6 Oxides of Nitrogen

The dispersion isopleths of NO_X emissions (annual as well as 24 hours averaging periods) from both plants' operation on all four scenarios are shown in Figure 8.11 to 8.18.

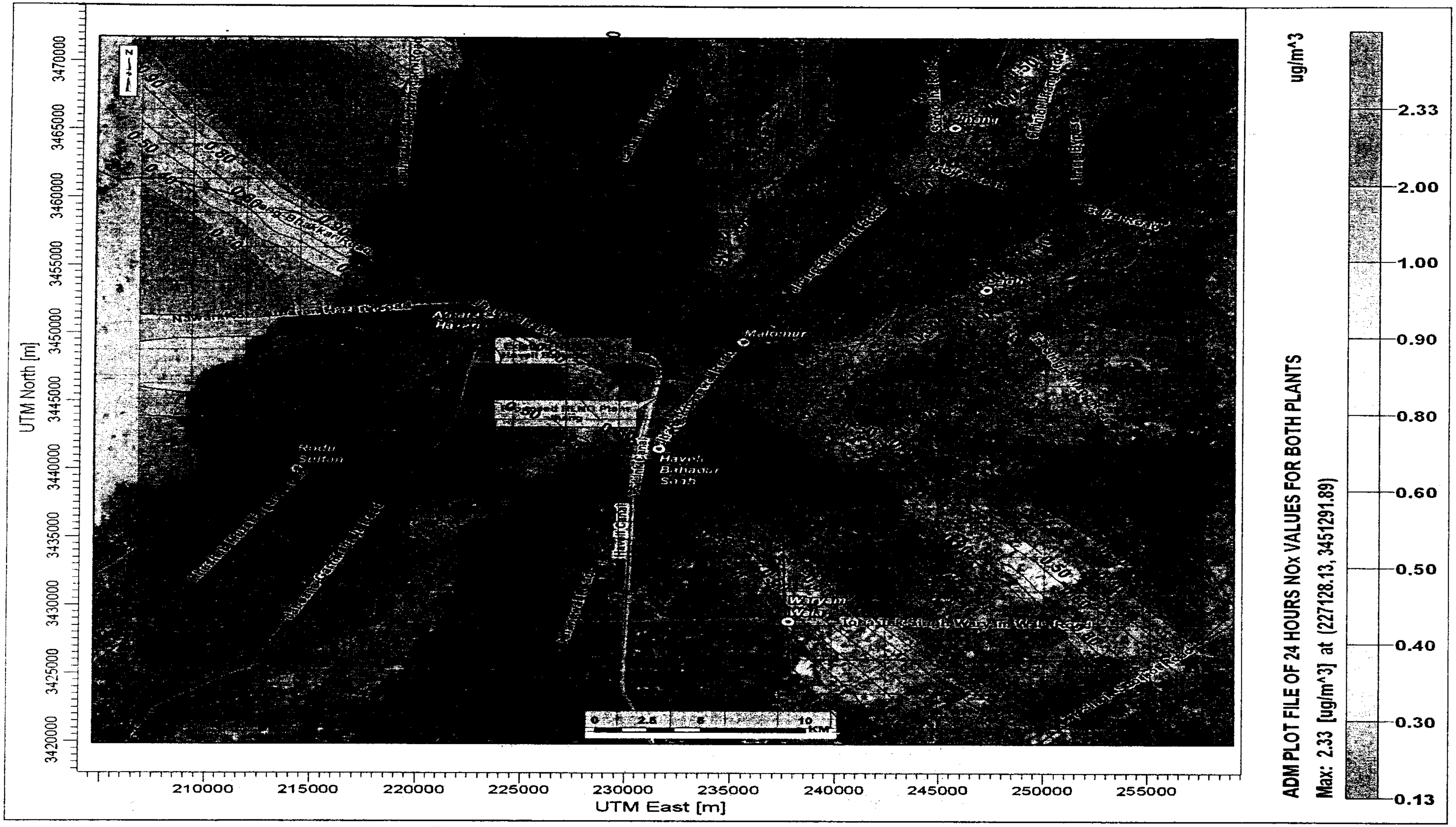


Figure 8.11: NO_x 24 Hours Average Isopleth RLNG+SC

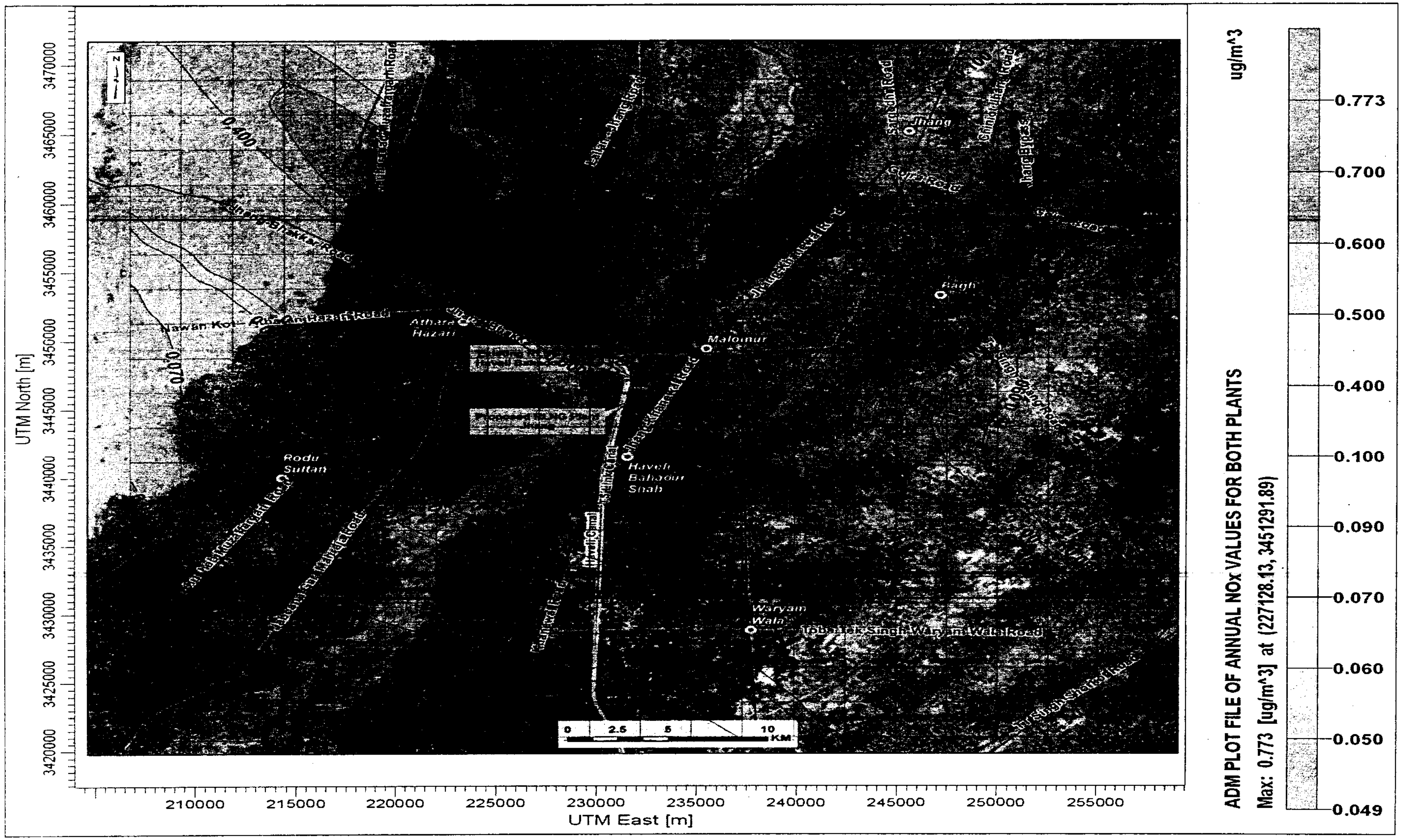


Figure 8.12: NO_x Average Annual Isopleth RLNG+SC

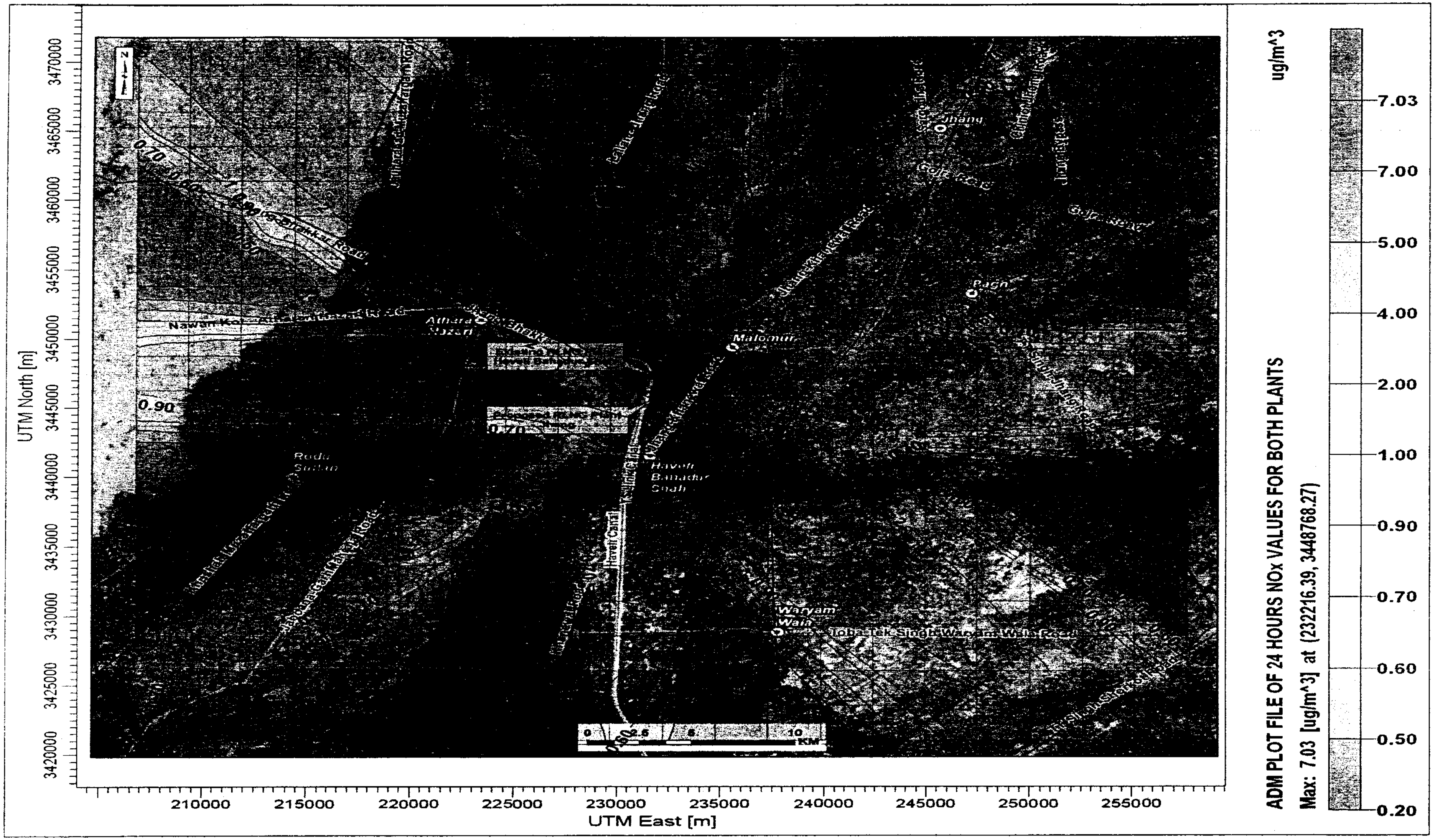


Figure 8.13: NO_x 24 Hours Average Isopleth RLNG+CC

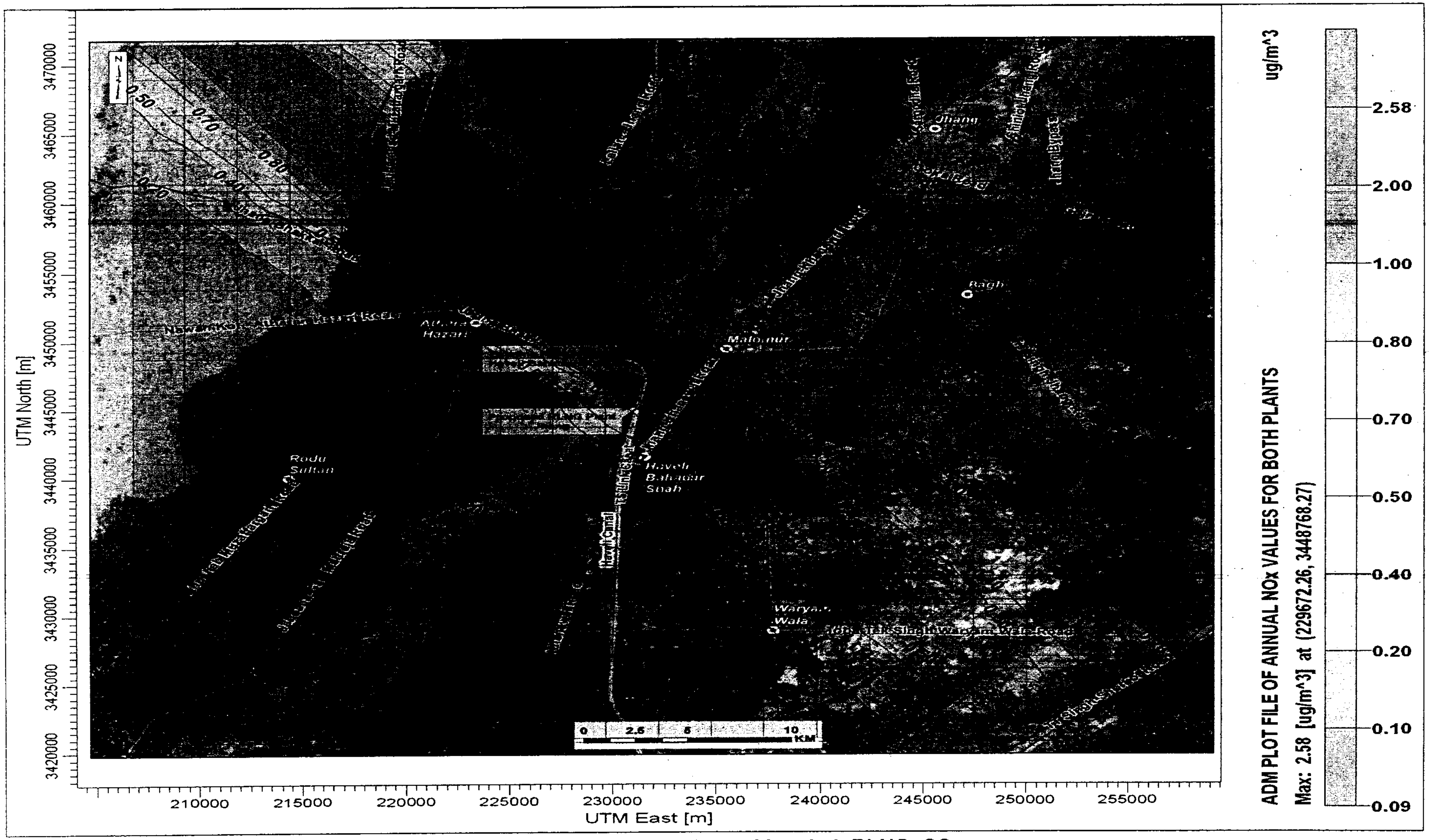


Figure 8.14: NO_x Average Annual Isopleth RLNG+CC

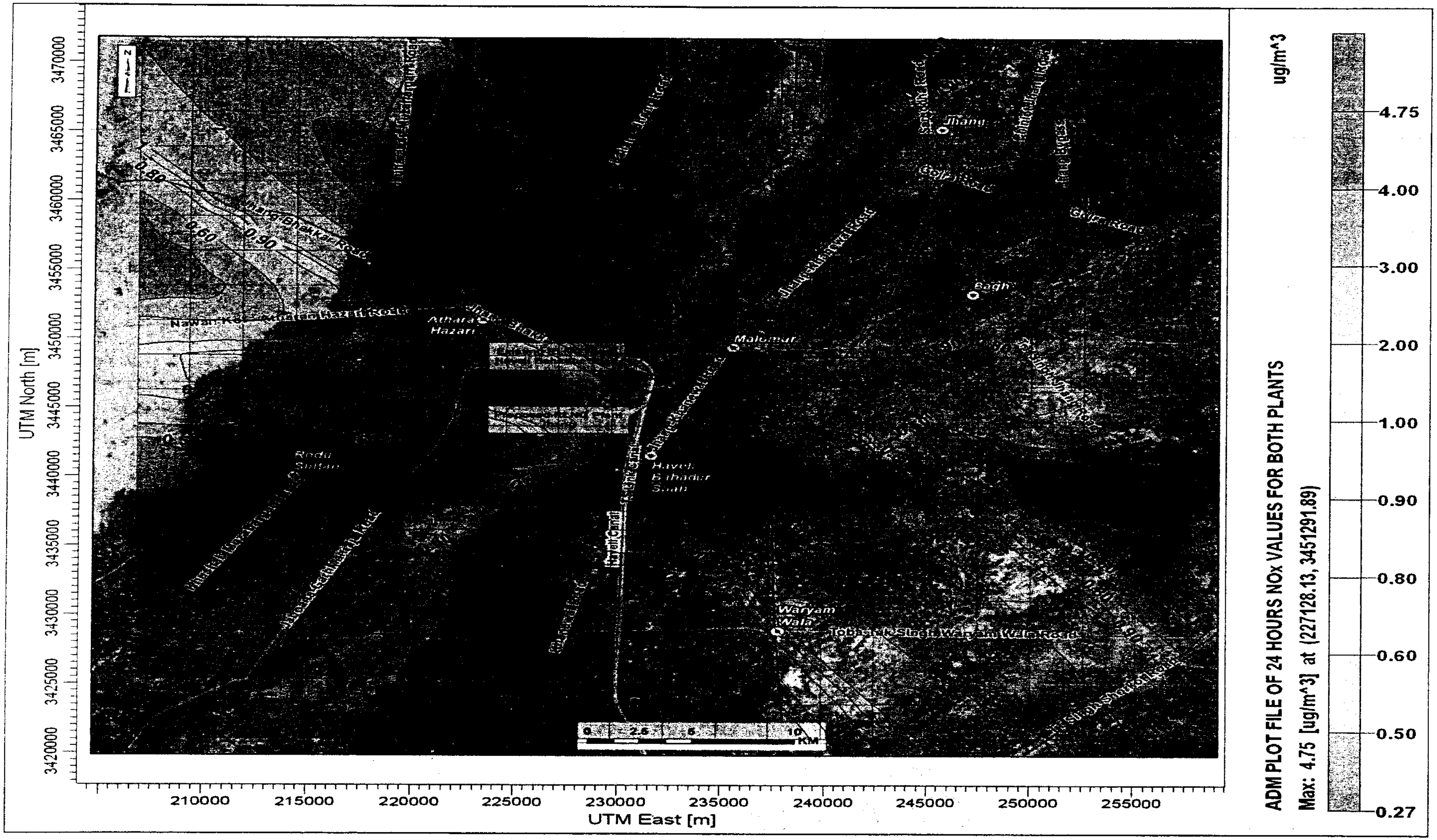


Figure 8.15: NO_x 24 Hours Average Isopleth HSD+SC

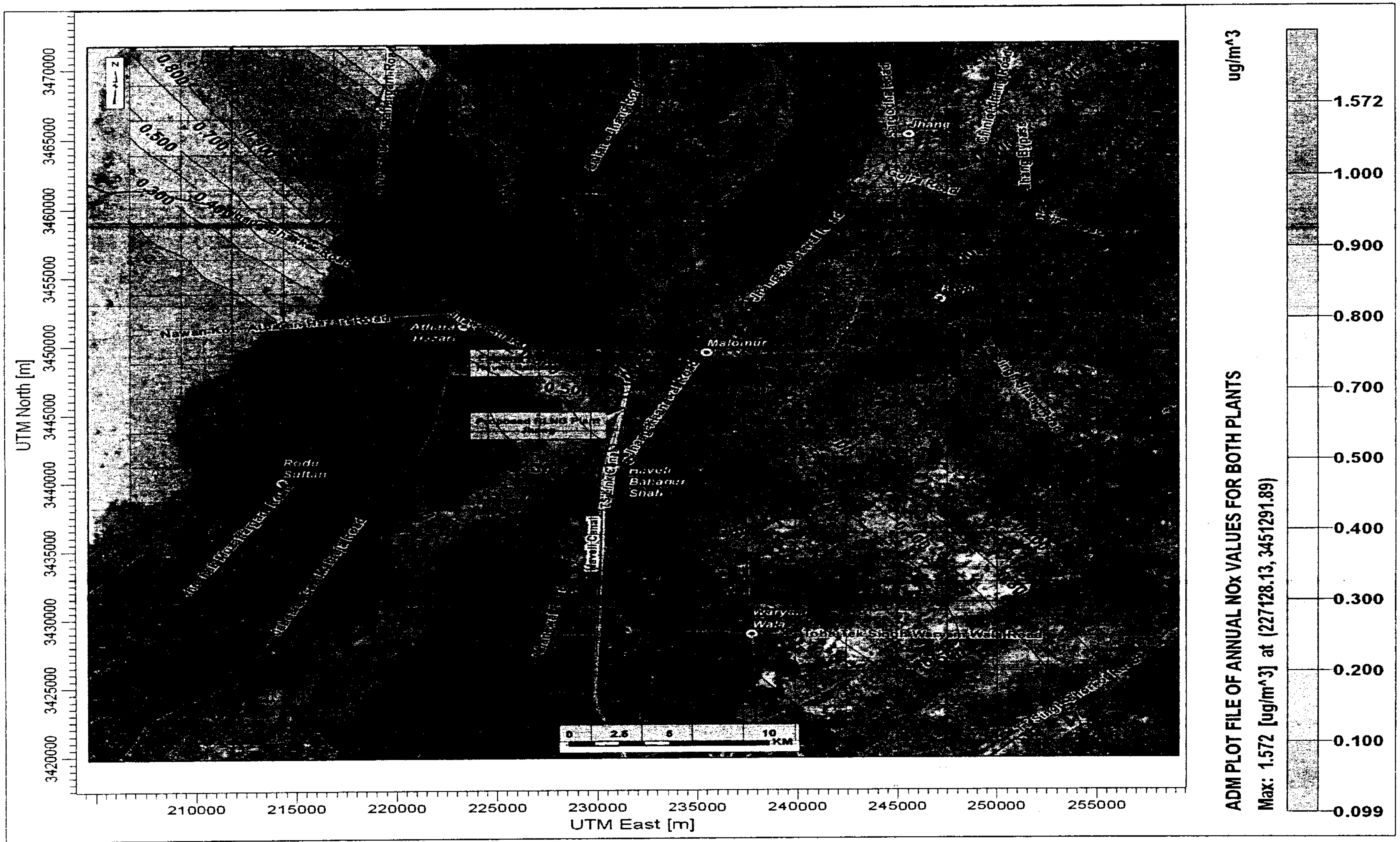


Figure 8.16: NO_x Average Annual Isopleth HSD+SC

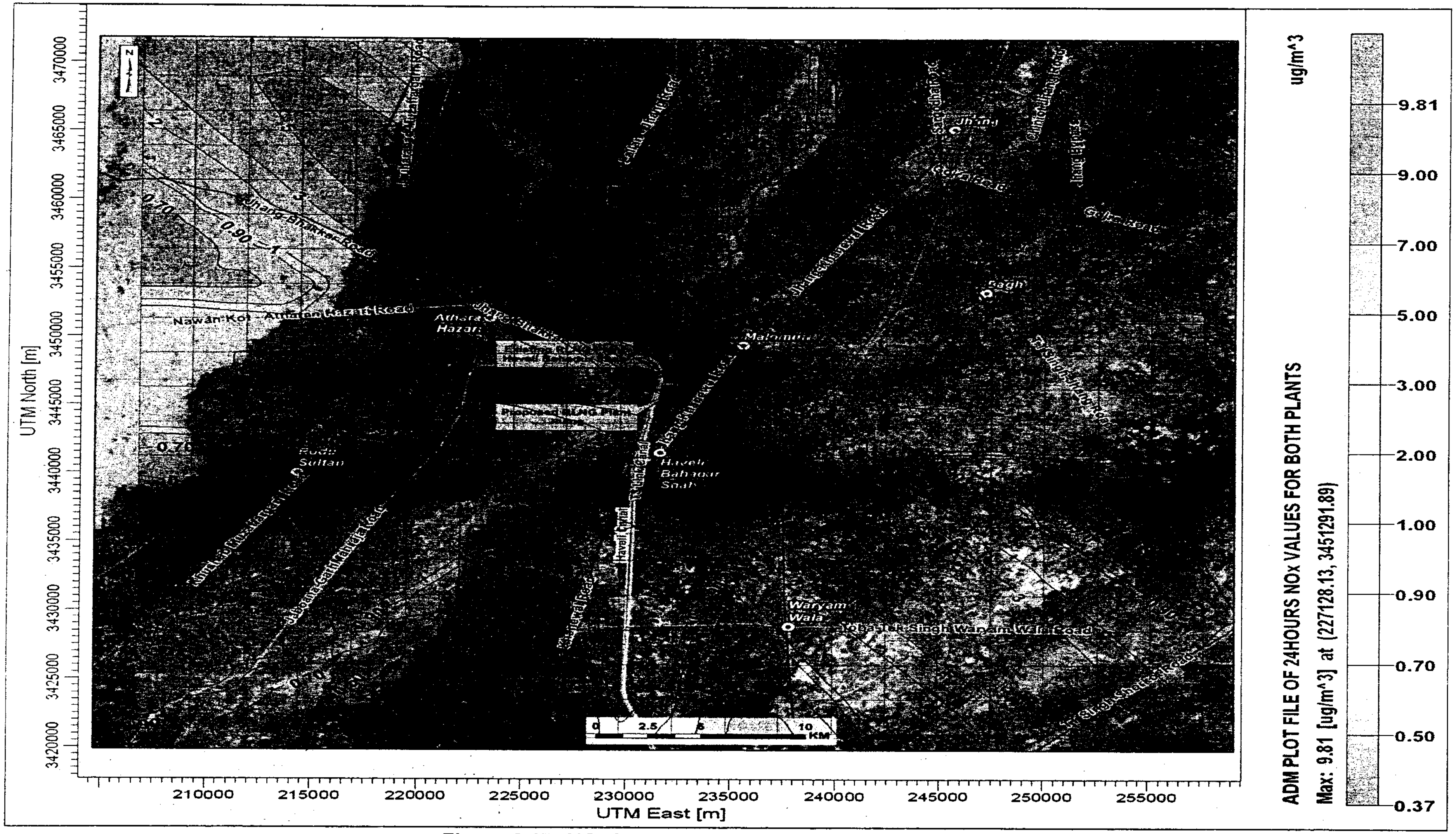


Figure 8.17: NO_x 24 Hours Average Isopleth HSD+CC

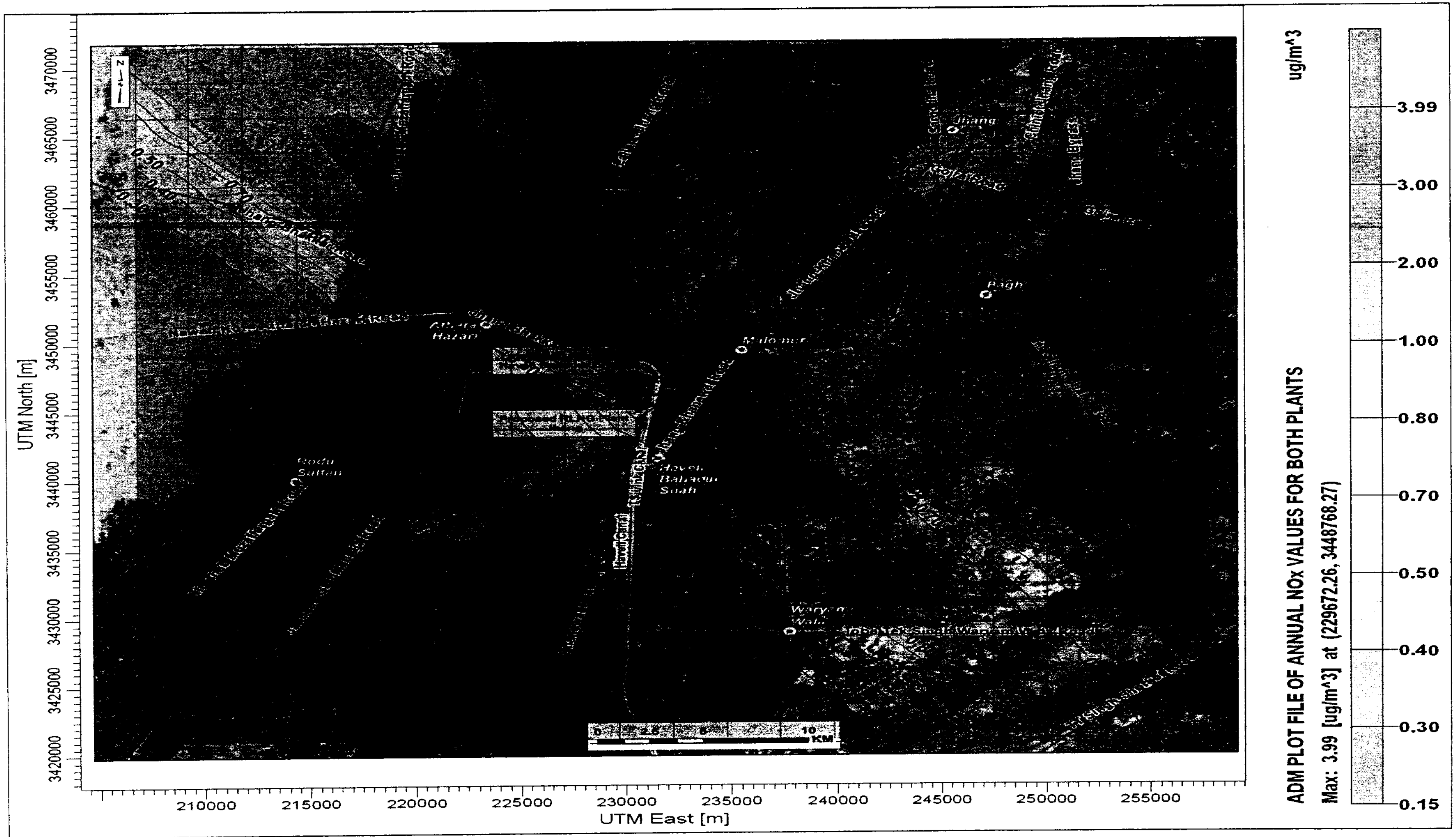


Figure 8.18: NO_x Average Annual Isopleth HSD+CC

The Table 8.14 below shows the maximum concentration of NO_x for all the four scenarios. Among the four scenarios, ADM has shown the maximum concentration for NO_x for both power plants' operation on HSD in a Combined Cycle Mode for 24 hours as well as annual averaging periods. The resulting maximum concentrations for 24 hours and annual average by utilizing HSD are 9.81 µg/m³ and 3.99 µg/m³ respectively.

Table 8.14: Maximum NO_x Concentrations for 24 Hours and Annual Averaging Periods

Sr. No	Scenarios	Maximum NO_x Concentration	
		24 Hours	Annual
1	RLNG +SC	1.56	2.33
2	RLNG+CC	7.03	0.773
3	HSD+SC	4.75	1.572
4	HSD+CC	9.81	3.99

The maximum value of baseline NO_x measured at site is 28.414 µg/m³ for 24 hours averaging period. The values if were measured for the annual averaging periods would be much lower than these concentrations. However, due to unavailability of average annual concentrations, the 24 hours averaging values are taken as baseline concentrations. The maximum concentration of NO_X for 24 hours averaging period is much less than the threshold of 40 µg/m³ for average annual and 80 µg/m³ for 24 hours averaging period for NO_2 specified by the PEQS[11].

The isopleths (Figure 8.10 to 8.18) show that the maximum annual average contribution of NO_x from both power plants (if run on HSD in CC mode altogether) will be 9.81 µg/m³ for 24 hours averaging and 3.99 µg/m³ for annual averaging periods. The maximum 24 hours and annual average contributions from both plants when added to the maximum baseline concentration results in a total ground level NO_x concentration values of 43.214 µg/m³ and 34.404 µg/m³ for 24 hours and average annual. These NO_x emissions from power plants if mutually operated on HSD are lower than ambient air quality standard of 80 µg/m³ and 40 µg/m³ for NO_2 specified by PEQS for 24 hours and average annual periods.

8.5.6.7 Particulate Matter (PM_{10})

The dispersion isopleths of PM_{10} emissions (annual as well as 24 hours averaging periods) from both plants' operation on all four scenarios are shown in Figure 8.19 to 8.26.

[11] *The average concentration of NO_X for 24 hours and annual average is compared with the threshold values of NO_2 as specified in the PEQs, 2016, because NO_X in ambient air exist mostly in the form of NO_2.*

