siddiqsons ENERGY LIMITED

27th Floor, Ocean Tower, G-3, Block-9, Scheme#5, Main Clifton Road, Karachi, Pakistan Phone: + 92 21 35166571-5

07.06.2017

Registrar
National Electric Power Regulatory Authority
NEPRA Tower, Ataturk Avenue (East), Sector G-5/1
Islamabad, Pakistan.

SUBJECT: **APPLICATION FOR GENERATION LICENCE**

I, Muhammad Abdul Vakil, Chief Operating Officer, being the duly authorized representative of Siddiqsons Energy Limited (the "**Company**") by virtue of a board resolution dated 23.05.2017, hereby apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of generation licence for the Company's 330 MW Thar mine mouth coal fired power plant at Thar Block II, District Tharparkar, Province of Sindh, Pakistan 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 provision of National Electric Power Regulatory Authority (NEPRA) Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and corrected to the best of my knowledge and belief.

A pay order in the sum of Rupees 750,960 (PKR Seven hundred and fifty thousand nine hundred and sixty), being the non-refundable application processing fee calculated in accordance with Schedule-II to National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Muhammad Abdul Vakil
Chief Operating Officer
Siddiqsons Energy Limited

Siddiqsons Energy Limited Karachi

Siddiqsons Energy Limited

Application for Grant of Generation License

Siddiqsons Energy Limited ("**SEL**" or the "**Applicant**" or the "**Company**") is a private limited company incorporated under the Companies Ordinance, 1984, to act as a special purpose vehicle (the "**SPV**").

Pursuant to the original Letter of Support (the "**Original LOS**") issued to the Company by the Private Power & Infrastructure Board (the "**PPIB**"), the Company was granted a Generation License No. IGSPL/65/2015 dated 14.09.2015 (the "**Generation License**") by NEPRA for the development of a 350 MW Imported Coal based Thermal Generation Facility located at Plot No. 12, Eastern Industrial Zone at Port Qasim, Karachi (the "**Original Project**") pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of 1997). Thereafter, SEL opted for the upfront tariff for imported coal vide its tariff determination No. NEPRA/TRF-313/SEL-2015/10440-10442 dated 13.07.2015, which is also placed at the NEPRA website

The Original Project was initially being developed on imported coal and was on-track to achieve its contemplated targets, having signed an EPC contract with Hyundai Electronics Industries Co Ltd, to whom a Limited Notice to Proceed had been issued for the works. On the basis of the aforesaid parameters, the Company had reasonably finalized its Implementation Agreement with the Government of Pakistan (the "**GOP**") and the Power Purchase Agreement with the Central Power Purchasing Agency (Guarantee) Limited (the "**CPPA**") and was actively pursuing the achievement of its financial closing on the basis of local financing within the Original LOS timelines and had obtained a comfort letter from the lead arranger, United Bank Limited (UBL).

At this junction, the GOP, through an unpublished policy directive, imposed a moratorium on the development of power projects on local financing and required the Company to arrange financing from foreign financial institutions. After the Company had successfully switched to foreign financing sources and made the necessary arrangements in order to meet these stringent requirements, the GOP, through PPIB letter # 1(103) PPIR-6011/16/PRJ/0-46889 dated 27.05.2016, required the Company to change the primary fuel of the Company from imported coal to local coal.

Accordingly, the Company agreed and decided to change the primary fuel of the project from imported coal to local coal and subsequently, PPIB, vide letter No. 1(103) PPIB-6016/16/PRJ/0-47561 dated 06.10.2016, amended the Original LOS ("**LOS Amendment-1**") to reflect change of fuel from imported to local coal and extended the financial closing date till 31.08.2017. The Company, thereafter, procured a fresh tariff approval on the basis of local coal from NEPRA vide determination No. NEPRA/TRF-371/SEL-2016/16212-16214 dated 01.12.2016 (the "**Local Coal Tariff**"), which is also available at the following NEPRA website link.

The Applicant also applied for a Licensee Proposed Modification (LPM) in its Generation License on 27.10.2016 under Regulation 10(2) of NEPRA (Application & Modification Procedure) Regulations, 1999 to reflect a change in fuel of the generation facility from Imported Coal to Local Coal and change of Commercial Operations Date of the project from 31.12.2018 to 30.06.2020 (the "**LPM**"). The LPM remained pending with NEPRA for months.

However, the transportation study undertaken pursuant to the requirements of the Local Coal Tariff revealed that transporting 1 Million tons of coal each year from Thar to Port Qasim is not only impractical and wasteful, but also hazardous. In light of this information, the Company decided to relocate the plant from Port Qasim to Thar Block II, in order to comply with the requirement of the GOP to keep transportation costs as low as possible, and obtained a firm commitment for the allocation of coal from the Sindh Engro Coal Mining Company vide letter No. SECMC-1492-1/2017 dated 11.01.2017. Moreover, the change in location from Port Qasim to Thar Block II affected the capacity of power plant, thereby reducing it from 350 MW to 330 MW.

Resultantly, PPIB, vide letter No. 1(103) PPIB-6016/17/PRJ/O- 48193 dated 13.01.2017 amended the LOS Amendment-1 to reflect change in location and capacity and valid up t0 31.08.2017 ("**LOS Amendment-2**").

Pursuant to the present LOS Amendment-2, the Company is now required to develop a 330 MW Thar mine-mouth coal power project at Thar Block II (the "**Revised Project**") as an Independent Power Producer ("**IPP**"), under the GOP's applicable power policy.

Due to the aforementioned reasons, the Company had been forced to make modifications to the Original Project. Yet, SEL continued with dedication the development of the Project and with the relevant and necessary documents in hand, including LOS Amendment-2, filed a fresh application in order to opt for the Upfront Tariff for Thar coal (the "**Thar Upfront Petition**"). However, the Thar Upfront Petition was unreasonably rejected by NEPRA vide letter dated 31.01.2017, claiming that "*...SEL has not submitted a fresh application for generation license, rather (earlier) a licensee proposed modification application is pending which relates only to a change of fuel from imported coal to local coal...the Authority observed that SEL has to file a fresh application for grant of generation license along with the aforementioned supporting documents.*"

The Company filed a Review Petition dated 20.02.2017 against NEPRA's decision to reject the Thar Upfront Petition (the "**Review Petition**"). It is pertinent to mention here that the Company's earlier tariff determination No. NEPRA/TRF-317/SEL-2016/16212-16214 dated 01.12.2016 was for Local Coal at Port Qasim.

NEPRA held a hearing on 12.04.2017 for the Review Petition filed by the Company, wherein SEL detailed the dynamics of the project and that the modifications to the Original Project had been executed through no fault of its own. SEL also took the stance that a Licensee Proposed Modification in its Generation License had been filed with the Authority in order to make it concurrent with the generation facility but was pending adjudication before NEPRA at the time of hearing for Review Petition. The Authority, vide its Determination dated 09.05.2017, stated that the Company did not fulfill the mandatory requirement of Regulation 4(3)(viii) of the NEPRA Up-front Tariff (Approval & Procedure) Regulations, 2011, which requires the applicant for grant of generation license to submit either an application for grant of generation license or a valid generation license along with the application for acceptance of upfront tariff. The Authority was of the considered opinion that the generation license and upfront tariff had to be for the same generation facility and failing the same, the Thar Upfront Petition was liable to be rejected. Furthermore, the Authority stated that the Company had not filed a Licensee Proposed Modification before the cessation date of the Thar Coal Upfront Traiff i.e. 19.01.2017. Thereby, the Review Petition of SEL was dismissed.

Simultaneously to the above, the Company also filed an Addendum to the LPM dated 20.02.2017 to reflect a change in capacity, location and technology of the project (the "**Addendum to LPM**"). The Authority, vide its Determination dated 23.05.2017, rejected the LPM application of the Company, stating that the fundamentals of the project had changed which required a new feasibility study, grid interconnection study, environmental study, allocation of land etc. The Authority directed SEL to file a fresh application for grant of generation license for its generation facility at Thar Block II, pursuant to which this Application for grant of generation license is being submitted for the consideration of the Authority.

We request the Authority to kindly consider the dynamics of the Project and pay due regard to the fact that SEL has not failed in its compliance with the law and regulatory approvals and has been actively pursuing the development of the Project, but has only suffered undue delays in reaching financial closing as a result of change of policy and subsequent directions of the Government of Pakistan. The shift from Imported Coal to Local Coal was a major concession granted by the GOP to SEL. The Company has invested over PKR two billion in developing the project and aims to bridge the gap between the demand and supply of electricity in the country and thereby, contribute significantly to economic growth and employment.

The Authority would appreciate that Siddiqsons Group, established in 1959, stands high amongst most seasoned and well-reputed industrial groups in Pakistan. Siddiqsons Group holds a vision to bring success, eminence and prosperity in Pakistan and with the implementation of its power project at Thar Block II, the Company will be able to achieve this aim.

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Annexure A
Board Resolution

siddiqsons ENERGY LIMITED
27th Floor, Ocean Tower, G-3, Block-9, Scheme#5, Main Clifton Road, Karachi, Pakistan Phone: + 92 21 35166571-5

EXTRACT OF THE RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF SIDDIQSONS ENERGY LIMITED (THE COMPANY)

I hereby certify that the following resolution was passed by the Board of Directors of the Company in their meeting held on 23rd May, 2017

Quote

"**RESOLVED THAT** the Company be and is hereby authorized to file the application for grant of Generation License with National Electric Power Regulatory Authority ("NEPRA") in relation to the 330 MW Thar mine mouth coal fired power plant to be located at Thar Block II, Tharparkar District, Sindh (the "Project").

RESOLVED THAT Mr. Muhammad Abdul Vakil, Chief Operating Officer be and is hereby empowered and authorized on behalf of the Company to review, sign, execute and submit the Generation License Application including all documents required by NEPRA, pay the necessary fees and appear before the NEPRA as needed, and do all acts necessary for completion and processing of the Generation License Application.

RESOLVED FURTHER THAT Mr. Muhammad Abdul Vakil be and is hereby authorized do all such acts, matters and things as may be necessary for carrying out the purposes aforesaid and giving full effect to the above resolution".

Unquote

For and on behalf of Siddiqsons Energy Limited

Siddiqsons Energy Limited
Karachi

Muhammad Ahmed
Company Secretary

Annexure -I

INTRODUCTION OF SIDDIQSONS ENERGY LIMITED (THE COMPANY)

General Information

i.	Name of Applicant	Siddiqsons Energy Limited
ii.	Business Office	27th Floor, Ocean Tower, Plot G-3, Block-9, Clifton, Karachi, Pakistan

Siddiqsons Energy Limited ("SEL" or the "Applicant" or the "Company") was incorporated on 15th May, 2014 under the Companies Ordinance, 1984 as a special purpose vehicle for development of 350 MW Imported Coal power plant at Port Qasim, Karachi and opted the upfront tariff on imported coal.

Pursuant to the original Letter of Support (the "Original LOS") issued to the Company by the Private Power & Infrastructure Board (the "PPIB"), the Company was granted a Generation License No. IGSPL/65/2015 dated 14.09.2015 (the "Generation License") by NEPRA for the development of a 350 MW Imported Coal based Thermal Generation Facility located at Plot No. 12, Eastern Industrial Zone at Port Qasim, Karachi (the "Original Project") pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act (XL of 1997). Thereafter, SEL opted for the upfront tariff for imported coal vide its tariff determination No. NEPRA/TRF-313/SEL-2015/10440-10442 dated 13.07.2015, which is also placed at the NEPRA website

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Whilst pursuing the relevant documentation/approvals, the Company approached Sindh Engro Coal Mining Company (the "SECMC") in October, 2016 for allocation of coal and execution of the Coal Supply Agreement. However, SECMC intimated that it will not supply coal outside Thar and SEL must consider relocating its Project from Port Qasim, Karachi to Tharparkar District, Sindh.

Resultantly, PPIB, vide letter No. 1(103) PPIB-6016/17/PRJ/O- 48193 dated 13.01.2017 amended the LOS Amendment-1 to reflect change in location and capacity and valid up to 31.08.2017 ("LOS Amendment-2").

Pursuant to the present LOS Amendment-2, the Company is now required to develop a 330 MW Thar mine-mouth coal power project at Thar Block II (the "Revised Project") as an Independent Power Producer ("IPP"), under the GOP's applicable power policy.

Due to the aforementioned reasons, the Company had been forced to make modifications to the Original Project. Yet, SEL continued with dedication the development of the Project and with the relevant and necessary documents in hand, including LOS Amendment-2, filed a fresh application in order to opt for the Upfront Tariff for Thar coal (the "Thar Upfront Petition"). However, the Thar Upfront Petition was unreasonably rejected by NEPRA vide letter dated 31.01.2017, claiming that "SEL has not submitted a fresh application for generation license, rather (earlier) a licensee proposed modification application is pending which relates only to a change of fuel from imported coal to local coal, the Authority observed that SEL has to file a fresh application for grant of generation license along with the aforementioned supporting documents."

The Company filed a Review Petition dated 20.02.2017 against NEPRA's decision to reject the Thar Upfront Petition (the "Review Petition"). It is pertinent to mention here that the Company's earlier tariff determination No. NEPRA/TRF-317/SEL-2016/16212-16214 dated 01.12.2016 was for Local Coal at Port Qasim.

NEPRA held a hearing on 12.04.2017 for the Review Petition filed by the Company, wherein SEL detailed the dynamics of the project. However, the Authority was of the considered opinion that the generation license and upfront tariff had to be for the same generation facility and failing the same, the Thar Upfront Petition was liable to be rejected. Thereby, the Review Petition of SEL was dismissed.

Simultaneously to the above, the Company also filed an Addendum to the LPM dated 20.02.2017 to reflect a change in capacity, location and technology of the project (the "Addendum to LPM"). The Authority, vide its Determination dated 23.05.2017, rejected the LPM application of the Company, stating that the fundamentals of the project had changed which required a new feasibility study, grid interconnection study, environmental study, allocation of land etc. The Authority directed SEL to file a fresh application for grant of generation license for its generation facility at Thar Block II, pursuant to which this Application for grant of generation license is being submitted for the consideration of the Authority.

SALIENT FEATURES OF THE FACILITY:

1. Plant Configuration

i.	Plant Size Installed Capacity (Gross ISO)	330MW
ii.	Type of Technology	Sub-critical steam parameters with Circulating Fluidized Bed Boiler
iii.	Number of Units/Size (MW)	01 x 330MW
iv.	Plant Location	Thar Block-II of Thar Coalfields, Tharparker District, Sindh, Pakistan
v.	Type of Generation Facility	Thermal Power Generation
vi.	Expected Life of the Facility	30 years from COD

2. Fuel Details

i.	Primary Fuel	Lignite (Thar Coal)		
ii.	Back-up Fuel	Imported Coal (Indonesian/ South African)		
iii.	Fuel Source	Thar Coal fields		
iv.	Fuel Supplier	**Primary Fuel**	**Alternative Fuel**	**Start-up Fuel**
		SECMC/Thar Block-II Lignite mine	Imported Coal (Indonesian/ South African)	PSO
v.	Supply arrangement for each of the above	SECMC/Thar Block-II Lignite mine	Imported Coal (Indonesian/ South African)	PSO
vi.	No of Storage Bunkers/Tanks/Open Yard	1,900,000 MT per annum via trucks/ from adjacent mine	Required capacity to be supplied via trucks from Karachi Port	Approx. 175 m^3 per annum
vii.	Storage Capacity of each Bunkers/Tanks/ Open Yard	Approx. 195,000t	Approx. 195,000t	2x500m^3
viii.	Gross Storage	Approx. 360,000 T	Approx. 360,000 T	2x500m^3

THE SOCIAL AND ENVIRONMENTAL IMPACT OF THE PROPOSED FACILITY OR SYSTEM:

The proposed Project entails the construction of a 330 MW coal power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

The findings of the study indicate that the Project will have positive impact on the socioeconomic environment through increased electricity generation, direct and in-direct employment generation; and, increased business opportunities.

Major potential impacts of the Project are associated with air quality and changes to the socioeconomic environment. However, if the field activities, including the implementation of all mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (Chapter 7), are carried out as described in this ESIA Report, the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in Chapter 2 of the ESIA Report.

330MW Thar II Coal Mine Mouth Power Plant Tariff

Base Capital Cost	USD Mn	**408.25**
Capital cost - indexed till May 2017	USD Mn	**391.11**
Water Pipeline Cost	USD Mn	20.00
Capital Cost Including Water Pipeline Cost	USD Mn	**411.11**
Custom Duties & Cess		
Custom duties & cess on the project cost	USD Mn	15.58
Sub-total of capital cost	USD Mn	**426.69**
Financing Fees & charges as % of borrowings		3.50%
Financing fee and charges	USD Mn	11.20
Sino Sure fee	USD Mn	17.43
Interest during construction	USD Mn	47.2
Project cost	USD Mn	**502.52**
Financing Plan		
Total Debt	%	75.00%
Total Equity	%	25.00%
Foreingn Debt	%	50%
Local Debt	%	50%
Financing Terms		
Base Kibor 3M	%	6.25%
Base Libor 3M	%	1.25%
Spread on Kibor 3M	%	3.50%
Spread on Libor 3M	%	4.50%
Debt Repayment	Years	10
Tariff Assumptions		
ROE	%	30.65%
Equity IRR USD Based	%	20%
WHT	%	0%
Financial Charges (% of Total Debt)	%	3.50%

Annexure - G

Schedule-III

Part – A(a) Serial no. 17

Efficiency Parameters	Unit	Value
Designed Efficiency of Power Plant (Net)	%	37.0
Gross Efficiency of Power Plant at Mean Site Conditions	%	40.6
Net Efficiency of Power Plant at Mean Site Conditions	%	37.0

A001654

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

[Under section 32 of the Companies Ordinance, 1984 (XLVII of 1984)]

Corporate Universal Identification No. **0088316**

I hereby certify that **SIDDIQSONS ENERGY LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **limited by shares.**

Given under my hand at **Karachi** this **Fifteenth** day of **May,** Two **Thousand** and **Fourteen**

Incorporation fee Rs. **3,22,000/=** only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

Certified to be True Copy

Joint Registrar of Companies

27/12/15

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : --

Memorandum of Association

of

SIDDIQSONS ENERGY LIMITED

I The name of the Company is "**SIDDIQSONS ENERGY LIMITED**".

II The Registered Office of the Company will be situated in the Province of Sindh.

III The objects for which the Company is established are to do all or any of the following:

1. To design, finance, insure, build, establish, own, operate, maintain, manage electric power generating plants for the generation, supply & transmission of electric power and in relation thereto, to establish, fix, carry out and maintain without limitation, any auxiliary works, cables, wires, meter, lines, interconnect facilities, grid stations, transmission facilities, civil, electrical and mechanical works.

2. To carry out a feasibility study for and to carry on the business of power generation and in relation thereto, to generate, accumulate, transmit, distribute and sell electric power anywhere in Pakistan, to the public sector, including the Water and Power Development Authority, National Transmission and Dispatch Company, Government and Government bodies, and the private sector subject to any permission required under the Law.

3. To manufacture, purchase, import or otherwise acquire, construct, own, process, operate and maintain buildings, apparatus, fixtures, fittings, plants, machinery, materials, and things as may be necessary, incidental to or convenient in connection with power generating plant for the generation of electric power and or in connection with supply, transmission and distribution of electric power.

4. To enter into any agreement or agreements with any government or other authority, supreme, municipal, local or otherwise, that may seem conducive to all or any of the objects of the Company and/or to obtain from such government or authority including the State Bank of Pakistan or National Electric Power Regulatory Authority (NEPRA) any rights, concessions or privileges, licenses which the Company may think desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges, concessions and licenses.

5. To buy, sell, manufacture, repair, alter, improve, exchange or let out, import, export and deal in all works legally permitted, plant, machinery, engines, tanks, cylinders, valves, regulators, testing equipment, tools, utensils, appliances, cookers, stoves, heaters, apparatus, products, materials, substances, raw materials, chemicals, natural gas, liquefied petroleum gas, fuel oil, coal, lubricants, articles and things and to manufacture, experiment with, render marketable and deal in all products legally permitted, incidental to or obtained in the business carried on by the Company.

6. To purchase, take on lease or tenancy or in exchange, hire, take options over or otherwise acquire for any estate or interest whatsoever and to hold, develop, work, cultivate, deal with and turn to account concessions, grants, decrees, licenses, privileges, claims, options, leases, property, real or personal or rights or powers of any kind which may appear to be necessary or convenient for the business of the Company but not to act as a leasing company or property developer.

7. To sell, exchange, mortgage, let on royalty or tribute, grant licenses, easements, options and other rights over and in any manner deal with or dispose of the Company's property or any part thereof for such consideration as may be thought fit and in particular for stocks, shares or securities of any company but in any event not to act as an investment company or leasing company.

8. To establish laboratories and to employ and promote scientific research and invention, patronize such invention and enter into manufacture in collaboration with outside parties for transfer of technology from abroad and to promote transfer of technology from Pakistan abroad, and to carry on business in all other allied fields permissible by law.

9. To invest and deal with any moneys of the Company not immediately for the time being required for any of the purposes of the Company in such investments as may be thought proper and to hold, sell or otherwise deal with such investments but in any event not to act as an investment company.

10. For the purposes of the business of the Company only, to advance money upon such terms as the Company may approve, and to guarantee the obligations and contracts of customers and others but not to act as a banking company.

11. To apply for, purchase or otherwise acquire and protect, prolong and renew whether in Pakistan or elsewhere any patents, patent rights, brevets d'invention, trademarks, design licenses, protections, concessions and the like conferring any exclusive or non-exclusive or limited right to use any secret or other information as to any invention, process or privilege which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated directly or indirectly to benefit the Company and to use, exercise, develop, manufacture under grant, licenses, privileges in respect of, or otherwise turn to account the property, rights and information so acquired and to carry on any business in any way connected therewith.

12. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the company whether in respect of its contracts, agreements, advances or securities or in respect of servants or employees of the company, or in respect of property belonging to or leased to or hired by the company, either by setting apart funds of the company or by effecting such insurance and in later case to pay the premium thereon.

13. To train personnel and workers, in Pakistan and/or abroad, to obtain technical proficiency in various specialties connected with the business of the Company.

14. To undertake and execute any project the undertaking whereof may seem desirable, and either gratuitously or otherwise.

15. To procure the Company to be registered or recognized in any foreign country or place.

16. To acquire and undertake all or any part of the business, property, goodwill and liabilities of any person or company carrying on any business which the Company is authorized to carry on or possessed of property suitable for the purposes of the Company.

17. To adopt such means of making known the business and/or services of the Company as may seem expedient and in particular by advertising in the press, or in the other media or by way of participation in exhibitions.

18. For the purposes of the Company, to purchase, manage, acquire by lease, mortgage, dispose of, sell, exchange, turn to account any part of the property and rights of the Company.

19. To employ or appoint any persons, experts, consultants, advisers, contractors (including O&M contractors), brokers in connection with the business of the Company.

20. To pay for any property or rights acquired by the Company, either in cash or fully paid shares or by the issue of securities, or partly in one mode and partly in another and generally on such terms as may be determined.

21. Only in connection with the business of the Company to open and operate any current, overdraft, loan, fixed or savings bank accounts for the Company, and draw, make, accept, discount, endorse, execute and issue promissory notes, bills of exchange, bills of lading and other negotiable or transferable instruments or securities and to deposit money, securities or property with any persons, firm or company and on any terms with or without security and to advance money to the Company's executives, officers and employees/agents/customers and others having dealings with the company but in any event not to act as an investment, banking or finance company.

22. In connection with the business of the Company only, to give guarantees and indemnities for the payment of money or the performance of contracts or obligations by this Company but in any event not to act as an investment, banking or finance company.

23. In connection with the business of the Company only, to borrow and where required, to secure the payment of money in such manner as the Company shall think fit and in particular by the creation of mortgages and charges over the (present and future) property, assets and/or undertaking of the Company and/or by issue of debentures, participation term certificates, term finance certificates and other securities charged upon all or any of the Company's property both present and future, and to purchase, redeem and pay off any such securities.

24. To lawfully raise moneys in such manner as the Company shall think fit and in particular by the issue of such securities, bonds and instruments payable to bearer or otherwise, and either permanent or redeemable or repayable convertible into shares and collaterally to secure the repayment of any such moneys so raised or any such securities or instruments of the Company by means of a trust deed or otherwise.

25. To take, or otherwise acquire, and hold shares in any other company having objects altogether or in part similar to those of this Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company but in any event not to act as an investment company.

26. To issue all or any part of the original or enhanced share capital of the Company at par or at a premium or discount subject to any permission required under the law.

27. To enter into partnership or into any agreement or agreements for sharing profits, union of interests, cooperation, joint venture, reciprocal concession and/or facilities with any person or company whether or not having objects similar to those of this Company but in any event not to act as managing agents.

28. So far as is permissible in law, to offer stock option schemes to employees, to grant funds, donations, annuities, pensions, allowances, gratuities, bonuses to any employees or Directors or employees of the Company or any dependent thereof or to any charitable, religious, social, scientific, educational, industrial institutions or organization and to establish provident, gratuity and/or superannuation funds for the benefit of present or ex-employees or Directors or former directors of the Company

29. To pay all or any costs charges and expenses preliminary and incidental to the promotion, formation, establishment and registration of the Company and to pay any development costs incurred (whether before or after the incorporation of the Company) by the sponsors of the Company in connection with any project of the Company.

30. To pay brokerage or commission to any person or persons in consideration of his/their subscribing, or agreeing to subscribe, whether absolutely or conditionally, for any shares or debentures of the Company, or for procuring or agreeing to procure subscriptions whether absolute or conditional for the same which brokerage or commission may be paid either in cash or shares of the Company, credited as fully paid up.

31. To distribute any of the Company's property among the members in the event of winding up of the Company.

32. To amalgamate, consolidate, or merge, either in whole or in part, with or into any other companies, associations, firms or persons carrying on any trade or business of a similar nature to that which this Company is authorized to carry on.

33. To resolve, settle disputes by negotiation, conciliation, mediation, arbitration, litigation or other means, judicial or extra judicial, and to enter in compromise agreement with creditors, members and any other persons in respect of a difference or dispute with them and to exercise the power to sue and be sued and to initial or oppose all actions, steps, proceedings or application which may seem calculated directly or indirectly to benefit or prejudice, as the case may be, the interest of the Company or of its members.