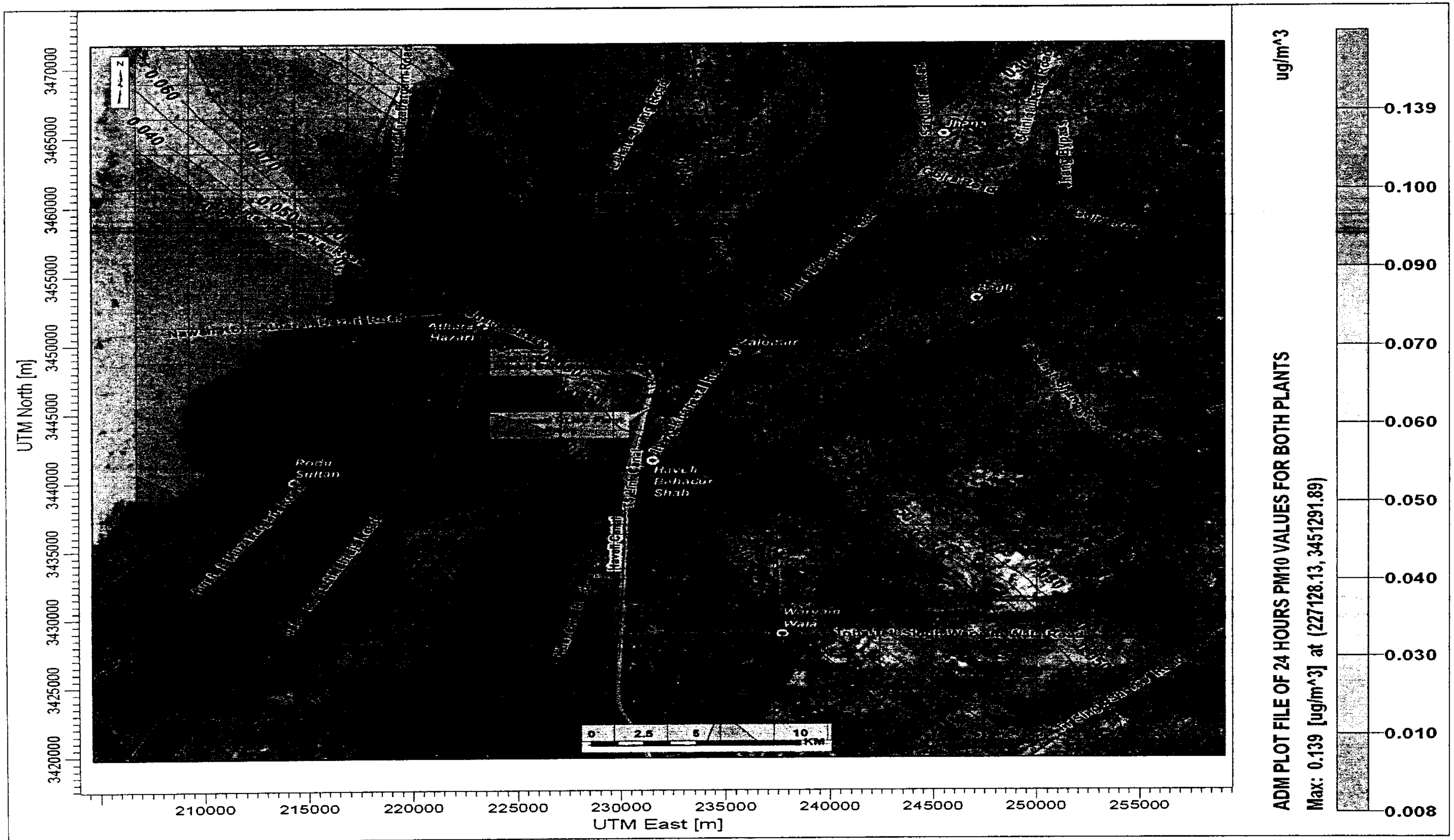


Figure 8.19: PM $_{10}$ 24 Hours Average Isopleth RLNG+SC

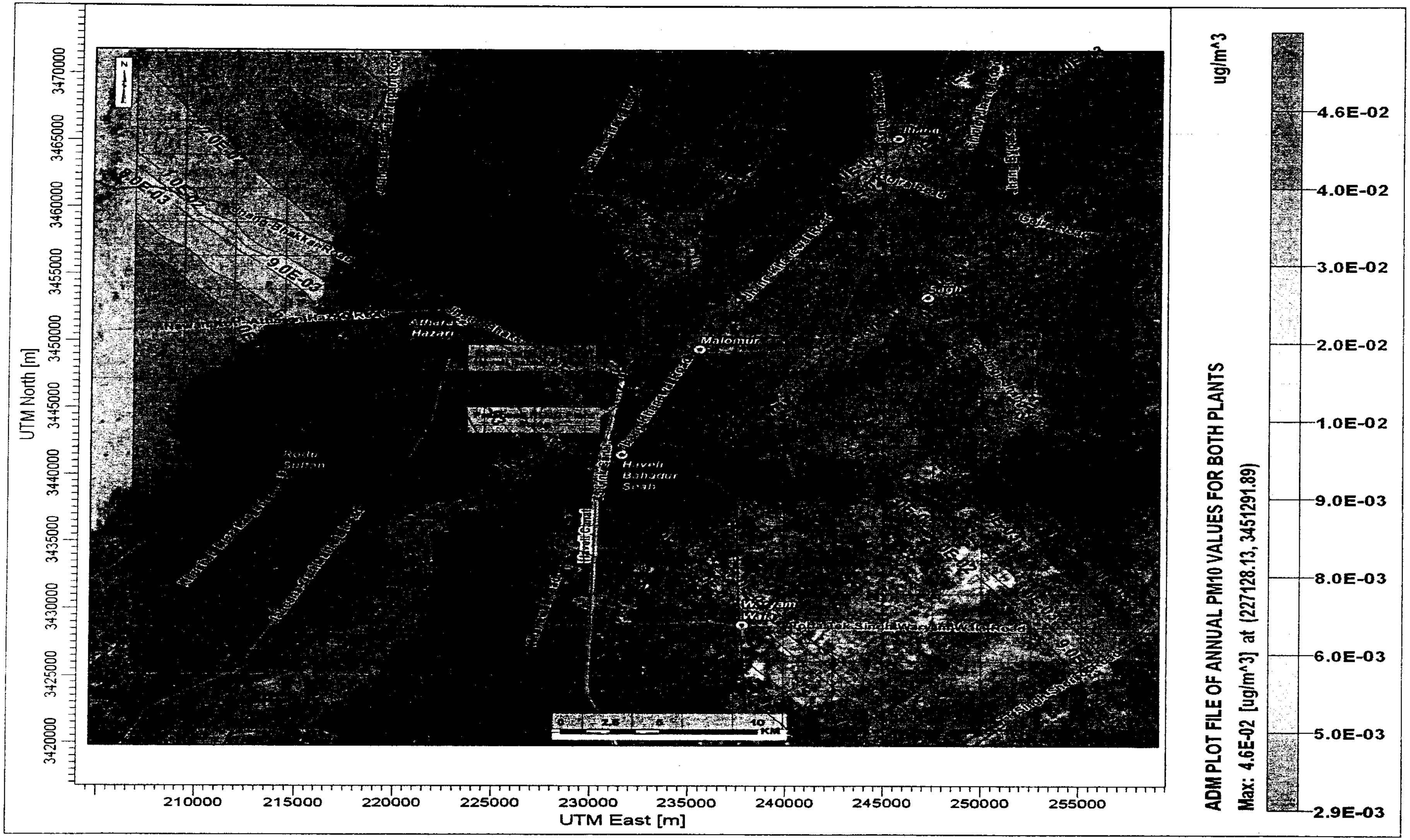


Figure 8.20: PM $_{10}$ Average Annual Isopleth RLNG+SC

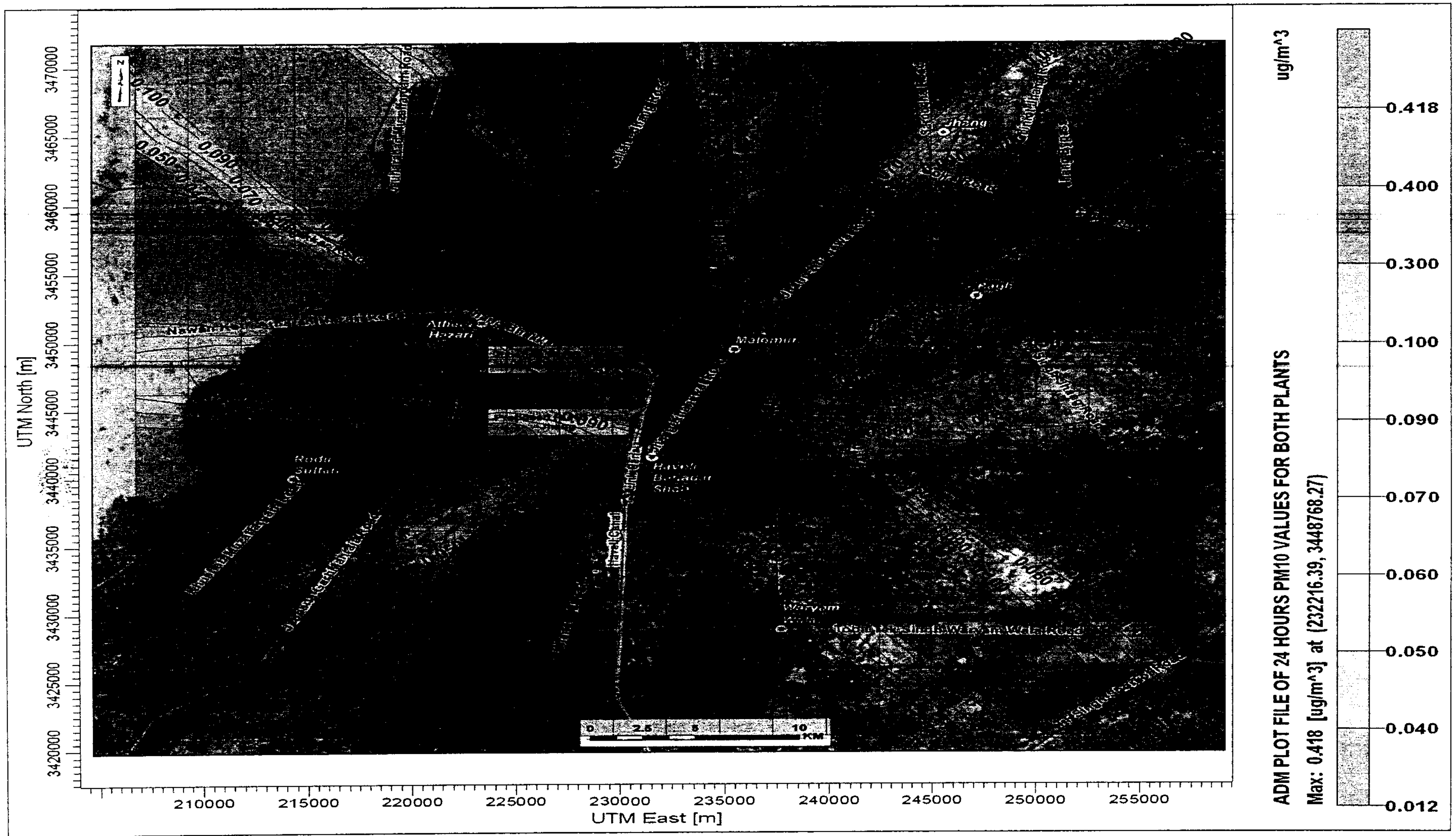


Figure 8.21: PM $_{10}$ 24 Hours Average Isopleth RLNG+CC

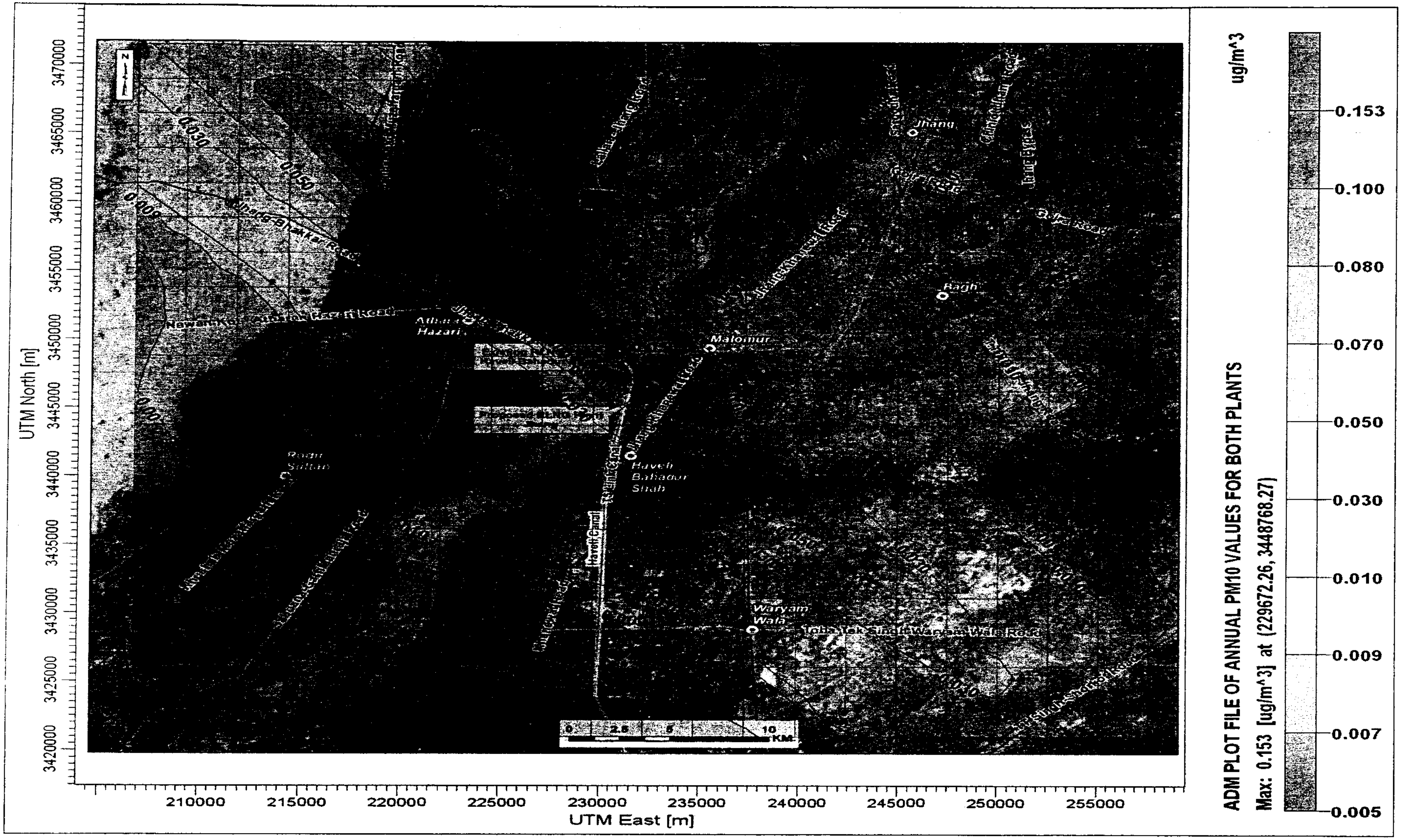


Figure 8.22: PM $_{10}$ Average Annual Isopleth RLNG+CC

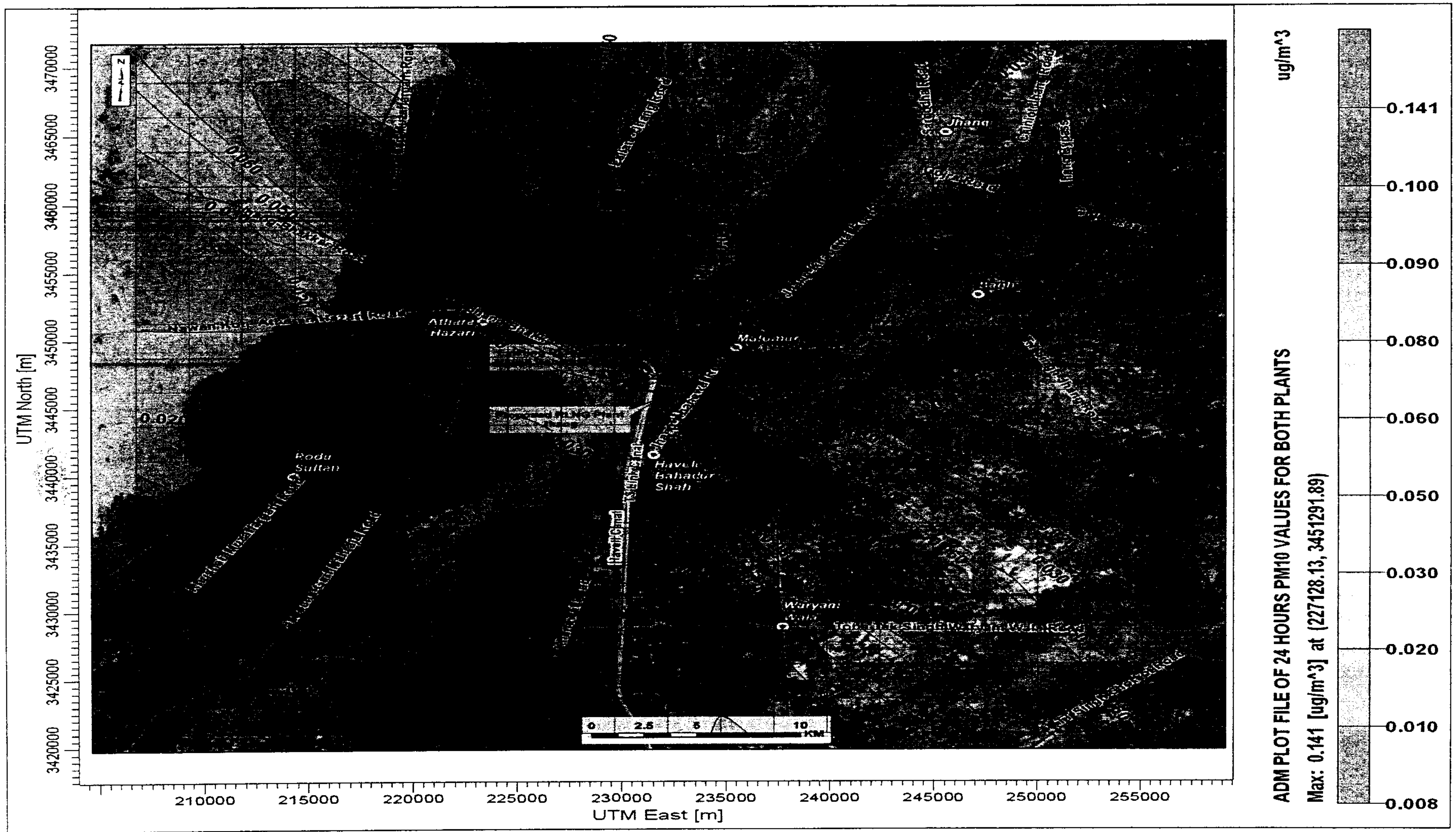


Figure 8.23: PM $_{10}$ 24 Hours Average Isopleth HSD+SC

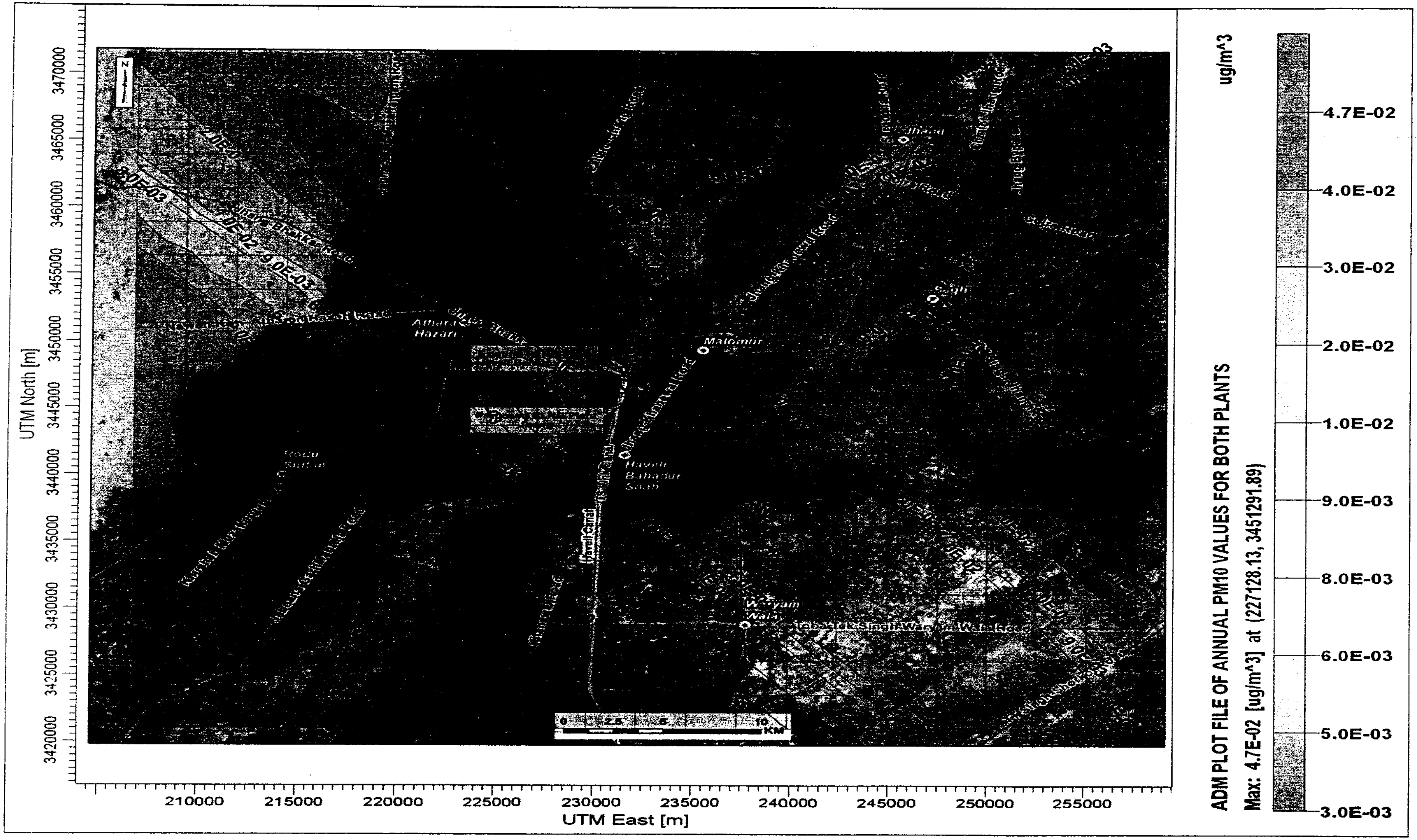


Figure 8.24: PM $_{10}$ Average Annual Isopleth HSD+SC

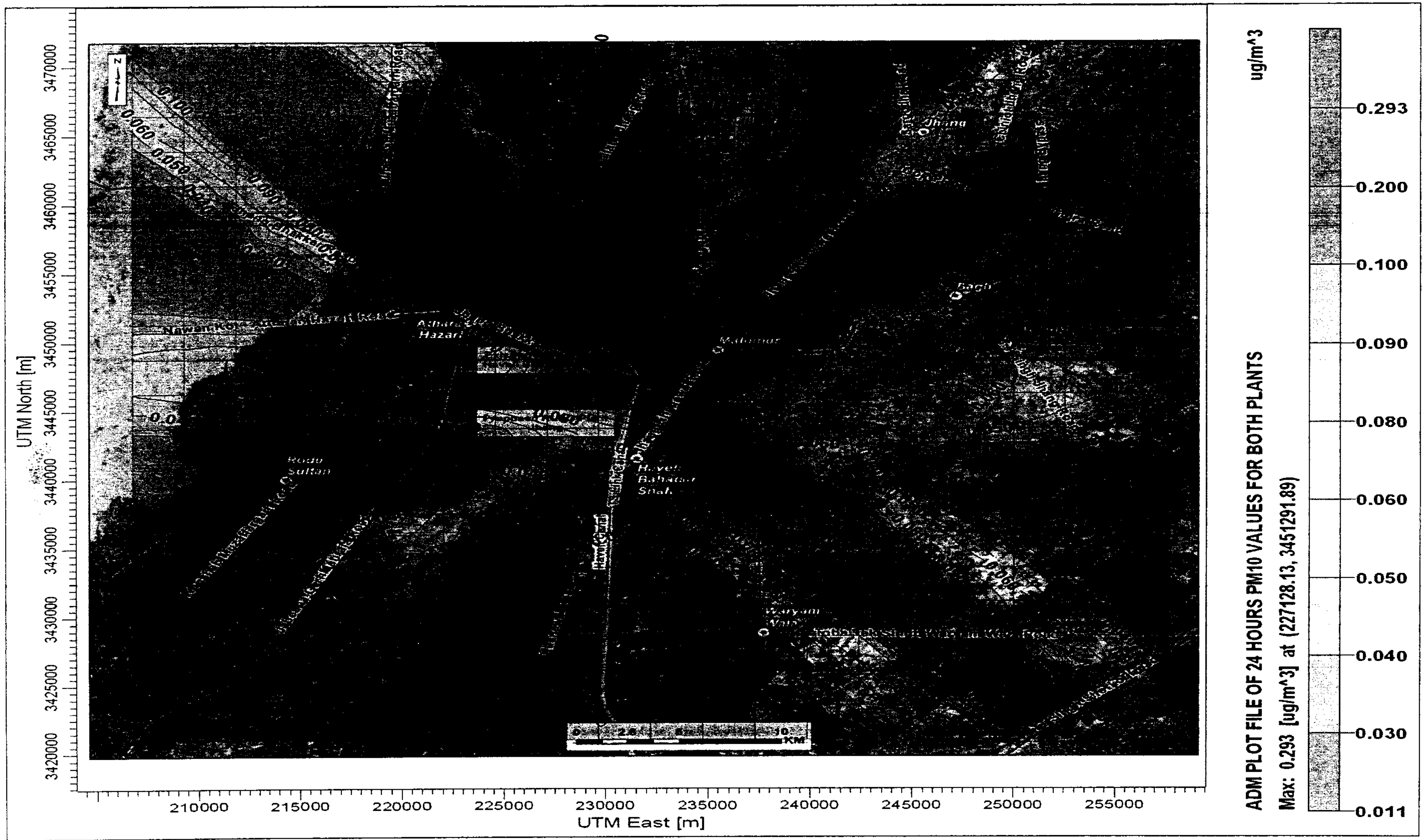


Figure 8.25: PM $_{10}$ 24 Hours Average Isopleth HSD+CC

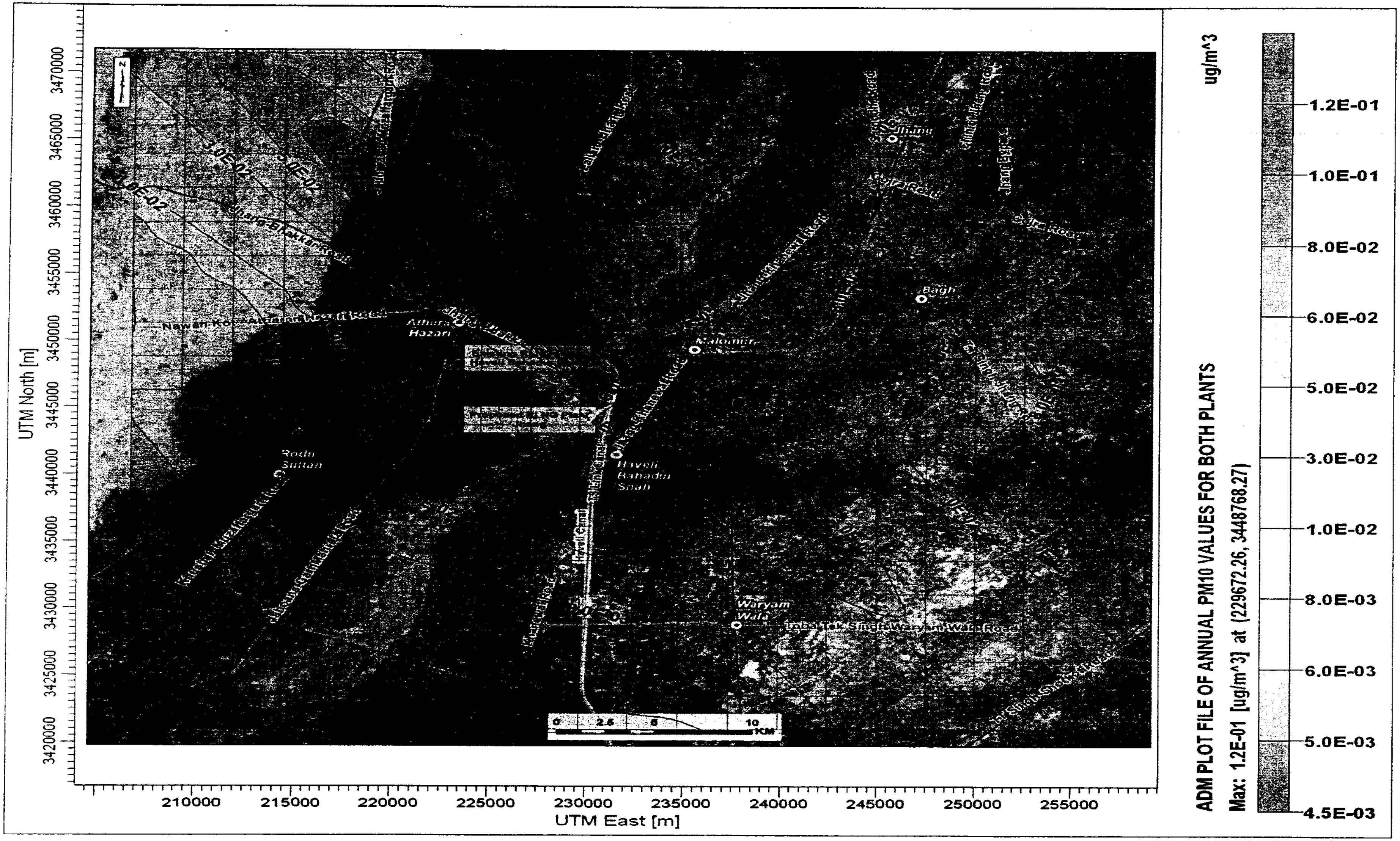


Figure 8.26: PM $_{10}$ Average Annual Isopleth HSD+CC

The Table 8.15 below shows the maximum concentration of PM_{10} for all the four scenarios. Among the four scenarios, ADM has shown the maximum concentration for PM_{10} for both power plants' operation on RLNG in a Combined Cycle Mode for 24 hours as well as annual averaging periods. The resulting maximum concentrations for 24 hours and annual average by utilizing RLNG are 0.418 µg/m^3 and 0.153 µg/m^3 respectively.

Table 8.15: Maximum PM_{10} Concentrations for 24 Hours and Annual Averaging Periods

Sr. No	Scenarios	Maximum PM_{10} Concentration	
		24 Hours	Annual
1	RLNG +SC	0.139	4.6E-02
2	RLNG+CC	0.418	0.153
3	HSD+SC	0.141	4.7E-02
4	HSD+CC	0.293	1.2E-01