34. To do all or any of the things herein in any part of the world either as principals, agents, contractors or otherwise, and either alone or in conjunction with others but in any event not to act as managing agents.

35. To provide engineering, construction, consultancy and design services and radio and other communication systems and services, and any facilities, equipment and installations whether related to such services and systems or otherwise.

36. To carry on any other business whether manufacturing or otherwise that may seem to the Company capable of being conveniently carried on in connection with the above objects or calculated directly or indirectly to enhance the value of or render profitable any of the Company's property or rights or which it may be advisable to undertake with a view to improving , developing, rendering or turning to account any property real or personal belonging to the Company or in which the Company may be interested and to do all or any of the above things either as principals, agents, contractors or otherwise, and either alone or in conjunction with others and either by or through agents, sub-contractors, trustees or otherwise, and to do all such things as are incidental or conducive to the attainment of the above objects but in any event not to act as managing agents.

37. To do all and everything necessary, suitable or proper or incidental or conducive to the accomplishment of any of the purposes or the attainment of any of the objects or the furtherance of any of the powers hereinbefore set forth, either alone or in association with other corporate bodies, firms or individuals or with any Government authority or public or quasi-public authority or any other authority, and to do every other act or thing incidental or appertinent to or arising out of or connected with the business or powers of the Company or part thereof, provided the same be lawful.

38 It is expressly declared that all the powers expressed therein are to be cumulative but in no case unless the context expressly so requires is the generality of any one sub-clause to be narrowed or restricted by the name of the Company or by the particularity of expression in the same sub-clause or by the application of any rule of construction such as the ejusdem generis rule, and accordingly none of such sub-clauses or the objects therein specified or the power thereby conferred shall be deemed subsidiary or auxiliary merely to the objects mentioned in any other sub-clause of this clause, and the Company shall have full power to exercise all or any of the powers conferred by any part of this clause in any part of the world.

39. IT IS HEREBY UNDERTAKEN that the Company shall not engage in the banking business, business of a finance, investment, leasing or insurance company, or as a modaraba management company, or the business of land development or a managing agent or any unlawful business and that nothing in the objects clause shall be construed to entitle it to engage in such business.

40. AND that none of such-clauses or the objects therein specified or the powers thereby conferred shall be or be deemed to be subsidiary or ancillary or ancillary merely to the objects mentioned in any of the other sub clause of this clause or any of them but the Company have full power to exercise all or any of the power conferred by any part of this clause in any part of the world, notwithstanding that the business undertaking property rights or acts proposed to be transacted, acquired, dealt with or performed do not fall within the objects of the earlier or any other sub-clauses of this clause or any of them.

IV. The liability of the Members is limited.

V. The authorized capital of the Company is Rs.100,000,000 (Rupees: One Hundred Million Only) divided into 10,000,000 (Ten Million only) shares of Rs.10 (Rupees Ten only) each, with power of the Company, specifically, to increase the authorized share capital to include a further issue including of preference shares and generally, to increase or reduce the capital and to divide the shares in the capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984 and any rules made there-under, and to attach thereto respectively such preferential, deferred, qualified or special rights, privileges or conditions as may be determined by or in accordance with the Articles of Association of the Company for the time being, and to vary, modify or abrogate any such rights, privileges or conditions in such manner as may for the time being be provided by the Articles of Association of the Company in accordance with law.

Certified to be True Copy

Joint Registrar of Companies

We, the several persons whose name 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 indicated herein below against our respective names:

[illegible]	[illegible]	[illegible]	Nationality with any former Nationality	Occupation	NIC Number	Residential address in full	No. of Shares	Signature
1	Muhammad Tariq Rafi	Muhammad Rafi	Pakistani	Business	42000-8453226-9	34-H, Block-6, PECHS, Karachi	1	
2.	Abdur Rahim	Muhammad Tariq Rafi	Pakistani	Business	42201-0409988-5	34/H-1, Block-6, PECHS, Karachi	1	
3	Nighat Tariq	Muhammad Tariq Rafi	Pakistani	Business	42201-9906534-6	34-H, Block-6, PECHS, Karachi	1	
4.	Rahma Ibrahim	Ibrahim Shamsi	Pakistani	Business	42301-0468767-6	House # 59, Street 19, Kh. Badban, DHA-V, Karachi	1	
5.	Alia Sajjad	Sajjad Ahsan	Pakistani	Business	42000-7241258-4	House # 19, Kh. Hilal, DHA, Karachi	1	
6.	Anum Abdur Rahim	Abdur Rahim	Pakistani	Business	42201-8648714-6	34/H-1, Block-6, PECHS, Karachi	1	

Total Shares Taken: 6

Dated the 19th day of April 2014

Witness to above signatures.

Name: National Institutional Facilitation Technologies (Pvt.) Ltd.

Nationality: Pakistani

Address: 5th Floor, AWT Plaza, I. I. Chundrigar Road, Karachi

THE COMPANIES ORDINANCE, 1984

--: o : --

(COMPANY LIMITED BY SHARES)

--: o : -

Articles of Association

of

SIDDIQSONS ENERGY LIMITED

I. PRELIMINARY

1. TABLE "A" Not to Apply

The regulations in Table 'A' in the First Schedule to the Companies Ordinance, 1984 shall not apply to the Company except so far as the same are repeated or contained in these articles.

2. DEFINITIONS

Unless the context otherwise requires, the terms used in these articles shall have the meanings set out below:

(a) **"Articles"** mean these articles of association of the company as originally framed or as from time to time altered by in accordance with the law.

(b) **"Board"** means the group of directors in a meeting duly called and constituted or, as the case may be, the directors assembled at a board.

(c) **"Book and paper"**, "book or paper" or "books of account" mean accounts, deeds, vouchers, writings and documents, maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media;

(d) **"Buy-back of shares rules"** mean the Companies (Buy-Back of Shares) Rules, 1999 or any modification or re-enactment thereof.

(e) **"Company"** means **Siddiqsons Energy Limited**.

(f) **"Central depository"** means a central depository as defined in clause (ca) of section 2 of the Securities and Exchange Ordinance, 1969 (XVII of 1969) and registered with the Securities and Exchange Commission of Pakistan under section 32 A of the said ordinance.

(g) **"Central Depositories Act"** means the Central Depository Act, 1997 or any modification or re-enactment thereof.

(h) **"Central Depository Regulations"** mean the central depository company of Pakistan limited regulations made pursuant to section 35(1) of the Central

Depository Act, 1997 or any modification or re-enactment thereof.

(i) "**Central Depository Register**" means a computerized electronic register maintained by a central depository in respect of book-entry securities.

(j) "**Code**" means the code of corporate governance.

(k) "**Commission**" means the Securities and Exchange Commission of Pakistan established under section 3 of the Securities and Exchange Commission of Pakistan Act, 1997.

(l) "**Directors**" mean the directors for the time being of the company including alternate directors and, subsequently elected pursuant to Companies Ordinance, 1984 or as the case may be, the directors assembled at a board.

(m) "**Dividend**" includes cash dividend, dividend in species and bonus shares.

(n) "**Electronic**" includes electrical, digital, magnetic, optical, bio-metric, electro-chemical, wireless or electromagnetic technology.

(o) "**Electronic transactions ordinance**" means the Electronic Transactions Ordinance, 2002 or any modification or re-enactment thereof.

(p) "**In Person**" includes attendance and/or voting at a meeting, personally or by video or telephone conference or other facility whereby all the participants of the meeting can hear and / or see each other unless expressly stated otherwise by the directors.

(q) "**Instrument of transfer**" includes transfer deeds and any record of transfer of book-entry securities in the central depository register, provided by the central depositories act and the central depository regulations.

(r) "**Issue of capital rules**" mean Companies (issue of capital) Rules, 1996 or any modification or re-enactment thereof.

(s) "**Listing requirements**" mean the listing regulations of the stock exchanges.

(t) "**Member**" means a person whose name is for the time being entered in the register of members by virtue of his being a subscriber to the memorandum of association of the company or of his holding by allotment or otherwise any share, scrip or other security which gives him a voting right in the company including but not limited to the account holders of a central depository.

(u) "**Memorandum**" means the memorandum of association of the company as originally framed or as from time to time altered in accordance with law.

(v) "**Month**" means calendar month according to the English calendar.

(w) "**Office**" means the registered office for the time being of the company.

(x) "**Ordinance**" means the Companies Ordinance, 1984 or any modification or re-enactment thereof for the time being in force.

(y) "**Preference shares**" not being ordinary shares mean preference shares whether redeemable or irredeemable, cumulative or otherwise with the rights, privileges and conditions attaching thereto as are provided by the articles.

(z) "**Preference shareholders**" not being ordinary shareholders mean, in relation to the Company, every person to whom the company has allotted, or who becomes the holder of such shares and whose name is entered in the register of members.

(aa) "**Proxy**" includes an attorney duly constituted under a power of attorney.

(ab) "**Record**" includes, in addition to a written or printed form, any disc, tape, sound-track, film or other device in which sounds and / or other data is embodied so as to be capable (with or without the aid of some other instrument or machine) of being reproduced there from in audible, legible or visual form.

(ac) "**Register**" means, unless the context otherwise requires, the register of members and include the register of debenture-holders or holders of other securities maintained on paper or computer network, floppy, diskette, magnetic cartridge tape, CD-Rom or any other computer readable media; to be kept pursuant to section 147 of the ordinance and / or central depository register under the central depositories act and the central depository regulations.

(ad) "**Registrar**" means a registrar, defined in section 2 (1) (31), performing the duty of registration of companies under the ordinance.

(ae) "**Regulations**" mean the rules of governance of the company made by the board from time to time.

(af) "**Seal**" means the common or official seal of the company.

(ag) "**Section**" means section of the ordinance.

(ah) "**Share Capital Rules**" mean the companies' Share Capital (Variation in Rights and Privileges) Rules, 2000.

(ai) "**Sign**" **and** "**Signature**" unless otherwise provided in these articles, include respectively lithography, printing facsimile, "advanced electronic signature" which is capable of establishing the authenticity and integrity of an electronic document, as defined by section 2(e) of the electronic transactions ordinance, and names impressed with a rubber or other kind of stamp.

(aj) "**Special Resolution**" means the special resolution of the company as defined in section 2(1) (36) of the ordinance.

(ak) "**Stock Exchanges**" mean the Islamabad, Lahore and Karachi stock exchanges and such other stock exchanges as may be established in Pakistan.

3. INTERPRETATION

In these articles, unless the context otherwise requires:

(a) the singular includes the plural and vice versa and words denoting any gender shall include all genders;

(b) references to any act, ordinance, legislation, the code, the listing requirements, rules or regulations or any provision of the same shall be a reference to that act, ordinance, legislation, the code, the listing requirements, rules or regulations or provisions, as amended, re-promulgated or superseded from time to time;

(c) the terms "include" or "Including" shall mean include or including without limitation;

(d) Expressions referring to writing shall, unless the contrary intention appears, be construed as including references to printing, lithography, photography, and other modes of representing or reproducing words in a visible form, including but not limited to, electronic transmission such as facsimile, and electronic mail or any other electronic process, as prescribed by section 3 of the electronic transactions ordinance.

(e) words importing persons shall include bodies corporate; and

(f) words and expressions contained in these articles shall bear the same meaning as in the ordinance.

REGISTERED OFFICE

4. The registered office of the company shall be in the Province of Sindh as the directors shall from time to time appoint.

PUBLIC LIMITED COMPANY

5. The company is a public limited company within the meanings of section 2(1), Clause (30) of the Companies Ordinance, 1984.

BUSINESS

6. All branches or kind of business which the company is either expressly or by implication authorized to undertake may be undertaken by the directors at such time or times as they shall think fit, and further may be allowed by them to be in abeyance, whether such branch or kind of business may have been actually commenced or not, so long as the directors may deem it expedient not to commence or proceed with such branch or kind of business.

II. CAPITAL

SHARES

7. The minimum Subscription upon which the Directors may proceed to make First Allotment is fixed at Rs.5,000,000/- (Rupees: Five Million Only).

8. The Authorized Capital of the Company is Rs.100,000,000/- (Rupees One Hundred Million Only) divided into 10,000,000 (Ten Million Only) (ordinary shares of Rs.10/= each, but the Company may from time to time by a Special Resolution increase, consolidate, sub-divide, reduce or otherwise re-organize the share capital of the Company, subject to the provisions of Section 108 of the Companies Ordinance, 1984

9. Subject to section 90 of the ordinance and any rules in that regard made under the ordinance, and without prejudice to any special rights previously conferred on the holders

of any existing shares or class of shares, any share in the company may be issued with different rights, restrictions and privileges, including but not limited to the following as may be approved by the company by special resolution:

(1) different voting rights; voting rights disproportionate to the paid-up value of share held; voting rights for specific purposes only; or no voting rights at all;

(2) different rights for entitlement of dividend, right shares or bonus shares or entitlement to receive the notices and to attend the general meetings;

(3) rights and privileges for indefinite period, for a limited specified period or for such periods as may from time to time be determined by the company;

(4) different manner and mode of redemption, including redemption in accordance with the provisions of these articles, subject to sections 85 and 95 (4) of the ordinance, including but not limited to, by way of conversion into shares with such rights and privileges as determined by the company in the manner and mode provided in these articles; and

(5) Different rights and privileges for listing or non-listing of any class of shares.

10. Subject to section 95(4)(a) of the ordinance and any rules in that regard made under the ordinance, the company may issue shares which are to be redeemed or any other redeemable security, on such terms and in such manner as may be provided in the said section and rules.

11. Subject to provisions of the ordinance and these articles and subject to any special rights or privileges for the time being attached to any issued shares, the shares in the capital of the company for the time being, including any new shares resulting from an increase in the authorized capital, shall be under the control of the directors who may allot or otherwise dispose of the same or any of them to such persons (subject to article 43), on such terms and conditions, and with such rights and privileges annexed thereto as the resolution creating the same shall direct, and if no direction be given, as the directors shall determine and at such times and in such manner as the directors think fit, either at par or at a premium or subject to section 84 of the ordinance at a discount, with power to the directors to give any person the right to call for and be allotted shares of any class of the company at par or at a premium or, subject as aforesaid, at a discount, such option being exercisable at such time, and for such consideration as the directors think fit. Provided that the shares in the capital of the company shall always be issued as fully paid shares and no shares shall be issued as partly paid shares. The directors shall, as regards any allotment of shares, duly comply with such of the provisions of sections 67 to 73, the central depositories act, the central depository regulations, the issue of capital rules and the share capital rules, as may be applicable to the company.

12. The directors may allot and issue shares in the capital of the company as payment or part payment for any property sold or transferred, or for services rendered, to the company in the ordinary course of its business, and shares so allotted shall be issued as and shall be deemed to be fully paid shares.

13. The board shall, as regards any allotment of shares, duly comply with such provisions of sections 67 to 73 of the ordinance as may be applicable.

14. The company may at any time pay a commission to any person for subscribing or agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company or procuring or agreeing to procure subscriptions (whether absolutely or conditionally) for any shares, debentures or debenture stock in the company; Provided, that, if the commission in respect of shares shall be paid or payable out of capital, the statutory requirements and conditions shall be observed and complied with, and the amount or rate of commission shall not exceed such percentage on the shares, debentures or debenture stock in each case subscribed or to be subscribed, as may be determined by the board subject to any limits required by law. The commission may be paid or satisfied, either wholly or partly, in cash or in shares, debentures or debenture stock. The company may also on any issue of shares pay such brokerage fees as may be lawful; Provided that such brokerage fees shall not exceed such percentage of the shares, debentures or debenture stock paid-up as may be determined by the board, subject to any limits required by law.

15. Subject to section 95A of the ordinance and any rules in that regard made under the ordinance, the company may purchase its own shares on such terms and in such manner as may be provided in the said section and rules.

16. Except as permitted in the ordinance and any rules in that regard made under the ordinance, no part of the funds of the company shall be employed in the purchase of its own shares or in giving, whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or in connection with a purchase made or to be made by any person of or any shares in the company.

17. Except as required by law, no person shall be recognized by the company as holding any share upon any trust, and the company shall not be bound by or be compelled in any way to recognize (even when having notice thereof) any equitable, contingent, future or partial interest in any share or any interest in any fractional part of a share or (except only as by these Articles or by law otherwise provided or under an order of a court of competent jurisdiction) any other rights in respect of any share except any absolute right to the entirely thereof in the registered an absolute right to the entirely thereof in the registered holder.

18. Save as herein otherwise provided, the company shall be entitled to treat the registered holder of any share as the absolute owner thereof and accordingly shall not, except as ordered by a court of competent jurisdiction or as by statute required, be bound to

recognize (even when having notice thereof) any benami, equitable, contingent, future, partial or other claim or right to or interest in such share on the part of any other person.

19. Shares may be registered in the name of persons, any limited company or other corporate body. Not more than four persons shall be registered as joint-holders of any share.

20. If any share or shares stand in the name of two or more persons, the person first named in the register shall, as regards receipt of dividend or bonus or service of notices and all or any other matters connected with the company except voting at the meeting and the transfer of shares, be deemed the sole holder.

RIGHTS PRIVILEGES AND CONDITIONS ATTACHED TO SHARES

21. As regards income, the profits which the company may determine to distribute in respect of any financial year or other period for which the accounts shall be made up, shall be applied in the following order of priority;

(1) In paying the holders of the preferences shares, the right to a cumulative preferential dividend as determined by the board on the capital paid up thereon payable as regards each financial year out of the profits of the company resolved to be distributed in respect of that year, but shall not be entitled to any further participation in profits; and

(2) Subject to the rights of any class of shares for the time being issued, in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

22. As regards conversion, the company may partly or wholly convert the preference shares at the option of the holders of the preference shares in accordance, respectively, with the terms and conditions of their issue.

22. As regards capital, on a return of capital in a winding up or otherwise (except upon the redemption of shares of any class of preference shares or the purchase by the company of its own shares), the surplus assets of the company remaining after payment of its liabilities shall be applied in the following order of priority:

(1) in paying to the holders of the preference shares, the capital paid up on the same without any further right to participate in profits or assets; and

(2) subject to the rights of any other class of shares for the time being issued, in distributing the balance amongst the holders of the ordinary shares according to the amounts paid up on the ordinary shares held by them respectively.

23. As regards entitlement to bonus or right shares, the holders of preference shares shall not be entitled to bonus or right shares in the event that the company increases its capital by the issue of further shares or otherwise.

24. As regards voting rights, the holders of the preference shares shall not be entitled to receive notice of, attend, or vote at, any general meeting of the company, except as otherwise provided by the ordinance, whereby the holders of such shares would be entitled to vote separately as a class, that is, with respect to voting entitlement of the preference shareholders on matters affecting, respectively, their substantive rights and liabilities. Without prejudices to the foregoing, the holders of preference shares may attend the general meeting of the company as observers with prior permission of the chairman.

CERTIFICATES

25. The Certificates of title to shares and duplicate thereof shall be issued under the seal of the company and signed by two of the directors or by one such director and the secretary provided that such signatures may if necessary be printed lithographed or stamped subject to the approval of the directors.

26. Every member shall be entitled to one certificate for all the shares registered in his name, or, if the directors so approve, to several certificates each for one or more of such shares, but in respect of each certificate for less than one hundred shares, the directors shall be entitled to charge a fee of Rupees 10 or such lesser sum as they may determine. Every certificate of shares shall specify the number and denoting numbers of the shares in respect of which it is issued.

27. The company shall within ninety days after the allotment of any shares, debentures or debenture stock and within forty-five days (or where the transferee is a central depository,

within five (5) days) after receipt by the company of the application for transfer of any such shares, debentures or debenture stock complete and have ready for delivery the certificate (such expression shall hereinafter be deemed to include book-entry security as defined in the central depositories act, and the central depository regulations) of all shares, the debentures and the certificate of all debenture stock allotted or transferred, and unless sent by post or delivered to the person entitled thereto within the period aforesaid the company shall immediately thereafter give notice to that person in the manner prescribed in these articles for the giving of notices to members that the certificate is ready for delivery.

28. If a certificate of shares, debenture or debenture stock is proved to the satisfaction of the company to have been lost or destroyed or, being defaced or mutilated or torn, is surrendered to the company, and the company is requested to issue a new certificate in replacement thereof, the company shall, after making such enquiry as it may deem fit, advise the applicant within thirty days from the date of application the terms and conditions (as to indemnity and otherwise and as to payment of the actual expenses incurred on such enquiry and of a fee not exceeding ten rupees) on which the company is prepared to issue a new certificate and a time for compliance therewith or of the reasons why the company is unable to issue a new certificate, as the case may be, and in the former case if the applicant shall within the time allowed comply with the terms and conditions specified, the company shall issue a new certificate to the applicant within

forty five days from the date of application.

29. The company shall not be bound to issue more than one certificate in respect of a share or shares held jointly by two or more persons and delivery of a certificate for a share to any one of joint holders shall be sufficient delivery to all.

TRANSFER AND TRANSMISSION

30.(1) The directors shall not refuse to register the transfer of fully paid shares unless the instrument of transfer is defective or invalid or is not accompanied by the certificate of the share(s) to which it relates. The directors may also decline to recognise any instrument of transfer unless it is accompanied, in addition to the certificate of the shares to which it relates, by such other evidence as the directors may reasonably required to show the right of the transferor to make the transfer. The directors may waive the production of any certificate upon evidence satisfactory on them of its loss or destruction.

(2) If the directors refuse to register a transfer of any shares they shall, within thirty (30) days (or where the transferee is a central depository, within five (5) days) after the date on which the instrument of transfer was lodged with the company, send to the transferee and the transferor notice of the refusal indicating the reason for such refusal; provided that if the directors refuse to register a transfer of shares on account of a defect in or the invalidity of the instrument of transfer, the transferee shall be entitled, after removal of such defect or invalidity, to re-lodge the instrument of transfer with the company.

31. Shares in the company shall be transferred in accordance with the central depositories act and the central depository regulations. If the shares of the company are not registered in the central depository, the same may be transferred through the instrument of transfer. The instrument of transfer of any share shall be in writing in the usual common form, or in the following form, or as near thereto as circumstances will admit:

"I/We.. of .... son/daughter/wife of .... being a national(s) of .... in consideration of the sum of Rupees .... only (Rs. ....) paid to me/us by .... of .... son/daughter/wife of .... being a national(s) of .... (hereinafter called the 'said transferee(s)') do hereby transfer to the said transferee(s) share(s) numbered standing in my/our name(s) in the books of **SIDDIQSONS ENERGY LIMITED**, to hold unto the said transferee(s) his/her/their executors, administrators and as signs, subject to the several conditions on which I/we hold the same at the time of execution hereof, and I/we the said transferee(s) do hereby agree to take the said share(s) subject to the conditions aforesaid.

As witness our hands the .... day of .... thousand and ...."

Signed by the said transferor in the presence of	Transferor's signature..........................
	Transferor's occupation...........................
Witness 1..................................	Witness 2 ....
Occupation	Occupation................................
Address....................................	Address....................................
Signed by the said transferee in the presence of Transferee's occupation	Transferee's signature
Witness 1	Witness 2 ....
Occupation	Occupation
Address....................................	Address....................................

32. No transfer shall be made to a minor or person of unsound mind.

33. All registered instruments of transfer shall be retained by the company, but any instrument of transfer which the directors may decline to register shall be returned to the person depositing the same.

34. The instrument of transfer of any share in the company shall be duly stamped and executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the register in respect thereof.

35. On giving seven days previous notice in the manner provided in the ordinance and articles, the transfer books and register may be closed during such time as the directors think fit, not exceeding in the whole forty-five days in each year, but not exceeding thirty days at a time.

36. Any member may make and deposit with the Company a nomination in writing specifying one or more eligible persons who or each of whom, in the event of the death of the Member, may be entered in the Register as the holder of such number of shares specified in the nomination for such nominee or each such nominee of which the member remains the registered holder, at the date of his death. A person shall be eligible for nomination for the purposes of this Article only if he is a spouse, parent, brother, sister or child of the member nominating him and the applicable relationship all should be specified in the nomination in respect of each nominee. A member may at any time by

notice in writing cancel, or by making and depositing with the company another nomination before his death vary any nomination already made by him pursuant to this Article. In the event of the death of a member any person nominated by him in accordance with this Article may, on written application accompanied by the relative share certificates and evidence establishing the death of the member, request the company to register himself in place of the deceased member as the holder of the number of shares for which the nomination in his favour had been made and deposited with the company, and if it shall appear to the Directors that it is proper so to do, the Directors may register the nominee as the holder of those shares in place of the deceased member.

(a) in the case of the death of a member who was a joint-holder of shares the survivor or survivors shall be the only persons recognized by the company as having any title to his interest in the shares. If the deceased member was a sole holder of shares, the nominee or nominees of the deceased where a nomination under Article 37 is effective, and the legal personal representatives, executors or administrators, of the deceased where no such nomination has been made and deposited with the company, shall be the only persons recognized by the company as having any title to his interest in the shares.

(b) Before recognizing any legal representative or executor or administrator, the Directors may require him to obtain a grant of succession certificate or probate or letters of administration or other legal representation, as the case may be, from some competent Court in Pakistan having effect in Karachi; provided nevertheless that in any case where the Directors in their absolute discretion think fit, it shall be lawful for the Directors to dispense with the production of succession certificates or probates or letters of administration or such other legal representation, upon such terms as to indemnity or otherwise as the Directors, in their absolute discretion, may consider necessary.

37. The executors or administrators or the nominee appointed under section 80 of the ordinance of a deceased member (not being one of several joint-holders) shall be the only person recognized by the company as having any title to the shares registered in the name of such member, and in case of the death of any one or more of the joint-holders of all registered shares (such expression shall hereinafter be deemed to include registration as a sub-account holder of a central depository under the central depositories act and the central depositories regulations) ,the survivors shall be the only persons, recognized by the company as having any title to or interest in such shares, but nothing herein contained shall be taken to release the estate of a deceased joint-holder from any liability on shares held by him jointly with any other person. Before recognizing any executor or administrator. the directors may require him to obtain a grant of probate or nomination as mentioned above or letters of administration or other legal representation, as the case may be. from some competent court in Pakistan having effect in Karachi. Provided nevertheless that in any case where the board in their absolute discretion think fit, it shall be lawful for the directors to dispense with the production of probate or letters of administration or such other legal representation upon such terms as to indemnify or otherwise as the directors, in their absolute discretion, may consider necessary.

38. Any person becoming entitled to a share in consequence of the death or insolvency of a member may upon such evidence being produced as may from time to time properly be required by the Directors and subject as hereinafter provided, elect either to be registered himself as the holder of the share or instead of being registered himself, to make such transfer of the share or instead of being registered himself, to make such transfer of the share as the deceased or insolvent person could have made but the Directors shall, in either case, have the same right to decline or suspend registration as they would have had in the case of a transfer of the share by that member before his death or insolvency as the case may be.

39. Any committee or guardian of a lunatic or minor member or any person becoming entitled to a share in consequence of the death or bankruptcy or insolvency of any member upon producing such evidence that he sustains the characters in respect of which he proposes to act under this article, or of his title, as the directors think sufficient, shall have the right to be registered as a member in respect of such share, or may, subject to the regulations as to transfer hereinbefore contained, transfer such share.

40. Neither the company nor the directors nor any other officer of the company shall incur any liability for registering or acting upon a transfer of shares apparently made by sufficient parties, although the same may, by reason of any fraud or other cause not known to the company or the directors or any other officer of the company, as aforesaid, be legally inoperative or insufficient to pass the property in the shares proposed or professed to be transferred, and although the transfer may, as between the transferor and transferee, be liable to be set aside, and, notwithstanding that the company may have notice that such instrument of transfer was signed or executed and delivered by the transferor in blank as to the name of the transferee or the particulars of the shares transferred, or otherwise in defective manner. And in every such case the person registered as transferee, his executors, administrators and assigns alone shall be entitled to be recognized as the holder of such shares and the previous holder shall, so far as the company is concerned, be deemed to have transferred his whole title hereto.

ALTERATION OF CAPITAL

41. The company may by ordinary resolution and subject to compliance with the requirements of section 92 of the ordinance increase the authorized share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

42. Subject to the provisions of section 92 (1) (d), 92(3) and 93 and section 13 of the central depositories act, the company may, by ordinary resolution;

(a) consolidate and divide its share capital into shares of larger amount than its existing shares;

(b) by sub-division of its existing shares or any of them, divide the whole or any part of its share capital into shares of smaller amount than is fixed by the memorandum of association;

(c) cancel any shares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.

43. The directors may from time to time increase the issued share capital by such sum as they think fit. Except as otherwise permitted by section 86 of the ordinance , rule 5 of share capital rules, the listing requirements and section 14 of the central depositories act, as are applicable to the company and subject to any special rights or privileges for the time being attached to any issued shares, all shares intended to be issued by the directors shall, before issue, be offered to the members strictly in proportion to the amount of the issued shares held by each member (Irrespective of class); provided that fractional shares shall not be offered and all fractions less than a share shall be consolidated and disposed of by the company and the proceeds from such disposition shall be paid to such of the entitled members as may have accepted such offer. Such offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the directors may dispose of the same in such manner as they think fit. In respect of each such offer of shares the directors shall comply with the provisions of section 86 of the ordinance and in particular with the provisions of sub -sections (3), (4) and (5) thereof. Any difficulty in the apportionment of shares amongst the members, such difficulty shall, in the absence of any directions given by the company in general meeting, be determined by the directors.

44. Except so far as otherwise provided by the conditions of issue or by these articles, any capital raised by the creation of new shares shall be considered part of the original capital and shall be subject to the provisions herein contained with reference to transfer and transmission and otherwise.

45. Subject to the provisions of sub-section (2) of section 86 of the ordinance, if, owing to any inequality in the number of new shares to be issued and the number of shares held by a member entitled to have the offer of such new shares, any difficulty shall arise in the apportionment of such new shares or any of them amongst the members, such difficulty shall, in the absence of any direction in the resolution creating the shares or by the company in general meeting, be determined by the directors.

46. The company may, by special resolution, reduce its share capital in any manner, with and subject to, any incident authorized and consent required by law.

47. The share premium account maintained pursuant to section 83(1) of the ordinance may, be applied by the company:

(a) in writing off the preliminary expenses of the company;

(b) in writing off the expenses of, or the commission paid or discount allowed on, any issue of shares or debentures of the company;

(c) in providing for the premium payable on the redemption to any redeemable preference shares or debentures of the company; or

(d) in paying up un-issued shares of the company to be issued as fully paid bonus shares.

48. Subject to the provisions of section 96 to 105 inclusive of the ordinance, the directors may accept from any member the surrender on such terms and conditions as shall be agreed of all or any of his shares.

VARIATION OF SHAREHOLDERS' RIGHTS

49. Whenever the capital is divided into different classes of shares, all or any of the rights and privileges attached to each class may, subject to the provisions of section 108 of the ordinance, be modified, commuted, affected, abrogated or dealt with by agreement between the company and any person purporting to contract on behalf of that class provided such agreement is (a) ratified in writing by the holders of at least three-fourths in nominal value of the issued shares of the class or (b) confirmed by a special resolution passed at an extraordinary general meeting of the holders of shares of that class and all the provisions hereinafter contained as to general meetings, shall, mutatis mutandis, apply to every such meeting. This article shall not by implication curtail the power of modification which the company would have if this article were omitted.

III. MEETINGS

CONVENING OF GENERAL MEETINGS

50. Except as may be allowed under section 158(1) of the ordinance and listing requirements, the company shall hold a general meeting once at least in every calendar year within a period of four months following the close of its financial year in the town in which the office is situate and at such time and place as may be determined by the directors, provided that no greater interval than fifteen months shall be allowed to elapse between two such general meetings. The company may, for any special reason and with permission of the commission, extend the time within which any annual general meeting, not being the first such meeting, shall be held.

51. The company shall hold its annual general meeting in the town in which the registered office is situate; provided that, it may, for any special reason and with permission of the commission, hold the said meeting at any other place. Save as aforesaid, the company may hold its general meeting at two (2) or more venues using any technology that gives the members as a whole a reasonable opportunity to participate in the meetings.

52. All general meetings of the company, other than the statutory meeting or any annual general meeting, shall be called extraordinary general meetings, and shall be subject to listing requirements.

53. The directors may, whenever they think fit, and they shall, on the requisition of the holders of not less than one-tenth of the issued capital of the company, forthwith proceed to convene an extraordinary general meeting of the company. If at any time there are not within Pakistan sufficient directors capable of acting to form a quorum, any director of the company may call an extraordinary general meeting in the same manner as nearly as

possible as that in which meetings may be called by the directors, and in the case of such requisition the following provisions shall have effect:

(1) The requisition must state the objects of the meeting and must be signed by the requisitioners and deposited at the office and may consist of several documents in like form each signed by one or more requisitioners.

(2) If the directors do not proceed within twenty-one days from the date of the requisition being so deposited to cause a meeting to be called, the requisitioners or a majority of them in value may themselves convene the meeting, but any meeting so convened shall not be held after three months from the date of the deposit.

(3) Any meeting convened under this article by the requisitioners shall be convened in the same manner as nearly as possible as that in which meetings are to be convened by the directors but shall be held at the office.

(4) A requisition by joint-holders of shares must be signed by all such holders.

54. (1) Notice of a general meeting shall be sent in the manner hereinafter mentioned at least twenty one (21) days before the date on which the meeting is to be convened to all such persons as are under these articles or the ordinance entitled to receive such notices from the company and shall specify the place and the day and hour of the meeting and the nature of the business to be transacted thereat.

(2) In the case of an emergency affecting the business of the company, an extraordinary general meeting may be convened by such shorter notice than that specified in article 54(1) as the registrar may authorize.

(3) Where any special business, that is to say, business other than consideration of the accounts, balance sheet and the reports of the directors and auditors, the declaration of dividend, the appointment and fixation of the remuneration of auditors and, where the notice convening the meeting provides for the election of directors, the election of directors (all such matters being herein referred to as ordinary business) is to be transacted at a general meeting, there shall be annexed to the notice of such meeting a statement setting out all such facts as may be material for the consideration of such business including the nature and extent of the interest (whether direct or indirect) of any director, and where the item of business involves approval of any document, the time and place appointed for inspection thereof, and to the extent applicable such a statement shall be annexed to the notice also in the case of ordinary business to be transacted at the meeting.

(4) Where a resolution is intended to be proposed for consideration at a general meeting in some special or particular form, a copy thereof shall be annexed to the notice convening such meeting.

(5) If a special resolution is intended to be passed at a general meeting, the notice convening that meeting shall specify the intention to propose the resolution as a special resolution.

(6) A notice for a general meeting at which an election of directors is to take place shall state the number of directors to be elected at that meeting and the names of the

retiring directors.

(7) The notice of every general meeting shall prominently specify that a proxy may be appointed who shall have the right to attend, demand or join in demanding a poll and vote on a poll and speak at the meeting in the place of the member appointing him and shall be accompanied by a form of proxy acceptable to the company.

(8) The company shall comply with the provisions of section 160(1) and section 50 of the ordinance with regard to giving notices of general meetings.

55. The accidental omission to give any such notice to, or the non-receipt of notice by, any of the members shall not invalidate the proceedings at any such meeting.

PROCEEDINGS AT GENERAL MEETINGS

56. No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business; save as herein otherwise. provided ten (10) members present in person or by proxy representing twenty five percent (25%) of the total voting power shall be a quorum.

57. The chairman of the board of directors shall preside as chairman at every general meeting of the company, or if there is no such chairman, or if he shall not be present in person within fifteen minutes after the time appointed for the holding of the meeting or is unwilling to act, the chief executive shall preside as chairman of the meeting, or if the chief executive is absent or unwilling to act, any one of the directors present in person may be elected to be chairman of the meeting, or if no director be present in person, or if all the directors present in person decline to take the chair, the members present in person shall choose one of their member to be chairman of the meeting.

58. If within half-an-hour from the time appointed for the meeting, a quorum is not present, the meeting if convened upon such requisition as aforesaid shall be dissolved, but in any other case it shall stand adjourned to the same day in the next week at the same time and place, and if at such adjourned meeting a quorum is not present within half an hour from the time appointed for it, the meeting shall be dissolved.

59. The chairman may adjourn the meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for more than seven days, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.

60. In the case of an equality of votes the chairman shall, both on a show of hands and at the poll, have a casting vote in addition to the vote or votes to which he may be entitled as member.

61. (1) At any general meeting a resolution put to the vote of the meeting shall be decided on a

show of hands, unless a poll is (before or on the declaration of the result of the show of hands) demanded in accordance with paragraph (2) of this article, and unless a poll is so demanded, a declaration by the chairman of the meeting that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, and an entry to that effect in the book or electronic record of the proceeding of the company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, the resolution.

(2) Any of the following persons may demand a poll:

(a) The chairman of the meeting; or

(b) Ten members having the right to vote on the resolution and present in person or by proxy; or

(c) Any member or members present in person or by proxy having not less than one-tenth of the total voting power in respect of the resolution.

62. If a poll is demanded, as aforesaid, it shall be taken (subject to section 168 of the ordinance) in such manner and at such time and place as the chairman of the meeting directs, and either at once or after an interval or adjournment of not more than fourteen days from the day on which the poll is demanded, and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was held. The demand for a poll may be withdrawn at any time by the person or persons who made the demand. In case of any dispute as to the admission or rejection of a vote, the chairman of the meeting shall determine the same, and such determination made in good faith shall be final and conclusive.

63. Any poll duly demanded on the election of a chairman of a meeting or on any question of adjournment shall be taken at the meeting and without adjournment. A poll demanded on any other question shall be taken at such time, not being more than 14 days from the day on which the poll is demanded as the chairman of the meeting directs.

64 The demand of a poll shall not prevent the continuance of a meeting for the transaction of any business other than the question on which a poll has been demanded.

VOTES OF MEMBERS

65. Subject to section 160 and any rights or restrictions for the time being attached to any class or classes of shares, every member present in person (where all the participants of a general meeting can see each other) shall have, whether on a show of hands or on a poll, votes proportionate to the paid up value of the shares or other securities carrying voting rights held by him according to the entitlement of the class of such shares or securities, as the case may be provided that , the provisions of section 178 shall apply in the case of the election of directors.

66. Without prejudice to articles 69 and 79, on a show of hands, every member present in person shall have one vote and upon a poll every member present in person or by proxy

shall have one vote in respect of each share held by him. Provided always that in the case of an election or removal of a director, the provisions of articles 91 and 94 respectively shall apply.

67. On a poll a member entitled to more than one vote need not, if he votes, use all his votes or cast all the votes he uses in the same way.

68. Any company or other corporation which is a member of the company may by resolution of its directors or other governing body authorize such person as it thinks fit to act as its representative at any meeting of the company or of any class of members of the company, and the person so authorized shall be entitled to exercise the same powers on behalf of the company or corporation which he represents as that company or corporation could exercise if it were an individual member of the company, present in person. The production before or at the meeting of a copy of such resolution purporting to be signed by a director or the secretary of such company or corporation and certified by him as being a true copy of the resolution shall be accepted by the company as sufficient evidence of the validity of the appointment of such representative.

69. Any person entitled under article 39 to any shares may vote at any general meeting in respect thereof in the same manner as if he were the registered holder of such shares, provided that forty-eight hours at least before the time of holding the meeting or adjourned meeting, as the case may be, at which he proposes to vote he shall satisfy the directors of his right to such shares, or the directors shall have previously admitted his right to vote at such meeting in respect thereof. If any member be a lunatic, idiot or non compos mentis, he may vote, whether by a show of hands or at a poll, by his committee, curator bonis or other legal curator and such last mentioned persons may give their votes by proxy.

70. Where there are jointly registered holders of any share, any one of such persons may vote at any meeting either in person or by proxy in respect of such share as if he were solely entitled thereto; and if more than one of such joint-holders be present at any meeting, either in person or by proxy, that one of the said persons so present whose name stands first in the register in respect of such share shall alone be entitled to vote in respect thereof. Several executors or administrators of a deceased member in whose name any share stands shall for the purposes of this article be deemed joint holders thereof.

71. On a poll votes may be given either in person (including without limitation a representative of a company duly authorized under article 68) or by proxy.

72. No objection shall be raised to the qualification of any voter except at the meeting or adjourned meeting at which the vote objected to is given or tendered, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due time shall be referred to the chairman of the meeting, whose decision shall be final and conclusive.

73. The instrument appointing a proxy shall be in writing under the hand of the appointer

(such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance) or of his attorney duly authorized in writing (such expression shall exclude electronic transmission as prescribed by section 3 of the electronic transactions ordinance) or if such appointer is a corporation under its common seal or signed by an officer or an attorney duly authorized by it (such expression shall exclude any reference to the electronic transactions ordinance in accordance with section 31 (1) of the electronic transactions ordinance). Save as provided by article 80, no person shall be appointed a proxy who is not a member of the company and qualified to vote.

74. Subject to article 73 hereof, the instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed, or a copy of that power or authority duly notarized, shall be deposited (such expression shall hereinafter include, where permitted by law, receipt in accordance with section 15 of the electronic transactions ordinance) at the office not less than forty-eight hours before the time for holding the meeting at which the person named in the instrument proposes to vote, and in default the instrument of proxy shall not be treated as valid.

75. A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death or insanity of the principal or revocation of the instrument or transfer of the share in respect of which the vote is given, provided no intimation in writing of the death, insanity, revocation or transfer of the share shall have been received at the office before the meeting. Provided nevertheless that the chairman of any meeting shall be entitled to require such evidence as he may in his discretion think fit of the due execution of an instrument of proxy and that the same has not been revoked.

76. Every instrument appointing a proxy shall, as nearly as circumstances will admit, be in the form or to the effect following and shall be retained by the Company:

SIDDIQSONS ENERGY LIMITED

I, ______________________ of ______________________, being a member of SIDDIQSONS ENERGY LIMITED, hereby appoint ______________________ of ______________________ (or failing him ______________________ of ______________________ or failing him ______________________ of ______________________) as my proxy in my absence to attend and vote for me and on my behalf at the (Annual or Extraordinary, as the case may be) general meeting of the company to be held on the ______ day of ________ and at any adjournment thereof.

As witness my hand this ________ day of _______________.

Signed by the said

In the presence of

Provided always that an instrument appointed a proxy may be in the form set out in regulation 39 of table A of the first schedule to the ordinance.

IV. DIRECTORS

NUMBER OF DIRECTORS

77. Subject to the provisions of these articles and the ordinance, all directors shall be elected by the members in general meeting.

78. The company shall have at least six directors. Subject to the said minimum, the directors themselves shall determine from time to time in the manner provided in this article the number of directors that the company shall have. At least thirty-five (35) days before the date of every general meeting at which directors are intended to be elected, the directors shall fix the number of elected directors that the company shall have from the effective date of the election and the number of such directors who shall be elected at the meeting. The number of elected directors so fixed by the directors shall not be changed except with the prior approval of the company in general meeting. The following persons shall be the first directors of the Company and shall hold the office up to the date of First Annual General Meeting.

(1) Mr. Muhammad Tariq Rafi

(2) Mr. Abdur Rahim

(3) Mrs. Nighat Tariq

(4) Mrs. Rahma Ibrahim

(5) Mrs. Alia Sajjad

(6) Mrs. Anum Abdur Rahim

ALTERNATE DIRECTORS

79. When any director intends to be, or is living outside Pakistan, he may with the approval of the directors appoint any person to be his alternate director, and such alternate director during the absence of the appointer from Pakistan, shall be entitled to receive notice of and to attend and vote at meeting of directors and shall be subject to and entitled to the provisions contained in these articles with reference to directors and may exercise and perform all such powers, directions and duties as his appointer could have exercised or

performed including the power of appointing another alternate director. An alternate director so appointed shall not be required to hold any qualification. Such appointment shall be recorded in the director minute book. A director may at any time by notice in writing to the company remove an alternate director appointed by him. The alternate director shall cease to be such provided that if any director retires but is re-elected at the meeting at which such retirement took effect any appointment made by him pursuant to this article which was in force immediately prior to this retirement and re-election and which has not otherwise ceased to be effectively shall continue to operate after his re-election as if he had not so retired. An alternate director shall not be deemed to be the agent of the director appointing him but shall be reckoned as one with his appointer. All appointments and removals of alternate directors shall be effected by writing under the hand of the director making or revoking such appointment and left at the office. For the purpose of assessing a quorum in accordance with the provisions of article 99 hereof an alternate director shall be deemed to be director. Any director may act an alternate director for any one or more directors, as well as being able to act as a director in his own right. An alternate director may resign as such upon giving thirty (30) days prior notice to the board to this effect. An alternate director need not be a member of the Company.

80. Notwithstanding article 164, an alternate director, even if not a member, shall, in the absence of a direction to the contrary in the instrument appointing him, be entitled to notice of general meetings of the company and (subject to the provisions of article 73) to vote at such meetings on behalf of his appointer, if his appointer is a member of the company, and generally to represent his appointer.

81. Directors shall have power at any time and from time to time to appoint any person as Technical/Executive Director and such Technical/Executive Director may be appointed only for a fixed period in such special remuneration as may be determined by the Board. The number of such directors appointed shall not be counted within minimum or maximum fixed for number of directors in these articles. Such Technical/Executive Directors would be the senior executives of the company and will not have any representation on the Board of the company unless specially invited by the members to assist them in the proceedings of the meeting of the Board of Directors of the company.

CHIEF EXECUTIVE AND OTHER PRINCIPAL OFFICERS OF THE COMPANY

82. The company shall have an office of chief executive which shall be filled from time to time by the directors who may appoint a director or (subject to section 201 of the ordinance) any other person to be the chief executive of the company for a period not exceeding three years and on such terms and conditions as the directors may think fit, and such appointment shall be made within fourteen days from the date on which the office of chief executive falls vacant. If the chief executive at any time is not already a director he shall be deemed to be a director of the company notwithstanding that the number of directors shall thereby be increased and he shall be entitled to all the rights and privileges and shall be subject to all liabilities of the office of director. Upon the expiry of his period of office, a chief executive shall be eligible for re-appointment. The chief executive may be removed from office in accordance with the provisions of section 202 of the ordinance notwithstanding anything contained in these articles or in any agreement between the company and the

chief executive.

83. No person who is ineligible to become a director of the company shall be appointed or continue as the Chief Executive except as permitted by Section 187.

84. The Chief Executive retiring under Article 82 continue to perform his functions until his successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

85. The directors may appoint other principal officers of the company including chief operating officer, chief financial officer, head of internal audit and the company secretary (who is to be a full time employee of the company as required by section 204 A), and give such officer such designations and with such terms and conditions as the directors may determine from time to time.

86. A chief executive of the company shall receive such remuneration as the directors may determine and it may be made a term of his appointment that he be paid a pension and/or gratuity and/or other benefits on retirement from his office.

87. The directors may from time to time entrust to and confer upon the chief executive for the time being such of the powers exercisable under these articles by the directors as they may think fit, and may confer such powers for such time, and to be exercised for such objects and purposes, and upon such terms and conditions, and with such restrictions as they think expedient; and they may confer such powers, either collaterally with, or to the exclusion of, and in substitution for all or any of the powers of the directors in that behalf; and may from time to time revoke, withdraw, alter or vary all or any of such powers.

QUALIFICATION AND REMUNERATION OF DIRECTORS

88. Any director who serves on any committee or who devotes special attention to the business of the company, or who otherwise performs services which in the opinion of the directors are outside the scope of the ordinary duties of a director, may be paid such extra remuneration as the directors may determine from time to time. The remuneration of a director for attending meetings of the board shall from time to time be determined by the directors.

89. Each director of the company may, in addition to any remuneration receivable by him, be reimbursed his reasonable travelling and hotel expenses incurred in attending meetings of the directors or of the company or otherwise whilst employed on the business of the company.

90. The qualification of an elected director, in addition to his being a member, where required, shall be his holding share of the nominal value of Rs. 10 at least in his own name, but a director representing the interests of a member or members holding share of the nominal

value of Rs. 10 at least shall require no such share qualification. A director shall not be qualified as representing the interests of a member or members holding shares of the requisite value unless he is appointed as such representative by the member or members concerned by notice in writing addressed to the company specifying the shares of the requisite value appropriated for qualifying such director. Shares thus appropriated for qualifying a director shall not, while he continues to be such representative, be appropriated for qualifying any other director. A director shall acquire his share qualification within two (2) months from the effective date of his appointment as director.

91. The continuing directors may act notwithstanding any vacancy in their body so long as their number is not reduced below the number fixed by or pursuant to these articles as the necessary quorum of directors.

92. The office of a director shall ipso facto be vacated if:

(a) he ceased to hold the share qualification, if any, necessary for his appointment; or

(b) he is found to be an unsound mind by a court of competent jurisdiction; or

(c) he is adjudged an solvent; or has applied to be adjudicated as an insolvent and his application is pending or is an un-discharged insolvent; or

(d) he has been convicted by a court of law for an offence involving moral turpitude;

(e) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the company in general meeting accepts or holds any office of profit under the company other than that of a chief executive or legal or technical adviser or a banker in contravention of the provisions of section 188 (i) (c) of the ordinance;

(f) he absents himself from three consecutive meetings of the directors or from all meetings of the directors for a continuous period of three months, whichever is the longer, without leave of absence from the board of directors; or

(g) he or any firm of which he is a partner or any private company of which he is a director accepts a loan or guarantee from the company in contravention of section 195 of the ordinance; or

(h) he acts in contravention of section 214 of the ordinance; or

(i) by notice in writing to the company he resigns his office; or

(j) he is removed from office by resolution of the company in general meeting in accordance with section 181 of the ordinance; or

(k) his appointment is withdrawn by the authority nominating him as director; or

(l) he has betrayed lack of fiduciary behavior and a declaration to the effect has been made by the court under section 217 of the ordinance at any time during the preceding five years.

93. Subject to authorization being given by the directors in accordance with section 196(2)(g)

of the ordinance, a director shall not be disqualified from contracting with the company either as vendor, purchaser or otherwise, nor shall any such contract or arrangement entered into by or on behalf of the company with any company or partnership of or in which any director of the company shall be a member or otherwise interested, be avoided, nor shall any such director so contracting or being such member or so interested be liable to account to the company for any profit realized by any such contract or arrangement by reason of such director holding that office or of the fiduciary relationship so established. A director who, or whose spouse or minor child, is in any way, whether directly or indirectly, concerned or interested in any contract or arrangement or proposed contract or arrangement with the company shall disclose the nature of such concern or interest in accordance with section 214 of the ordinance that is to say:

(a) in the case of a contract or arrangement to be entered into, at the meeting of the directors at which the question of entering into the contract or arrangement is first taken into consideration or, if the director was not, on the date of that meeting, concerned or interested in the contract or arrangement, at the first meeting of the directors held after he becomes so concerned or interested; and

(b) in the case of any other contract or arrangement, at the first meeting of the directors held after the director becomes concerned or interested in the contract or arrangement.

A general notice that any director of the company is a director or a member of any other named company or is a member of any named firm and is to be regarded as interested in any subsequent transaction with such company or firm shall, as regards any such transaction, be sufficient disclosure under this article. Provided, however, that any such general notice shall expire at the end of the financial year in which it was given and may be renewed for a further period of one financial year at a time by giving fresh notice in the last month of the financial year in which it would otherwise expire.

94. Except as provided in Section 216 of the Ordinance, a Director shall not vote in respect of any contract or arrangement in which he is either directly or indirectly concerned or interested nor shall his presence count for the purpose of forming a quorum at the time of any such vote and if he does so vote, his vote shall not be counted.

95. Whereby any contract or resolution of the directors an appointment or a variation in the terms of an existing appointment is made (whether effective immediately or in the future) of a chief executive, whole time director or secretary of the company, in which appointment of any director of the company is, or after the contract or resolution becomes, in any way, whether directly or indirectly, concerned or interested, or whereby any contract or resolution of the directors, an appointment or a variation in the terms of appointment is made (whether effective immediately or in the future) of a chief executive, the company shall inform the members of such appointment or variation in the manner required by section 218 of the ordinance and shall comply with the requirements of that section in regard to the maintaining of such contracts and resolutions open for inspection by members at the office, the provision of certified copies thereof and extracts there from and otherwise.