The maximum baseline value for PM_{10} is 91.50 µg/m^3 for 24 hours averaging period. The values if were measured for the annual averaging periods would be much lower than these concentrations. However, due to unavailability of average annual concentrations, the 24 hours maximum values are taken as baseline concentrations. The maximum concentration of PM_{10} for 24 hours averaging period is much less than the threshold of 120 µg/m^3 for average annual and 150 µg/m^3 for 24 hours averaging period specified by PEQS.

The isopleths (Figure 8.19 to 8.26) show that the maximum 24 hours average contribution of PM_{10} from both power plant (if run on RLNG in CC mode altogether) will be 0.418 µg/m^3. The maximum contribution from both power plants when added in maximum baseline concentration would result in a total value of 92.124 µg/m^3 which is much lower than 24 hours average ambient air quality threshold of 150 µg/m^3 as specified by PEQS. The maximum annual average contribution of PM_{10} from both power plants (if run on RLNG in CC mode altogether) will be 0.153 µg/m^3. The contribution from both power plants when added in maximum baseline concentration would result in a total value of 91.73 µg/m^3 which is much lower than average annual ambient air quality threshold of 120 µg/m^3 as specified by PEQS.

8.5.6.8 Particulate Matter ($PM_{2.5}$)

The dispersion isopleths of $PM_{2.5}$ emissions (annual as well as 24 hours averaging periods) from both plants' operation on all four scenarios are shown in Figure 8.27 to 8.34.

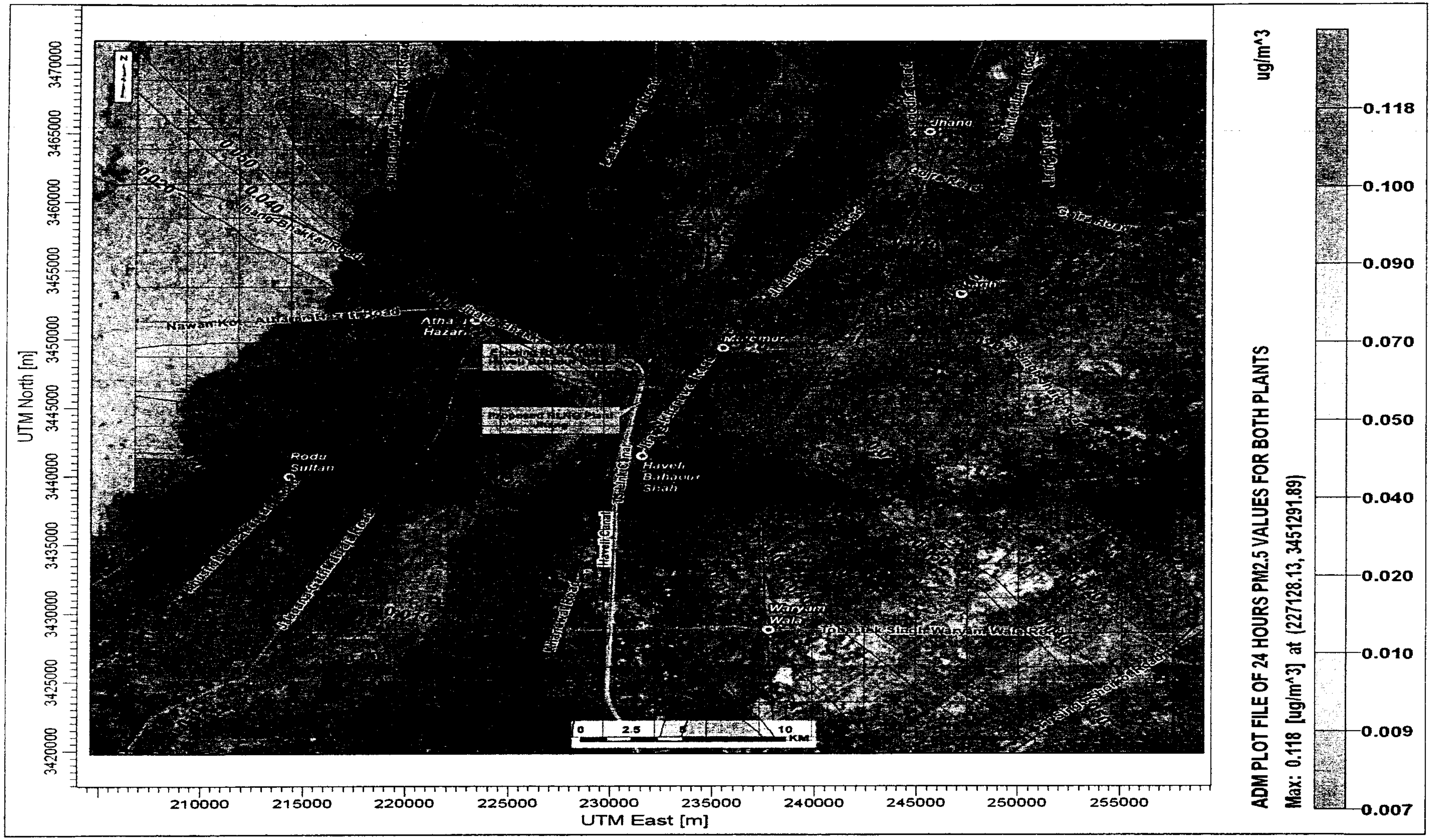


Figure 8.27: PM $_{2.5}$ 24 Hours Average Isopleth RLNG+SC

frameworks, guidelines and structure provided in EMP. EMC will check if these plans are appropriate and effective in addressing the relevant issues.