96. In accordance with section 219, the company shall maintain at its office a register or electronic record, in which shall be entered separately particulars of all contracts, arrangements or appointments in which the directors are interested. Such register or electronic record shall be open to inspection to the members during business hours, subject to any reasonable restriction that may be imposed by the company in general meeting.

97. A director of the company may be or become a director of any other company promoted by the company or in which the company may be interested as a vendor, shareholder or otherwise, and no such director shall be accountable for any benefits received as a director or member of such other company.

ELECTION OF DIRECTORS

98. The number of directors determined by the directors under articles 78 shall be elected to office by the members in general meeting in the following manner, namely:

(a) a member present in person or by proxy shall have such number of votes as is equal to the product of voting shares held by him and the number of directors to be elected,

(b) a member may give all his votes to a single candidate or divide them between more than one of the candidates in such manner as he may choose, and

(c) the candidate who gets the highest number of votes shall be declared elected as director and then the candidate who gets the next highest number of votes shall be so declared, and so on until the total number of directors to be elected has been so elected.

If the number of persons who offer them to be elected as directors is not more than the number of vacancies for which elections are being held, such persons being otherwise eligible shall be deemed to have been elected as directors from the date on which the election was proposed to be effective.

99. A director elected under article 98 shall hold office for a period of three years unless he earlier resigns or becomes disqualified from being a director, or otherwise ceases to hold office.

100. A retiring director of the company shall be eligible for re-election.

101. The company in general meeting may remove a director from office by a resolution passed with the requisite number of votes determined in accordance with the provisions of section 181 of the ordinance.

102. Any casual vacancy occurring among the directors may be filled up by the directors within a time period prescribed by the code, and the person so appointed shall hold office for the remaining period of the director in whose place he is appointed. Provided that the directors may not fill a casual vacancy by appointing any person who has been removed from the office of a director of the company under article 101.

103. No person including a retiring director of the company shall be eligible for election to the office of director of the company at any general meeting unless he has, not less than fourteen days before the date of the meeting, left at the office, a notice in writing, and duly signed, signifying his candidature for the office.

104. The company shall keep at the office a register of the directors and officers, containing the particulars required by section 205 of the ordinance and the company shall otherwise comply with the provisions of that section as regards furnishing returns to the registrar and giving inspection of the register.

PROCEEDINGS OF DIRECTORS

105. The directors shall meet together at least once in each quarter of a year for the despatch of business, adjourn and otherwise regulate their meetings and proceedings as they may think fit in accordance with the ordinance, the code and the listing requirements. Questions arising at any meeting shall be decided by a majority of votes and in case of an equality of votes the chairman shall have a second or casting vote.

106. The quorum necessary for the transaction of the business of the directors shall be one-third of the number of directors or two directors, whichever is greater, present in person. An alternate director whose appointment is effective shall be counted in a quorum. If all the directors except one are disqualified from voting, the matter should be decided in general meeting.

107. A director may, and the secretary on the requisition of a director shall, at any time summon a meeting of the directors. Such meetings may be held using any technology consented to by all the directors, including but not limited to telephone and video conferencing. The consent may be a standing one, withdrawable by a director only within a reasonable period of time before the meeting. It shall not be necessary to give notice of a meeting of directors to any director for the time being absent from Pakistan.

108. The board of directors of the company shall from time to time elect one of the directors as chairman of the board of directors of the company and determine the period for which he is to hold office and his remuneration. The chairman or in his absence the chief executive shall preside over all meetings of the board of directors, but if at any meeting neither the chairman nor the chief executive is present in person within half an hour of the time appointed for holding the same, the directors present in person may choose one of their member to be chairman of the meeting.

109. A meeting of the directors at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretion by or under these articles for the time being vested in or exercisable by the directors generally.

110. The directors may from time to time delegate of their powers to committees consisting of such two members or more members of their body as they think fit, and may from time to time revoke such delegation. Any committee so formed shall, in the exercise of the

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110. The directors may from time to time delegate of their powers to committees consisting of such two members or more members of their body as they think fit, and may from time to time revoke such delegation. Any committee so formed shall, in the exercise of the

powers so delegated, conform to any regulations that may from time to time be imposed upon it by the directors.

111. The meeting and proceedings of any such committee consisting of two or more members shall be governed by the provisions herein contained for regulating the meetings and proceedings of the directors, so far as the same are applicable thereto and are not superseded by any regulations made by the directors under article 110.

112. All acts done by any meeting of the directors or by a committee of the directors or by any person acting as a director of the company shall, notwithstanding that is shall afterwards be discovered that there was some defect in the appointment or continuance in office of any such directors or person acting as aforesaid, or that they or any of them were disqualified or had vacated office, or were not entitled to vote, be as valid as if every such person had been duly appointed or had duly continued in office and was qualified and had continued to be a director and had been entitled to be a director. Provided that nothing in this article shall be deemed to give validity to acts done by any such director after the appointment of such director has been shown to be invalid.

113. A resolution, other than resolution in respect of any matter specified in section 196(2) of the ordinance circulated through fax or email or any form of electronic transmission to all the directors for the time being entitled to receive notice of a meeting of the directors, passed without any meeting of the directors or of a committee of directors and signed or affirmed through fax or email or any form of electronic transmission, by a majority of all directors in writing under the hands of all directors (or in their absence their alternate directors) for the time being in Pakistan, being not less than the quorum required for meetings of the directors, or as the case may be of the members of the committee, shall be valid and effectual as if it had been passed at the meeting of the directors, or as the case may be of such committee, duly called or constituted. The resolution in writing of the company may consist of several copies of a document signed by one or more director(s) and takes effect at the date and time on which the last director, necessary for the resolution to be passed, signs a copy of the resolution; or a record of several signed electronic messages each indicating the identity of the sender, the text of the resolution and the sender's agreement or disagreement to the resolution, as the case may be and such a resolution takes effect on the date on which the last director's message, necessary for the resolution to be passed, is received.

114. If any director of the company, being willing, shall be called upon to perform extra services or to make any special exertions in going or residing away from his place of business for the time being for any of the purposes of the company or in giving special attention to the business of the company as a member of a committee of the directors, the company may remunerate such director so doing either by a fixed sum or by a percentage of profits or otherwise as may be determined by the directors, and such remuneration may be either in addition to or in substitution for his or their share in the remuneration above provided for the directors.

MINUTES

115. The directors shall cause minutes to be duly entered in books provided for the purpose of or as an electronic record, of:

(a) all appointments of officers;

(b) the names of the directors present in person at each meeting of the directors and of any committee of the directors;

(c) all orders made by the directors and committees of the directors;

(d) all resolutions and proceedings of general meeting and of meetings of the directors and of the committees of the directors;

and any such minutes of any meeting of the directors or of any such committee or of the company, if purporting to be signed by the chairman of such meeting or by the chairman of the next succeeding meeting, shall be prima facie evidence of the matter stated in such minutes.

POWERS AND DUTIES OF DIRECTORS

116. The directors shall duly comply with the provisions of the ordinance, the listing requirements and the code. In particular and without prejudice to the generality of the foregoing, the company shall comply with the provisions of the ordinance in regard to the registration of the particulars of mortgages and charges affecting the property of the company or created by it, to the keeping of a register of the directors, and to the sending to the registrar of an annual list of members and a summary of particulars relating thereto, and notice of any consolidation or increase of share capital, sub-division of shares, and copies of special resolutions and a copy of the register of directors and notifications of any changes therein. All such information may be stored as an electronic record and transmitted accordingly, where possible.

117. The control of the company shall be vested in the directors, and the business of the company shall be managed by the directors who may exercise all such powers of the company and do all such acts and things as may be exercised or done by the company as by the ordinance or by these articles or by a special resolution expressly directed or required to be exercised or done by the company in general meeting, subject nevertheless to any regulations of these articles, to the provisions of the ordinance, and to such regulations being not inconsistent with the aforesaid regulations or provisions, as may be prescribed by the company in general meeting; but no regulation made by the company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.

118. Without prejudice to the general powers conferred by article 117 and to any other powers or authorities conferred by these articles on the directors, it is hereby expressly declared that the directors shall have the following powers, that is to say, power:

(1) To purchase or otherwise acquire for the company any property, rights or privileges which the company is authorized to acquire at such price and generally on such terms and conditions as they think fit, and to sell, let, exchange or otherwise dispose

of absolutely or conditionally any part of the property, privileges and undertaking of the company upon such terms and conditions, and for such consideration, as they may think fit.

(2) At their discretion to pay for any property, rights, privileges acquired by or services rendered to the company either wholly or partially in cash or in shares (subject to the provisions of section 86 of the ordinance) bonds, debentures or other securities of the company. Any such bonds, debentures or other securities may be either specifically charged upon all or any part of the property of the company or not so charged.

(3) To open account with any bank or financial institution and deposit into and withdraw money from such accounts from time to time.

(4) To make, draw, endorse, sign, accept, negotiate and give all cheques, bills of lading, drafts, orders, bills of exchange, and other promissory notes and negotiable instruments required in the business of the company.

(5) To secure the fulfillment of any contracts, agreements or engagements entered into by the company by mortgage or charge of all or any of the property of the company for the time being or in such other manner as they may think fit.

(6) Subject to the provisions of the ordinance, to appoint and at their discretion remove or suspend such agents (other than Managing Agents), managers, secretaries, officers, employees for permanent, temporary or special services as they may from time to time think fit, and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as they think fit.

(7) To appoint any person or persons (whether incorporated or not) to accept and hold in trust for the company any property belonging to the company or in which it is interested or for any other purposes, and to execute and do all such deeds, documents and things as may be requisite in relation to any such trust and to provide for the remuneration of such trustee or trustees.

(8) To institute, conduct, defend, compound or abandon any legal proceedings by or against the company or its officers or otherwise concerning the affairs of the company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company.

(9) To refer claims or demands by or against the company to arbitration and observe and perform the awards.

(10) To make and give receipts, releases and other discharges for money payable to the company and for the claims and demands of the Company.

(11) To act on behalf of the company in all matters relating to bankrupts and insolvents.

(12) To determine who shall be entitled to sign on the company's behalf bills, notes, receipts, acceptances, endorsements, cheques, releases, contracts and documents.

(13) From time to time to provide for the management of the affairs of the company either in different parts of Pakistan or elsewhere in such manner as they think fit, and in particular to establish branch offices and to appoint any persons to be the attorneys or agents of the

company with such powers (including power to sub-delegate) and upon such terms as may be thought fit.

(14) To invest and deal with any of the moneys of the company not immediately required for the purposes thereof upon such securities and in such manner as they may think fit, and from time to time to vary or realize such investments.

(15) To execute in the name and on behalf of the company in favour of any director of the company or other person who may incur or be about to incur any personal liability for the benefit of the company, such mortgages of the company's property (present and future) as they think fit, and any such mortgage may contain a power of sale and such other powers, covenants and provisions as shall be agreed on.

(16) To give to any person employed by the company, a commission on the profits of any particular business or transaction or a share in the general profits of the company, and such commission or share of profits shall be treated as part of the working expenses of the company.

(17) To enter into all such negotiations and contracts and rescind and vary all such contracts and execute and do all such acts, deeds and things in the name and on behalf of the company as they may consider expedient for or in relation to any of the matters aforesaid or otherwise for the purposes of the company.

(18) To establish, maintain, support and subscribe to any charitable or public object, and any institution, society, or club which may be for the benefit of the company or its employees, or may be connected with any town or place where the company carries on business; to give pensions, gratuities, or charitable aid to any person or persons who have served the company or to the wives, children, or dependants of such person or persons, that may appear to the directors just or proper, whether any such person, his widow, children or dependants, have or have not a legal claim upon the company.

(19) Subject to the provisions of section 227 of the ordinance, before recommending any dividends, to set aside portions of the profits of the company to form a fund to provide for such pensions, gratuities, or compensation; or to create any provident or benefit fund in such or any other manner as to the directors may seem fit.

(20) Subject to the provision of the ordinance to accept from any member on such terms and conditions as shall be agreed a surrender of his shares or any part thereof.

(21) To make advances and loans without security or on such security as they may deem proper and as permissible under the law.

(22) To make and alter rules and regulations concerning the time and manner of payment of the contributions of the employees and the company respectively to any such funds and the accrual,

127. Every register of holders of debentures of the company may be closed for any periods not exceeding in the whole forty five days in any year and not exceeding thirty days at a time. Subject as aforesaid, every such register shall be open to the inspection of members or debenture holders. But the company may in general meeting impose any reasonable restrictions, so that at least two hours, in each day when such register is open, for inspection.

128. Subject to the provisions of section 76 of the ordinance, no transfer of registered debentures shall be registered unless a proper instrument of transfer duly stamped and executed by the transferor and transferee has been delivered to the company together with the certificate or certificates of the debentures.

129. If the directors refuse to register the transfer of any debentures, they shall, within thirty days from the date on which the instrument of transfer was lodged with the company, send or cause to be sent to the transferee and transferor notice of the refusal.

130. The company shall comply with the provisions of section 136 of the ordinance as to allowing inspection of copies kept at the office in pursuance of section 130 of the ordinance, and as to allowing inspection of the register of mortgages to be kept at the office in pursuance of section 135 of the ordinance.

131. The company shall comply with the provisions of sections 113 and 150 of the ordinance as to supplying copies of any register of holders of debentures or of any trust deed for securing any issue of debentures.

LOCAL MANAGEMENT

132. Subject to the provisions of sections 206 and 207 of the ordinance, directors may from time to time provide for the management of the affairs of the company outside Pakistan or in any special locality in Pakistan in such manner as they shall think fit and the following provisions shall operate without prejudice to the general powers hereby conferred.

(1) The directors may from time to time and at any time establish any local boards or agencies for managing any of the affairs of the company outside Pakistan or in any specified locality in Pakistan and may appoint any persons to be members of such local board or any managers or agents and may fix their remuneration.

(2) The directors may from time to time and at any time delegate to any persons so appointed any of the powers, authorities and discretions for the time being vested in the directors and may authorize the members for the time being of any such local board or any of them to fill up any vacancies therein and to act notwithstanding vacancies and any such appointment or delegation may be made on such terms and subject to such conditions as the directors may think fit; and the directors may at any time remove any person so appointed and may annul or vary any such delegation.

(3) The directors may at any time and from time to time, by power of attorney under the seal of the company, appoint any person to be the attorneys of the company for such purposes and with such powers, authorities and discretions (not exceeding those

122. The Directors shall establish management committees to comply with the requirements of the code of the corporate governance and their own requirements for effective management and control. The Directors shall nominate members for each committee which may be from the board of directors or outside the board.

BORROWING POWERS

123. (1) The directors may exercise all the powers of the company to borrow money and to mortgage or charge its undertaking, property and assets (both present and future), and to issue debentures, debenture stocks, and other securities, whether outright or as collateral security for any debt, liability or obligation of the company or of any third party.

(2) In exercising the powers of the company aforesaid the directors may, from time to time and on such terms and conditions as they think fit, raise money from banks and financial institutions and from other persons under any permitted system of financing, whether providing for payment of interest or some other form of return, and in particular the directors may raise money on the basis of the mark up on price, musharika, modaraba or any other permitted mode of financing, and without prejudice to the generality of the foregoing the directors may exercise all or any of the powers of the company arising under section 19(2) of the ordinance.

(3) In regard to the issue of securities the directors may exercise all or any of the powers of the company arising under sections 19(2), 87 and 120 of the ordinance and in particular the directors may issue any security as defined in section 2(1)(34) of the ordinance or may issue any instrument or certificate representing redeemable capital as defined in section 2(1)(30A) of the ordinance or participatory redeemable capital as defined in section 2(1)(25) of the ordinance.

124. Debentures, debenture-stock, bonds and other securities may be made assignable free from any equities between the company and the person to whom the same may be issued.

125. Any debentures, debenture-stock, bonds or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawing, allotment of shares, attending and voting at general meetings of the company, appointment of directors of the company or otherwise.

126. The directors shall cause a proper register to be kept in accordance with the provisions of section 135 of the ordinance, of all mortgages and charges specifically affecting the property of the company, and shall duly comply with the provisions of the sections of the ordinance, namely, sections 121 and 122 (Registration of mortgages and charges), section 128 (Endorsement of certificates), section 129 (Filing of prescribed particulars), section 130 (Keeping of a copy of every instrument creating any mortgage or charge by the company at the office) and section 132 (Giving of intimation of the payment or satisfaction of any charge or mortgage created by the company).

signed by the chief executive and at least one director but if on account of his absence from Pakistan or other reason the signature of the chief executive cannot be obtained, the balance sheet and profit and loss account shall be signed by at least two directors for the time being in Pakistan, and in every such case a statement signed by those two directors shall be subjoined to the balance sheet and profit and loss account stating the reason why the signature of the chief executive was not obtained.

(3) The directors may authorize the chairman or the chief executive to sign the report of the directors which may then be signed accordingly, but in the absence of any such authority the report of the directors shall be signed as required by section 236(3) of the ordinance in the same manner as the balance sheet and profit and loss account.

138. (1) A copy of the balance sheet, profit and loss account and the reports of the directors and auditors shall be sent not less than twenty one (21) days before the date of the annual general meeting to the members and other persons entitled to receive notices of general meetings in the manner in which notices are to be given hereunder and a copy thereof shall be kept for a period of at least fourteen (14) days before the meeting at the office for inspection by members. The company shall send, each stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), and to the registrar of companies and to the commission, five copies (or such number as may be prescribed from time to time), each of the balance sheet, profit and loss account and the reports of the directors and auditors at the same as they are dispatched to the members and other persons in accordance with this article.

(2) After the balance sheet, profit and loss account and the reports of the directors and auditors have been laid before the annual general meeting of the company, three copies thereof (or, such larger number as may be prescribed under section 242(1) of the ordinance) signed by the signatories thereto shall be filed with the registrar within thirty days from the date of the meeting and the company shall also comply with the provisions of section 242(2) of the ordinance where applicable.

(3) Subject to provisions of sections 245 and the listing requirements, the company shall, within one month from the close of the first and third quarters and two month from the close of the second quarter, of the year of account of the company, prepare and transmit to the members one copy and to stock exchange listing the shares of the company three hundred copies (or such number as may be prescribed from time to time), each of the profit and loss account for that quarter and of the balance sheet as at the end of that quarter. Such quarterly profit and loss accounts and balance sheets need not to be audited but must be signed in the same manner as the annual profit and loss accounts and balance sheets are required to be signed. The directors shall also send, to the commission and to the registrar three copies (or such number as may be prescribed for the time being under section 245(1) (b) of the ordinance), each of such quarterly profit and loss accounts and balance sheets at the same time as they are sent to the members in accordance with this article.

(4) The company may with the consent of shareholders and consultation of respective stock exchange(s), transmit quarterly accounts through web site of the company

vested in or exercisable by the directors under these articles) and for such period and subject to such conditions as the directors may from time to time think fit; and any such appointment may, if the directors think fit, be made in favour of all or any of the members of any local board established as aforesaid, or in favour of any company or of the members directors, nominees or managers of any company or firm, and any such power of attorney may contain such provisions for the protection or convenience of persons dealing with such attorneys as the directors think fit.

(4) Any such delegates or attorneys as aforesaid may be authorised by the directors to sub-delegate all or any of the powers, authorities and discretions for the time being vested in them.

V. ACCOUNTS AND DIVIDENDS

BOOKS OF ACCOUNT

(References to books of account, balance sheet, profit and loss accounts and auditors' report shall hereinafter mutatis mutandis include all electronic forms of record or storage of the company.)

133. The directors shall cause to be kept proper books of account with respect to the matters set out in section 230 of the ordinance.

134. The books of account shall be kept at the office or at such other place as the directors think fit, and shall be open to inspection by the directors during business hours. If the directors decide to keep the books of account at a place other than the office they shall comply with the directions contained in the proviso to section 230(1) of the ordinance.

135. The company shall preserve in good order the books of account of the company in respect of any financial year for a period of ten years following the close of that year or otherwise as provided in the section 230(6) of the ordinance.

136. The directors shall from time to time determine whether and to what extent and at what times and places and under what conditions or regulations the accounts and books of the company or any of them shall be open to the inspection of the members, and no member (not being a director of the company) shall have any right of inspecting any account or book or document of the company except as conferred by law or authorized by the directors or by the company in general meeting.

137. (1) The directors shall arrange to place before the annual general meeting of the company in every year a duly audited balance sheet and profit and loss account, conforming to the requirements of section 234, 237 and 238 of the ordinance and made up to a date not more than four months before the date of such meeting and having the auditor's report attached thereto, and a report of the directors conforming to the requirements of section 236 of the ordinance.

(2) As required by section 241 of the ordinance the balance sheet and profit and loss account shall first be approved by the directors and when so approved shall be

security of the company, or paid-up shares, debentures, debenture-stock or other security of any other company, or in any one or more of such ways.

150. Any general meeting may resolve that any moneys, investments, or other assets forming part of the undivided profits of the company standing to the credit of the reserve fund referred to in article 157 or in the hands of the company and available for dividend (or representing premiums received on the issue of shares and standing to the credit of the share premium account) be capitalized and distributed amongst such of the members as would be entitled to receive the same if distributed by way of dividend and in the same proportion on the footing that they become entitled thereto as capital and that all or any part of such fund be applied on behalf of such members in paying up in full any un-issued shares, debentures, debenture-stock or other security of the company, which shall be distributed accordingly, and that such distribution or payment shall be accepted by such members in full satisfaction of their interest in the said capitalized sum.

151. For the purpose of giving effect to any resolution under article 149 or article 150, the directors may settle any difficulty which may arise in regard to the distribution as they think expedient and may fix the value for distribution of any specific assets and may determine that cash payments shall be made to any members upon the footing of the value so fixed in order to adjust the rights of all parties and may vest any such cash or specific assets in trustees upon such trusts for the persons entitled to the dividend or capitalized fund as may seem expedient to the directors. Where requisite a proper contract shall be filed in accordance with the provisions of section 73 of the ordinance, and the directors may appoint any person to sign such contract on behalf of the persons entitled to the dividend or capitalized fund, and such appointment shall be effective.

152. A transfer of shares shall not pass the rights to any dividend declared thereon before the registration of the transfer.

153. The directors may retain the dividends payable upon shares in respect of which any person is under article 38 entitled to become a member or which any person under that article is entitled to transfer until such person shall become a member in respect thereof or shall duly transfer the same.

154. Any one of several persons who are registered as the joint-holders of any share may give effectual receipts for all dividend and payments on account of dividends in respect of such share.

155. The dividend in respect of any share shall be paid to the registered holder of such share or to his banker or to a financial institution (as defined in section 2(1) (15A) of the ordinance) nominated by him for the purpose. Unless otherwise directed, any dividend may be paid by cheque or warrant sent through post to the registered address of the member or person entitled thereto, or, in the case of joint-holders, to the registered address of that one whose name stands first on the register in respect of the joint-holding, or to such financial institution or bank as the member or person entitled thereto or such joint-holders, as the case may be,

subject to the approval of the commission.

139. The directors shall in all respects comply with the provisions of sections 230 to 247 of the ordinance, or any statutory modification thereof for the time being in force.

ANNUAL RETURNS

140. The company shall make the requisite annual returns in accordance with the provisions of section 156 of the ordinance.

DIVIDENDS

141. The company in general meeting may declare dividends, but no dividend shall exceed the amount recommended by the directors, provided that the company in general meeting may declare a smaller dividend.

142. No dividend shall be paid otherwise than out of the profits of the year or any other undistributed profits, and in the determination of the profits available for dividends the directors shall have regard to the provisions of the ordinance and in particular to the provisions of sections 83, 235 and 248 of the ordinance.

143. The declaration of the directors as to the amount of the net profits of the company shall be conclusive.

144. The directors may from time to time pay to the members such interim dividends as in their judgment the position of the company justifies.

145. All dividends shall be declared and paid according to the amounts paid on the shares. All dividends shall be apportioned and paid proportionally to the amounts paid or credited as paid on the shares during any portion or portions of the period in respect of which the dividend is paid; but if any share is issued on terms providing that it shall rank for dividend as from a particular date such share shall rank for dividend accordingly.

146. All dividends declared shall be paid within the periods specified in section 251 of the ordinance.

147. No dividend payable in respect of a share shall bear interest against the company.

148. The directors may retain any dividends on which the company has a lien and may apply the same in or towards satisfaction of the debts, liabilities or engagements in respect of which the lien exists.

149. Any general meeting declaring a dividend may resolve that such dividend be paid and satisfied wholly or in part in cash or by the distribution of specific assets, and in particular by the distribution of paid-up shares, debentures, debenture-stock or other

direct, and every cheque or warrant so sent shall be made payable to the order of the person to whom it is sent, or to the order of the institution or bank, directed as aforesaid.

156. All dividends unclaimed for one year after having been declared may be invested or otherwise made use of by the directors for the benefit of the company until claimed and all dividends unclaimed for three years after having been declared may be forfeited by the directors for the benefit of the company, but the directors may annul the forfeiture wherever they may think proper.

RESERVE AND DEPRECIATION FUNDS

157. The directors may from time to time before recommending any dividend set apart any and such portion of the profits of the company as they think fit as a reserve fund to meet contingencies or for the liquidation of any debentures, debts or other liabilities of the company, for equalization of dividends or for repairing, improving, and maintaining any of the property of the company, and for such other purposes of the company as the directors in their absolute discretion think conducive to the interests of the company; and may invest the several sums so set aside upon such investments (other than shares of the company) as they may think fit, and from time to time deal with and vary such investments, and dispose of all or any part thereof for the benefit of the company, and may divide the reserve fund into such special funds as they think fit, with full power to employ the reserve funds or any part thereof in the business of the company, and that without being bound to keep the same separate from the other assets.

158. The directors may, from time to time before recommending any dividend, set apart any and such portion of the profits of the company, as they think fit, as a depreciation fund applicable at the discretion of the directors, for providing against any depreciation in the investment of the company or for rebuilding, restoring, replacing or for altering any part of the buildings, work, plant, machinery, or other property of the company destroyed or damaged by fire, flood, storm, tempest, earthquake, accident, riot, wear and tear, or any other means whatsoever, and for repairing, altering and keeping in good condition the property of the company, or for extending and enlarging the buildings, machinery and property of the company with full power to employ the assets constituting such depreciation fund in the business of the company, and that without being bound to keep the same separate from the other assets.