9.5.6 Approvals

EPC Contractor will be responsible for obtaining all relevant approvals from Proponent through EMC such as approvals for final solid waste disposal, disposal of used oil/lubricants and other liquid waste, utilizing ground or surface water sources and others as specified in the MMM. Whereas, approvals of above matters from concerned government department will be the core responsibility of Proponent. In addition to MMM, EPC Contractor would be required to prepare CCMP covering all aspects (physical, social and ecological environment) and submuit to Consultants for approval.

9.5.7 Communication and Documentation

Proponent, EPC Contractor and the EMC will ensure that the communication and documentation requirements specified in the EMP are fulfilled during the construction phase of the project.

Table 9.1: Mitigation Management Matrix

Responsible Agency/ies: PP = Project Proponent EPD = Environmental Protection Department EPC = Engineering, Procurement and Construction Contractor HSE = Health Safety & Environment (HSE) Section EMC = Environmental Monitoring Cell		**Project Phases:** Design /Pre-construction Phase Construction Phase O&M Phase
Potential Positive Impacts		
1	**Electricity Generation**	The power plant is expected to generate 1,100-1,400 MW of electricity. Given that Pakistan currently faces a shortfall of about 5,000 to 7,000 MW per day, the generation capacity of this power plant will help towards meeting a portion of the shortfall, thus providing some measure of relief to the people of Pakistan. The generation of electricity will not only help the industrial sector and its outputs but will also help to raise the standard of living as it will reduce load shedding. Furthermore, the proposed Power Plant is based on RLNG which will prove to be less costly than the thermal power plants based on oil.
2	**Employment Opportunities**	Electricity generation will help industry in producing more output and work more efficiently, which in turn will have a ripple effect of increasing skilled and unskilled employment. Even during the construction phase of the project, the requirement of engineers, workers, laborers, technicians, para-professionals etc. will help to generate employment opportunities. Apart from this, opportunities of small businesses (for example, shop keepers etc.) will also be increased resulting more income for local inhabitants. Locals will also have the opportunity to diversify their incomes by being employed during the construction period of the project. It is estimated that about 2500 to 3500 staff will be deployed during the construction phase and about 150-200 staff will be employed during the operation phase of proposed project. Hence, there will be a large number of employment opportunities mainly for the local people, during the construction and O&M phase of the project.
3	**Increase in Business**	With the influx of laborers for the proposed project, there will be more opportunities for small scale businesses such as small grocery shops, small cafes (khokas), and vehicle tuning, tire-repair shops etc. Additionally the generation of electricity will reduce load shedding and contribute towards more business in the country.
4	**Increased Accessibility**	Construction of the access road for the construction of Power Plant and up gradation of existing tracks to the Project Area will result in improved accessibility.

5	**Increase in Land Value**	Construction of new RLNG CCPP Project is expected to increase the land value, due to the increased accessibility, especially in villages where little or no road infrastructure is present. Land owners will have an opportunity to sell their land at increased prices and start new businesses.
6	**Indirect Benefits**	In addition to the power production and other benefits described above, there will be other economic benefits associated with the project implementation. These are known as secondary or indirect benefits, which are as follows: • The generation of 1,100-1,400 MW of electricity which will be added to the national grid, will help in reducing the current crisis of the electricity. The availability of electricity will boost the industrial sector of Pakistan. This will have a huge impact on the economy of the country; • The proposed Project will have positive impacts on the areas due to the development of quarry sites. In this regard, construction of new roads to the quarry sites will also benefit the local population apart from job opportunities; • The construction and operation of the proposed Project will stimulate business and employment opportunities for the labor in the form of handling, transportation, business etc.; • In addition to all these benefits, the project will result in the general economic and social uplift of the people particularly in areas of the Punjab Province and will provide basic infrastructure and raw material for other projects in the region. • The benefit of decrease in electricity load shedding will facilitate other services, such as health facilities, schools, water supply, and expansion of the industrial activities etc., which are dependent on electricity, resulting in the improvement of the socio-economic conditions of the locals.

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
Design /Pre-construction Phase				
a. Land Acquisition for the Proposed Project				
1	The project will be constructed over a land area of 649,804 square meters (160.57 acres) which includes the permanent as well as temporary area requirement for construction camp and	The plant construction mostly involves the government land which will be acquired according to the policy of GoPb. On the other hand, private land is being acquired according to the provision of the LAA 1894. The LAA is broadly grouped into eight (8) parts comprising 55	District Government, Revenue Department, Jhang	Proponent/EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	other construction related activities. The access road will have a total area of 36,543 square meters (9.03 acres). More than 50% of the land acquired for this project is government owned (Auqaf and Irrigation Departments) land which will be acquired as per the policy of GoPb. However, remaining private land will be acquired as per provision of LAA 1894. The land acquisition process has already been started. PAPs residing in 40 houses and those having landholdings in Project area have been notified to vacate their lands.	Sections dealing with the details of land acquisition and compensation. The main relevant Sections of LAA, 1894 are shown in Figure 8.2. Apart from other relevant sections, the sections describing the aspects to be considered and not to be included during the determination of compensation are as summarized below: **Section-23 (Matters to be considered in Determining Compensation):** Section-23 testifies that in determining the amount of compensation to be paid for land acquired under this Act, the Collector shall take into account the followings: • Market value of land at the date of publication of notification under Section-4; • Damage sustained, by reason of the taking of any standing crops or trees at the time of the Collector's taking possession thereof; • Damage (if any) sustained, at the time of taking possession of the land, by reason of severing such land from his other land; • Damage (if any) sustained, at the time of taking possession of the land, by reason of the acquisition injuriously affecting his other property or his earnings; • If in consequence of the acquisition of the land, the person interested is compelled to change his residence or place of business, the reasonable expenses (if any) incidental to such change; • The damage sustained by diminution of the profits of the land between the time of the publication of the declaration under Section-6 and the time of taking		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		possession of the land; and • 15% over and above the cost of the land determined by the Collector as charges for acquisition. **Section-24 (Matters to be neglected in Determining Compensation)**: In accordance with Section-24, following matters shall not be taken into consideration in determining: • The degree of urgency which has led to the acquisition; • Any disinclination of the person interested to part with land acquired; • Any damage sustained by him which, if caused by a private person, would not render such person liable to a suit; • Any damage which is likely to be caused to the land acquired after the date of publication under Section 6, by or in consequence of the use to which it will be put; • Any increase to the value of the land acquired likely to accrue from the use to which it will be put when acquired; • Any increase to the value of the other land of the person interested likely to accrue from the use to which the land will be put; and • Any outlay or improvements made without the sanction of the Collector after the date of the publication of the notification under Section-4. EIA team has recommended the strict compliance with above Sections 23 nd 24 and inclusion of compensation for household materials and livelihood restoration. Accordingly, due compensation should be given by		

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
		district government/Proponent along with livelihood assistance. The above provision will be strictly complied with during the determination and payment of compensation. Proper measures need to be taken to safeguard the livelihoods of the affectees apart from the compensation.		
b. Water Quality & Quantity				
1	It is expected that the requirement of water during pre-construction phase will be fulfilled from ground water source i.e. tube wells. The preconstruction activities include construction of new access tracks and improvement of existing track, clearing and leveling of Project Areas etc. Water extraction from ground will negatively affect the existing water quantity.	This impact on groundwater needs to be addressed carefully by considering the recommendations of hydrogeological study and Electrical Resistivity Survey (ERS). Contractor should consult with the concerned department and obtain permit for extraction of water during pre-construction phase.	Irrigation Department, Public Health Engineering Department and TMA, Jhang	Proponent/EMC
c. Loss of Livelihood				
1	Due to the acquisition of the private land i.e. about 75.5 acres for proposed new power plant, about 40 families have direct impact and will lose their livelihood. Based on the field survey most of the farmers belonging to the village Shamme Wala, Moza Kot Dewan have small land holdings i.e. less than 2 acres. The bread and butter of these families rely on the agricultural yield of these lands. With the acquisition of these lands	As per LAA, no provisions for the loss of livelihoods exist. Other compensation should be provided to the adversely affected population who may have usufruct or customary rights to the land or other resources taken for the project. A Resettlement Action Plan (RAP) is strongly recommended. It is strongly recommended that the Proponent should provide livelihood assistance to the affectees like loans, trainings, employment in unskilled work etc. Government should also promote the social welfare facilities such as free health and education facility, subsidize food purchasing facility, etc. to compensate the effect of loss of livelihood of PAPs.	Proponent/ District Government, District Council, Jhang	Proponent / EMC

Sr. No.	Impacts	Mitigation Measure	Responsibility: Implementation	Responsibility: Monitoring
Potential Negative Impacts				
	livelihood of these families will be lost. As per the LAA these families will get the compensation of these lands however, loss of livelihood is a significant adverse social impact of the proposed Project.	Affectees along with their children losing their agricultural land in proposed new power plant should be given employment opportunities on preferential basis during the construction and O&M phases of project.		
d. Impacts on Built Up Areas, Infrastructure and Crops				
1	The implementation of the Project will affect built up area (about 40 houses), crops, katcha track, tube wells (about 20 nos.) and hand pumps that will mainly come under Project Area. The detail of the Project Area land quantification is elaborated in Chapter 8.	The loss of private land, built-up area, infrastructure and crops should be compensated according to the provisions of the LAA 1894. Other government infrastructure should be relocated by the concerned department in consultation with the project Proponent. Affected trees should be compensated by planting more trees as per the provisions of Forest Department. The planting of new trees should be carried out as per the Tree Plantation Plan.	Proponent/ District Government, District Council, Revenue Department, Agriculture Department, Jhang	Proponent / EMC
e. Loss of Agricultural Land				
1	The proposed project will result in the conversion of agriculture land in to built-up area that will decrease the gross agriculture yield of this area.	The Proponent should consult with the locals and take guidance from the agriculture department and facilitate farmers in converting barren lands into agricultural land. The provision of high tech agricultural machinery, water and and soil conservation approaches and micronutrients with efficient use of safe fertilizers would help to mitigate the loss. Proponent, Agriculture Department and Farmers should also promote such practices and techniques that will increase the yield and soil fertility. Following steps are recommended for yield increase in the nearby surrounding area. • Promote and adopt new irrigation techniques like drip	Proponent/ District Government, District Council, Agriculture Department, Revenue Department, Jhang	Proponent / EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		irrigation, sprinkle irrigation, etc. and other prevailing modern scientific methods that will improve the crop yield; • Use of Effective Microorganisms (EM) technology for crop yield enhancement; • Agricultural inputs should be offered on subsidized prices to farmers of small land holdings relating to electricity tariff, supply of seeds, fertilizers, machinery and other agricultural tools so as to attract the farmers zeal to work hard in increasing the crop yield; • Soil microbial inoculants as an alternative biological approach should be used to improve the soil quality; • Integrated use of green manure, farmland manure and inorganic fertilizers may be promoted; • Improving agronomic performance of crops, particularly wheat and rice, by controlling insect pests; • Use of modern machines for cultivation and harvesting will increase yield of the crops; • Government may evolve a system to offer credit facilities to farmers of small holdings to purchase certified seeds, pesticides, fertilizers, etc. and • Lack of guidance to small farmers about new agricultural techniques and allied sciences may be overcome by means of communication through Radio and TV in rural areas to air the programs in regional and local languages for better understanding and field adoption.		
f.	**Impact on Mosques and Graveyards**			
1	As per baseline survey, two small mosques in Shamme Wala village and one graveyard comprising 8 graves	Mosques are privately constructed by the local persons, therefore, compensation should be paid to the locals. For graveyard maximum efforts should be done to avoid this	Proponent/ District Government,	EPD/Proponent /EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	will be coming within project boundary.	graveyard from being affected through making necessary design changes. If impact on graveyard is unavoidable then shift these graves to nearby graveyard of Basti Waisaan.	Jhang	
Construction Phase				
a. Impacts on Land Resources				
1	**Soil Erosion:** In the Project Area, soil erosion may be occurred as a result of improper runoff drawn from the equipment washing-yards, accidental spills from batching plants and improper management of construction activities. Soil erosion may also occur at quarry and borrow areas due to the non-engineered and inappropriate material extraction activities. Most of the construction works of the proposed project such as surface leveling, grading, filling etc., will cause temporary change in the natural ground surfaces due to which instability of top soil surface and soil erosion may occur. Operation and movement of construction machinery such as excavators, bulldozers, cranes, batching plants and crushers my cause soil erosion.	Good engineering practices will help in controlling soil erosion at the construction site areas. Controlled excavations at quarry or borrow areas will reduce the soil erosion. Contractor should make proper arrangements for drainage of water through channels in the washing yards and quarry areas. Removal of vegetation and trees will be avoided to the extent possible. In case of unavoidable circumstances the exposed soil will be re-vegetated quickly and compensatory plantation, (as per Tree Plantation Plan presented in Section 9.19 of EMP), will be carried out after construction is over. If construction work is divided among the sub-contractors then they all should have close coordination to accomplish their work without much damage to land/soil. It is recommended that a properly developed quarry management plan should be prepared for each quarry site. The Waste Management Framework (WMF) and Site Restoration Framework described in Section 9.13 of this report should also be adhered to by the EPC contractor to develop plans and overcome soil contamination issues.	EPC Contractor	Proponent / EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
2	**Soil Contamination:** All the carbon and sulfur based compounds are toxic to varying degrees. Hydro Cabrons (HCs), petrol, diesel etc. are toxic in nature. The insulation on electric wires and cables are made from hydrocarbon compounds, which are also toxic in nature. Paints and varnishes are also toxic in nature, which are used during construction phase. If proper care is not taken for handling, storing and transportation of these toxic substances these may cause damage to the health of the workers as well as their spills will contaminate the soil. The other waste generated is mostly composed of rubbish, ashes and residues, demolition materials and hazardous wastes which will be generated from batching plant activities, construction camps, offices, borrow/quarry areas, stockpile and fabrication areas and other related construction activities. Indiscriminate disposal of these wastes will contaminate the soil. Improper storage of construction materials such as bricks, cement, crushes, lubricant, chemicals and deployment of project machinery such	Oil leakages, chemicals and other hazardous / non-hazardous liquids spills should be avoided (to extent possible) or minimized by providing appropriate storage places depending on the type of stored material. Oil and other lubrication material should be stored in water proof tanks especially built for oil storage. These tanks should be built away from the main road and residential areas for public and workers safety purposes. Access to these tanks should only be allowed to the authorized personnel with specific work permit. Safety equipment and personal protective equipment along with firefighting system should be provided near these places along with identification signs and Standard Operating Procedures (SOPs). Workers must be familiar with the Material Safety Data Sheets (MSDS) of each chemical used at site. MSDS are provided with each chemical storage box. Chemicals will be stored as per the instructions of MSDS. Utmost care should be taken during the handling of these chemicals. Precautions should be taken to prevent spills and all workers should be trained in proper handling, storage and disposal of hazardous or toxic materials. Contractor should consult with the Proponent and the Tehsil Municipal Administration (TMA) for final disposal of solid waste which is the one of the major source of soil contamination. Segregated solid waste collection and disposal strategy should be adopted with adequate number of collection containers. The location of these containers should be easily approachable to workers/staff working within the Project site. Contractor	EPC Contractor	Proponent / EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	as bulldozers, cranes, excavators will also contaminate the soil. Another source of soil contamination is the discarded construction materials which include chemicals, wires, plastics, cut pieces of pipes, pieces of empty fuel and lubricants tins and cardboard packing and other discarded materials/solid waste. Construction camps and offices are one of the most important sources of solid waste during construction phase. The major components of the camp's waste are garbage, putrescible wastes. The construction camp will be located over reasonable area, and therefore there is significant area that is potentially susceptible to soil contamination. Immediate attention is required for such type of wastes as these are degradable and those that produce odor. It is expected that approximately 0.5 kg/capita/day waste will be generated from the camps. The total expected labor force will vary between 2500 to 3500 nos. during the peak course of the construction phase of the project. Considering the above per capita solid waste generation rate, about 1,500 kg/day solid waste will be generated which may cause	shall also manage the disposal of waste to the designated places after consultation with TMA. Separate primary collection of organic and in-organic waste arrangements need to be provided. In this regard, workers should be made well aware of the solid waste management system being adopted at the site. Hazardous, Non-hazardous, inert and municipal waste such as garbage, refuse, etc. produced during the construction, pre-commissioning and commissioning phases shall be disposed in compliance with the National guidelines and government ordinances. All hazardous wastes shall be clearly labeled. Other waste shall be placed in designated containers. Regular clean-up of scrap material, saw dust, rags, oil, paint, grease, flammable solvents and other residue of construction operations shall not only remove or reduce the fire hazard, but shall promote general safety at the same time. Impermeable sheets should be placed at chemical/lubricant storage areas to avoid contamination. Left over construction materials and excavated soil will be disposed off in designated areas to avoid soil contamination/land degradation. Contractor will arrange adequate waste disposal and toilet facilities, potable water for use of its employees. In addition, Contractor shall comply with all laws, standards, codes and regulations relating to sanitation at the work-site, including company's requirements as to waste disposal and toilet facilities and potable water.		

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
	contamination of soil.	All the above measures should be implemented as part of a Waste Management Plan to be prepared by the contractor under the guidelines presented in the WMF in Section 9.8 of this report. The contractor should prepare Construction Camp Management Plan (CCMP) for Project implementation prior to deputing on site and submit to Consultant for approval.		
3	**Water Ponding:** The excavated material will be generated from the excavations of trenches for foundations, laying of water supply pipelines, underground electricity wiring and other structures. These excavated materials will be used for filling works as much as possible. However, a bulk of the excavated material will not be reused. If this material is left at places of excavation, it will remain there in loose form and may promote development of temporary water ponding within the Project Area and its vicinity.	Proper storage place for each type of material should be built to avoid the development of water ponds. Left over material should be disposed off immediately at appropriate places designated by concerned department (TMA). Employees/workers should also be trained enough to reduce the excessive wastage of water on land or depression areas to minimize this impact.	EPC Contractor	Proponent / EMC
b. Impacts on Water Resources				
1	**Water Utilization for Construction:** Large amount of water will be required especially during batching process of construction. Annually two (02) months closure has been recorded for TS Link Canal. During this period, the water requirement will be fulfilled by installation of deep wells for the supply	Efforts should be made to draw water from deep aquifer which does not influence the top unconfined aquifer which is being exploited by the local community. The location of these deep well should be finalized considering the drawdown phenomena of existing tube wells. Recommendations of hydrogeological study and ERS should be considered carefully. It will be EPC contractor's responsibility to ensure safe supply of water	EPC Contractor	EPD / EMC / Proponent

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
	of makeup water during construction phase. If the overall quantity of water required during construction phase will be extracted from groundwater then it may have negative effect on water domestic demand and may raise conflict between local communities and workforce. Apart of this, relatively less amount of water will be utilized for drinking and domestic purpose of employees or workers at Project site. Ground water will be the only source utilized for this purpose. Estimation of this water usage for about 3000 no. of workers has been carried out based on the per capita demand of 100 liters per day.	for construction purposes, to train workers on minimum use of water and to not disturb the proposed water scheme, tube wells etc.		
2	**Contamination of Water Resource:** Sewage and wastewater will be generated at the construction camps, offices, stockyard areas and from various construction activities. If the generated sewage is not properly treated or disposed off, this may contaminate the water quality of the T-S link Canal and might affect the groundwater resources apart from soil contamination due to percolation. Water from dewatering activities (during rainy season) has the potential to contain suspended solids, oil &	To avoid sewage, untreated wastewater, and chemicals and oil spillage from draining into the canal during construction activities, measures should be taken to collect, store and dispose off the chemicals, sewage and untreated wastewater. Contractor should not in any case dispose off the hazardous chemicals into the nearby Canal. Similarly utmost care should be taken to avoid any spills of oils and hazardous chemicals by adopting best management practices, good house-keeping and following the MSDS. In case of accidental spill, SOPs should be developed and strictly followed by contractor. The chemicals and other oils shall be disposed off at	EPC Contractor	EPD / Proponent / EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	grease and if disposed off untreated may affect the quality of surface water bodies. Furthermore, spills of oils and hazardous chemicals if in large quantities can drain into the nearby water channels that are a source of irrigation water to the agricultural fields. This is a potentially significant adverse impact as the wastewater will directly drain from the Project Area into the Canal. Such contamination of canal water can have adverse impacts on the water quality. The Table 8.4 below shows an estimate of the wastewater to be generated during the course of the construction phase of the project assuming that 80% of the water demand will become wastewater. The groundwater can also be contaminated by sewage from the septic tanks, seepage of contaminated water in ground and leakage of underground fuel storage tanks.	designated places or supplied to other industries as raw material (considering its reuse) to avoid contamination. Measures should also be taken to remove settle-able solids prior to discharging of wastewater from the site which include the use of sediment sumps. Any visible oil and grease can be skimmed off the surface by using absorbent pads or oil scrapers. For Sanitary drainage, installation of proper temporary sanitary sewage disposal facilities for the entire site should be considered. These include provisions for the construction offices and living area. The number of comfort rooms/portables shall correspond to the number of workers, as required by law, and the sanitary sewage facilities should be adequately sized. Sewage from construction camps, offices, etc. should be disposed off by development of on-site sanitation systems i.e. septic tanks along with soakage pits. On-site sanitation system can be operated well as long as the difference from the bottom of the soakage pit is 2 m (6.56 ft) from the groundwater. Therefore, this system will minimize the negative effect on groundwater quality. During the construction work of existing HBS CCPP, overall 2000 to 3000 labor (800-1000 nos. local labor) were involved which are now reduced to 1000-1200 nos. of labor. All the temporary facilities such as offices, construction camps, batching plant facility, stockpile area etc. are located within the boundary of this RLNG CCPP. The photographs of HBS CCPP are shown in Photolog. The contractor should prepare Construction Camp Management Plan (CCMP) for Project implementation		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		prior to deputing on site and submit to Consultant for approval.		
c. Impacts on Ambient Air and Noise				
	Air quality is likely to be adversely affected by the construction of the Power Plant. Following types of emissions are expected, including: • Gaseous emissions (SO_x, NO_x, CO_x, etc.) due to movement of construction machinery such as cranes, excavators, crushers, batching plants, bulldozers, vehicles and operations of equipment; • Fugitive dust emissions due to movement of machinery on dirt tracks, construction of roads and excavation of borrow areas; and • Particulate Matters (PM) such as PM_{10} and $PM_{2.5}$ emissions during the operation of concrete batching plants, asphalt mixing plants and other construction equipment. These emissions are described in the following sections.	• Tuning of vehicles should be mandatory to reduce the emissions of NO_x, SO_2, CO, HC and PM to ensure that these emissions do not exceed PEQS limits of Motor Vehicle Exhaust and Noise. All vehicles will be required to carry a fitness certificate; • Emissions points from batching plants, asphalt plants and other equipments can be controlled efficiently by the installation of cyclone. It is also recommended that during the operations of the machines labor shall wear Personal Protective Equipment (PPEs) in order to save their health. Diesel operated equipment and vehicles should be well maintained to minimize particulate emissions. Maintenance will include changing of lubricating oil, changing of air and fuel filter, cleaning of fuel system, draining the water separators and proper tuning; • Haulage trucks carrying soil, sand, aggregate and other materials will be kept covered with tarpaulin to contain the construction materials being transported within the body of each carrier. Moreover, slightly wet material controls air pollution; • Dust emissions will be reduced by regular sprinkling of water. Sprinkling will take place at an interval of three	EPC Contractor	EPD / Proponent / EMC
1	**Gaseous and Fugitive Dust Emissions:** Various types of machinery will be required for the construction activities. Machinery will consist of gantry cranes, tower cranes,	hours during daylight hours and six hours during night time throughout the construction period in the summer and during the winter the frequency can be reduced as per the requirement. Sprinkling will be done on access	EPC Contractor	EPD / Proponent / EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	crawler cranes, loaders, trailer pumps, mixers, excavators, dumpers, concrete rollers, etc. Since most of the machinery will use diesel as fuel, emissions will mainly consist of carbon monoxide (CO), sulfur dioxide (SO_2), PM, nitrogen oxides (NO_x) and HC. Most of the above machinery (excluding the batching plants) will move around during the construction period. Fugitive dust will be produced by earth moving activities, excavation, haulage, heavy machinery movement and construction of access roads outside and within the power plant area. Fugitive dust emissions are a function of silt content of dirt tracks, vehicle speed and the mean annual number of days with 0.01 inches (0.254 mm) or more of rainfall. Gaseous and fugitive dust emissions will result in an impact of medium significance, due to their moderate magnitude, relatively small duration (less than five years), and localized geographic impact area. Gaseous and fugitive dust emissions will affect the environmental components especially inhabitants living in the nearby	roads, tracks which are frequently used by vehicles, project site, construction material such as soil, sand etc. storage area; • Noisy construction activities will be avoided during the night times and silencers should be provided in all vehicles. Noise complaints should be logged and kept onsite by the construction contractor. Noise producing machinery should be properly examined to reduce noise; • All the provisions of PEQS, 2016 based on the zone classification should be strictly enforced; and • The proposed Project Area site should be fenced and noise barriers must be installed; • Vibrational affects should be minimized by installing shock abosrbers with allproject machinery.		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	settlements. Moderate levels of vehicular emissions tend to cause lung irritation, shortness of breath and increase a person's susceptibility to asthma. This impact is classified as moderately significant.			
2	**Particulate Matter Emissions:** Concrete batching plants will be a major source of PM emissions. These emissions accumulate in the respiratory system and can lead to decreased lung function, and respiratory disease. Direct impacts will be encountered by the construction workers working in close proximity to the batching plants as well as those residents in nearby settlements. The other critical sources of air pollution during the construction phase are: • Quarry or borrow areas that generate fugitive dust during the excavation and related activities; and • Construction material haulage trucks that generate dust, particularly during the loading and unloading processes.		EPC Contractor	EPD / Proponent / EMC
3	**Noise and Vibration:** Various activities during construction such as batching and asphalt plants operation, vehicular movement,			

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	clearing activities and other associated works etc. are the main source of noise and vibration. These activities might affect the nearby receptors such as villages, schools and especially labor working at Project site if noise crosses the PEQS limits.			
d. Impacts on Ecological Environment				
1	**Impacts on Flora** • The initial construction works at the project site, involving land clearance, cutting, filling and leveling will cause loss of potential productive agricultural land and loss of vegetation. Vegetation which shall be impacted are Gum Arabic (*Accacia nilotica*), Indian Rosewood (*Dalbergia sisso*), Date Palm (*Phoenix Dactylifirra*), and Sirris (*Albizia lebbek*) etc. Agriculture Crops such as Wheat, Rice, and Cotton and grasses i.e. Bermuda (*Cynodon dactylon*), Gam or Mall (*panicum antidotale*), Khawi (*Cymbopogan jawarnica*) and Dib (*Typha angustata*) will be impacted. • Construction of the Power Plant in any case shall involve cutting and removal of trees, which shall have a negative effect on the flora of the tract.	• Only trees coming within the various structures to be constructed on the site, shall be removed and every possible effort shall be made to save the remaining trees, which fall in open spaces or those which can be adjusted in the future landscape of the Power Plant; • Campsites and asphalt plants will be established on vacant land rather than on green areas. However, if such type of land is not available, it will be ensured that minimum clearing of the vegetation is carried out and minimum damage is caused to trees and undergrowth; • Nearly 4500 trees (10 times more trees than trees, likely to be effected) of suitable species shall be raised in accordance with the Tree Plantation Plan to improve aesthetic value and offset the effect of removal of vegetation. About 3,000 along the Plant boundary and remaining 1100 plants in the open spaces within the boundary of the power plant and along the adjoining T S Link canal and Haveli canal, where open spaces are available. • Construction vehicles, machinery and equipment will remain confined within their designated areas of movement; • The Contractor's staff and labor will be strictly directed	EPC Contractor	EPD/Proponent /EMC

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	solid waste generated from the power plant, residential buildings, offices and other allied facilities can contaminate the soil.			
b. Impacts on Water Resources				
1	**Impact on Water Requirements:** Cooling water for main cooling cycle will be taken from TS-Link irrigation canal next to project site which has been agreed by the Irrigation Department. During a yearly period of canal closure (6-8 weeks) the cooling demands of the power plant will be met using cooling towers. During this period, water will be taken from underground wells that have to be developed as part of the EPC Contract. Since the wells will be used only for up to 8 weeks per year, a permanent impact is not expected. Tube wells near the project boundary might be impacted due to the drawdown phenomena of groundwater extraction carried out through the deep well installed for this purpose during canal closure period.	The water requirement for power plant will be about 22 Cumecs (770 Cusecs). The impact is not expected to be significant. The impact of the extraction of the water on the aquifer should be determined on the basis of recommendations of Hydrogeological and ERS study.	HSE Section	EPD
2	**Wastewater produced from Plant Operations:** The plant operation will generate industrial as well as sanitary wastewater. It is estimated that about a maximum of 2 m^3/h of sanitary, 4	Wastewater treatment system needs to be selected carefully considering the characteristics of wastewater generated from the power plant. The Contractor shall investigate the possibility of discharge into the canal during the annual canal closure period. In case, if treated water discharge is not permitted during this time by the	HSE Section	EPD

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	m^3/h of industrial wastewater will be generated along with cooling tower blow down (expected concentration factor: 4 - 5) in canal closure period. The release of hot water from new CCPP and existing RLNG HBS may have cumulative impact on canal water temperature rise.	canal authorities, a sufficiently sized seepage pit for all cleaned effluents shall be provided. The location of seepage pit will be finalized by EPC Contractor during the design with consultation concerned department (TMA). It is highly recommended that a separate water quality modeling study be conducted to monitor water quality along a stretch of the TS- Link Canal from the point of discharge of hot water into canal. The modeling study should also be done to analyze thermal variations in canal water due to release of hot water from both plants. The cumulative temperature rise should not be more than 3 degree Celsius. Sanitary wastewater from the plant area shall be treated in biological treatment plant where all sanitary effluents will be reduced from organic matter to stable sediment. The water discharged from this plant shall be conveyed to the cooling water outfall. Separated sludge shall be collected in a sludge collector pond and suitably disposed off. The system shall have a sufficient treatment capacity and will be divided into several components which will be performing a specific phase of the treatment (retention basin, aeration basin, clarifier, sludge pit). The chlorination of separated clear water shall be performed by hypochlorite solution generated in the chlorination plant. The plant shall be designed to meet the applicable discharge limits as per PEQS. The treated effluent from the sanitary wastewater treatment plant shall be transferred through piping to the		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		treated water monitoring basin by gravity or dedicated pump station. The industrial waste water treatment plant shall be constructed to treat all wastewater occurring during O&M of the power plant. The facilities have to be capable to achieve discharge limits for discharge into surface waters, stipulated in the most recent issue of the PEQS. In industrial wastewater treatment plant, all oil contaminated drains and wash waters from the plant area shall be collected and treated by oil separators. The oil separators shall have two stages and shall be designed to meet the applicable wastewater discharge standards for residual oil and grease. In case of accidents, large amounts of oil may lead to a blocking of the oil separators. Therefore, the de-watering of transformer areas shall be equipped with a retention basin with sufficient capacity to hold up the maximum possible oil discharge plus the firefighting water in case of fire NFPA Standard. The oil free water from the oil separators and all other industrial drains shall be directed to the wastewater retention basin. The wastewater will be treated by the following steps: clarifier, secondary oily cleaning stage, and mechanical filters. The effluent from the mechanical filters and the boiler blow down shall also be directed to the treated wastewater basin for regular sampling and analyses in the plant chemical laboratory. From there, all plant effluents shall be finally discharged through the		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
		cooling water outfall pipes to the canal. Only Sodium Hypochlorite (NaClO) will be used in the cooling water, the level will be closely monitored to keep it at the specified value which is evaluated as acceptable for the environment. Chemical drains from the water demineralisation plant, electrochlorination plant, battery room, etc. shall be collected in a separate drainage system, stored in a chemical waste water pit and treated on demand in a waste water treatment tank by means of precipitation and neutralisation chemicals. The treated effluent from the chemical waste water treatment tank shall be discharged into treated waste water monitoring basin and from there to the cooling water outfall. Separated sludge from waste water and oily water treatment, as well as effluents from boiler acid cleaning and GT compressor washing shall be disposed off externally by a certified waste disposal contractor. The GT wash waters and effluents boiler acid cleaning shall be collected during the washing procedure in dedicated tanks (to be provided) and disposed off externally by a certified waste disposal contractor.		
3	**Raw Water Reservoir:** If raw water reservoir will be constructed during the canal closure to store ground water, the water quality of this reservoir (if uncovered) can be impacted by solid waste, sewage or other contaminated material. Furthermore, there is risk of	The raw water reservoir must be managed properly by the Project Proponent with a plan to ensure that it is not contaminated. Preferably, it should be covered.	HSE Section	EPD

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
	vector borne diseases like malaria or dengue if the reservoir is uncovered or not properly monitored.			
c. Impacts on Air				
1	Air quality can be reduced by emissions of typical pollutants such as SO_2, NO_x, and PM. Oxides of Nitrogen (NOx) are formed when combustion temperatures exceed 1,300 degree Celsius. Oxides of sulphur (SO_2 mainly), and PM are emitted depending upon the fuel characteristics. The proposed power plant Jhang will utilize the RLNG as main fuel and HSD as a backup fuel. There exists another RLNG based CCPP HBS which is near completion. HBS power plant will also utilize RLNG as main fuel and HSD as a backup fuel. The side-by-side operation of both power plants is expected to pose cumulative impact on air quality. The impact on air quality is not expected to be significant if plants are run on RLNG (main fuel) which is a clean fuel with less air emissions. The emission	It can be seen from the above assessment that the stacks' air emissions from both power plants are within the permissible limits of PEQS except for SO_x if both power plants run on HSD altogether. The stacks of the power plant will be kept high i.e. at minimum 45 m in case of HSD and 60 m in case of RLNG above ground level for bypass stack and the main HRSG stack. Low NOx burners will be used in GT to control emissions and the water will be injected during the use of HSD to control the NO_X emissions. For SO_X emissions control, scrubbers are highly recommended for both existing and new RLNG power plants in case of HSD. The long term baseline monitoring for $PM_{2.5}$ spreading atleast over a period of one year before commissioning of power plant or start of power plant construction should be done to establish average annual baseline concentration of $PM_{2.5}$ to assess compliance. A continuous emission monitoring system (CEMS) will be installed, including flue gas analysers at each HRSG stack for NO_x, SO_2, Particulate Matter, CO, Volatile Organic Carbon (VOC, only at Aux. Boilers) and the reference parameters O_2, flue gas pressure and flue gas temperature, sample conditioning equipment, calibration	HSE Section	EPD

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
	estimates for the RLNG[12] and HSD provided by the designers of both RLNG power plants are within PEQS limits. the pollutant's concentration to be emitted from stacks of both power plants, are within the thresholds of PEQS. PEQS also lays down the compliance criteria for maximum allowable ground level increment to ambient and maximum SO_2 emissions in tons/day/plant. These criteria are required to be met on the basis of classification of the airshed as unpolluted, moderately polluted and much polluted, which is based on the measurement of SO_2 as annual average and maximum 24 hrs interval as shown in Table 8.10. The maximum cumulative ground level concentrations for both RLNG power plants as determined by ADM are within limits of PEQS for 24 hours averaging period except SO_2 limts if both power plants run on HSD with combined cycle altogether. For annual	gases, analysers for temperature, data acquisition module, data evaluation and visualisation equipment for the measured emission data with connection to the DCS. During the monitoring of the power in O&M phase, it will be determined if the occasional use of HSD fuel requires a flue gas desulphurisation system to be installed. The designer should comply with the standards for CEMS i.e. ISO 10396: Stationary Source Emissions – Sampling for the Automated Determination of Gas Concentrations (2007) and ISO 10849: Stationary Source Emissions – Determination of the Mass Concentration of Nitrogen Oxides – Performance Characteristics of Automated Measuring Systems (04/1996).		

[12] Data provided by the designer to the best of their knowledge. NO_X values have been based on limits, which can be achieved and guaranteed, while the PM values are taken from similar projects on diesel fuel with a typical split between $PM_{2.5}$ and PM_{10}.

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
	averaging, the results of SO_2, NO_x, and PM_{10} cumulative emissions are within thresholds of PEQS. The maximum cumulative annual average contribution of $PM_{2.5}$ from the power plant will be 0.193 μg/m^3 which is quite low.			
d. Impacts on Noise and Vibration				
1	There are various villages such as Moza Qadeemi, Dhueen Mohammad, Mahmoodabad Basti, Basti Kora Wala etc. adjacent to the Project Area. Noise and vibration during the O&M phase are likely to affect the health of employees, local residents and animals. Some of the noise sources from the proposed power plant during the O&M phase include operation of the turbines, boilers (steam blowing and purging) as well as combustion.	The plant will be designed to control the noise generated to meet National regulations within the plant and at the fence line. It is already recommended to provide and adjust the height of boundary wall and noise barrier as per distribution of living structures outside the Project Area. Noise during plant operation would be significantly blocked by trees to be planted all along the periphery of the Project Area. Tree plantation should be started during the construction phase Equipment noise will be controlled using conventional noise control measures, such as insulation, lagging, ear protection, and enclosures as needed to comply with the PEQS. Each GT shall be located in a compartment, which shall reduce the dissipated noise. The noise reduction shall achieve a noise level of 85 dB(A) measured one meter away at 1.5 meter height from the floor level. Additional efforts will include the declaration of a "no horn zone", construction of a wall and buffer zones around the project site. An ambient noise measurement program will be instituted upon executions of the Project which will cover the construction and O&M	HSE Section	EPD

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
		of the project. The monitoring program will consider the noise limits during day-time and night-time at the closest point of receptor. EPC Contractor should conduct noise and vibration study to measure, analyze and minimize the impacts.		
e. Impacts on Aesthetics				
1	Aesthetics plays an important role in improving the working environment of an area. Similarly the design provision can improve the aesthetics of an area and thereby improve the working efficiency of labor. In this regard greenery and plantation play an important role.	In order to improve the working environment, good house-keeping, cleaning, efficient solid waste management system should be implemented. Moreover, it is suggested that use of flower pots and other techniques should be used inside the buildings to improve the working environment of the area. It is suggested that plantation of trees and vegetation will be carried out as per the Tree Plantation Plan within the plant area. This activity will remarkably add the aesthetics to the natural outlook of the area.	HSE Section	EPD/
f. Impacts on Ecological Environment				
1	• The release of hot water in TS Link Canal after passing once through cooling system, will distuirb the aquatic life in canal. If temperature differential of intake water and water at outfall is more than 3°C, it would cause seious issues. • Movement of traffic in the area shall increase, causing noise and air pollution, which will be a permanent source of disturbance to fauna of the	Cooling water to be released back to canal must not exceed the allowable differential limit of 3°C. For that purpose a controlling gauge should be installed at outfall structure which should automatically close if and when temperature exceeds the allowable PEQS limits. Compensatory plantation of trees shall be undertaken along the boundary of the Power Plant, along the access roads and in open spaces and other available places. A tree plantation program for raising 4500 plants (10 times more plants than the number of plants expected to be removed). About 3630 trees will be planted along the	Contractor	EPD/ Proponent

Potential Negative Impacts				
Sr. No.	**Impacts**	**Mitigation Measure**	**Responsibility**	
			Implementation	**Monitoring**
	area and especially the birds, which shall avoid this area on account of noise and fear of being harassed or killed. • As the requisite number of trees to be felled are already removed, there will be no further damage to the flora of the Project Site during O&M phase. Maximum possible number of trees of suitable species shall be raised during O&M phase, which shall result in a healthy impact on the flora of the area. • Both the flora and fauna are an integral part of the eco-system. In many ways fauna of a tract is dependent upon flora for its resting, nesting and roosting activities. With the plantation of 10 times more plants than the number of plants removed, the negative impact due to cutting of trees shall be mitigated to a reasonable extent, due to raising of additional plants in the area. The fauna and specially the avi-fauna shall be attracted to the area, adding to the environmental rehabilitation. • The birds which were scared away due to noise and degradation of their habitat shall return or start visiting the area again. So there will be a positive impact on the fauna.	power plant boundary and 870 will be planted in the open spaces within the plant boundary and along paths and roads within the plant. For this purpose, requisite funds shall be placed at the disposal of DFO by the Proponent.		

Potential Negative Impacts				
Sr. No.	Impacts	Mitigation Measure	Responsibility	
			Implementation	Monitoring
g. Impacts on Socio-economic Environment				
1	**Gender Issues:** During O&M phase, the induction of outside labor may create social and gender issues due to the unawareness of local customs and norms. It will also cause hindrance to the mobility of the local women. Disturbance may occur to the privacy of the local women residing in the nearby villages.	Power plant staff should respect the local community's sensitivity towards their customs and traditions. The staff must not involve any un-ethical activities and should obey the local norms and cultural restrictions particularly with reference to women.	Contractor	EPD/ Proponent
2	**Noise and Vibration:** Due to the operation of plant noise and vibration will be produced which will have impact in the adjoining villages/bastis, schools, and surrounding areas. This will be an impact on the local population.	To minimize the noise of the proposed power plant pollution barriers should be placed around the boundary of the power plant and continuous monitoring should be done to determine noise levels and ensure that they are within the PEQS limits. As already mentioned, EPC Contractor should conduct Noise and Vibration Study.	Contractor	EPD/ Proponent
3	**Wastewater:** With the operation of this power plant, wastewater will be generated. The disposal of wastewater without proper treatment will have impact on the local community. If the wastewater is discharged into the TS-Link Canal, it is likely to cause damage to the livestock as it is used for their drinking purposes. Similarly some villagers use this water for washing purposes of their clothes and other domestic uses.	As discussed in the mitigation of impacts on water resources due to wastewater, the wastewater should be treated to prevent any impacts.	Contractor	EPD/ Proponent

9.6 INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION OF EMP AND ROLES & RESPONSIBILITIES

After 18^{th} amendment in the Constituent of Pakistan, the provinces are now vested with full authority to develop power projects of any capacity through public or private sector and establish required regulatory framework. In the view of lingering energy crises and opportunity provided by new enabling framework, GoPb has decided to play a proactive role in the energy sector. An independent PTPL company has been established accordingly for the proposed Jhang project.

The organizational structure of PTPL is shown in Figure 9.1. PTPL will mainly be responsible for EPC, LTSA, O&M and Fuel Supply Agreement (FSA). The Power Purchase Agreement (PPA) will be done by Central Power Purchase Authority (CPPA).

9.6.1 Proposed Organization Structure

Considering the upcoming thermal power projects, it is strongly recommended that PTPL should establish its own environment and social setup. The proposed organizational setup for both phases of the Project is shown in Figures 9.2 and 9.3 respectively. The immediate requirement considering the existing institutional setup of Proponent is the establishment of EMC. The cell will have a competent Environment & Resettlement Team (E&RT) that will render its duties in close coordination with the EPC Contractor and Plant Management. It is a pre-requisite that all the land acquisition issues and compensation to Project Affected People (PAP) need to be handled and covered before mobilization of EPC Contractor.

The E&RT will focus its activities as a monitor specifically during the construction phase of power plant and other allied facilities. This E&RT will remain on-board throughout the construction time and will finally be merged into the proposed HSE Section. The HSE Section is highly recommended to be on-board within the existing setup of Proponent. The department will primarily be responsible for tackling all the HSE issues throughout the project cycle.

The proposed staff is listed below:

9.6.1.1 E&RT

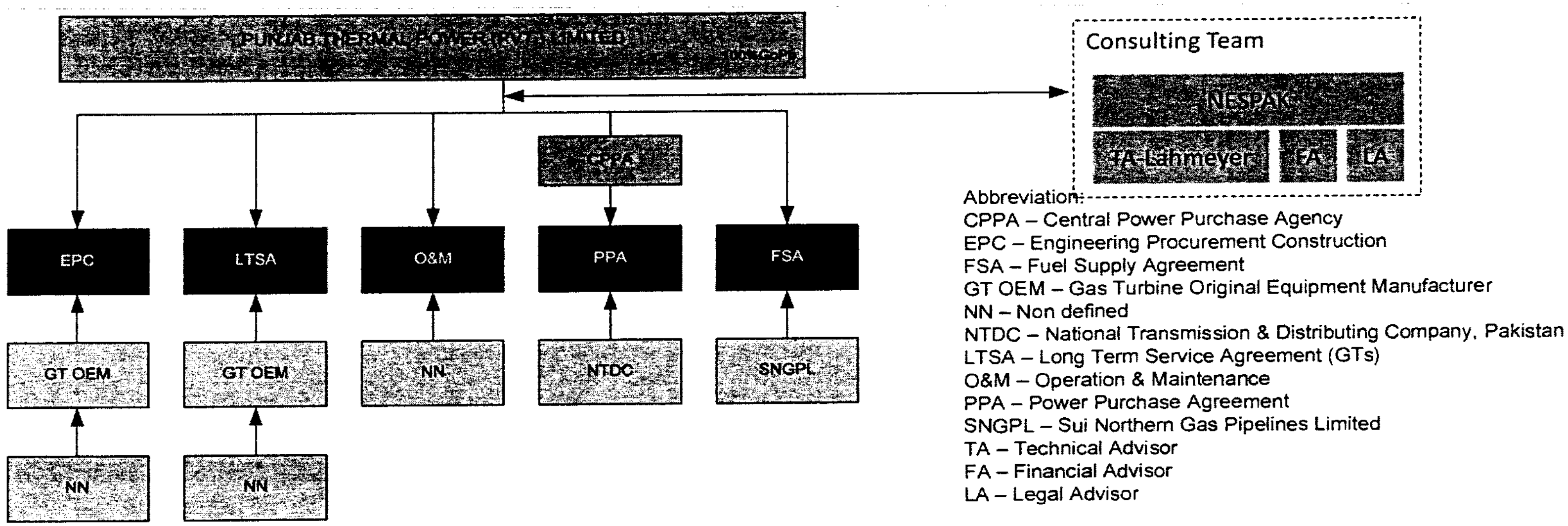
- Senior Environmental Engineer with Masters in Environmental Engineering or related Field having 5 years of experience in power plant sector; and
- Senior Sociologist with Master in Social Work/Sociology or related Field having 5 years of experience in resettlement sector.

9.6.1.2 HSE Section

- Senior Safety Engineer with Masters in Mechanical/Electrical/Environmental Engineering having 5 years of experience in power plant; and
- HSE Engineer with Masters in Environment/Chemical/Mechanical Engineering having 5 years of experience in power plant sector.

EPC Contractor must have an HSE Section having qualified professional staff. Proponent must consider this matter while selecting the EPC Contractor.

EPD-Punjab is the regulatory authority for issuance of NOC for this proposed project. As part of its mandate, protection of environment (water, air and noise) is their responsibility. Therefore, the agency will undertake an audit (as and when required) of the activities of the project (both phases) with respect to the protocols as defined in EMP.