159. All moneys carried to the reserve fund and depreciation fund respectively shall nevertheless remain and be profits of the company applicable, subject to due provision being made for actual loss or depreciation, for the payment of dividends and such moneys and all the other moneys of the company not immediately required for the purposes of the company may be invested by the directors in or upon such investment or securities as they may select or may be used as working capital or may be kept at any bank on deposit or otherwise as the directors may from time to time think proper.

160. The directors may also carry forward any profits which they may think prudent not to distribute, without setting them aside as a reserve.

thereof and may award by whom, and to whom, and in what manner the same shall be borne and paid.

XII. WINDING UP

183. If the company shall be wound up and the assets available for distribution among the members, subject to the rights attached to any preference share capital, as such shall be insufficient to repay the whole of the paid-up capital, such assets shall be distributed so that as nearly as may be the losses shall be borne by the members in proportion to the capital paid up on the shares held by them respectively. And if in a winding up the assets available for distribution among the members shall be more than sufficient to repay the whole of the capital paid up at the commencement of the winding up, the excess shall be distributed amongst the members in proportion to the capital at the commencement of the winding up, paid up on the shares held by them respectively. But this article is to be without prejudice to the rights of the holders of shares issued upon special terms and conditions.

184. If the company shall be wound, whether voluntarily or otherwise, the liquidator may with the sanction of a special resolution divide among the members in specie or kind any part of the assets of the company, and may with the like sanction vest any part of the assets of the company in trustees upon such trusts for the benefit of the members or any of them as the liquidator with the like sanction shall think fit.

XIII. INDEMNITY

185. Every director or officer of the company and every person employed by the company as auditor shall be indemnified out of the funds of the company against all liability incurred by him as such director, officer or auditor in defending any proceedings, whether civil or criminal, in which judgment is given in his favour, or in which he is acquitted, or in connection with any application under section 488 of the ordinance in which relief is granted to him by the court.

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situate, shall be deemed to be duly given to him on the day on which the advertisement appears.

167. A notice may be given by the company to the joint-holders of a share by giving the notice to the joint-holder named first in the register in respect of the share.

168. A notice may be given by the company to the persons entitled to a share in consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of representatives of the deceased, or assignee of the insolvent or by any like description, at the address (if any) in Pakistan supplied for the purpose by the persons claiming to be so entitled or addressing it in a similar manner and dispatching it to a designed electronic address or until any such address has been so supplied, by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

169. Notice of every general meeting shall be given in same manner hereinbefore authorized to (a) every member of the company except those members who (having no registered address within Pakistan) have not supplied to the company either a postal address within Pakistan or electronic address for the giving of notices to them, and also to (b) every person entitled to a share in consequence of the death or insolvency of a member, who but for his death or insolvency would be entitled to receive notice of the meeting. Subject to the provisions of articles 80 and section 255(6), no other person shall be entitled to receive notices of general meetings.

170. Any notice required to be given by the company to the members or any of them and not expressly provided for by these articles shall be sufficiently given, if given by advertisement.

171. Any notice required to be or which may be given by advertisement shall be advertised once in a newspaper circulating in the province in which the office is situate and in at least one issue each of a daily newspaper in the English language and a daily newspaper in the Urdu language circulating in the province in which the stock exchange on which the company is listed is situate.

172. Any notice given by advertisement shall be deemed to have been given on the day on which the advertisement shall first appear.

173. Every person who by operation of law, transfer or other means whatsoever shall become entitled to any share shall be bound by every notice in respect of such share which previously to his name and address being entered on the register shall be duly given to the person from whom he derives his title to such shares.

174. Any notice or document delivered or sent by post to or left at the registered address of any member in pursuance of these articles shall, notwithstanding that such member may be then deceased and whether or not the company shall have received notice of his decease, be

holders, as the case may be, for any time or times not exceeding in the whole forty-five (45) days in a year and not exceeding thirty (30) days at a time, in accordance with section 151.

3. The notice of a general meeting of the company, whether annual or extraordinary general meeting, shall be published in at least one (1) issue each of daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 158(3) and 159(7).

4. All notices received by the company in pursuance of section 178 (3) for election as a director, shall be transmitted to the members not later than seven (7) days before the date of the general meeting at which the directors are to be elected, by publication in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the Province in which the stock exchange(s) on which the Company's securities are listed is / are situated, in accordance with section 178 (4).

5. If a resolution is to be passed at the company's annual general meeting appointing as auditors a person other than a retiring auditors, the company shall, not less seven (7) days before the date fixed for the annual general meeting, publish in at least one (1) issue each of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 253 (2).

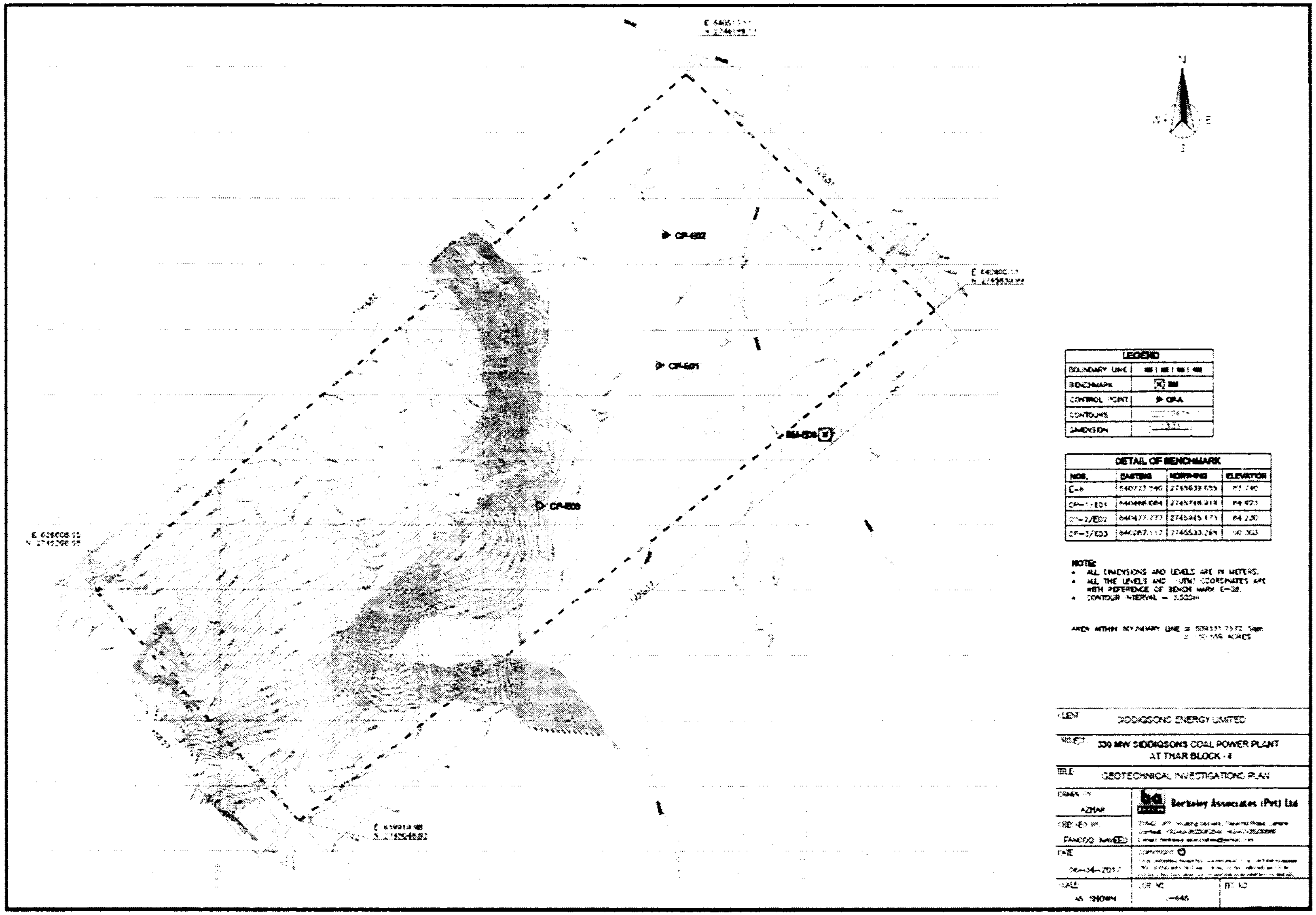
6. Notice of any resolution for winding up a company voluntarily under section 358, shall be given by the company within ten (10) days of the passing of the same by advertisement in the official Gazette of Pakistan, and also in a newspaper circulating in the province where the office of the company is situated and, in addition, shall also published in at least one (1) issue of a daily newspaper in English language and a daily newspaper in Urdu language having circulation in the province in which the stock exchange(s) on which the company is listed is / are situated, in accordance with section 361 (1).

IX. AMALGAMATION, DIVISION AND RECONSTRUCTION

178. Subject to and in accordance with the provisions of section 287, the company may reconstruct, amalgamate into another company or divide into two (2) or more companies in the process of which the whole or any part of the undertaking, property or liabilities of the company or any other company, may be transferred to any other company or the company, respectively, as the case may be. Provided that any sale of the undertaking of the company, the directors, or the liquidator on a winding up, may, if authorised by a special resolution, accept fully paid shares, debentures or securities of any other company, whether incorporated in Pakistan or not, either then existing or to be formed, for the purchase in whole or in part of the property of the company, and the directors (if the profits of the company permit) or the liquidator (in a winding up) may distribute such shares, or securities, or any other property of the company amongst the members without realization, or vest the same in trustees for them, and any special resolution may provide for the distribution or appropriation of the cash, shares or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the company, and for valuation of any such securities or property at

Annexure H
Technical Details and Design of the Project

PLANT DETAILS



1. General Information

i.	Name of Applicant	Siddiqsons Energy Limited
ii.	Business Office	27th Floor, Ocean Tower, Plot G-3, Block-9, Clifton, Karachi, Pakistan
iii.	Plant Location	Thar Block-II of Thar Coalfields, Tharparker District, Sindh, Pakistan
iv.	Type of Generation Facility	Thermal Power Generation

2. Plant Configuration

i.	Plant Size Installed Capacity (Gross ISO)	330MW
ii.	Type of Technology	Sub-critical steam parameters with Circulating Fluidized Bed Boiler
iii.	Number of Units/Size (MW)	01 x 330MW
iv.	Commercial Operation Data (COD)	December 2020
v.	Expected Life of the Facility from COD	30 years

3. Fuel Details

i.	Primary Fuel	Lignite (Thar Coal)		
ii.	Back-up Fuel	Imported Coal (Indonesian/ South African)		
iii.	Fuel Source	Thar Coal fields		
		Primary Fuel	**Alternative Fuel**	**Start-up Fuel**
iv.	Fuel Supplier	SECMC/Thar Block-II Lignite mine	Imported Coal (Indonesian/ South African)	PSO
v.	Supply arrangement for each of the above	SECMC/Thar Block-II Lignite mine	Imported Coal (Indonesian/ South African)	PSO
vi.	No of Storage Bunkers/Tanks/Open Yard	1,900,000 MT per annum via trucks/ from	Required capacity to	Approx. 175 m^3 per annum

		adjacent mine	be supplied via trucks from Karachi Port	
vii.	Storage Capacity of each Bunkers/Tanks/ Open Yard	Approx. 195,000t	Approx. 195,000t	2x500m³
viii.	Gross Storage	Approx. 360,000 T	Approx. 360,000 T	2x500m3

4. Emission Value

i.	SO_x	>850	mg/Nm³
ii.	NO_x	>510	mg/Nm³

5. Cooling System

i.	Cooling Water Source/Cycle	Water from GoS Scheme/ Well water from mine/ any available water source Closed cycle cooling system

6. Project Cost

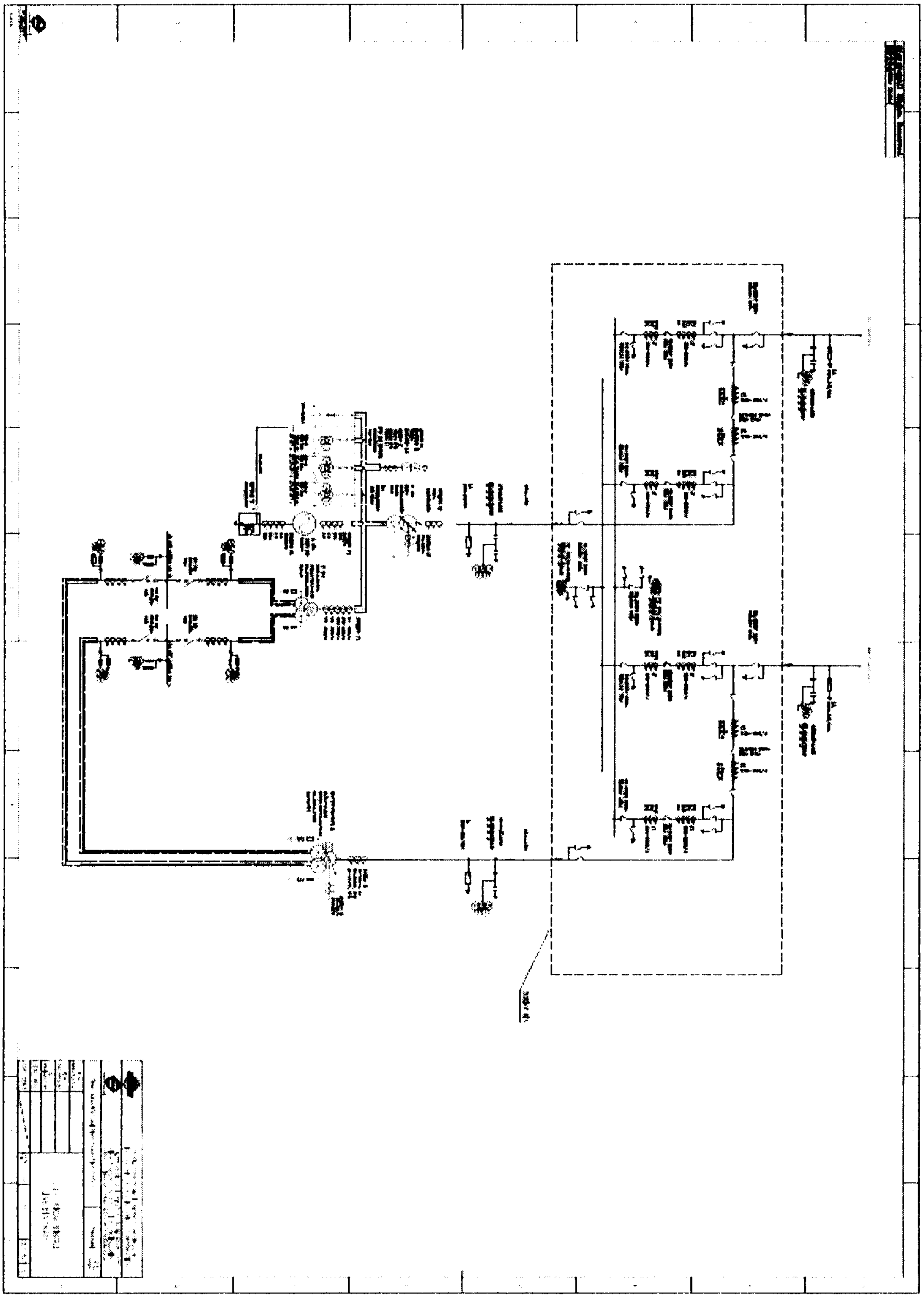
i.	Total (USD)	US$ 520 million
ii.	Debt (USD)	US$ 390 million (75%)
iii.	Equity (USD)	US$ 130 million (25%)

7. Interconnection Arrangement

A double circuit transmission line, approximately 0.78 km length on Drake conductor to Engro Thar 500 kV bus. Looping in-out one 500 kV circuit between Engro Coal Fired Power Plant and Matiari Convertor Station

Nearest Grid: Matiari Grid Station
Voltage Level at POI: 500 KV

SINGLE LINE DIAGRAM



8. Infrastructure: roads, rail, staff colony, amenities

Will be constructed as deemed necessary during detailed project design and execution stage. Housing colony will be constructed based on operational requirements.

9. Project commencement and completion schedule with milestones

Milestone	Time
Generation License Application	June'17
Upfront Tariff Application	June'17
Finalization of EPC Contractor	July'17
Finalization of Security Documents	Oct'17
Financial Close (FC)	Mar'18
Commercial Operations Date (COD)	December'20

10. Plant Characteristics

i.	Generation Voltage	11 / 20 KV
ii.	Frequency	50 Hz (±5%)
iii.	Power Factor	0.8 (lagging) / 0.95(leading)
iv.	AGC	Yes
v.	Ramping Rate (MW/min)	To be discussed as part of PPA
vi.	Time required to synchronize to Grid (Hrs.)	To be discussed as part of PPA

Note: The above data is indicative. Will be finalized in design stage

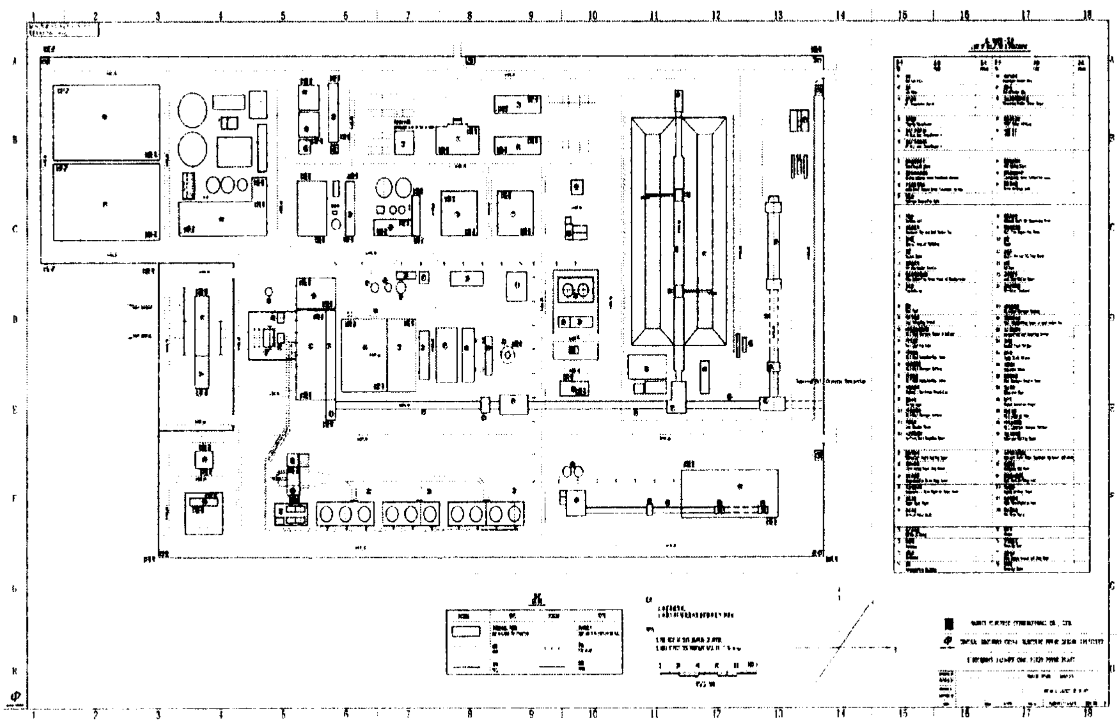
10. In case of a generation license application:

Type of Generation Facility	Thermal Power Generation	
Type of Technology	Sub-critical Coal Power Plant	
Model	Steam Turbine	Sub-critical, condensing steam turbine
	Boiler	CFB Boiler with sub critical Parameters
Expected life of the facility	30 years	

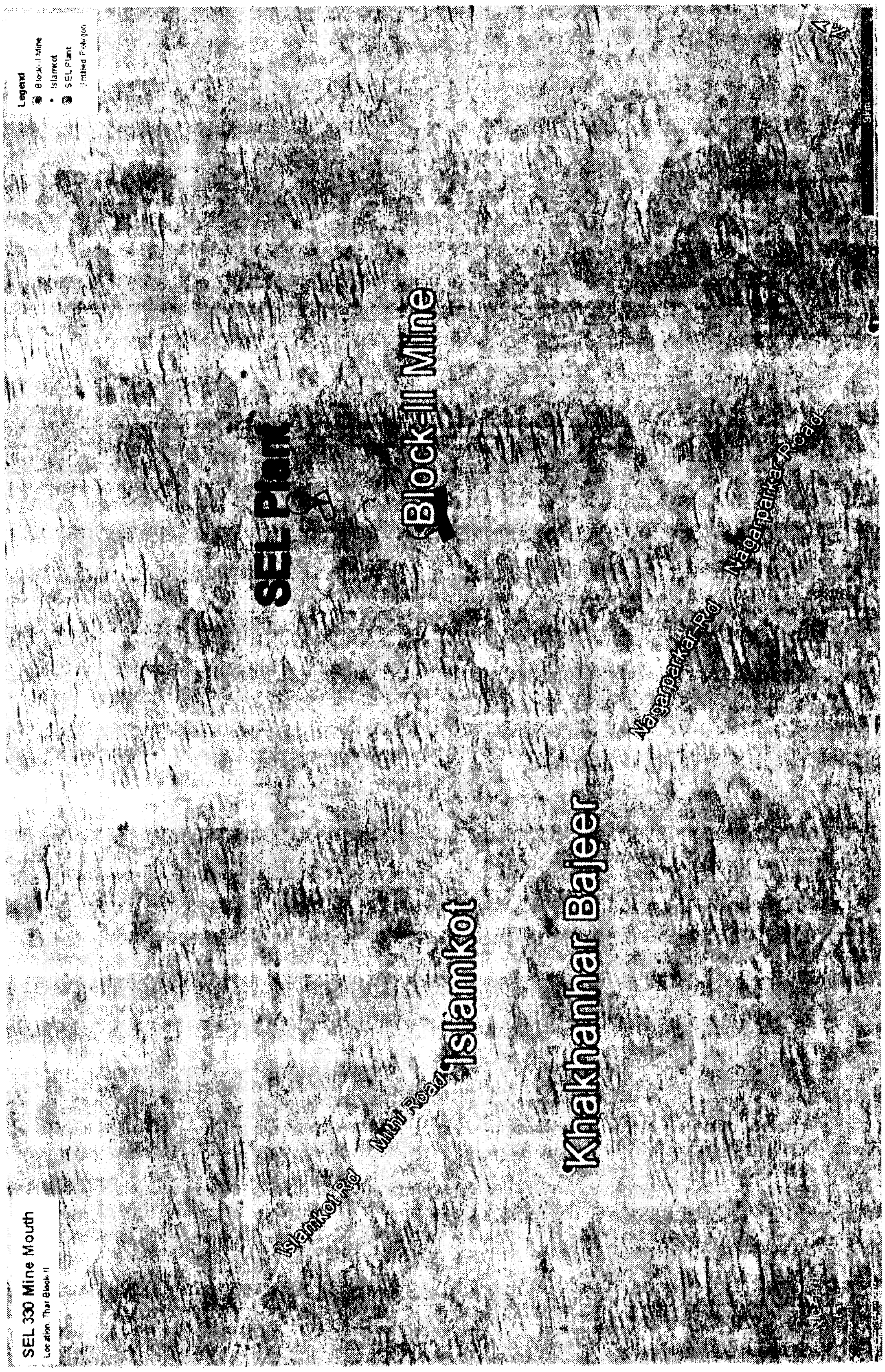
Technical details and design of the facilities proposed to be acquired, constructed, developed or installed

The Project shall be a Rankine cycle power plant, and include all required fuel supply, water supply, waste discharge, and electrical distribution and interconnection facilities. Sub-critical, single reheat natural circulation steam drum and circulating fluid bed boiler in outdoor design will be implemented.

The steam cycle shall be based on a constant/sliding pressure steam turbine. The exhaust from the steam turbine shall be condensed in a condenser operating with a vacuum. The steam turbine generator shall be connected to the local 500 kV system through a step-up transformer.



12. LOCATION MAP

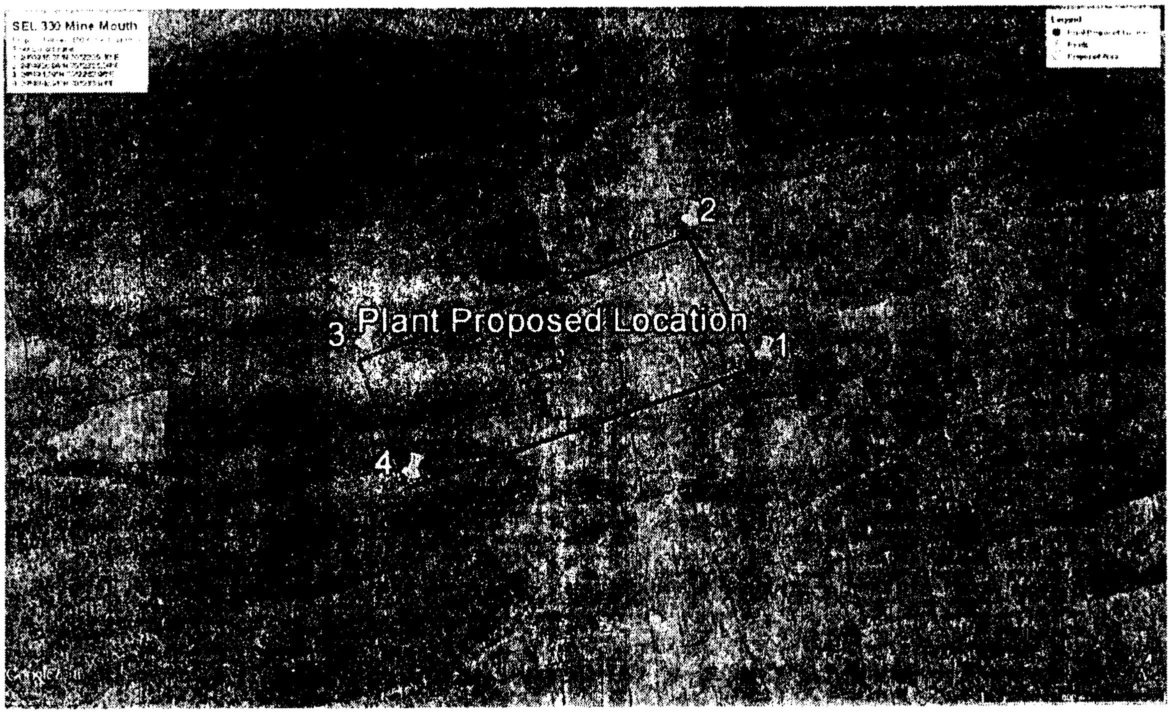


LAND DETAILS

Proposed project land with an estimated area of 140 Acres is located in the power park area of Thar Block-II. The following are the land coordinates provided by SECMC for this project:

24°49'15.07"N 70°23'39.10"E
24°49'26.84"N 70°23'25.34"E
24°49'1.39"N 70°22'52.96"E
24°48'49.91"N 70°23'3.91"E

The land shall be leased from SECMC for a period of atleast 30 years. The proposed area of the land is highlighted in the image below:



Annexure I
Environmental and Social Impact Assessment

Hagler Bailly Pakistan

330 MW Coal-Fired Power Plant in Energy Park, Block II Thar Coalfields

Environmental and Social Impact Assessment

Preliminary Report

HBP Ref.: D7V02SON

February 3, 2017

Siddiqsons Energy Limited.

Karachi

Contents

Appendices

Exhibits

1. Introduction

The Thar Coalfields in Sindh with an estimated lignite reserve of 175 billion tonnes is considered an important source of energy for Pakistan in future. Sindh Coal Authority (SCA) has identified more than a dozen areas, called *blocks* for development of coal mines (**Exhibit 1.1**). Among these development work in Block II, operated by the Sindh Engro Coal Mining Company (SECMC), has started. Simultaneously, work has also started on development of power plants based on coal extracted from Block II. SECMC has set aside an area of 270 hectares (ha)—about 667 acres—for construction of power plants. The area set aside for the power plants has is called the Energy Park.

Siddiqsons Energy Limited (SEL) plans to establish a 330 megawatt (MW) thermal power plant in the Block II Energy Park (the "Project"). This will be the fourth power plant in the Energy Park. The previous three power plants, for which ESIA has already been approved by the Sindh Environmental Protection Agency (SEPA), are:

1. Engro PowerGen Limited (660 MW)
2. Thar Energy Limited (330 MW)
3. ThalNova Power Thar (Private) Limited (330 MW).

The Project will be developed in one of the available plots in the Block II Energy Park (**Exhibit 1.2**). *The final location of the plant is yet to be decided.*

This document presents the preliminary result of the environmental and social impact assessment (ESIA) conducted for the construction and operation of the SEL's proposed 330MW power plant (the 'Project'). The ESIA has been commissioned by SEL and prepared by Hagler Bailly Pakistan (Pvt.) Limited (HBP).

> *This is a preliminary ESIA. The location and specifications of the plant, primary baseline data and outcomes of stakeholder consultations will be included in the final ESIA.*

Exhibit 1.1: Location of Thar Coalfield and Mining Leases

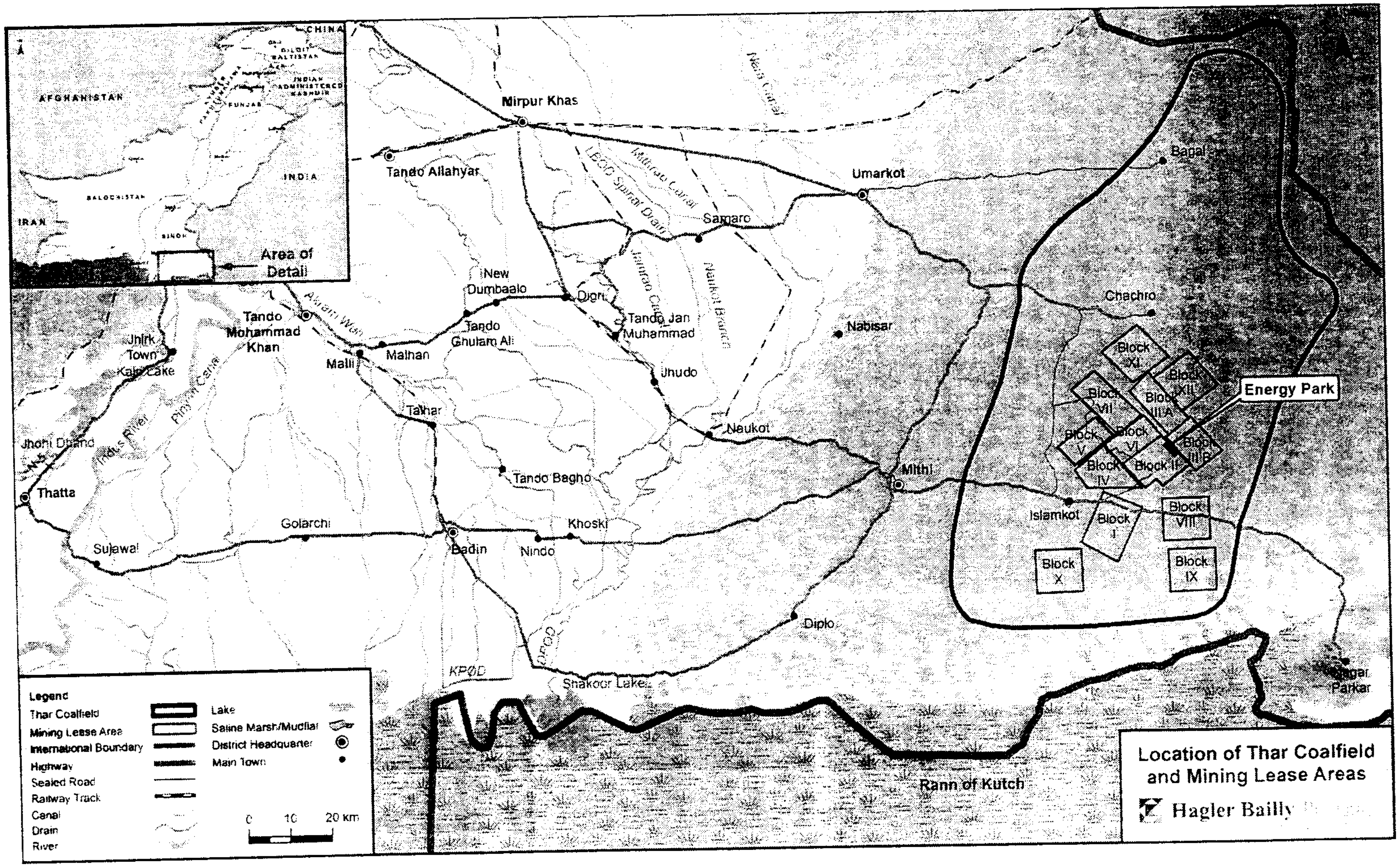
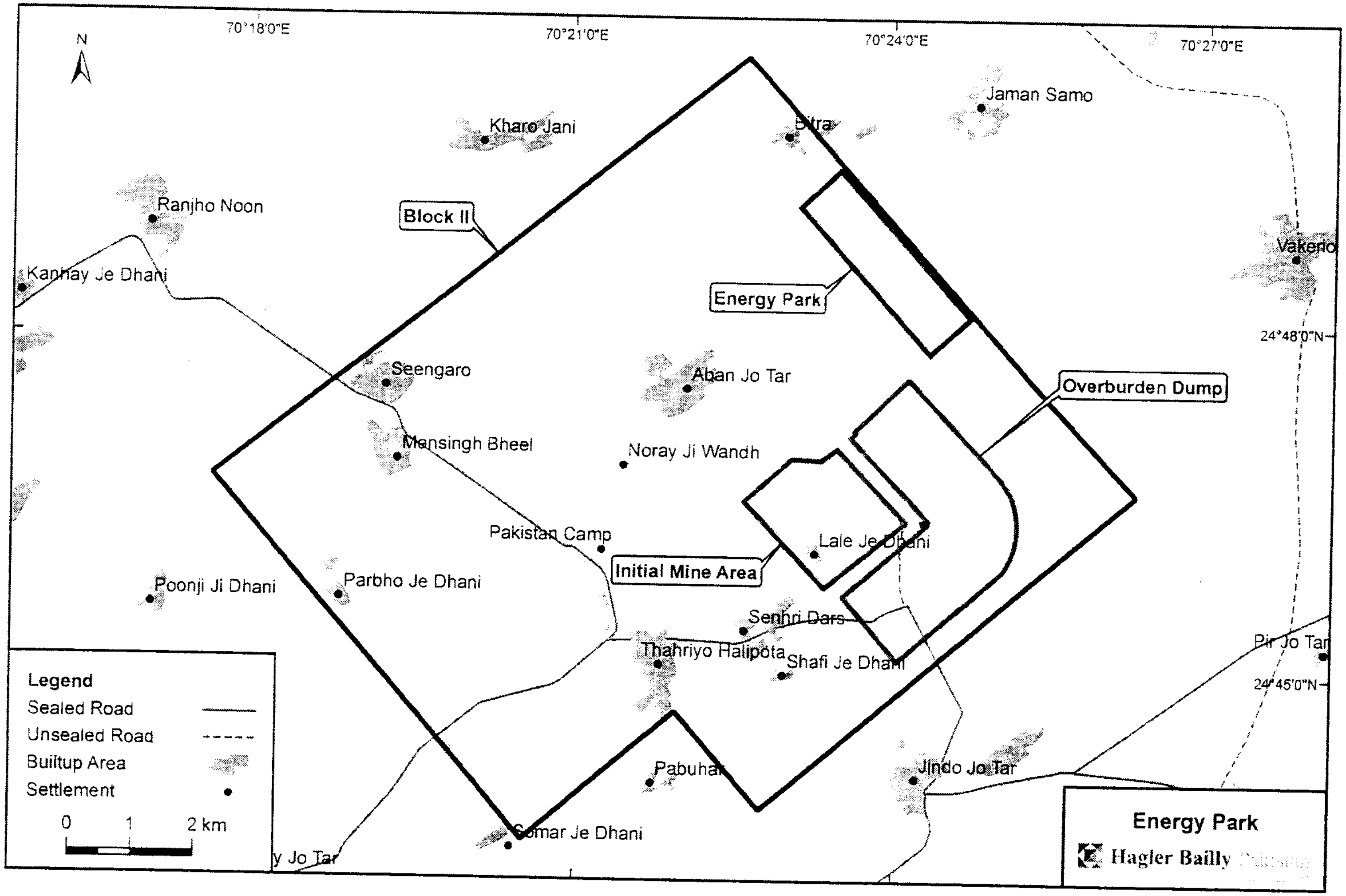


Exhibit 1.2: Energy Park



1.1 Introduction to the ESIA Study

This ESIA was conducted to meet the regulatory requirements as set out in the Sindh Environmental Protection Act 2014 (Sindh Act 2014), and its associated rules and regulations. Wherever appropriate, reference is also made to the International Finance Corporation's (IFC) Performance Standards (PS)[1] and Environmental, Health, and Safety Guidelines.[2] The guidelines provided by these documents are considered as the best industry practice in environment.

1.1.1 Objectives of the ESIA

The objectives of ESIA are to:

- Assess the existing physical, ecological and socioeconomic conditions in the Project area, including the identification of environmentally sensitive areas.
- Assess the proposed Project activities to identify their potential environmental and social impacts, evaluate the impacts, and determine their significance.
- Determine the compliance of proposed Project activities with the relevant environmental regulations of Pakistan.
- Propose appropriate mitigation and monitoring measures that can be incorporated into the design of proposed activities to minimize any environmentally adverse effects as identified by the assessment.

1.1.2 Scope of the ESIA

The scope of the ESIA includes an assessment of the environmental and social impacts of:

- Development of site for the power plant;
- Construction of power plant including, but not limited to, on-site civil works and installation activities of power plant, on-site coal yard, ash storage, and coal and ash transfer system;
- Disposal of waste from the construction activities;
- Unloading and storage of coal at the Project site;
- Operation of the power plant; and
- Hiring of labor and labor issues during construction and operation of the power plant and the associated social issues.

1.1.3 Exclusion from Scope of the ESIA

The impacts of some of the associated activities are excluded from the scope of the ESIA. The activities and the reason for the exclusion are as follows:

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1 Available at www.ifc.org/sustainability 'Available at www.ifc.org/ehsguidelines '

2 Available at http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines

- The mining of coal and all associated activities: This is covered in the ESIA of Block II which is already approved by SEPA;
- Sourcing and transport of water from Left Bank Outfall Drain (LBOD), its treatment and storage at Nabisar and Vajihar: This scheme is in the scope of GoS and is subject to a separate environmental assessment;
- Disposal of ash: SECMC has provided space within Block II for temporary storage of ash for about two years. The disposal of ash from the storage into the spent coal pit with overburden from the temporary storage and directly from the power plant, beyond two years, is not in the scope of this ESIA and will be managed by SECMC;
- Disposal of cooling tower blowdown: SECMC has provided space within Block II for an evaporation pond for power plant effluents other than the cooling water blowdown. The final disposal scheme of cooling tower blowdown is not yet decided;
- Evacuation of power: This is in the scope of the National Transmission and Despatch Company (NTDC) and is subject of a separate environmental assessment; and
- Acquisition of land or resettlement for the power plant: This is covered in the ESIA of Block II mining project[3] which is already approved.

1.2 Organization of this Report

The ESIA report is organized in the following sections:

Chapter 1 (*Introduction*) provides an introduction of the Project and outlines the scope of ESIA.

Chapter 2 (*Legal and Institutional Framework*) presents the legislative requirements that need to be followed while conducting an ESIA.

Chapter 3 (*The Proposed Project*) contains information about key features of the proposed Project, such as its location and design.

Chapter 4 (*Description of the Environment*) documents in detail the existing physical, ecological and socioeconomic conditions around the Project site. *Primary baseline data will be included in the final ESIA.*

Chapter 5 (*Public Consultation and Disclosure*) *will be included in the final ESIA.*

Chapter 6 (*Project Impacts and Mitigation Measures*) presents an assessment of the Project's impact on the physical, ecological, and socioeconomic environment, as well as recommended mitigation measures. *Will be updated in the final ESIA.*

Chapter 7 (*Environmental Management Plan*) facilitates the implementation and monitoring of the mitigation measures identified in the environmental impact assessment.

Chapter 8 (*Conclusion*) summarizes the findings and recommendations of this ESIA study and concludes the report.

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3 Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project, Sindh Engro Coal Mining Company

2. Legal and Institutional Framework

In Pakistan, the history of legislation drafted specifically to protect the environment dates back to 1980s. This section provides a brief historical and constitutional context followed by a detailed discussion of relevant laws.

2.1 Historical and Constitutional Context

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency (Pak–EPA), the primary government institution at that time dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards (NEQS) were established in 1993. In 1997, the Pakistan Environmental Protection Act (PEPA) 1997 was enacted to replace the 1930 Ordinance. PEPA conferred broad–based enforcement powers to the environmental protection agencies. This was followed by the publication of the *Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations 2000* which provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA).

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. The main consequences of this change were as follows:

- The Ministry of Environment at the federal level was abolished. Its functions related to the national environmental management were transferred to the provinces. To manage the international obligations in the context of environment, a new ministry—the Ministry of Climate Change—was created at the federal level.
- The PEPA 1997 is technically no longer applicable to the provinces. The provinces were required to enact their own legislation for environmental protection. However, to ensure legal continuity PEPA 1997 continued to be the

legal instrument for environmental protection in the provinces till enactment of provincial laws.

All four provinces have enacted their own environmental protection laws. These provincial laws are largely based on PEPA 1997 and, hence, provide the same level of environmental protection as the parent law.

2.2 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act 2014 (Sindh Act 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. As per the law, the Sindh Environmental Protection Agency (SEPA) is responsible to implement the provisions of this Act in Sindh. The Sindh Act 2014 is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine, and noise pollution, as well as to the handling of hazardous wastes. The articles of Sindh Act 2014 that have a direct bearing on the proposed Project are listed below. The details are discussed in the following sections.

Article 11 that deals with the Sindh Environmental Quality Standards (SEQS) and its application

Article 13 that deals with hazardous substances

Article 14 that prohibits various acts detrimental to the environment

Article 17 that establishes the requirement for environmental impact assessment.

To implement the provisions of the Sindh Act 2014, *rules* and *regulations* are required.[4] The key rules and regulations are:

1. National Environmental Quality Standards (Self–Monitoring and Reporting by Industries) Rules, 2001
2. Environmental Samples Rules, 2001
3. Sindh Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2014 (IEE–EIA Regulations 2014)

Guidelines are issued by the Pak–EPA for preparation of environmental assessment. The relevant guidelines are discussed in **Section 2.3**. All the rules, regulations, and guidelines issued under PEPA 1997 and discussed above remain valid after promulgation of Sindh Act 2014.

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[4] Rules and regulations are similar instruments but differ in their hierarchy. The power to make rules and regulations is given in the enabling law, PEPA 1997 and Sindh Act 2014 in this case. The rules are made by the government (federal or provincial, as the case may be) and require publication in the official gazette. Regulations are made by the government agency which is empowered by the law, environmental protection agencies in this case, and are not always published in the official gazette. Rules deal with relatively important matters such as delegation of powers and authorities, whereas regulations usually deal with procedural matters.

2.3 Requirements for Environmental Impact Assessment

The articles of Sindh Act 2014 that have a direct bearing on the environmental assessment of the proposed Project are:

> Article 17(1): 'No proponent of a project shall commence construction or operation unless he has filed with the Agency[5] an initial environmental examination or an environmental impact assessment, and has obtained from the Agency approval in respect thereof.'
>
> Article 17(3): 'Every review of an environmental impact assessment shall be carried out with public participation…'

The IEE-EIA Regulations 2014 provides the necessary details on the preparation, submission, and review of the IEE and the EIA. Categorization of projects for IEE and EIA is one of the main components of the IEE-EIA Regulations 2014. Projects have been classified on the basis of expected degree of adverse environmental impact. Project types included in Schedule II of the regulations those that are likely to have potentially significant impact on the environment and thus an EIA is required for such projects, whereas those included in Schedule I as having potentially less adverse effects and therefore require an IEE. Coal fired power plants with capacity less than 50 MW is included in Schedule I (List of Projects requiring an IEE) whereas Coal power projects above 50 MW is included in Schedule II (List of Projects requiring an EIA). As the project involves development of a power plant of more than 50 MW, it falls within the category of Schedule II and an EIA has been prepared for it.

The word 'project' as defined in the Sindh Act 2014 includes new developments as well as modifications, expansions and rehabilitations of the existing projects. The proposed Project is considered a new development and not a modification to the existing Project because it will have its own separate staff, resources, financing, accounting, utilities, and administrative control. None of these items will be shared. Hence the existing project is not the subject of this ESIA.

Regulation 9 of the IEE-EIA Regulations 2014 requires that '(1) Ten paper copies and two electronic copies of an IEE or EIA shall be filed with the Federal Agency; (2) Every IEE and EIA shall be accompanied by (a) an application, in the form set out in Schedule V; (b) copy of receipt showing payment of the review fee; (c) no objection certificates from the relevant departments in case of EIA shall be the part of reports; and (d) the environmental check list as per its guidelines.

The prescribed procedure for review of EIA by the EPA is described in Regulations 10–17 and is depicted in **Exhibit 2.1**. The key features are:

On acceptance of the EIA for review, EPA will place a public notice in national English and Urdu newspapers and in local language newspaper informing the public about the project and where it's 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.

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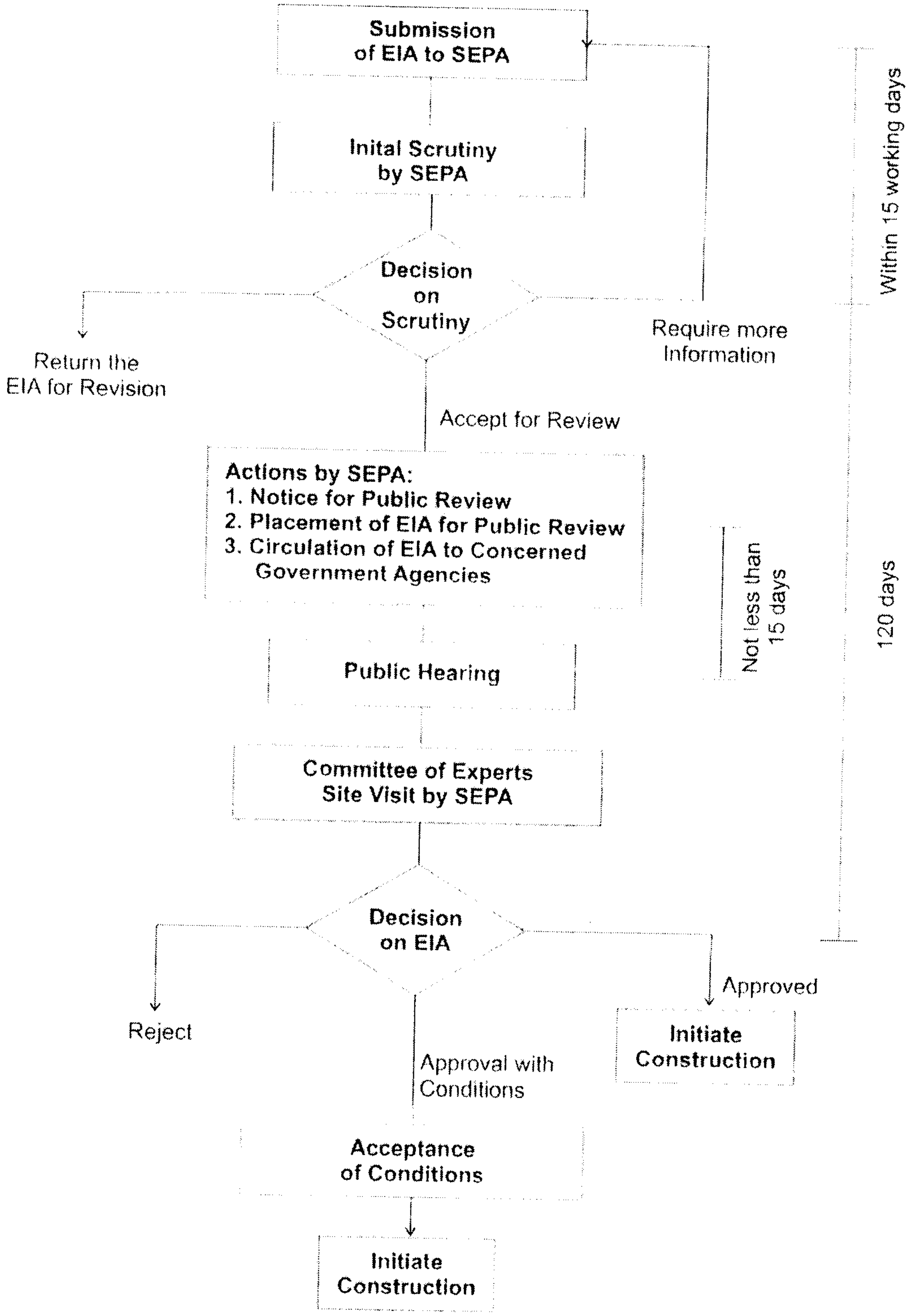
5 The term 'Agency' refers to the Sindh Environmental Protection Agency.

Exhibit 2.1: EIA Review and Approval Procedure



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 17(4) of SEPA Act 2014 binds the SEPA to 'communicate its approval or otherwise … within a period of four months from the date the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which … 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'.

Regulation 7 of the IEE-EIA Regulations 2014 pertains to the guidelines. It states that: '(1) The Agency may issue guidelines for preparation of an IEE or EIA or an environmental checklist, including guidelines of general applicability and sectoral guidelines indicating specific assessment requirements for planning, construction and operation of projects relating to a particular sector. (2) where guidelines have been issued under sub-regulation (1), an IEE or EIA shall be prepared, to the extent practicable, in accordance therewith and the proponent shall justify in the IEE or EIA or in environmental checklist any departure therefrom.' An EIA is required for thermal power generation over 100MW and for coal power projects above 50 MW.

The relevant guidelines are the follows:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments, Pakistan Environmental Protection Agency, September 1997

  These guidelines define the policy context and the administrative procedures that will govern the environmental assessment process, from the project pre-feasibility stage, to the approval of the environmental report. The section on administrative procedures has been superseded by the IEE-EIA Regulations, 2000.

- Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997

  These guidelines target the project proponents and specify:

  - The nature of the information to be included in environmental reports
  - The minimum qualifications of the EIA conductors appointed
  - The need to incorporate suitable mitigation measures at every stage of project implementation
  - The need to specify monitoring procedures.

  The terms of reference for the reports are to be prepared by the project proponents themselves. The report must contain baseline data on the project area, detailed assessment thereof, and mitigation measures.

- *Guidelines for Public Consultation*, Pakistan Environmental Protection Agency, May, 1997

  These guidelines support the two guidelines mentioned earlier. It deals with possible approaches to public consultation and techniques for designing an effective program of consultation that reaches out to all major stakeholders and ensures the incorporation of their concerns in any impact assessment study.

- *Guidelines for Sensitive and Critical Areas*, Pakistan Environmental Protection Agency, October, 1997

  The guidelines on sensitive areas are more specific in that they identify the officially notified protected areas in Pakistan, including critical ecosystems, archeological sites, etc., and present checklists for environmental assessment procedures to be carried out inside or in the vicinity of such sites. Environmentally sensitive areas include, among others, archeological sites, biosphere reserves and natural parks, and wildlife sanctuaries and preserves. The guidelines state that the approach recommended in the document should extend to areas in the vicinity of such sensitive and critical sites, although the term 'vicinity' is not explicitly defined.

2.4 Other Relevant Laws

2.4.1 Self-Monitoring and Reporting by Industry Rules 2001

Under the *National Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules 2001* (the 'SMART' Rules), industrial units are responsible for monitoring their gaseous and liquid discharges and reporting them to the relevant environmental protection agency (EPA). As coal-fired thermal power plants fall under Schedule I Category B of industrial categorization and reporting procedure for SMART, the respective environmental monitoring reports are required to be submitted on quarterly basis to the relevant authorities. The project proponents will report their emission and effluent to SEPA in accordance with the rules.