ORGANIZATIONAL STRUCTURE OF PUNJAB THERMAL POWER (PVT.) LIMITED (PTPL) 1,100-1,400 MW (Gross) RLNG based Combined Cycle Power Plant at Jhang, Punjab	Figure 9.1

Figure 9.1: Organizational Structure of PTPL

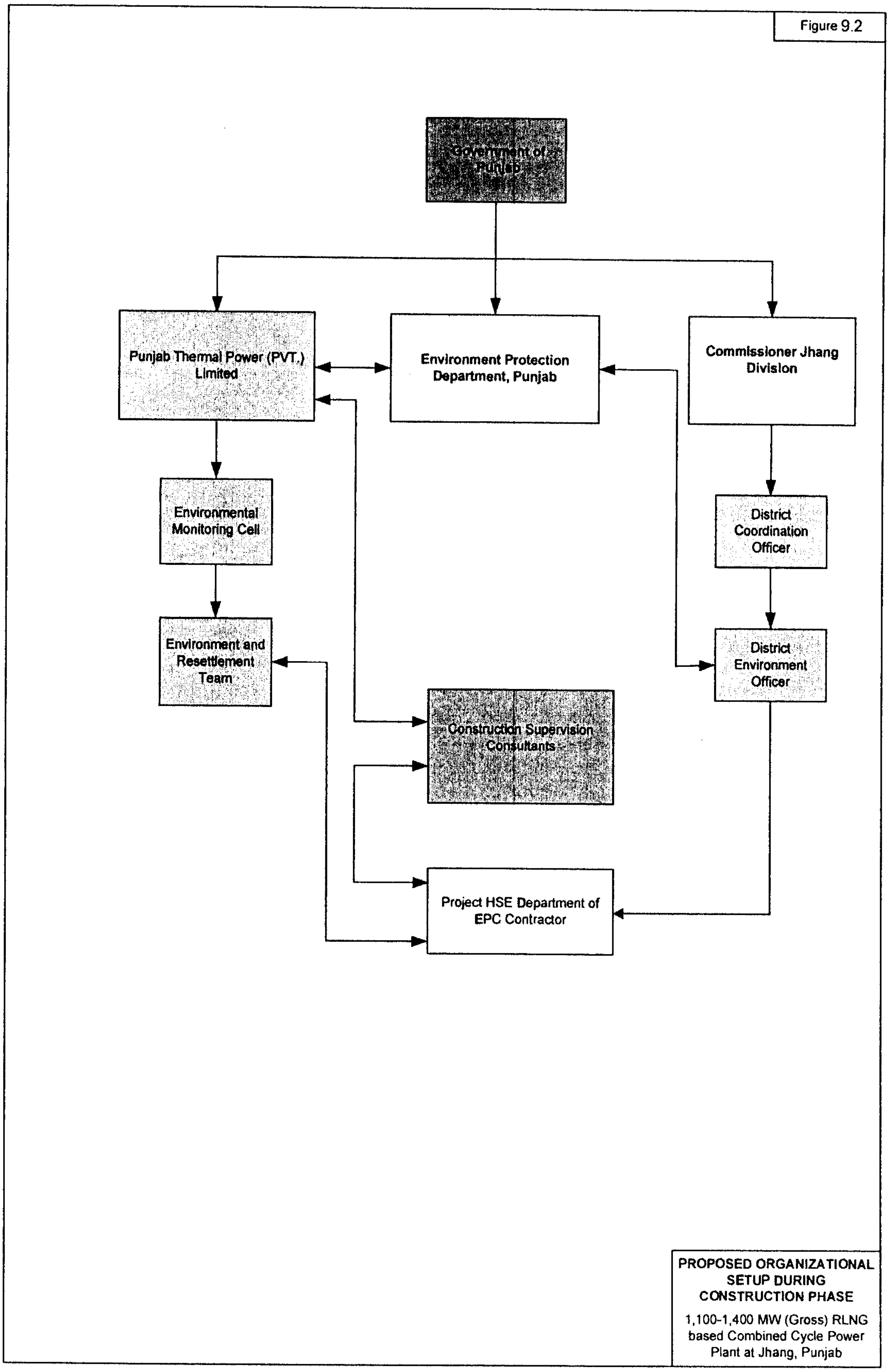
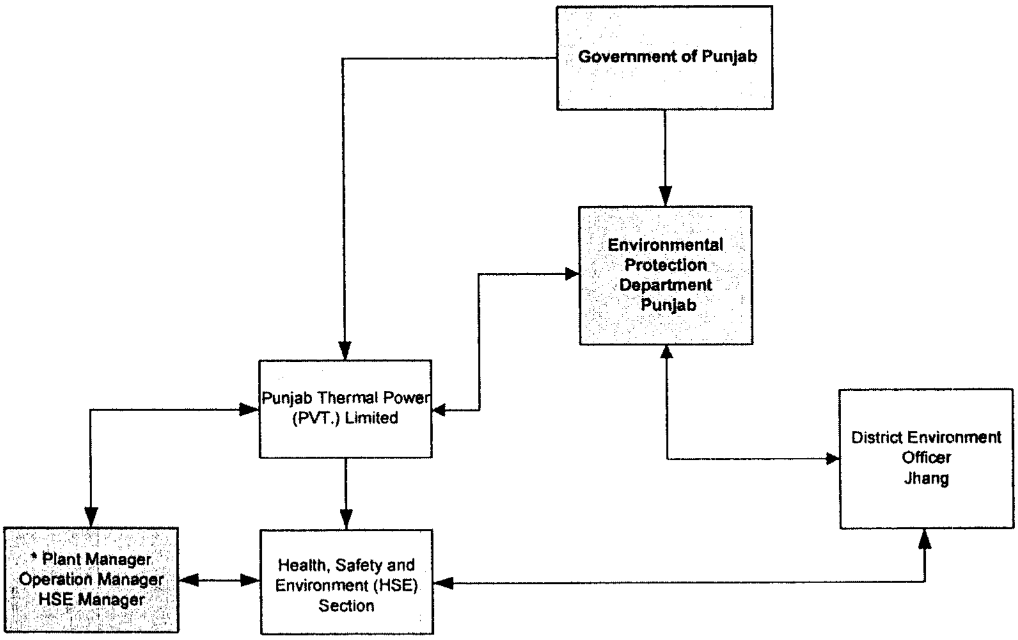


Figure 9.2: Proposed Organizational Setup during Construction Phase

Figure 9.3



* The Plant Manager and HSE and Training Department are the part of O&M Organization

PROPOSED ORGANIZATIONAL SETUP DURING OPERATION AND MAINTENANCE PHASE

1,100-1,400 MW (Gross) RLNG based Combined Cycle Power Plant at Jhang, Punjab

Figure 9.3: Proposed Organizational Setup during O&M Phase

9.6.2 Roles and Responsibilities

The foremost responsibilities of Proponent, EMC (E&RT/HSE Section), EPC Contractor and Plant Management are given in Table 9.2.

EPC Contractor is the main force behind meeting the project goals. EPC Contractor is essentially deemed as the commercial leader of the project, in close coordination with the Proponent, he has to manage and ensure some of the most important elements of the project including safety of the project workers, equipment handling, HSE compliance, budget control, time allocation and remaining costs of the project.

Table 9.2: Roles and Responsibilities

Organization	Designation	Responsibilities
Proponent *Construction, O&M Phase*	Plant Management	• Overall in-charge and supervision of EMC's activities. • To ensure the project's compliance with the PEPA 1997 (Amended, 2012) and other national environmental regulations and stakeholder participations in the project construction and O&M phases. • Liaison with EMC and EPC Contractor.
EMC (E&RT)*Construction Phase*	E&RT	• Monitor the activities and check the proper implementation of all mitigation measures for physical, ecological and social sectors. • Liaison with HSE department of EPC Contractor. • Ensure compliance and implementation of national and provincial rules and regulations enforced by EPD, Punjab especially regarding social and environmental aspects. • To assist EPC Contractor for obtaining necessary approvals from the concerned departments. • To document the social complaints and prepare the social complaint register. • Monitoring and evaluation of environmental & social related matters of the project. • Monitoring and evaluation of accommodation facilities and workplace condition of the project to address the worker's issues. • Carry out consultation with the local residents and labor with regards to any social issue that needs to be settled down. • Supervise the EPC Contractor activities and make sure that all the contractual obligations related to the environmental and social compliance are met. • Prepare periodic Environmental Reports and distribute according to the requirement of EMP.
Proponent (HSE Section) *O&M Phase*	HSE[13]	• Oversee all the HSE activities being carried out by EPC Contractor. • Implement the HSE activities as provided in HSE plan. • Liaison with EPC Contractor. • Conduct site visits to ensure compliance with HSE protocols. HSE department will also ensure the compliance of all safety and health protocols during the O&M phase.

[13] *If EPC Contractor remain responsible for O&M of project for one year.*

Organization	Designation	Responsibilities
EPC Contractor *Construction, O&M Phase*	HSE Team	• Compliance of all the monitoring programs as given in EMP (MMM, emergency plan, plantation plan, waste management plan etc.). • Ensure health & safety of site workers. • Liaison with HSE Section of Proponent. • Liaison with EMC and HSE Section of Proponent. • Training of workers. • Strict compliance of social mitigation measures. • Effective liaison with locals and heads of the villages.
EPD-Punjab *Construction, O&M Phase*	Monitoring Team	• Audit of the activities being undertaken by EPC Contractor and all other organizations as given in the proposed institutional plan. • Liaison with the Proponent and HSE Section to check compliance of measures as given in the EMP during construction and O&M phase.
District Departments (TMA, District Council, Agriculture Department, Revenue Department, Social Welfare etc.)	Monitoring Team	• Audit of the respective activities being undertaken by EPC Contractor as per legal requirements. • Liaison with the Proponent and HSE Section to check compliance of all relevant measures as given in the EMP during construction and O&M phase.

9.7 ENVIRONMENTAL MONITORING PLAN

Environmental Monitoring provides timely and useful information to the project management and implementation agencies. Conceptually, "monitoring" means to check and balance, on a regular basis, the status of the project activities and realization of various developmental targets during construction and O&M phases. It helps in timely identification/analysis and removal of the bottlenecks and expedites actions. Certain environmental parameters (physical, chemical and ecological) are selected and quantitative analysis is carried out. The results of analysis are compared with the guidelines; standards and pre-project condition to investigate whether the EMP and its implementation are effective for the mitigation of impacts or not.

9.7.1 Objectives

The objective of environmental monitoring program during the construction and O&M phases will be as follows:

- Monitor the actual project impacts on physical, ecological and socio-economic receptors;
- Recommend mitigation measures for any unforeseen impact or where the impact level exceeds than the anticipated in the EIA;
- Ensure compliance with legal and community obligations including safety during construction and O&M phases;
- Ensure the safe disposal of excess construction materials, solid waste, water and wastewater and gaseous emissions;
- Appraise the adequacy of the EIA with respect to the project's predicted long-term impacts on the area's physical, ecological and socio-economic environment;
- Evaluate the effectiveness of the mitigation measures proposed in the EMP, and recommend improvements in EMP, if required; and
- Compile periodic incidents/accidents data to support analyses that will help to minimize future risks.

9.7.2 Monitoring Strategy

During the EIA process, environmental monitoring was done by an EPD approved laboratory to establish baseline conditions which was supervised by NESPAK. The main purpose to conduct the monitoring is to get the results of various parameters of water, air and noise and to compare them with monitored parameters during the construction of the power plant. EPC Contractor should compare these results with the PEQS. The monitoring during the construction phase will be carried out by EPC Contractor and afterwards HSE Section of Proponent will take the responsibility of all environmental monitoring activities.

9.7.2.1 Major Receptors

The main receptors during the design/pre-construction, construction and O&M phases are mainly:

- Water Bodies including TS-Link Canal and Haveli Main Line, Minors, Tube wells, Water outlets, the sources of drinking water and the boundaries of the proposed project;
- Agricultural areas including crops;
- Trees and other plantation in vicinity of Project Area; and
- Settlements / villages near the Project Area.

9.7.2.2 Reliability Test Run

Before the commissioning of the power plant, EPC Contractor will conduct a Reliability Test Run (RTR) of the power plant for continuous 72 hours at various loads to check the reliability of the power plant. It is recommended that all the environmental parameters such as emissions of gases from stacks, noise levels, effluent from treatment plant should be monitored at all plant loads during the test run. It should be ensured that these environmental parameters should be within the applicable standards at all loads and as per specifications.

9.7.3 Implementation of Monitoring

9.7.3.1 EPC Contractor

Physical implementation of the EMP is the sole responsibility of EPC Contractor during the construction of the project. Contractor will be responsible for in-house monitoring to ensure that the construction activities are being carried out as specified in the EMP. However, EPC Contractor's presence later in the O&M phase is dependent upon the agreement between Proponent and EPC Contractor.

9.7.3.2 EMC

EMC will be responsible to check the environmental monitoring activities (during construction phase only) being carried out by the Contractor and will perform the following activities.

- Check whether monitoring of the environmental aspects of project during construction phase is being properly carried out and to ensure that the environmental requirements of the contract and the mitigation measures proposed in the EMP are implemented;
- Undertake routine visual monitoring of construction activities, solid and liquid waste disposal, storm water drainage management, noise levels, exhaust gases etc.;
- Review the monitoring reports that would be prepared by the Contractor and make recommendations (if any); and
- To submit a monitoring report to Proponent and actions taken for rectification.

9.7.3.3 Auditing

The internal audit of the power plant during O&M phase will be carried out by the Plant Manager who will be assisted by HSE Manager. It is recommended that EMC should be involved in auditing throughout during the construction phase while Supervisory Consultant will be involved on quarterly basis. Audit will also suggest remedial measures to overcome the environmental and social problems.

9.7.4 Monitoring Parameters and Frequency

The major negative impacts of the Project activities are related to ambient air & noise, and water resources, which will directly or indirectly effect the environment and will cause health problems to the receptors residing in the surrounding of the power plant. In order to counteract these problems an environmental monitoring protocol has been proposed (Table 9.3). The proposed protocol contains the following monitoring parameters:

9.7.4.1 Physical Environment

For physical environment, following parameters will be monitored:

- Ambient air quality
- Stack emissions
- Smoke, dust
- Noise levels
- Water (Ground and surface)
- Wastewater
- Solid waste disposal

9.7.4.2 Ecological Environment

During construction activities, it will be required to check whether plantation of trees was carried out as per the Tree Plantation Plan described in EIA or not. EPC Contractor staff is advised not to do illegal cutting of existing trees in the AOI. During O&M phase, monitoring team will be required to observe the growth of new plantation.

9.7.4.3 Socio-economic Environment

Effects on the socio-economic environment during construction phase will be monitored by EMC, considering parameters like hiring of local employment, employees' wages, employees' accommodation and food related facilities, community health and safety, mobility of local women, cultural compliance due to presence of foreign EPC Contractor. Similarly, the above parameters will be monitored by HSE Section of Proponent during O&M phase. EMC during construction phase and HSE Manager during O&M phase will maintain a Social Complaint Register.

Table 9.3: Proposed Environmental Monitoring Protocol

Project Phase	Parameters	Location	Frequency	Estimated Points
(a) Air Quality				
Design /Pre-Construction	SO_2, NO_x, PM_{10}, $PM_{2.5}$, VOC, and CO and CO_2. (Ambient Air Quality)	• At the boundary of Plant Area. • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements. • At the access Road.	Once before the start of construction	10 Nos.
Construction	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO, CO_2, and VOC. (Ambient Air Quality)	• At the boundary of Plant Area. • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements. • At the access Road. • Workers Camp Area • Near batching and asphalt plant. • Excavated areas.	Monthly	10 Nos.
Operation & Maintenance	PM_{10}, $PM_{2.5}$, SO_2, NO_x, CO, HC (Ambient Air Quality).	• At the boundary of Plant Area. • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements. • At the access Road. • Maintenance Facilities	Bi-Annually	15 Nos.

Project Phase	Parameters	Location	Frequency	Estimated Points
	PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO, and HC (For Stack Emissions).	• All the stacks.	Monthly	3 Nos. (Three readings @ 8 hrs interval)
(b) Water Quality				
Design /Pre-construction (Ground Water)	Color, pH, Odor, Taste, Turbidity, TDS, TSS, Heavy Metals, Phosphate, NH_3, Arsenic, Sulphate, Sulphide, Coliforms, other Heavy Metals and Fecal Coliforms.	• Tube wells and any other drinking water sources approximately within 5 km radius where major settlements and villages exist.	Once before the start of construction	10 Nos.
Construction (Ground Water)	Color, pH, Odor, Taste, Turbidity, TDS, TSS, Heavy Metals, Phosphate, NH_3, Arsenic, Sulphate, Sulphide, Coliforms, Other Heavy Metals and Faecal Coliforms	• Tube wells and any other drinking water sources approximately within 5 km radius where major settlements and villages exist. • Camp Area (Tube well/drinking water source).	Monthly	10 Nos.
O&M (Ground Water)	Color, pH, Odor, Taste, Turbidity, TDS, TSS, Heavy Metals, Phosphate, NH_3, Arsenic, Sulphate, Sulphide,Coliforms, Other Heavy Metals and Faecal Coliforms	• Tube wells and any other drinking water sources approximately within 5 km radius where major settlements and villages exist. • Ground water / drinking water samples from main Plant building, residential colonies, offices and other working places.	Quarterly	10 Nos.

Project Phase	Parameters	Location	Frequency	Estimated Points
Pre-construction (Surface Water)	Color, pH, TSS, TDS, Turbidity, DO, BOD_5, (COD), Total Toxic Metals etc.	• TS- Link Canal • Drain near plant boundary • Haveli Main Line • Other sources like ponds exist approximately within 5 km radius	Once before the start of construction	10 Nos.
Construction (Surface Water)	Color, pH, TSS, TDS, Turbidity, DO, BOD_5, COD, Total Toxic Metals etc.	• TS- Link Canal • Drains • Haveli Main Line • Other sources like ponds exist approximately within 5 km radius	Monthly	10 Nos.
O&M (Surface Water)	Color, pH, TSS, TDS, Turbidity, DO, BOD_5, COD, Total Toxic Metals etc.	• TS- Link Canal • Drains • Haveli Main Line • Other sources like ponds exist approximately within 5 km radius	Quarterly	10 Nos.
Construction and O&M: Wastewater	PEQS 32 Parameters.	• Composite discharge outside the plant boundary. • Wastewater ponds exist approximately within 5 km radius.	Monthly	5 Nos.
(c) Noise				
Pre-Construction	Noise levels on dB(A) Scale.	• In the area of about 1-2 Km from the proposed Gas Turbines and in the Plant Boundary • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements • At the access Road • Workers Camp Area • Excavated areas	Once before the start of construction	10 Nos.

Project Phase	Parameters	Location	Frequency	Estimated Points
Construction	Noise levels on dB(A) Scale.	• In the area of about 1-2 Km from the proposed Gas Turbines and in the Plant Boundary. • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements. • At the access road. • Construction camp site, workshops and dirt tracks. • Near batching / asphalt plant	Monthly	15 Nos.
O&M	Noise levels on dB(A) Scale.	• In the area of about 1-2 Km from the proposed Gas Turbines and in the Plant Boundary. • Nearby communities where major settlements are seen around the area like Dhueen Muhammad, Basti Kora Wala, Basti Rasheed Wala, Moza Kot Dewan, Moza Qadeemi, Mahmoodabad Basti, Haveli Bahadur Shah, Malu Mor, Trimmu Barrage and other major settlements. • At the access road. • Maintenance Facilities	Quarterly	15 Nos.
(d) Soil				
Pre-Construction	Oil and grease, Total Toxic Metals, Nitrate and Phosphate.	• Camp site location. • Proposed chemical storage tank and soakage pit sites.	Once before start of construction	5 Nos.
Construction	Oil and grease, Total Toxic Metals, Nitrate and Phosphate.	• At access roads, fuel and chemical storage sites, camp site. • Within Workplace.	Once a month	5 Nos.
O&M	Oil and grease, Total	• Tank farm area, fuel and chemical storage	Bi-annually	5 Nos.

Project Phase	Parameters	Location	Frequency	Estimated Points
	Toxic Metals, Nitrate and Phosphate.	areas. • Within Workplace.		
(e) Endangered, Vulnerable and Near Threatened Species (Hog Deer, Houbara Bustard & Kachuga smithii)				
Construction	Population, Behavior, Feeding and Grazing Timings	• Around the Project Area • Near Head Trimmu, along the TS Link canal and other natural habitats	Bi-annually	5 Nos.
O&M	Population, Behavior, Feeding and Grazing, Breeding, Habitat	• Around the Project Area • Near Head Trimmu, along the TS Link canal and other natural habitats	Bi-annually	5 Nos.

9.8 WASTE MANAGEMENT FRAMEWORK

The WMF describes the framework of waste management program and provides general procedures or guidance on routine waste management issues. It has been assessed that various types of waste will be generated during the construction and O&M phases of the proposed power plant. This plan also addresses how potentially hazardous and non-hazardous waste will be managed by EPC Contractor during construction and O&M phases.

This WMF is intended to serve as;

- A primary waste management reference document;
- A basis for the EPC Contractor and Proponent to develop a detailed WMP during construction and O&M phases respectively; and,
- A compliance bench mark.

9.8.1 Relevant National Rules, Regulations and Institutions

- PEPA 1997 (Amended 2012) Section 11;
- PEQS for Wastewater Effluents;
- Hospital Waste Management Rules, 2005;
- Draft Hazardous Substances Rules, 2003;
- Draft Guideline for Solid Waste Management, 2005;
- Final Report for Domestic Solid Waste Management in Pakistan, 2002;
- Public Health Engineering Department, Jhang;
- Local Government Acts; and
- EPD-Punjab.

9.8.2 Type of Power Plant Waste

- Solid Waste;
- Wastewater; and
- Other hazardous waste.

9.8.3 Construction and O&M Phase Wastes and their Disposal Method

The waste envisaged to be generated during the construction and O&M phases of the proposed project include;

- Steel;
- Concrete;
- Black Water;
- Wood;
- Cotton;
- Paper;
- Plastics;
- Rubbish;
- Food;
- Organic Waste;
- Wastewater;
- Waste Oil;
- Medical treatment materials such as bandages, swipes etc.; and
- Other types of wastes.

The anticipated waste should be collected, handled and stored through a properly designed Waste Management System. EPC Contractor will develop details of this system for construction and O&M phases based on the general protocols as follows:

- Color coded waste buckets should be provided within the contractor's camp so that the waste should be categorized and separated accordingly;
- Some of the construction waste/waste material to be generated at the construction site may be hazardous to the environment or to personnel. It is always important to read the MSDS of the materials or products that are located on-site; they may contain warning information that indicates a potential problem. All hazardous wastes shall be clearly labeled. Scrap, Trash other waste shall be placed in designated containers;
- Divert the filtered waste to the nearest available landfill site. If the landfill site is not available then EPC Contractor needs to develop a landfill at the area mutually agreed with the Proponent, EMC, Local Community, TMA and District Government, Jhang;
- Based on the conditions of the region, organic waste should be frequently collected to avoid odor problems;
- Temporary waste storage area should be prepared, maintained and visually inspected and recorded on regular basis by the HSE Section of EPC Contractor during the construction phase;
- Wastewater generated at contractor's camp will be disposed off in the soaking pit and the pits should be away from the TS-Link canal;
- The final location of the pits will be mutually agreed on-site with EMC, HSE Section of EPC Contractor and Proponent;
- The contractor will keep accurate records that track the amount of waste generated and the disposal method used;
- A wastewater treatment plant is proposed during O&M phase. The wastewater will be treated up to secondary or tertiary level (if required); and
- Regular clean-up of scrap material, saw dust, rags, oil, paint, grease, flammable solvents and other residue of construction operations shall not only remove or reduce the fire hazard, but shall promote general safety at the same time.
- Site restoration and cleaning of all waste material after ending of contract period.