2.4.2 The Forest Act 1927

The Act empowers the provincial forest departments to declare any forest area reserved or protected. The act also empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling, and lopping. Vegetation clearing will be required in the site preparation for the power plant but since the area is not declared as a reserve forest this law will have no implication on the project.

2.4.3 Factories Act 1934

Particular sections of the act applicable to this project are:

- Section 13(1): Every factory shall be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- Section 14(1): Effective arrangements shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on therein.
- Section 16(1): In every factory in which, by reason of the manufacturing process carried on, there is given off any dust or fume or other impurity of such a nature and to such an extent as is likely to be injurious or offensive to the workers

employed therein, effective measures shall be taken to prevent its accumulation in any work-room and its inhalation by workers and if any exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust, fume or other impurity, and such point shall be enclosed so far as possible.

- Section 16(2): In any factory no stationary internal combustion engine shall be operated unless the exhaust is conducted into open air and exhaust pipes are insulated to prevent scalding and radiation heat, and no internal combustion engine shall be operated in any room unless effective measures have been taken to prevent such accumulation of fumes therefrom as are likely to be injurious to the workers employed in the work-room.
- Section 20(1): In every factory effective arrangements shall be made to provide and maintain at suitable points conveniently situated for all workers employed therein a sufficient supply of whole-some drinking water.
- Section 26(1) d(i): In every factory the following shall be securely fenced by the safeguards of substantial construction which shall be kept in position while the parts of machinery required to be fenced are in motion or in use, namely – (a) every part of an electric generator, a motor or rotary convertor.

2.4.4 The Sindh Irrigation Act 1879

This Act empowers the Government of Sindh (GoS) to use the natural sources of water such as lakes, rivers, and streams, for supply of water for irrigation and other purposes. It allows the government to develop the required infrastructure, for example, canals, channels, pipelines, for the supply of water. It also allows the government to charge fee for the supply of water and regulate the water supply.

2.5 Environmental Guidelines

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, based on environmental assessments and/or environmental audits as appropriate, with an appropriate timetable for achieving them.

This document includes information relevant to combustion processes fueled by gaseous, liquid, and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of these.

2.6 Institutional Framework

Under the Sindh Act 2014, SEPA is an autonomous agency. For administrative purposes, it is part of the Forest, Environment and Wildlife Department of the Government of Sindh. SEPA is a regulatory agency with the following main functions:

- Enforcement of Sindh Act 2014
- Prepare environmental policies for approval of the GoS
- Implement environmental policies
- Publish annual state of the environment report for Sindh
- Prepare or revise SEQS
- Ensure implementation of SEQS
- Establish systems and procedures for environmental management
- Promote research and studies on environmental issues
- Issue license for handling of hazardous substance
- Certify environmental laboratories
- Initiate legislation for environmental protection
- Provide assistance to government agencies in case of environmental accidents
- Providing advice to the government on issues related to environment
- Assist governments agencies in implementation of waste management schemes
- Provide guidance to public on environmental matters
- Assist education institutions in prescribing environmental curricula
- Undertake measures to enhance awareness on environment among general public
- Disseminate knowledge on environment
- Specify safeguards for the prevention of accidents which may cause pollution
- Review and approve mitigation plans and give guidance for clean-up operations
- Encourage the formation and working of nongovernmental organizations, community organizations and village organizations for environmental protection
- Carry out any other task related to environment assigned by the government.

SEPA will be responsible for the review and approval of the EIA of the proposed Project.

2.7 International Treaties

Important international environmental treaties that have been signed by Pakistan and may have relevance to the Project are listed in **Exhibit 2.2**. They concern: climate change and depletion of the ozone layer; biological diversity and trade in wild flora and fauna; desertification; waste and pollution; and cultural heritage.

Exhibit 2.2: International Environmental Treaties Endorsed by Pakistan

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
Climate change and the ozone layer	United Nations Framework Convention on Climate Change - the primary objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	1992	1994
	Kyoto Protocol to the United Nations Framework Convention on Climate Change - enabled by the above Convention on Climate Change. It has more powerful and legally binding measures. It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions.	1997	2005
	Vienna Convention for the Protection of the Ozone Layer - acts as a framework for the international efforts to protect the ozone layer with a primary objective to protect human health and the environment against adverse effects resulting from human activities that modify or are likely to modify the ozone layer.	1985	1993
	The Montreal Protocol on Substances that Deplete Ozone Layer and associated amendments - enabled by the Vienna Convention, it is designed to protect the ozone layer by phasing out the production and consumption of a number of substances believed to be responsible for ozone depletion.	1987	1993
Waste and pollution	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal - regulates the transboundary movement of hazardous waste and other waste with a stated purpose to protect human health and the environment against the adverse effects from generation and management of hazardous waste and other waste. The Convention provides for three sets of measures with binding obligations. These are: Strict control of transboundary movement of hazardous waste; Environmentally sound management of hazardous waste; and Enforcement and implementation of the provisions of the convention at international and national levels.	1989	1994
	International Convention on Oil Pollution Preparedness, Response and Co-operation	1990	1995

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
	Stockholm Convention on Persistent Organic Pollutants –seeks to protect human health and the environment from Persistent Organic Pollutants, which are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife.	2001	2008
Desertification	International Convention to Combat Desertification – with an objective to combat desertification and mitigate the effects of drought. It is supported by international cooperation and partnership arrangements, with the aim of achieving sustainable use of land and water resources and sustainable development in affected areas.	1994	1997
Biodiversity and the protection of plants and animals	Convention on Biological Diversity – covering ecosystems, species, and genetic resources and also the field of biotechnology. The objectives are to conserve biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources.	1992	1994
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity - addresses potential risks posed by living modified organisms resulting from modern biotechnology.	2000	2009
	Bonn Convention on the Conservation of Migratory Species of Wild Animals - aims to conserve terrestrial, marine and avian migratory species throughout their range. It is concerned with the conservation of wildlife and habitats on a global scale.	1979	1987
	Memorandum of Understanding concerning Conservation Measures for the Siberian Crane - parties undertake to provide strict protection to Siberian Cranes, and identify and conserve wetland habitats essential for their survival.	1998	1999
	Convention on International Trade in Endangered Species of Wild Fauna and Flora - to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	1973	1976
	International Plant Protection Convention (1997 Revised Text) - to prevent the international spread of pests and plant diseases. It requires maintenance of lists of plant pests, tracking of pest outbreaks, and coordination of technical assistance between member nations.	1951/52	1954

Topic	*Convention*	*Date of Treaty*	*Entry into force in Pakistan*
	Agreement for the Establishment of the Near East Plant Protection Organization - to establish the Near East Plant Protection Organization (NEPPO), which promotes international co-operation with a view to implementing International Plant Protection Convention.	1993	2009
	Plant Protection Agreement for the Asia and Pacific Region and amendments – establishes the Asia and Pacific Plant Protection Commission to review and promote the region's progress in the implementation of the Agreement. Trade in plants and plant products are regulated by certification, prohibition, inspection, disinfection, quarantine, destruction, etc., as necessary.	1955 (amended 1967)	1958 (amended 1969)
	Convention on Wetlands of International Importance especially as Waterfowl Habitat and associated protocols and amendments - to promote conservation and sustainable use of wetlands. The Ramsar List of Wetlands of International Importance now includes almost 1,800 sites (known as Ramsar Sites). There are currently 19 Ramsar sites in Pakistan.	1971 (amended 1987)	1976 (amended 1994)
Cultural heritage	Convention concerning the Protection of the World Cultural and Natural Heritage - requires parties to adapt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.	1972	1976

2.8 Environmental Standards and Guidelines Applicable to the Projects

The proposed Project is legally required to comply with the SEQS for gaseous emission, and liquid effluent. In **Exhibit 2.3** and **Exhibit 2.4**, comparisons of SEQS with IFC Guideline and Target value for key parameters of emission and ambient air quality are provided. **Exhibit 2.5** provides a comparison of SEQS and IFC Guideline for effluents. **Exhibit 2.6** provide SEQS for sound levels. The IFC Guidelines are legally not applicable to this Project and is provided here for reference only.

Exhibit 2.3: Comparison of SEQS and IFC Guideline for Emission of Key Pollutants from Coal Fired Power Plant

Parameter	*Source of Emission*	*National Standards*	*IFC Guidelines >=600MWth*
SEQS for Gaseous Emissions			
Particulate matter	Boilers and furnaces: coal-fired	500 mg/Nm^3	For NDA: 50 mg/Nm^3 For DA: 30 mg/Nm^3
Carbon monoxide	Any	800 mg/Nm^3	-
Nitrogen Oxides	Boilers and furnaces: coal-fired	1,200 mg/Nm^3	For NDA: 510 mg/Nm^3 For DA: 200 mg/Nm^3
SEQS for Sulfur Dioxide and Nitrogen Oxides for Power Plants			
Sulfur Dioxide	Power plant operating on oil and coal	100 - 500 Tons per day	For NDA: 200-850 mg/Nm^3 For DA: 200 mg/Nm^3
Nitrogen Oxides	Power plant operating on oil and coal	For lignite fossil coal: 260 ng/J of heat input	For NDA: 510 mg/Nm^3 For DA: 200 mg/Nm^3

Notes:

1. For additional parameters and explanation, see complete SEQS in **Appendix A**
2. A "-" in the fourth column indicates that IFC has not provided any guidelines for the parameter
3. NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly
4. In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to SEQS for gaseous emissions, comply with the standards stated in SEQS for sulfur dioxide and nitrogen dioxides.
5. MWth means the energy input

Exhibit 2.4: Comparison of SEQS and IFC Limits for Ambient Air Quality

Pollutants	*Time-weighted Average*	*SEQS (µg/m³)*	*IFC Interim Target Value (µg/m³)*	*IFC Guideline Value (µg/m³)*
Sulfur Dioxide (SO_2)	Annual Average	80	–	–
	24 hours	120	125	20
Oxide of Nitrogen as Nitric Oxide (NO)	Annual Average	40	–	–
	24 hours	40	–	–
Oxide of Nitrogen as Nitrogen Dioxide (NO_2)	Annual Average	40	–	40
	24 hours	80	–	–
Ozone (O_3)	1 hour	130	–	–

Pollutants	*Time-weighted Average*	*SEQS ($\mu g/m^3$)*	*IFC Interim Target Value ($\mu g/m^3$)*	*IFC Guideline Value ($\mu g/m^3$)*
Suspended Particulate Matter (SPM)	Annual Average	360	–	–
	24 hours	500	–	–
Respirable particulate Matter PM_{10}	Annual Average	120	70	20
	24 hours	150	150	50
Respirable Particulate Matter $PM_{2.5}$	Annual Average	40	35	10
	24 hours	75	75	25
Lead (Pb)	Annual Average	1	–	–
	24 hours	1.5	–	–
Carbon Monoxide (CO)	8 hours	5,000	–	–
	1 hour	10,000	–	–

Notes:

1. For additional parameters and explanation, see complete SEQS in **Appendix A**
2. A "–" in the fourth column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment

Exhibit 2.5: Comparison of SEQS and IFC Guideline for Effluents (mg/l, unless otherwise defined)

Parameter	*SEQS (Into Inland Waters)*	*IFC Guidelines (For Reference)*
Temperature increase	=<3°C	–
pH value	6 to 9	6 to 9
Five-day bio-chemical oxygen demand (BOD) at 20°C	80	-
Chemical oxygen demand (COD)	150	–
Total suspended solids (TSS)	200	50
Total dissolved solids (TDS)	3,500	–
Grease and oil	10	10
Phenolic compounds (as phenol)	0.1	–
Chlorides (as Cl')	1,000	–
Fluorides (as F')	10	–
Cyanide total (as CN')	1	–
Anionic detergents (as MBAS)	20	–
Sulfate (SO_4)	600	–
Sulfides (s')	1.0	–
Ammonia (NH_3)	40	–
Pesticides	0.15	–
Cadmium	0.1	0.1
Chromium (trivalent and hexavalent)	1	0.5

Parameter	*SEQS (Into Inland Waters)*	*IFC Guidelines (For Reference)*
Copper	1	0.5
Lead	0.5	0.5
Mercury	0.01	0.005
Selenium	0.5	–
Nickel	1	–
Silver	1	–
Total toxic metals	2	–
Zinc	5	1.0
Arsenic	1	0.5
Barium	1.5	–
Iron	8	1.0
Manganese	1.5	–
Boron	6	–
Chlorine	1	0.2

Notes:

1. A "-" in the third column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment.
2. IFC General Guidelines describes "temperature of wastewater prior to discharge does not result in an increase greater than 3 °C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations".

Exhibit 2.6: SEQS for Noise

No.	*Category of Area/Zone*	*Effective from July 1, 2010*		*Effective from July 1, 2012*	
		*Limit in dB(A) Leq**			
		Daytime	*Nighttime*	*Daytime*	*Nighttime*
1.	Residential area (A)	65	50	55	45
2.	Commercial area (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence zone (D)	55	45	50	45

Note:

1. Daytime hours: 6 .00 am to 10.00 pm
2. Nighttime hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

3. The Proposed Project

This section provides details of the proposed Project including the location, technology used, emission controls, raw materials required and waste generated.

3.1 Project Setting

The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparkar District, Sindh.

The location of the plant is yet to be decided and will be included in the final ESIA.

3.2 Project Technology

The proposed Project will utilize circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters. Plant specifications are summarized in **Exhibit 3.1**.

Exhibit 3.1: Power Plant Specifications

Plant Specifications	*Approx. Value*	*Unit*
Gross Capacity	330	MW
Net Capacity	300	MW
Availability factor	85	%
Coal Lower Heating Value (LHV)	2,675	kcal/kg (kilocalorie per kilogram)
Net Efficiency on LHV	37	%
Coal Consumption[6]	1.9	MT/y (million tons per year)

The main components of the power plant are described below.

3.2.1 Combustion Chamber

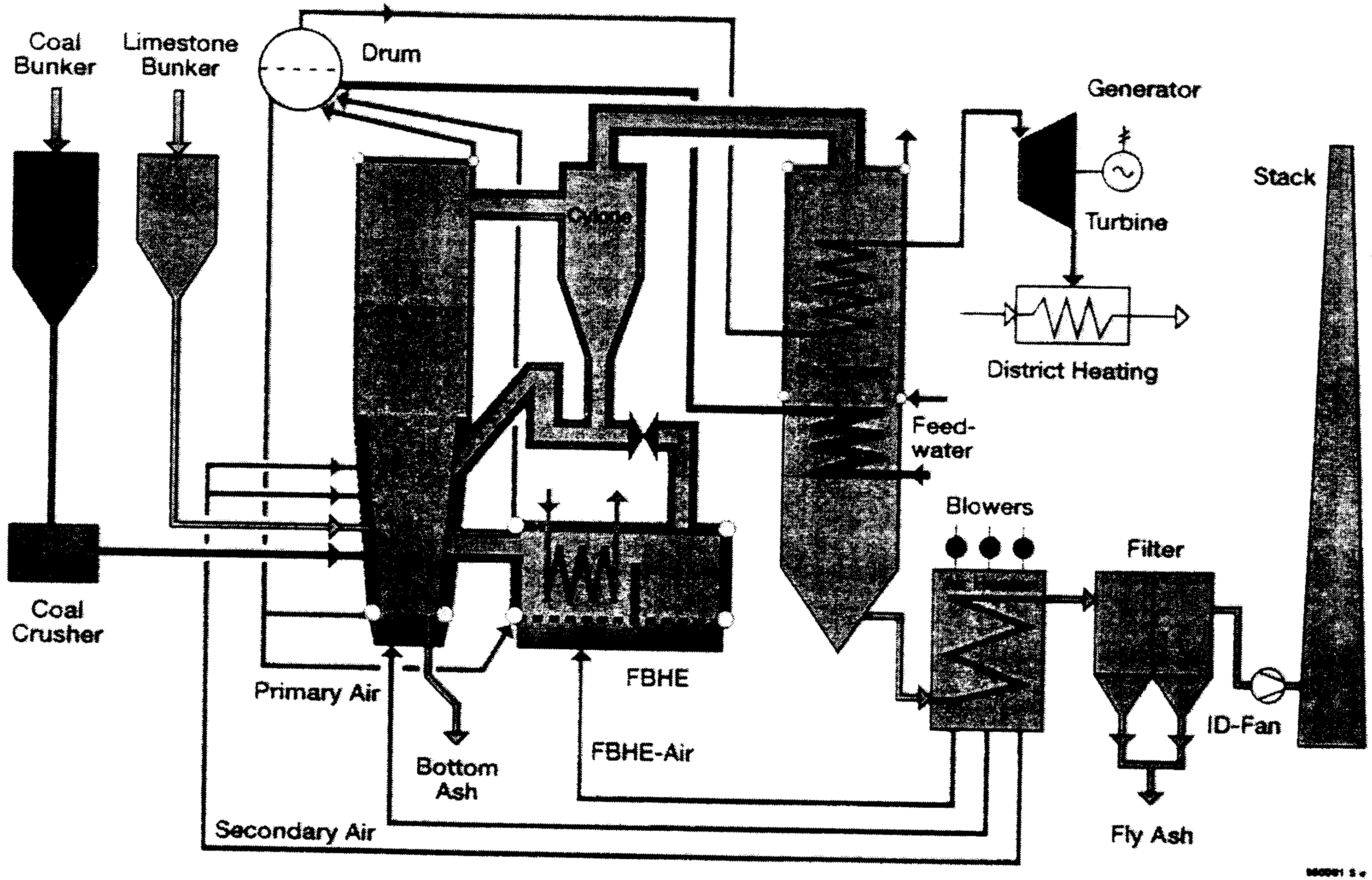
The vertical combustion chamber is at the core of the CFB boiler. Fuel (in this case coal) and fine grained limestone are fed into the combustion chamber. The bed is where the coal (fuel) spreads for combustion.

The bed material circulating in the combustion system consists primarily of the particles of coal ash, bed makeup material (such as sand), gypsum and excess calcined limestone. A high pressure preheated air supply from the bottom lifts the bed material and coal particles and combustion takes place while it is suspended. Combustion of this suspended bed is known as 'fluidized bed combustion'.

A block diagram of a CFB is shown in **Exhibit 3.2**.

6 Based on above values in the table

Exhibit 3.2: Schematic of CFB Power Plant



3.2.2 Cyclone

In the cyclone the heavier particles separate from the gas and fall to the hopper of the cyclone returning it to the furnace. Hence the name 'Circulating' as the unburnt or partly burned coal, ash or bed material is circulated back into the furnace. The hot gases from the cyclone pass to the heat transfer surfaces and go out of the boiler.

The long solids residence time in the furnace resulting from the collection/recirculation of solids via the cyclone, plus the vigorous solids/gas contact in the furnace caused by the fluidization airflow, result in better combustion efficiency, even with difficult-to-burn fuels, such as Thar coal.

3.2.3 Electricity Generation

Heat released from the combustion of coal in the CFB sub-critical boiler will be used to generate steam at a pressure of around 175 bar. The steam will then be fed into the steam turbine, where it will rotate the turbine to generate mechanical energy. The steam, after passing through the turbine, will be condensed back to water and to be re-injected into the boiler after passing through condensate polishing system. The rotating steam turbine will operate the power generator, which will generate electricity.

3.2.4 Cooling Towers

Cooling towers will be installed to cool the heated circulating water by evaporation that occurs when water droplets are brought into direct contact with the upwards-flowing ambient air. To maintain required water quality parameters, water from the cooling tower basin will be continuously removed through blowdown and dumped into the wastewater collection basin for reuse in various plant services, such as ash handling and coal dust suppression.

3.3 Emission Controls

Emissions controls for pollutants of concern (NO_X, SO_2 and particulate matter) are as follows.

3.3.1 NOx

Combustion takes place at relatively low temperatures when compared with pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these temperatures results in an effective suppression of NOx-formation.

3.3.2 SO_2

SO_2 control will be provided by the injection of limestone in the CFB boiler and converting sulfur to gypsum (calcium sulfate). The efficiency of the system will be more than 90%.

3.3.3 Particulate Matter

The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). The ESPs will be designed to have an efficiency of not less than 99.9% and will limit the outlet flue gas particulate loading to below 50 parts per million (ppm) at all loads when burning design coal.

3.4 Raw Material Inputs

The major inputs required for the proposed coal power plant Project are coal, limestone and water.

3.4.1 Coal

The design specification of the fuel is given in **Exhibit 3.3.** The annual requirement of coal is estimated to be 1.9 million tons of coal, calculated on the basis of net calorific value and plant capacity.

Coal will be transported via truck to the Project site after preliminary crushing and will be stored at the coal stockyard located within the Project site. It will have a capacity of 7 days coal consumption. The height of the coal stockpile will be around 10 meters (m). The coal stockyard will be equipped with a water sprinkling system for coal dust suppression. Fixed conveyer belts above ground, except those associated with the stacker/reclaimers, will be in enclosed galleries. The bucket wheel stacker/reclaimer will be provided with water tanks, spray hoses and nozzles to be used when fly dust becomes a problem.

Exhibit 3.3: Design Specification of the Fuel[7]

Coal Quality of Thar Block-II Lignite for Power Plant Design		*Average Quality*
A	**Calorific Value**	
i	Gross calorific value, kcal/kg (kJ/kg)	2,984 (12,491)
ii	Net calorific value, kcal/kg (kJ/kg)	2,630 (11,011)
B	**Proximate Analysis**	
i	Moisture (a.r)	45.71%
ii	Ash (a.r)	9.69%
iii	Volatile matter (a.r)	25.00%
iv	Fixed carbon (a.r)	19.6%
C	**Ultimate Analysis**	
i	C (a.r)	33%
ii	H (a.r)	2.7%
iii	N (a.r)	0.5%
iv	O (a.r)	7.02%
v	S.t (a.r)	1.38%
D	**Ash analysis**	
i	Silica (as SiO_2)	25.24
ii	Alumina (as Al_2O_3)	15.26

7 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Prepared for Thar Power Company. January 2014

	Coal Quality of Thar Block-II Lignite for Power Plant Design	*Average Quality*
iii	Titanium oxide (as TiO_2)	1.86
iv	Iron oxide (as Fe_2O_3)	11.79
v	Calcium oxide (as CaO)	14.25
vi	Magnesium oxide (as MgO)	6.43
vii	Sodium oxide (as Na_2O)	2.67
viii	Potassium oxide (as K_2O)	0.43
x	Sulphur oxide (as SO_3)	13.18
xi	Base / Acid Ratio	0.84
E	**Ash fusibility characteristic**	
i	Initial deformation temperature, °C	1,166
ii	Softening temperature, °C	1,190
iii	Fluid temperature, °C	1,200
F	**Hardgrove grindability index (HGI)**	**70-80**

a.r = as received

atm = standard atmosphere

Hardgrove Grindability Index is a measure of coal's resistance to crushing

3.4.2 Water

The water source and requirements for the proposed coal power Project are discussed below.

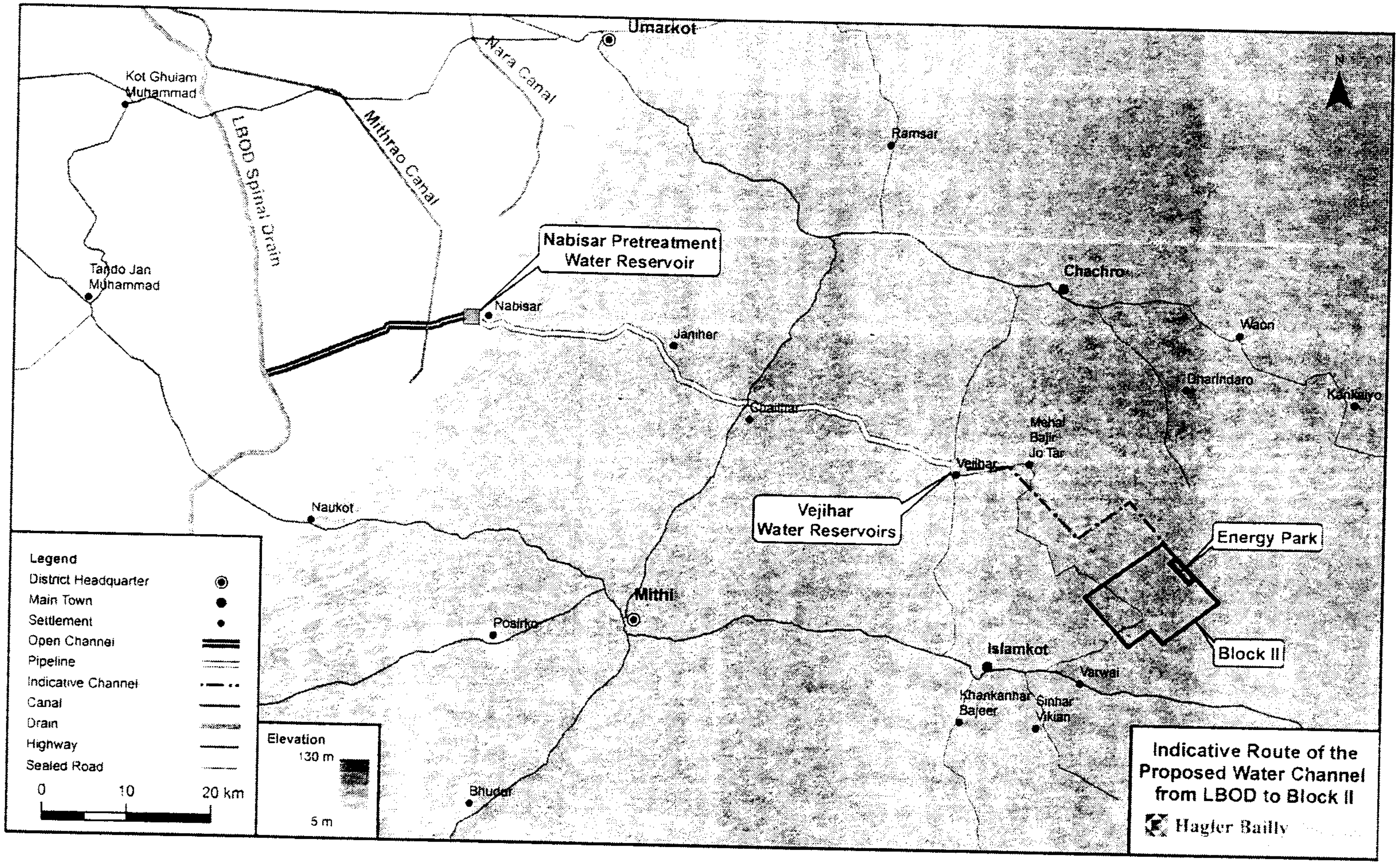
Water Source

A water channel will be constructed from a distributary of LBOD[8] to Block II to meet the water requirements for mining and power generation activities at Block II. An indicative route of the water channel is shown in **Exhibit 3.4**. As the GoS is developing this water channel as an independent project it is not within the scope of the current Project and its impacts are not evaluated as part of this ESIA.