9.8.4 Transportation and Disposal Record Sample

EPC Contractor and its sub-contractors will be responsible for the lawful transportation and disposal of the collected waste in approved facilities, a sample sheet of Transportation and Disposal Records is shown below in Table 9.4:

Table 9.4: Transportation and Disposal Record

NAME OF STATION				
MODE OF TRANSPORTATION				
WASTE DISPOSAL STATION				
VEHICLE NUMBER				
Waste Type	Hazardous Yes/No	Non-Hazardous Yes/No	Quality and Quantity of waste	Disposal

SUPERVISOR SIGNATURE DATE			FACILITY SUPERVISOR SIGNATURE DATE	

9.8.5 Staff Training

For the given WMF, it has been envisaged that the waste management and handling is an important aspect during the construction and O&M phases of the project and therefore it requires training of relevant staff. Detailed training plan will be prepared by the EPC Contractor as a part of the WMF prior to the start of the construction work, which will be implemented after approval from Proponent.

9.9 EMERGENCY PREPAREDNESS AND RESPONSE FRAMEWORK

The EPRF provides an overview of the procedures to mitigate and control the impacts on community, on occupational health and safety, on the environment and on the Project in the event of emergency situations and to respond in life threatening situations usually occurring suddenly and unexpectedly during the construction and O&M phases of the proposed RLNG based power plant project. This plan applies to all the processes of emergency responses to accidental calamities that can occur in an office, construction area and living area as well as first aids and emergency responses as per actual environmental situations during construction. This plan provides a general reference and a basis for detailed sub-plans and procedures that have to be developed by EPC Contractor before the initiation of the construction of the power plant and will be approved by Proponent.

9.9.1 Objectives of EPR

- Outline the applicable standards with reference to emergency preparedness and response;
- Define the emergency preparedness and response procedures utilized during the construction phase;
- Define departments involved and their roles and responsibilities;
- Define training requirements; and,
- Signpost supplementary emergency scenario or facility plans where response procedures are detailed.

9.9.2 Types of Risks (Emergencies/Accidents) in a Power Plant

The response to each hazard in a power plant will be different. A few types of emergencies/accidents will include the following;

a) **Natural risk:** earthquake, flood, and other natural disaster
b) **Political risk:** civil strife, upheaval, riot, kidnap, and terrorist attack
c) **Construction:** fire, traffic accident, falling, hit and electric shock
d) **Public health:** dengue fever, malaria, food sanitation, high-temperature operation and insect sting
e) **Security:** injury and property loss resulted from theft, robbery, and law case

9.9.3 Action Response Planning

To minimize human suffering and financial losses, all personnel must know their responsibilities under the emergency preparedness and response plan. The plan should be used to set emergency procedures, implement and communicate the procedures and ensure that any required training has been completed. Planning for emergencies should include the following points:

- Hazard identification/assessment;
- Emergency resources;
- Communication systems;
- Administration of the plan;
- Emergency response procedure;
- Communication of the procedure; and
- Debriefing and post-traumatic stress procedure.

The Following are the main features of the plan:

- **Details of Emergency Preparedness and Response Plan:** Contact information of concerned persons for those who need more information or clarification about any aspect of the plan;
- **Identification of Assembly Points:** The assembly point is an area outside the building where evacuees should assemble and remain until the end of the emergency.
- **Emergency Exit Routes:** Emergency escape procedures and emergency escape route assignments and drills. Map of construction and operation sites with exits, access points, evacuation routes, alarms, emergency equipment, a central control or command centre, first aid kits, emergency shut-down buttons, and any other important information;
- **Medical Staff:** Provision of first aid kits on site. Rescue and medical training for those employees who are to perform them;
- **Accident and Emergency Register:** Preferred procedures for reporting accidents and other emergencies. Maintaining a log register for such cases;
- **Communication:** 24 hours mobile phone service should be available to communicate with fire department, ambulances, police and security department, plant manager, first aid department etc. Outside plant communication with district hospitals, rescue 1122 and other department should also be made practicable, and
- **Chain of Command:** An organizational chart will be hung in all noticeable locations of the construction site illustrating the chain of command with phone numbers and names.

9.9.4 Suggested Contents of EPRF

EPC Contractor should prepare the EPRF based on the guidelines provided in the above section. The suggested structure of the EPRF is listed below:

1. Purpose
2. Applicable Scope
3. Preparation Basis
4. Emergency Response System
   - 4.1 Generals
   - 4.2 Emergency Response System
   - 4.3 Responsibilities
5. Major Safety Risks
6. Precautionary Measures
   - 6.1 Training and Exercise
   - 6.2 Hazard Source Monitor
   - 6.3 Alert Action
   - 6.4 Management Measures
7. Control Measures
   - 7.1 Response
   - 7.2 Response Procedures
   - 7.3 Emergency Response
   - 7.4 Emergency Completion and Restoration

8 Emergency Response Report and Settlement
9 Supporting Measures

9.1 Communication
9.2 Emergency Team
9.3 Funding for Emergency
9.4 Provisions and Resources

10. Records

9.10 EVACUATION FRAMEWORK

The Evacuation Framework ensures that all personnel at the project site should be evacuated to a safe place after an emergency or an accident happens and to do the best to reduce the loss to fixed-assets or properties.

9.10.1 Evacuation Team and Responsibilities

EPC Contractor will be held responsible for preparing a detailed evacuation plan and giving trainings to the HSE Section who will execute it. E&RT/EMC should be involved for supervision during the implementation. However, this document provides general details of an evacuation plan and the key components that will be required for the preparation of a detailed plan before the construction of the Project.

HSE Section will issue the evacuation notice as and when required. The evacuation plan should also be displayed in and around the power plant premises and should be presented in such a way that it is easily understood by all the workers and laymen. An Evacuation Plan Implementation Team comprising trained persons from the HSE Section headed by the Plant Manager will be created. The following emergency evacuation measures that should be taken by the Team during any emergency include:

- The Plant Manager should issue evacuation notice when received from the HSE Section;
- Management for evacuation of personnel, materials, equipment and documents to ensure all personnel to be evacuated and equipment & materials to be shifted to a safe place and make sure the evacuation is carried out in order;
- To prevent traffic accidents during evacuation vehicles should be strictly restricted to enter the Project Area;
- Supply of first aid to the person injured or ambulance for those suffering from an acute accident during the evacuation or after; and
- Material supply should be inline in case of any evacuation situation like PPEs, life vest and safety rope, crane, dump truck, the location of which shall be identified in the evacuation documents.

The evacuation team will include the following sub-teams:

9.10.1.1 Security Team

- To maintain the order of evacuation and to ensure it is being carried out properly;
- To check site to ensure that all important items and persons have been carefully shifted; and,
- To carry out safety inspection and prevent traffic accident during evacuation.

9.10.1.2 Emergency Action Team

- To turn off the power supply;
- To shift the construction equipment and material (that can be moved) to a safe place; and,
- To ensure that all persons have evacuated the site under danger.

9.10.1.3 First Aid Team

- To apply simple medical procedures and help the injured or those suffering from any acute disease under emergency situations.

9.10.1.4 Equipment and Material Supply Team

- To prepare the equipment and materials necessary for emergency evacuation plan.

9.10.2 Evacuation Sequence and Emergent Evacuation Routes

The details of evacuation sequence and routes will be finalized after understanding the layout plan by the EPC Contractor. The emergency exits will be provided with enough light and regular drills will be conducted for the labor working at site. When preparing an evacuation plan, primary and secondary evacuation routes and exits will be clearly marked. To the extent possible under the conditions, it will be ensured that evacuation routes and emergency exits meet the following conditions:
- Clearly marked and well lit;
- Wide enough to accommodate the number of evacuating personnel;
- Unobstructed and clear of debris at all times; and
- Unlikely to expose evacuating personnel to additional hazards.

The drawings and Figures that show evacuation routes and exits should be posted prominently.

9.10.3 Training and Awareness

Training and awareness will be conducted to educate the employees about the types of emergencies that may occur and train them in the proper course of action. General training the employees should address the following:

- Individual roles and responsibilities;
- Threats, hazards, and protective actions;
- Notification, warning, and communications procedures;
- Means for locating family members in an emergency;
- Emergency response procedures;
- Evacuation, shelter, and accountability procedures;
- Location and use of common emergency equipment; and
- Emergency shutdown procedures.

9.10.4 Suggested Contents of Evacuation Plan

EPC Contractor will be responsible for preparing a detailed evacuation plan based on the above guidelines. A suggested content and structure of evacuation plan is given below:

- Purpose;
- Organization;
- Roles and Responsibility;
- Preparative Measures for Evacuation; and
- Emergency Action required before Evacuation.

9.11 HEALTH AND SAFETY MANAGEMENT FRAMEWORK

The Health and Safety Management Framework provides a basis for EPC Contractor to create a detailed plan to reduce and remove any harm due to construction activities to local management, construction staff and local residents' health and ensure human safety of the management and construction staff at the power plant.

9.11.1 Occupational Health and Safety Hazards

Hazards at the power plant can occur due to:

- Over-exertion;
- Slips and Fall;
- Working on Heights;
- Struck by Objects;
- Moving Machinery;
- Dust;
- Confined Spaces and Excavations; and
- Other Site Hazards etc.

9.11.2 Safety Planning

The potential safety requirements that should be taken care of during construction are as follow:

- Everything needs to be properly ordered;
- Confined space entry procedures;
- Compress gas cylinder safety;
- Leakage and spillage control;
- Compliance with safety belt requirements;
- Provision of protection rail;
- Provision of safety signs on construction site;
- Inspection at open bulk excavation area;
- Measure for operation of electrical and mechanical equipment;
- Forecasting and precautions against natural disaster;
- Providing driving/operating safety requirements;
- Installation of traffic signs on construction roads;
- Safety guard during transportation of dangerous products;
- Providing slip and fall trainings;
- Use of Personal Protective Equipment (PPE) provides additional protection to workers exposed to workplace hazards;
- Controlled measures for confined spaces; and
- Disciplinary sanctions against offenders.

9.11.3 Health Plan

The HSE Section of the EPC Contractor will be responsible for publicizing and implementing labor protection, vocational health and sanitary epidemic prevention policies and standards during construction, offering health training to the staff and applying preventive measures. Some of the clauses that should be duly taken care while preparing a Health Plan will include the following:

- Measures to avoid diseases on site;
- Establishment of the construction staff's vocational health file; and
- Establishment of the medical treatment room and configuring professional medical treatment and nursing staff.

9.11.4 Responsibility

EPC Contractor will establish HSE Section as a standing organization for health and safety management during the construction phase. The contractor and sub-contractor construction units will be responsible for establishing the management system, implementation of management measures and ensuring realization of its objectives. While during the O&M phase, Proponent and Plant Management will be held responsible for all HSE issues.

The details of organizational structure, roles and responsibilities will be determined in detailed plan to be prepared by EPC Contractor.

9.11.5 Health and Safety Documentation

EPC Contractor will be responsible for implementing the following procedure and rules during the construction phase. These include:

- Permit to work system;
- The field safety management rules;
- Labor protection management rules;
- Fire-fighting management rules;
- The field traffic management rules;
- Working order management rules for special operation;
- Emergency proposal;
- Management rules for safety meeting;
- Various safety check records and meeting minutes; and
- Training records.

9.11.6 Trainings and Awareness Programs

Training and awareness programs should be developed and implemented by the EPC Contractor. This program should be circulated among all the relevant personnel prior to construction activities. Following trainings as a minimum should be given to the Project Team during the course of the project:

- HSE awareness training; and
- Preventive Medical Treatment, Checkups and Pre-examination.

9.11.7 Suggested Contents of Health and Safety Plan

The suggested contents of Health and Safety Plan to be developed by EPC Contractor are described below:

a Purpose
b Scope of Application
c Complying Basis
d Health and Safety Objectives
e Organization and Responsibility
  - Project Manager
  - HSE Management Department of the EPC Contractor
  - EPC Contractor Medical Treatment Room of the EPC Contractor
  - Subcontractor's Project Manager
  - Subcontractor's HSE Managers
  - Occupational Health and Safety
  - Community Health and Safety
f Health Plan
  - Labour Protection
  - Sanitary Epidemic Prevention
g Safety Plan
  - Summary
  - Qualification Review
  - Safety Training
  - Construction Plans and Documents
  - Control Measures
  - Monitoring Measures
  - Management of the Key Safety Accidents

h Public Security Plan
i Local Community Health and Safety

9.12 CONSERVATION AND MANAGEMENT FRAMEWORK

The EPC Contractor and EMC of Proponent will develop strategy with the help of Wildlife Department for sustainable conservation of all the endangered, vulnerable or near threatened species, which may consist of following actions:

- Vision or objective;
- Surveys/research and data collection regarding Species;
- Management of ecologically sustainable populations;
- Effect on Wildlife species due to Project activities;
- Management/Enhancement of native biodiversity;
- Institutional responsibilities and monitoring framework; and
- Auditing by Concerned Government Agency.

9.13 SITE RESTORATION FRAMEWORK

The main areas to be considered for site restoration include the construction area, camp site area, temporary tracks, land used for vehicle and material storage, material excavation pits etc. These areas should be restored to its original condition with maximum possible effort. The restoration work comprises the removal of temporary construction works and removal of any fence installed, leveling of areas (wherever required), etc. The following procedures will be adopted for the restoration of the site:

- All temporary construction material (debris) used for the site development will be removed;
- Site for construction camps should be restored to its previous conditions as much as possible;
- All the toxic and hazardous chemicals/materials will be completely removed from the site. Efforts will be made to completely remove oils and chemical spills during the construction;
- Land will be contoured to match adjacent undisturbed areas;
- Re-construction of interrupted drainage channels and foreign lines;
- At the completion of excavation from borrowing site the contractor should ensure giving flat slopes to the edges of pits. Leveling the surface should be done as far as possible; and
- All fencing and gates will be removed and pits will be backfilled.

EPC Contractor will prepare a site restoration plan well before the completion of construction activities and submit it to Proponent through EMC for approval. Finally, after the completion of the restoration process, EMC in consultation with Proponent will inspect the site and give restoration clearance to the EPC Contractor.

9.14 CONSTRUCTION MATERIAL TRANSPORTATION

The document provides an overview to consider unique handling requirements and to evaluate alternative transportation approaches during construction of the proposed RLNG based power plant.

9.15 TRAFFIC MANAGEMENT

During the course of the construction of proposed Project, EPC Contractor will provide the signage and/or traffic control to the extent deemed necessary by the conditions and amount of traffic using or accessing the site roads.These signs will inform, control, warn, shift, or stop traffic on all site roads affected by the project's heavy traffic. The following measures will be taken during the construction phase for the effective implementation of the traffic plan:

- Pakistan national and local traffic rules and regulations, instructions manual for motor vehicle and mobile machinery operation is to be followed;
- No one will be allowed to drive motor vehicle or operate mobile machinery without a driving license;
- It should be prohibited to drive or operate vehicle in case of over fatigued or mental disease;
- Traffic speeds on unpaved roads should be limited to no more than 30 Km per hour;
- Traffic speed signs should be displayed prominently at all site entrances;
- A daily routine checkup of vehicles should be conducted no less than 5 minutes before its service;
- Use of appropriate signs, equipment, and traffic control measures that conform to the provisions in the Traffic Manual of city traffic police;
- Traffic inspection and security during transportation;
- Limit vehicular traffic designated access roads, construction laydown area worker, parking areas and the project site;
- All damaged, destroyed or modified pavement legend, traffic control devices, signing and striping associated with the proposed development should be replaced as required prior to issuance of a certificate of Occupancy; and
- Construction signs, lighting and barricading should be provided during construction as required.

9.15.1 Material Transportation Routes

These routes would be specified for construction camp and should be established in such a way that there is a minimum hindrance or disturbance to the local communities and to the flow of traffic. The routes should be marked on a map by the EPC Contractor and approved by District Traffic Police, District Government and concerned road authority.

9.15.2 Material Transportation and HSE Arrangements

Following arrangements should be made for Material Transportation and HSE:

- Transportation timings should preferably be at night, to minimize the traffic conflicts;
- Filled trucks should be covered with tarpaulin to avoid fugitive dust and should be visually inspected for proper loading, sealing and decontamination;
- Bulk solid debris should be removed from the trucks with shovels before leaving the site. Where necessary, trucks should be pressure washed before leaving the site. Pressure washing should only be used if other methods do not work;
- Vehicles should be passed an annual inspection and carry a fitness certificate;
- A summary chart representing the load and maps showing the proposed route to the disposal facility will accompany with each truckload. In the event of an accident involving the transported material, it will immediately be notified to HSE Section of Proponent, Traffic Police, Emergency Response Team; and
- The truck drivers will be strictly instructed not to play music and use horns at night time to minimize disturbances.

9.15.3 Material Transportation Documentation

A field logbook will be maintained for the documentation. This logbook will additionally serve to document observations, onsite personnel, equipment arrival and departure times, a truck exit inspection checklist and other project information.

Field logbooks will document where, when, how, and from whom any vital project information is obtained. Logbook entries will be completed and accurate enough to permit reconstruction of field activities. Logbooks will be bound with consecutively numbered pages. Each page will be dated and the time of entry will be noted. All entries will be legible, written in black ink, and signed by the individual making the entries. Language will be factual, objective, and free of personal opinions or inappropriate terminology. If an error is made, corrections will be made by crossing a line through the error and entering the correct information. Correction will be dated and initialed. No entries will be obliterated or otherwise rendered unreadable.

Entries in the field logbook will include at a minimum the following for each field work date:

- Site name and address;
- Recorder's name;
- Time of site arrival/entry at site and time of site departure;
- A Summary of any onsite meeting;
- Description of transport vehicles;
- Quantity of materials in truck (approximate percentage of full load);
- Names of waste transporters and proposed disposal facilities;
- Quantity of borrow material in truckloads; and
- Levels of safety protection.

9.16 ENVIRONMENT, HEALTH AND SAFETY AUDITS

EPC Contractor will develop all the management plans in the light of above mentioned frameworks (refer Sections 9.8-9.15) during implementation of the Project. The plans shall be approved by Supervisory Consultants and EPD-Punjab before implementation. EMC and Supervisory Consultants will conduct periodic audits to check the performance of plans' implementation. The audits will be conducted on quarterly basis during construction phase and biannually during O&M phase of the Project.

9.17 CHANGE MANAGEMENT PLAN

If some changes in the O&M phase of Project may be required to fulfill the requirement of EMP during its construction and O&M phases, a CMP manages such changes. The management of changes is discussed under two separate headings, i.e. additions to the EMP and changes to the operation and the EMP.

9.17.1 Additions to the EMP

The EMP has been developed based on the best possible information available at the time of the study. However, it is possible that during the conduct of the proposed operation, additional mitigation measures based on the findings of environmental monitoring during the construction and operation may have to be included in the EMP. In such cases following actions will be taken for changes during the construction phase:

- A meeting will be held between Proponent, EPC Contractor and the EMC representatives. During the meeting, the proposed addition to the EMP will be discussed and agreed upon by all parties;
- Based on the discussion during the meeting, a change report will be produced by EPC Contractor, which will include the additional EMP clause and the reasons for the addition;
- The report will be signed by all parties and finalized at the site office. A copy of the report will be sent to Proponent, EPC Contractor and EMC; and
- All relevant project personnel will be given information about the addition/change.

During the O&M phase, all actions would mainly be the responsibility of Plant Management.

9.17.2 Changes to the Operation and EMP

The change management system recognizes three orders of changes:

9.17.2.1 First Order

A first order change is one that leads to a significant departure from the project described or the impacts assessed and consequently require a reassessment of the environmental impacts associated with the change. Action required in this case will be that the environmental impacts of the proposed change to be reassessed by EMC/Proponent or EPC Contractor and forward to the EPD by Proponent such as:

- If change in plant configuration (i.e. deviation from 2:2:1) then ADM must be run again to assess the ground level concentrations of typical pollutants.
- Deviations from the minimum requirements for Effects Monitoring specified in the EMP; and
- Changes in the design/alignment, documentation, communication, or stakeholders' consultation program such as if the overall objective of documenting compliance with the EMP and its communication to Proponent, EMC and the EPC Contractor or interested stakeholders at regular intervals is not being met.

9.17.2.2 Second Order

A second order change is one that does not result into change in the project description or impacts that are significantly different from those in the EMP.

Action required for such changes will be that EMC will reassess the impact of the activity on the environment and specify additional mitigation measures, if required, and report the changes to Proponent.

9.17.2.3 Third Order

A third order change is one that does not result in impacts above those already assessed in the EMP, rather these may be made on-site to minimize the impact of an activity such as relocation of certain areas of construction camp to minimize effects on the environment. The only action required for such changes will be to record the change.

9.18 TRAINING PROGRAM

9.18.1 Training Strategy

Environmental training will form a part of the Environmental Management System and in order to build the capacity of key staff of EPC Contractor and Proponent to effectively implement the project specific EMP. The training will be directed towards concerned personnel forenvironmental awareness and compliance. In addition to the above training, additional trainings will be imparted to the key staff and community as and when required.

9.18.2 Objectives

The key objective of the training program will be to ensure that the requirements of the EMP are clearly understood and followed throughout the project. The trainings will help in communicating environment related restrictions specified in the EIA and EMP.

The main objectives are as follow:

- To train the project staff on how to interact and involve the concerned communities;
- To train the managers for the protection of the health and safety of the workers/labor;
- To define the roles and responsibilities of the concerned stakeholders according to the EMP; and
- To train the concerned communities for protection of water bodies such as TS-Link Canal and their participation and cooperation in the proposed project.

9.18.3 Roles and Responsibilities

EMC will primarily be responsible for providing environmental training to concerned project personnel on potential environmental issues of the project. EPC Contractor will be responsible to arrange trainings and ensure the presence of targeted staff. EMC, along with relevant District departments, will prepare a project specific training program for this purpose. EPC Contractor will be required to provide induction training/briefing to all their staff before the start of any activity within the Project Area. It is proposed that before the commissioning of plant, HSE Manager of Proponent having HSE certification should also get a foreign training course to be arranged by EPC Contractor.

9.18.4 Training Aspects

9.18.4.1 Training Log

- Topic;
- Date, time and location;
- Trainer; and
- Participants.

9.18.4.2 Training Needs Assessment

In addition to the trainings identified in the training logs, additional trainings will be provided during the project activity. The criteria to assess the need of training will be based on the following:

- When a specified percentage of staff is newly inducted in the project;
- When any non-compliance is repeatedly reported refresher training will be provided regarding that issue;
- When any incident/accident of minor or major nature occurs;
- Arrival of new sub-contractor; and
- Start of any new process/activity.

9.19 COMMUNICATION AND DOCUMENTATION

9.19.1 Kick-Off Meeting

One kick off meeting will take place between Proponent/EMC and EPC Contractor before the start of construction. The purpose of this kick off meeting will be to demonstrate the regulatory and monitoring requirements prior to the start of the individual project activities to be met and to have an understanding of the proposed activity of monitoring.

9.19.2 Meetings and Reports

Monthly meetings will be held during the construction phase at construction camp office. The purpose of these meetings will be to discuss the activities of the last months, non-compliances as pointed out by EMC and their remedial measures. The meeting will be chaired by the representative nominated by CEO of Proponent. The meeting will be recorded in the form of a Monthly Environmental Report (MER) to be prepared by EPC Contractor and reviewed by EMC and will be submitted to Proponent for final approval. The report will include but not limited to:

- Summary of project activities during last month;
- EMC and EPC Contractor environmental personnel present onsite;
- Summary of monitoring activities; and
- Non-compliances observed and mitigation measures taken or required.

9.19.3 Social Complaints Register

EMC will maintain a register of complaints received from local communities, labors/employees and measures taken to mitigate these concerns. All complaints will be resolved by HSE Manager; however, if any dispute arises the case will be forwarded to the CEO by the HSE Manager.

9.19.4 Change Record Register

All changes to the EMP or the project will be handled through the Change Management referred earlier. During the construction phase, EMC will be responsible to maintain the change record register while during O&M phase, HSE Section of Proponent working at the power plant will maintain this register. This register will include details such as date, type of change, person/s responsible for change and action taken to get approval for change from competent authority.

9.19.5 Photographic Record and Data Base

EPC Contractor and EMC will maintain a photographic record of all areas to be used during the implementation of the project. As a minimum the photographic record will include the photographs of the sites, access track, camp sites, offices, canteen areas, clinical facility, any accident/incident happening and monitoring of different categories, data base of persons involved in monitoring, compliance and effects, HSE database and compliance and non-compliance record according to HSE Plan.

9.20 TREE PLANTATION PLAN

In order to rectify the loss of habitat due to cutting/removal of trees extensive plantation shall be carried out along the boundary of the power plant, along the paths and roads, connecting various units and in open spaces, within the power plant area.

One row of large size trees shall be raised within power plant area, at a distance of 2 meters, from the outer boundary of the power plant, while 2nd row of medium size ornamental trees is to be grown, keeping the distance between two rows as 2 meters. Plant to plant distance in a row is also to be kept as 2 meters.

As per standing instructions of the GoP, 10 (ten) number of plants are to be raised in lieu of each tree removed for any developmental activity as mitigation measure/replenishment plan. Since total number of trees to be removed / affected in the Project Area is 449. Therefore minimum number of plants, which shall be raised within or outside the plant area is 4500.

Total length of the outer boundary of power plant is nearly 3630 meters, so number of plants to be raised in two rows along the boundary comes to 3630. The remaining 870 plants and ornamental shrubs shall be raised, along the roads and paths, connecting various units of the plant and in the open spaces within the plant in the form of grooves of flowery shrubs.

Trees recommended for raising along the boundary of the power plant in outer row are large size trees and are given in Table 9.5:

Table 9.5: Large Trees to be planted along Outer Row

Sr. No.	Local Name	Common Name (English)	*Scientific Name*
1.	Neem	Indian lilac	*Azadirachtaindica*
2.	Arjan	Arjuna	*Terminaliaarjuna*
3	Pipal	Bodhi tree /Peepal	*Ficus religiosa*
4.	Simal	Red silk-cotton	*Bombar cilba*
5.	Lasura	Assyrian plum/ Lasura	*Cordia myra*
6.	Mulberry	Mulberry	*Morus alba*
7.	Gule-Nishtar	Indian Coral tree and sunshine tree	*Erythorinasuberosa*

Ornamental Trees proposed for plantation in the inner row (medium sized ornamental trees) as given in the Table 9.6.

Table 9.6: Medium Sized Trees to be Planted along Inner Row

Sr. No.	Local Name	Common Name (English)	Scientific Name
1.	Sirris	Lebbek tree	*Albizzialebbek*
2.	Amaltas	Golden rain tree	*Cassia fistula*
3.	GulMohar	Flamboyant	*Delonixregia*
4.	Jacarnda	Jacarnda	*Jacaranda mimosefolia*
5.	Robinia	Robinia	*Robinia pseudo acacia*
6.	Ailanthus	Ailanthus	*Ailanthus altissima*
7.	Silver Oak	Silver Oak	*Grevillearobusta*
8.	Bottle Brush	Bottle Brush	*Callistemon viminalis*
9.	Sukhchain	M. pinnata	*Pongamiaglabra*
10.	Kachnar	Orchid tree /Kachnar	*Bauhinia variegata*

In addition to these trees, following ornamental Shrubs can also be planted, along the inner roads and paths within the power plant area and in the form of grooves in open spaces within the power plant.

- Golden Duranta;
- Setcreasea Purpurea;
- Bougainvillea;
- Bougainvillea Variegated species;
- Tecoma Stans;
- Jasminum Humile;
- Cassia Glauca;
- Hibiscus;
- Jastropha; and
- Murraya Exotica.

9.21 ENVIRONMENTAL COST

9.21.1 Environmental Monitoring Cost

An estimated cost for instrumentation monitoring (including security, transportation, preservation collection cost) for all the three phases of the Project is given in Table 9.7. For details such as sampling parameters, location, frequency and estimated number of points please refer to Table 9.3.

Table 9.7: Environmental Monitoring Cost

Project Phase	Environmental Monitoring Cost (Rs.)
Pre-Construction	1.3 million
Construction (Annual)	23 million
Operation and Maintenance (annually)	6.6 million

9.20.2 Cost of Establishment of EMC

Initial cost for establishment of EMC has been calculated. The details are presented in Table 9.8 below.

Table 9.8: Cost of Establishment of EMC

Project Phase	Costs (Rs.)
Setting up EMC during Construction (24 months)	Rs. 29.2 million
Site visits by HSE Section persons Operation (annual)	Rs. 15,.2 million

Note: The above cost for setting up EMC during construction includes the salary cost, purchase of equipment's and vehicles, office rent and furniture purchase and visits to Jhang. During O&M phase, cost included the salary, office and other expenses. Detail of these costs is attached as Annex-8.

9.21.2 Plantation Cost

As discussed earlier, minimum number of trees to be raised will be 10 times the number to be removed, thus 4500 number of plants will be raised in lieu of approximately 449 trees which are liable to be effected during construction phase of the project. Out of these 4500 plants, 3630 plants shall be raised along the boundary of the power plant in two rows, while the remaining 870 plants are to be grown, along the paths and roads, within the plant area and in the open spaces. The cost of raising one avenue mile i.e. 500 plants, has been estimated as Rs. 328,000/- including price of plants, earthwork, procurement of manures, continued supply of water to young plants throughout the year and its maintenance five (5) years.

The break-up of planting and maintenance cost for a period of five years is given in (Tables 9.9 to 9.14) keeping the labor rate as Rs. 500 per day per man (MD):

Table 9.9: Estimated Cost of Plantation of One Acre/Av. Mile (500 Plants) for First Year

Sr. No.	Particulars of Work	Quantity	Rate (Rupees)	Amount (Rs.)
1	Layout	1 km	2 MD/Av.km	1000
2	Digging of Pits 2.5 ft. each 2.5x500 =1500 cft.	1500 cft.	10 MD/Av.km	5000
3	Cost of Plants including	500 No.	Rs.20/- plant	10,000
4	Cost of planting of plants	500 No.	Rs. 10/- plant	5,000
5	Carriage of plants from private nursery to site including loading/unloading	500 No.	Rs. 2/- plant	1000
6	Cost of Manure and Bhall (silt) including carriage	500 plants		5,000
7	H/watering 50 times 500x50 with water bowser, one driver and one coolie	25,000 no.	5 MD/per 1000	62,500
8	Weeding twice 500x2	1000 no.	5 MD	2,500
9	Reopening of Pits twice (500x2)/cft/pit	1000 cft.	5 MD	2,500
10	Unforeseen			500
Sub-total				95,000

Table 9.10: Estimated Cost of Plantation of One Acre (500 Plants) for 2nd Year

Sr. No.	Particulars of Work	Quantity	Rate (Rupees)	Amount (Rs.)
1	Cost of Plants 20% Restocking	100 No.	Rs.20/- plant	2000
2	Cost of planting	100 No.	Rs. 10/- plant	1000
3	Carriage of plants	100 No.	Rs. 2/- plant	200
4	H/watering 50 times with water bowser, one driver and one coolie	25,000 no.	5 MD/per %	62500
5	Reopening of Pits twice (500x2)	1000 cft.	5 MD	2,500
6	Weeding twice 500x2	1000 no.	5 MD	2,500
7	Unforeseen			300
Sub-total				71,000

Table 9.11: Estimated Cost of Restocking and Maintenance for 3rd Year

Sr. No.	Particulars of Work	Quantity	Rate (Rupees)	Amount (Rs.)
1	Cost of Plants 20% Restocking 100 No.	100 No.	Rs.20/- plant	2000
2	Cost of planting	100 No.	Rs. 10/- plant	1000
3	Carriage of plants	100 No.	Rs. 2/- plant	200
4	H/watering 40 times	20,000 no.	5 MD/1000	50,000
5	Reopening of Pits twice (500x2)	1000	5 MD	2,500
6	Unforeseen			300
Sub-total				56,000

Table 9.12: Estimated Cost of Restocking and Maintenance for 4th Year

Sr. No.	Particulars of Work	Quantity	Rate (Rupees)	Amount (Rs.)
1	H/watering 40 times	20,000 no.	5 MD/1000	50
2	Pruning and cleaning of plants	500 no.	5 MD	2,500
3	Unforeseen			500
Sub-total				53,000

Table 9.13: Estimated Cost of Maintenance for 5th Year

Sr. No.	Particulars of Work	Quantity	Rate (Rupees)	Amount (Rs.)
1	H/watering 40 times	20,000 no.	5 MD/1000	50
2	Pruning and cleaning of plants	500 no.	5 MD	2,500
3	Unforeseen			500
Sub-total				**53000**
Grand Total of Subtotal for Tables (8.9-8.13)				**328,000**

Table 9.14: Total Plantation Cost

Sr. No.	Item	Cost (Rs.)
1.	Total cost for raising 500 plants (1 Km of plantation) and Maintenance for 5 years (1 to 5)	328,000
2.	Total cost for raising, 3630 plants including maintenance for 5 years along the boundary of power plant	2,381,280
3.	Total cost for raising and maintenance of 870 plants for 5 years along the access road	570,720
Total Plantation Cost		**2,952,000 or 2.95 million**

Cost of raising one plant with four years maintenance: Rs. 656.

9.21.3 Summary of Environmental Costs

Table 9.15 below presents a summary of all the environmental costs.

Table 9.15: Summary of Environmental Costs

Project Phase	Environmental Monitoring Cost (Rs.)
Pre-Construction	1.3 million
Construction (annually)	23 million
Operation and Maintenance (annually)	6.6 million
Cost of Tree Plantation	2.95 million
Setting up EMC during Construction (26 months)	29.2 million
Site visits by HSE Section Operation (annual)	15.2 million

CHAPTER–10: CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusion drawn and provides recommendations based on these conclusions.

10.1 CONCLUSION

The study conducted for the RLNG Based Thermal power plant near Haveli Bahadur Shah, District Jhang has the following set of major conclusions:

1. The proposed Project is essentially a 1,100-1,400 MW (Gross) RLNG Based CCPP. The Power Plant will operate on imported RLNG to be transported from Karachi through pipelines. However, HSD will be used as back-up fuel. The site is located on the left bank of the TS-Link Canal in a village "Kot Dewan" which is about 25 km from Jhang City. The Project site is accessible through Bhakkar-Jhang Road which passes approximately 0.9 km from the project site; however, main railway line is approximately 6.6 km from the proposed site. The evacuation of power is proposed by means of 500 kV existing RLNG HBS transmission line which is connected to the existing Muzaffargarh – Gatti 500 kV S/C transmission line to dispatch the electricity to National Grid;

2. This EIA report has been prepared in accordance with the requirements of the Punjab Environmental Protection Act, 1997 (Amended 2012); Pak-EPA Regulations, 2000 for review of IEE and EIA; Pakistan EIA procedures; and Sectoral guidelines for environmental reports: Major Thermal Power Stations, 1997;

3. The site alternatives were analyzed to assess the better approach, minimum acquisition of private land and evacuation of power from project site. Other alternatives discussed in EIA report include the technological, wastewater disposal, power generation options;

4. Provincial, district and local (villages) level stakeholder consultations and consultations with existing RLNG HBS labor/staff were carried out in order to record the concerns and observations of the stakeholders, especially the affected people;

5. The major positive impacts of the Project include the following:

- ***Electricity Generation:*** Given that Pakistan currently faces a shortfall of about 5,000 to 7,000 MW per day, the generation capacity of this power plant will help towards meeting a portion of the shortfall. The generation of electricity will not only help the industrial sector and its outputs but will also help to raise the standard of living as it will reduce load shedding;
- ***Employment Opportunities:*** During construction and O&M phases of the project, the requirement of engineers, workers, laborers, technicians, para-professionals etc. will increase. It is estimated that about 3,000 laborers and staff during the construction phase and about 200 personnel during the O&M phase will be employed;
- ***Increase in Businesses:*** With the influx of laborers for the proposed Project, there will be more opportunities for small scale business;
- ***Increased Accessibility:*** Construction of the access road for the construction of Power Plant and up gradation of existing tracks to the Project Area will result in improved accessibility;
- ***Increase in Land Value:*** Construction of new RLNG CCPP Project is expected to increase the land value, due to the increased accessibility, especially in villages where little or no road infrastructure is present. Land owners will have an opportunity to sell their land at increased prices and start new businesses; and

- ***Socio-economic Uplift:*** The project will result in the general economic and social uplift of the people particularly in nearby area of the proposed project and will provide basic infrastructure and raw material for other projects in the region. The benefit of decrease in electricity load shedding will facilitate other services, such as health facilities, schools, water supply, and expansion of the industrial activities etc., which are dependent on electricity, resulting in the improvement of the socio-economic conditions of the locals.

6. The negative impacts of the project and their mitigation measures are mentioned below:

- The project will be constructed over a land area of 649,804 square meters (160.57 acres) which includes the both permanent as well as temporary area required for the proposed project. The access road will have a total area of 36,543 square meters (9.03 acres). More than 50% of the land acquired for this project is government owned (Auqaf and Irrigation Departments) land which will be acquired as per the policy of GoPb. However, remaining private land will acquire the land as per provision of LAA 1894. The implementation of the Project will affect forty (40) built up areas, about twenty (20) tube wells and hand pumps that will mainly come under Project Area;

- The loss of private built up area and infrastructure should be compensated according to the provisions of the LAA 1894. Proper measures need to be taken to safeguard the livelihoods of the affectees apart from the compensation;

- Efforts should be made to draw water from deep aquifer which does not influence the top unconfined aquifer which is being exploited by the local community. Recommendations of hydrogeological study and ERS should be considered to overcome this issue;

- Impact of soil erosion as a result of improper runoff from construction activities should be mitigated by good engineering practices such as mulching and compaction;

- Contamination of soil due to the improper handling of toxic and fuel based chemical materials should be mitigated by appropriate storing of the chemicals in drums and necessary precautions taken by the contractor's staff;

- Loss of vegetation cover due to removal of trees, shrubs, and fruit plants etc. should be mitigated by planting additional trees in appropriate and suitable areas around the proposed power plant as per the Tree Plantation Plan which will also act as a noise barrier;

- Aesthetic value of the area should be improved by placing vegetative barriers around the proposed power plant site and developing green areas within the Project site as well as in its vicinity;

- Degraded quality of irrigation water and surface water due to contamination (if any) should be mitigated by controlling the chemical and oil spills directly into open drains and by preventing untreated wastewater and sewage to flow towards the irrigation channels. The wastewater and sewerage flow should be channeled towards septic tanks and soakage pits to reduce the potential of this impact;

- Impacts on ambient air and noise quality due to gaseous and fugitive dust emissions and movement of vehicles, vibration by machinery/equipment etc. should be mitigated by timely tuning of the vehicles, sprinkling water on the access roads/tracks to prevent dust from rising, and by adjusting timing of construction activities so that there is no excessive noise during the night;

- Impacts on downstream water users due to the discharge of untreated wastewater should be mitigated by the treatment of that wastewater to meet the relevant PEQS limits;

- Increase in solid waste generation should be mitigated by adopting a comprehensive solid waste management plan for the collection, storage, transportation and final disposal of all types of wastes. This plan should be prepared by EPC Contractor based on the framework provided in the EMP;

- The impact on species like Turtle (Near Threatened), Hog Deer (Endangered) and Houbara Bustard (Vulnerable) will be minimized and managed by adopting specific mitigation and preparing a conservation and management plan by EPC Contractor based on the framework provided in the EMP;

- Impacts on Socio-economic aspects should be mitigated by ensuring that cultural sensitivity should be understood by the contractor and good relationships are maintained between the locals and the power plant staff;

- Air quality can be impacted from SO_2, NO_x, PM_{10} and $PM_{2.5}$ emissions which are typical air pollutants. The cumulative impact on air quality due to simultaneous operations of Existing RLNG HBS and new/proposed RLNG Jhang is expected. Both the plants will utilize RLNG as main and HSD as a backup fuel. The impact on air quality is not expected to be significant if both plants are run on RLNG (main fuel) which is a clean fuel with less air emissions. The stacks emission estimates provided by the designers of both RLNG Power Plants run on RLNG[14] or HSD are within the thresholds of PEQS. The Air Dispersion Modeling (ADM) software was run for predicting cumulative ground level concentrations of the pollutants (SO_2, NO_x, PM_{10} and $PM_{2.5}$) from operation of both RLNG plants, to check the compliance with the standards and assess the impacts on receptors. The baseline values of NO_x, SO_2, PM_{10} and $PM_{2.5}$ were measured for four stacks (two stacks at HBS and two at new RLNG CCPP) at 24 hours and annual averaging periods;

- The maximum cumulative ground level concentrations as determined by ADM are within the limits of PEQS if both plants are run on RLNG (single cycle or combined cycle) and HSD (single cycle only). However, contribution of SO_2 from both plants (if run on HSD and combined cycle) at 24 hours averaging would be 131.0 $\mu g/m^3$ which exceeds 24 hours average SO_2 threshold of 120 $\mu g/m^3$ as specified by PEQS. In that scenario, close monitoring should be done and if emissions are beyond limits, scrubbers will be required. For annual averaging, the results of SO_2, NO_x, and PM_{10} are within thresholds of PEQS;

- Cooling water for main cooling cycle will be taken from TS-Link irrigation canal next to project site. During a yearly period of canal closure (6-8 weeks) the cooling demands of the power plant will be met using cooling towers. During this period, water will be taken from underground wells that have to be developed as part of the EPC Contract. The impact of the extraction of the water on the aquifer can be determined as soon as more details of the wells are known. Since the wells will be used only for up to 8 weeks per year, a permanent impact is not expected. The water requirement for plant will be about 22 Cumecs (770 cusecs) for the cooling purpose. Recommendations of hydrogeological study and ERS should be considered to ascertain the impact on groundwater sources;

- The plant operation will generate industrial as well as sanitary wastewater. It is estimated that about a maximum of 2 m^3/h of sanitary, 4 m^3/h of industrial wastewater will be generated along with cooling tower blow down (expected concentration factor: 4 - 5) in canal closure period. The release of hot water from both plants will have cumulative impact on canal water temperature rise. For this, canal water thermal modeling is recommended. Wastewater treatment systems will be designed and implemented to treat the wastewater and ensure compliance with the PEQS;

[14] *Data provided by the designer to the best of their knowledge. NO_x values have been based on limits, which can be achieved and guaranteed, while the PM values are taken from similar projects on diesel fuel with a typical split between PM2.5 and PM10.*

- Impact on surface water bodies due to improper handling and disposal of many chemicals being used at the power plant should be mitigated by using leakage proof drums and storage containers and ensuring that the staff should be trained enough to respond against the accidental spills;

- Impact on Human health due to improper disposal of sanitary waste from residential colony and solid waste should be mitigated by proper solid waste management plan to deal with collection and disposal of waste; and

- Impacts on Socio-economic aspects such as gender issues due to outside labor at the power plant, impacts of noise and air pollutants on local population etc. should be mitigated by continuous monitoring to ensure that emissions are not exceeding PEQS limits and the contractor should make an effort to follow the local norms and be culturally sensitive to the local population.

7. An Environmental Management Plan (EMP) has been developed as part of the report which provides a detailed mitigation matrix that covers impacts, mitigation measures, roles and responsibilities and timings to avoid, minimize or mitigate the adverse impacts and justify the friendly nature of the power plant Project;

8. Environmental Monitoring Plan for both the phases (construction and O&M) has also been separately given in the EMP. During the construction phase, EPC Contractor shall undertake HAZOP, or similar for the entire Plant. EPC Contractor shall prepare comprehensive plans based on the frameworks, guidelines and structure provided in EMP. During the construction phase, the monitoring plan shall be implemented by the Contractor and EMC. For the first year during operation phase EPC Contractor will be responsible for monitoring activities after which Proponent will be entirely responsible for implementation of monitoring and execution of EMP; and

9. The institutional capacity of the Proponent needs to be strengthened with respect to the environmental and social aspects for the effective implementation of EMP.

10.2 RECOMMENDATIONS

Following are the set of major recommendations and next steps:

1. Proponent should initiate the establishment of EMC within its existing institutional structure on priority basis;

2. EMP should be made a part of all bidding/tender documents;

3. EPC Contractor should be bound to completely implement relevant mitigation measures set out in the EMP to ensure environmental sustainability. Also the cost related to these mitigation measures has to be borne by the EPC Contractor;

4. Ground water extraction during operation phase to meet CCPP water requirements should be planned as per hydrogeological surveys so that the availability of groundwater in in existing tubewells in the vicinity of proposed project is not disturbed;

5. Modeling study of canal water temperature should be done to assess the cumulative impacts from both power plants on temperature and careful selection of water intake and outfall points;

6. PAPs must be compensated for their lost land, property or any other asset as per existing market rates. This step will reduce any future social impacts or political strains due to power plant Project implementation. Livelihood assistance should also be provided to PAPs;

7. The Proponent should do more consultation with the primary stakeholders to take them into confidence and to satisfy their all concerns regarding project;

8. Proponent and EPC contractor should also allocate special funds for social welfare of PAPs and nearby villages. The provisions of this cost should be included in bidding document;

9. Some Confidence Building Measures (CBMs) in the form of general improvement of the social infrastructure in the villages should be planned and implemented by the Proponent to lessen the loss of the local community and to build trust and confidence;

10. The loss of agriculture due to conversion of agriculture land in to built-up area will be compensated (apart from the compensation as per LAA, 1894) by adopting and promoting modern and scientific irrigation techniques and agricultural practices to be promoted in consultation with the agriculture and irrigation departments like improved variety of seeds, fertilizers and machinery on subsidized rates that will increase the yield and soil fertility;

11. EPC Contractor should prepare evacuation plan; emergency preparedness and response plan; waste management plan, HSE plan, borrow and quarry management plan, site restoration plan and other plans mentioned in the EMP. These plans should be communicated with the Supervisory Consultant and Proponent for their review and approval;

12. The temperature of cooling water discharge into canal should not be more than 3 degree centigrade;

13. Efforts should be made to draw water from deep aquifers which do not influence the top unconfined aquifer. These deep wells will be used for the supply of makeup water during the Canal closure period. Recommendations of Hydrogeological and ERS studies should be followed;

14. In case both plants run on back-up fuel (HSD) and combined cycle, it must be ensured that cumulative impact on ambient air quality is addressed by installation of proper equipment such as scrubbers, if required;

15. The long term baseline monitoring for $PM_{2.5}$ spreading atleast over a period of one year before commissioning of power plant or start of power plant construction should be done to determine the average annual concentration to assess compliance during plant operation; and

16. If there are any changes in Plant layout, or any other changes in Project description then change should be carried out through CMP included in EMP of this EIA report.