[8] The LBOD is an environmental improvement project which was conceived in the 1960s as a response to the problem of rising water tables and resulting waterlogging and salinity. The project area includes some of the most hard-hit areas on the left side of the Indus River in the arid zones of Sindh Province. The project's primary function is to remove and safely convey saline water to the sea through a network of drains. The project provides for the integrated development of irrigation and drainage which include an outfall for saline drainage effluent to the Arabian Sea, phased construction of three drainage subareas in Nawabshah, Mirpurkhas and Sanghar, remodeling of the Nara/Jamrao Canal system, and watercourse improvement in the arid zones in Sindh Province.

The World Bank. "Left Bank Outfall Drain Project Tackling Pakistan's Waterlogging and Salinity Problems." Projects and Operations. http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20017537~menuPK:64282137~pagePK:41367~piPK:279616~theSitePK:40941,00.html (accessed October 15, 2014).

Exhibit 3.4: Indicative Route of the Proposed Water Channel from LBOD to Block II



Water Demand Estimate

The anticipated normal demand for water is between 1,200 to 1,400 cubic meter per hour (m^3/h). Of the required makeup water approximately 40% goes towards evaporation losses and 40% goes towards discharge of pre desalting water station.

3.4.3 Limestone

Limestone is a key input to control SO_2 production. The Project site will house a limestone processing facility and storage yard.

3.5 Waste Materials

The major waste streams generated by the proposed coal power plant Project include gaseous emissions, ash and wastewater.

3.5.1 Gaseous Emissions

The main pollutants emitted from coal power plants include sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and dust (PM_{10} and $PM_{2.5}$). A summary of key parameters related to air emissions, including stack specifications and emission rates, are presented in **Exhibit 3.5**. The release and dispersion of these pollutants is discussed in **Chapter 6**.

Exhibit 3.5: Estimated Air Emission Parameters

Parameters	*Value*	*Units*
Stack Specifications		
Height	180	m
Inner diameter	5.76	m
Flue Gas Specifications		
Exit velocity	20.8	m/s
Exit temperature	170	°C
Flow rate	543	m^3/s
Emission Rates		
SO_2	195.5	g/s
PM_{10}	5.5	g/s
$PM_{2.5}$	2.2	g/s
NO_2	127.5	g/s
Control Technology Efficiency		
PM - Electrostatic Precipitators (ESP)	99.9	%
SO_2 – Limestone Injection	90.0	%

3.5.2 Ash

The combustion of coal results in the production of both bottom ash and fly ash. Bottom ash is what remains after combustion in the furnace and consists of non-combustible matter in the inputs. The bottom ash will be evacuated from the bottom of the furnace. Fly ash is a product of combustion and is made of fine particles. The fly ash will be collected by means of an electrostatic precipitator (ESP). A five chamber ESP house will be installed which is capable of recovering 99.9% of solid carryover.

All the waste streams including fly ash and bottom ash if not exported for commercial use will be sluiced or conveyed to a mixing vessel where water will be added and the product will be transferred to the mine overburden area where the ash solids (wet) will be mixed with the mine overburden and will be dumped there.

The ash will be transported via truck and it will be stored temporarily on the power plant site until it is transported to the mine area for final disposal. The mine area is at a distance of around 5 km. It will be used as backfill in the spent mine pit. The dumped ash will be compacted, mixed with sand and given leaching protection by lining the area.

3.5.3 Wastewater

The maximum possible water from the power plants will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. A sewage treatment plant will treat sewage from the housing complex and construction camp. Wastewater from the sewage plant will be discharged or recycled in appropriate processing streams.

Non-recycled wastewater from the Project will be disposed through a 50 cusec (cubic foot per second) drainage and waste water effluent channel being prepared by the Government of Pakistan (GoP). The wastewater disposal through the effluent channel is being prepared by the GoP as an independent project and hence is not part of this Project and its impact are not evaluated in this ESIA. The expected outfall is at the Rann of Kutch (see **Ecological Baseline, Exhibit 4.31**), which is a natural depression connected to active sea creek system which is a highly saline water body.[9]

However, if this scheme is not available to the Project, alternate environmentally responsible wastewater disposal methods will be explored.

3.6 Analysis of Alternatives

This section considers the alternatives available to the current proposed Project. The different facets of the Project that were looked into for an analysis of alternatives are as follows:

- No project alternative
- Coal-source
- Boiler technology
- Particulate matter emission control
- Transport route

3.6.1 No Project Alternative

The no project alternative will have the following economic and environmental consequences:

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9 http://sindhcoal.gos.pk/effluent-disposal/

- Pakistan is going through an acute power shortage. The gap between supply and demand has crossed 6,000 MW. In the absence of this project, the gap in power supply and demand will continue to grow.
- The power plant will provide a market for the coal mined at Block II and aid in the development of the Thar Coalfields, thereby helping develop Pakistan's indigenous energy reserves.
- This Project will contribute to the job creation for the surrounding communities, the people of Sindh in particular and people of Pakistan in general in skilled, technical and administrative categories during construction and operation. These opportunities would contribute towards improving the economic conditions of the communities.

Therefore, unless economically, socioeconomically and environmentally more viable options can be found, the 'no project' option will have a negative impact on the economy

3.6.2 Coal Source for the Project

The following coal sources can be used for a coal based power plant in Pakistan

1. Imported coal. This is generally high quality (low ash, low sulfur, and high calorific values) sub-bituminous coal imported from coal exporting countries as Australia, Indonesia and South Africa.
2. Local coal. Thar lignite deposits are of low quality (high ash, high sulfur, and low calorific values). These reserves are estimated at 175 billion tonnes.

A comparison of the quality of Thar lignite with that of the imported bituminous coal is summarized in **Exhibit 3.6.**

Exhibit 3.6: Comparison of Local Thar Lignite with Imported Bituminous Coal

Coal Properties	*Sub-bituminous Coal*		*Lignite Coal*
	Australia	*Indonesia*	*Thar*
Moisture (ar %)	4-16	4-26	45-50
Coal Ash Content (ar. %)	4-16	3.0-22.0	14-15
Volatile Matter (ar %)	18-32	18-38	21-29
Sulfur Content (ar %)	0.4-0.9	0.2-0.94	0.2-2.7
Coal Net Calorific Value (kcal/kg)	4,000-6,900	3,105-6,900	2,500-3,700

ar = as received

Despite the difference in coal quality, Thar lignite is preferred for the following reasons:

1. The use of imported coal entails large environmental impacts of coal transport, which includes, unloading and transport through the densely populated city of Karachi which will be avoided.

2. To minimize transport distance, plants based on imported coal are usually situated near the port of import (Karachi). This deteriorates the already polluted airshed of the city.
3. The use of Thar coal, development of Project and ancillary facilities will help develop the Thar Coalfields, contributing to energy independence for Pakistan
4. The use of Thar coal will stimulate the local economy of the region.

Environmental controls to minimize pollutant release are discussed in **Chapter 7**.

3.6.3 Boiler Technology

Boiler technologies that can be considered for the Project are:

- Various advanced pulverized coal (PC) combustion technologies (subcritical, supercritical, ultra-supercritical)
- Fluidized bed combustion (FBC) technologies (atmospheric, circulating and pressurized).

FBC combustion uses the same thermodynamic cycle as a PC system. Thus, its power generation efficiency is in the same range as PC, but with a lower capital cost. This is due to its' ability to effectively control gaseous emission without the need to install additional SO_2 treatment system. In addition, FBC combustion has significantly lower power consumption compared to PC system. Of FBC systems, circulating FBC is most suitable for high ash, variable quality, high moisture and high sulfur fuels, which makes it ideal for a Thar lignite based power plant. Therefore, the selected combustion technology is the best available technology for the proposed Project.

3.6.4 Particulate Matter Emission Control

Particulate matter treatment technologies are electrostatic precipitators (ESP), fabric filters, cyclones and wet scrubbers. ESP were selected as the PM emission control technology for the following reasons:

1. High efficiency, compared to wet scrubbers and cyclones. The background particulate matter is already very high and hence a high efficiency technology is required.
2. Low maintenance requirements as compared to fabric filters. Although fabric filters also have high efficiency they require expensive and regular maintenance for said performance.

Exhibit 3.7 presents a detailed comparison among the technologies in terms of efficiencies, advantages and disadvantages.

Exhibit 3.7: Particulate Matter Control Technologies

Control Technology	Description	Control Efficiency	Advantages	Disadvantages
Electrostatic precipitator (ESP)	The ESP applies high-voltage fields to particles moving through the exhaust. The particulates are charged and move towards an oppositely charged collection surface, where they accumulate. The accumulated particles are than removed by rapper and collected at ESP hopper.	>99 %	High collection efficiency of 99% or greater at relatively low energy consumption. Continuous operation with minimum maintenance. Relatively low operation costs. Operation capability at high temperature (up to 700 °C) and high pressure (up to 10 atm) Capability to handle relatively large gas flow rates. (up to 50,000 m^3/min)	High capital cost High sensitivity to fluctuations in gas stream (flow rates, temperature, particulate and gas composition, and particulate loadings) Difficulties with the collection of particles with extremely high or low resistivity. High space requirement for installation Highly trained maintenance personnel required.
Fabric filters or bag houses	The particle-laden gas stream pass through the tightly woven fabric and the particulates are collected on one side of fabric. Filtered gas passes through the bags and is exhausted from the unit. When cleaning is necessary, dampers are used to isolate a compartment of bags from the inlet gas flow. Then, some of the filtered gas passes in the reverse direction in order to remove some of the dust cake. The gas used for reverse air cleaning is re-filtered and released.	99.9%	Very high collection efficiency (99.9%). Relative insensitivity to gas stream fluctuations and large changes in inlet dust loadings (for continuously cleaned filters). Recirculation of filter outlet air. Dry recovery of collected material for subsequent processing and disposal. No corrosion problems. Simple maintenance, flammable dust collection in the absence of high voltage Various configurations and dimensions of filter collectors Relatively simple operation	Requirement of costly refractory mineral or metallic fabric at temperatures in excess of 290 °C. Need for fabric treatment to remove collected dust and reduce seepage of certain dusts. Relatively high maintenance requirements Shortened fabric life at elevated temperatures and in the presence of acid or alkaline particulate. Respiratory protection requirement for fabric replacement.

Control Technology	Description	Control Efficiency	Advantages	Disadvantages
Wet scrubber	Water is injected into the flue gas stream at the venture throat to form droplets. Fly ash particles impact with the droplets forming a wet by-product which then generally requires disposal.	95-99%	Relatively small space requirement. Ability to collect gases, as well as "sticky" particulates. Ability to handle high-temperature, high-humidity gas streams Low capital cost (if wastewater treatment system is not required) High collection efficiency of fine particulates (95-99%).	Potential water disposal/effluent treatment problem. Corrosion problems (more severe than with dry systems). Potentially objectionable steam plume opacity or droplet entrainment Potentially high pressure drop. Potential problem of solid buildup at the wet-dry interface Relatively high maintenance costs
Cyclone or multi-cyclone	The flue gas enters the vessel tangentially and sets up a rotary motion whirling in a circular or conical path. The particles are hit against the walls by centrifugal force of the flue gas motion where they impinge and eventually settle into hoppers. Cyclones is referred as mechanical collectors and are often used as a pre-collector upstream of an ESP, fabric filter or wet scrubber so that these devices can specified for lower particle loadings to reduce capital and operating costs.	90-95%	Relatively small space requirements Low capital cost. Relative simplicity and few maintenance problems. Relatively low operating pressure drop. Temperature and pressure limitations imposed only by the materials of construction used Dry collection and disposal.	Relatively low overall particulate collection efficiencies especially for particulate sizes below 10 micron (PM10). Inability to handle sticky materials.

3.6.5 Transport Route

There are two transport routes from Karachi to the Project site shown in **Exhibit 3.8**.

1. The shorter of the routes is 366 km long and passes through the following towns:

Karachi → Thatta → Badin → Mithi → Islamkot → Energy Park

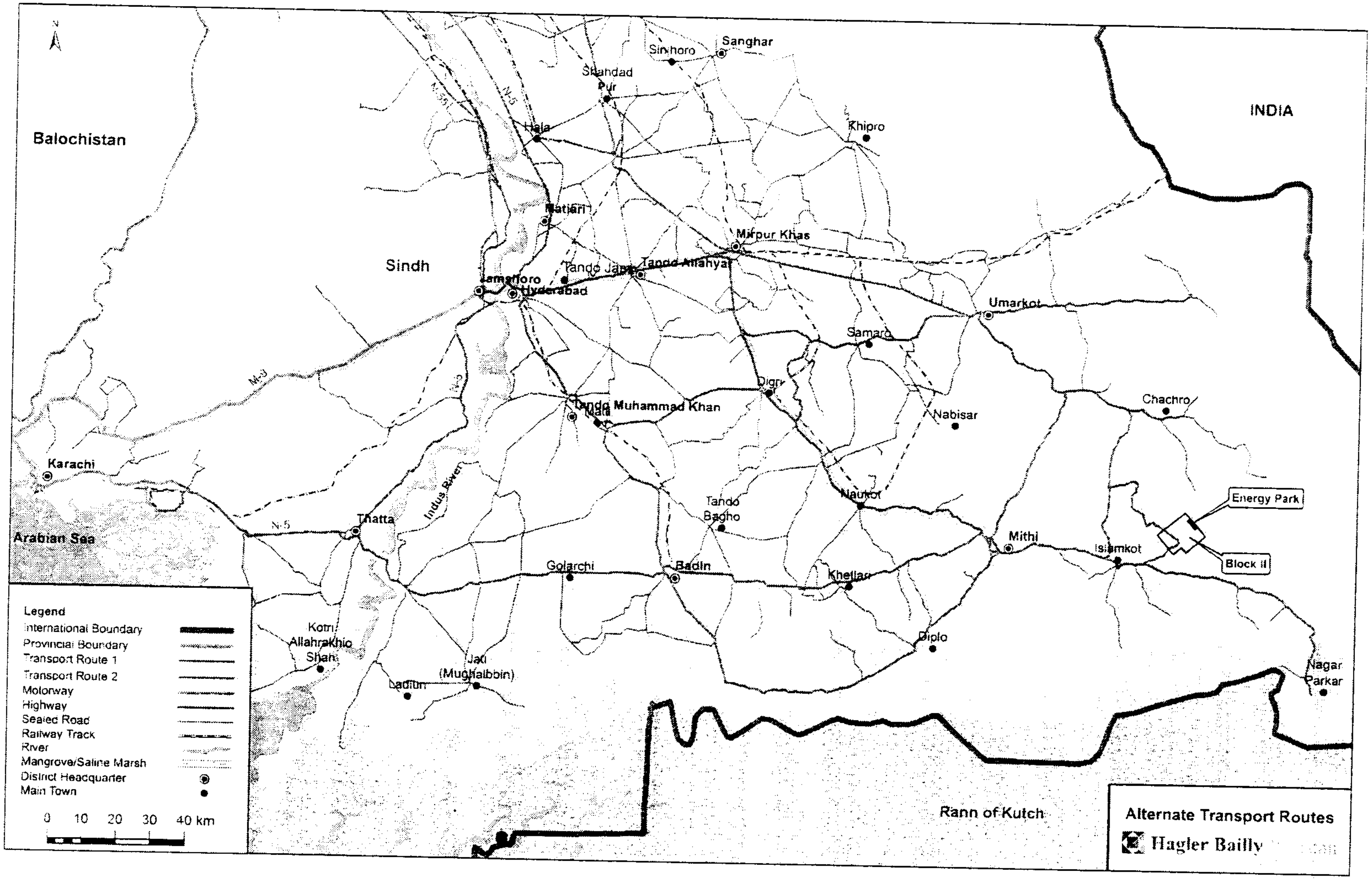
National Highway N-5 75 km Two lane 7.3 m wide	Provincial Highway 105 km Two lane 6.1-6.7 m wide	Provincial Road 114 km Two/One lane 4-6 m wide	Provincial Road 44 km Two/One lane 4-6 m wide	Provincial Road 28 km Two/One lane 4-6 m wide

2. The alternate route is 425 km long and passes through the following towns:

Karachi → Hyderabad (via M-9) → Mirpurkhas → Mithi → Islamkot → Energy Park

The first route is selected as the alternate route is 22% or 59 km longer.

Exhibit 3.8: Alternate Transport Routes



4. Description of the Environment

The existing environment including the physical, ecological and socioeconomic conditions is discussed in this section. The information on existing environment for the preliminary ESIA was collected through the ESIAs of the approved projects and other published literature.

This section will be updated in the final ESIA once the primary data collection is completed.

4.1 Methodology for Developing the Baseline

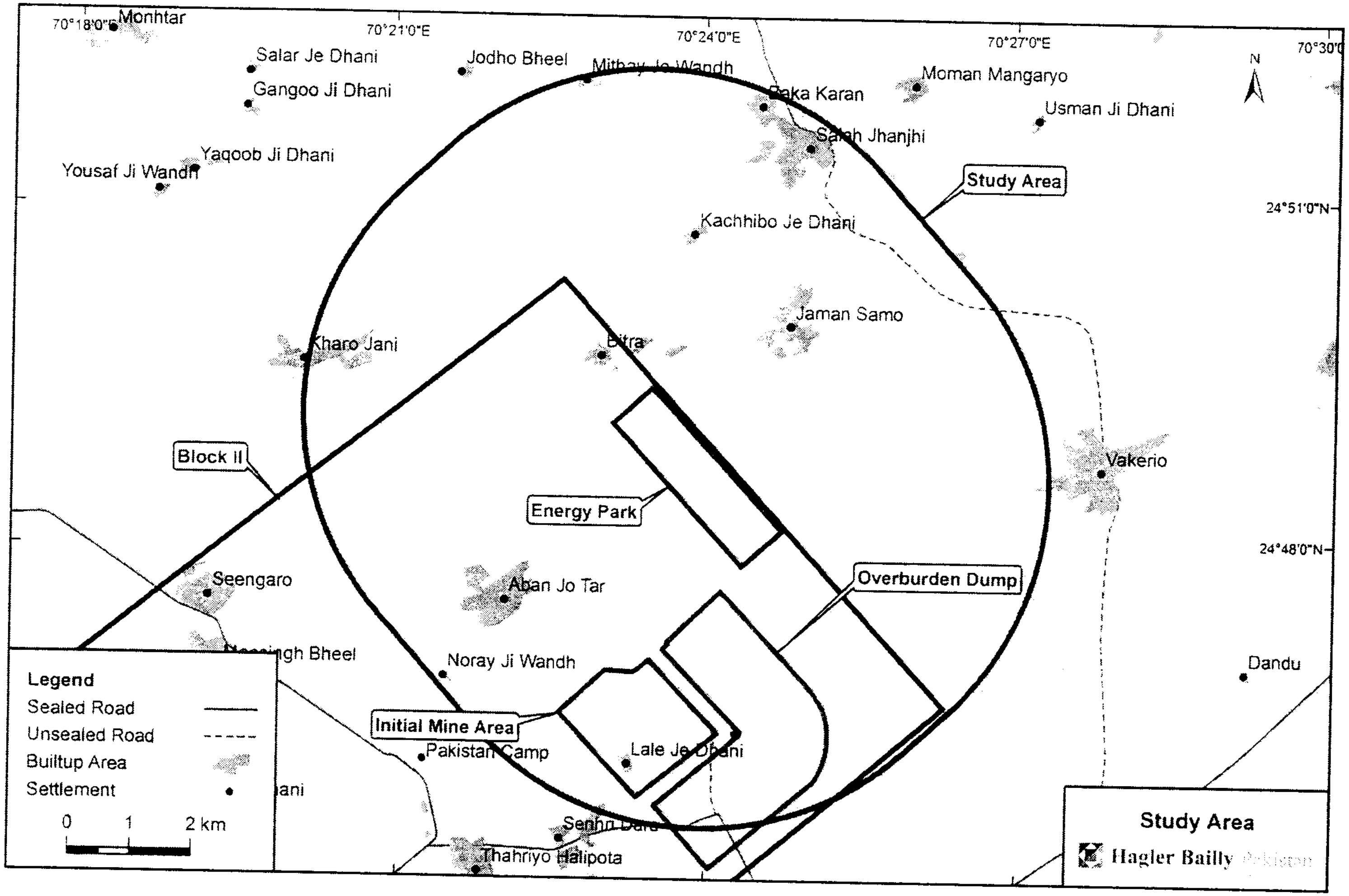
As a number of mining and power projects have been approved in the Thar area, the 'baseline' for the proposed Project takes into account the potential impact of these developments on the environment. This approach is especially used in developing air quality baseline.

4.2 Study Area

The description of the environment in this section focuses on an area where potential impacts from the Project are most likely to extend. The selected Study Area includes the Energy Park and covers an area within a 5 km radius around it and is depicted in **Exhibit 4.1.** The Study Area includes the sensitive receptors[10] that are most likely to be impacted by the Project's development activities.

10 Sensitive receptors include, but are not limited to, residential areas, schools, places of worship, wetlands, and habitats. These are areas which are more susceptible to the adverse effects of an anthropogenic activity such as noise, air emissions, traffic influx, and privacy issues.

Exhibit 4.1: Study Area



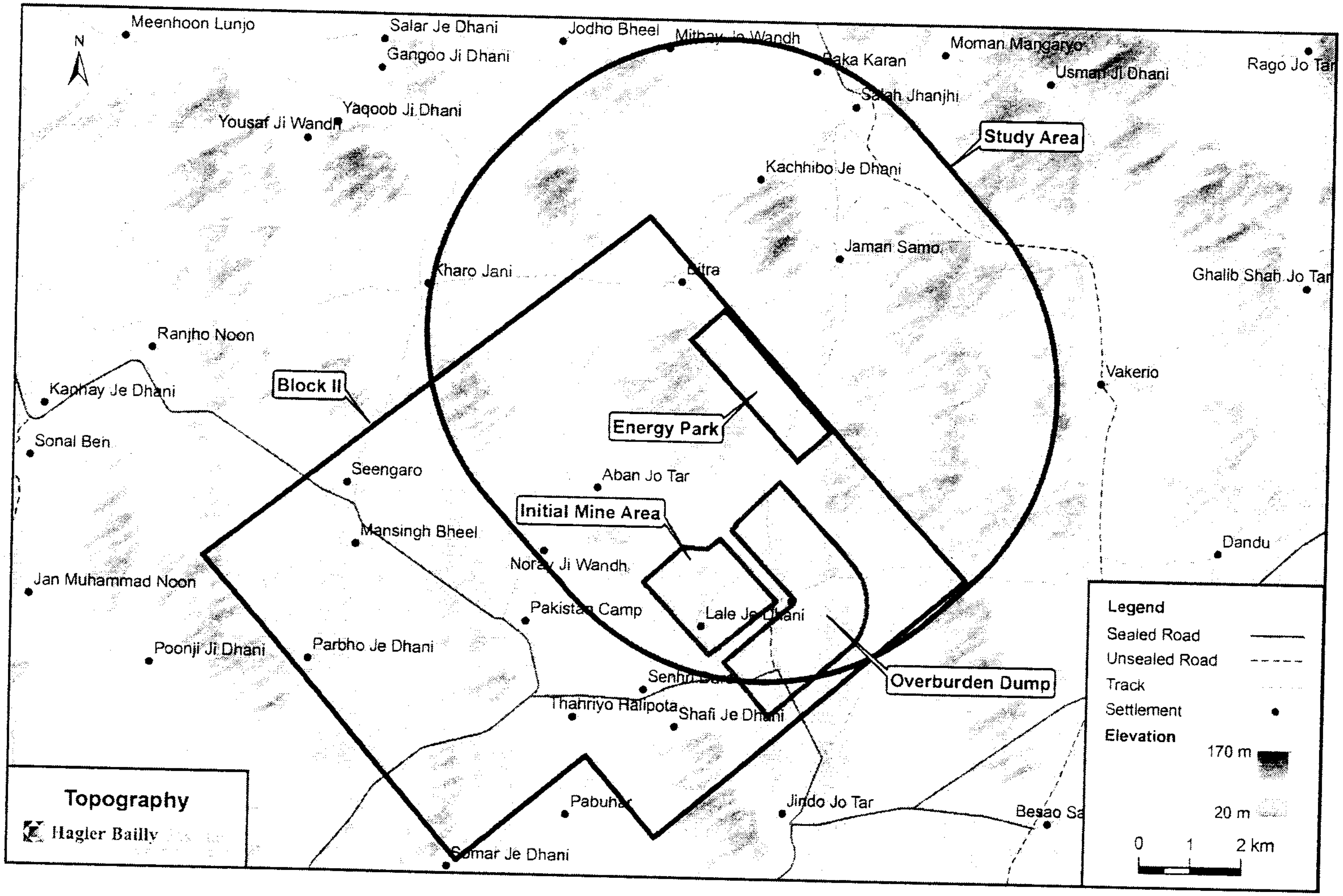
4.3 Physical Baseline

The physical baseline includes geomorphology, visual character, water resources, climate, air quality, sound levels, and traffic.

4.3.1 Topography

The topography of the Study Area is typical of the Thar Desert. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. A topographical map of the Study Area is shown in **Exhibit 4.2**. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (m amsl). Dunes are interspersed with areas of very flat plain being approximately 90 m amsl. There are no river courses close to the Study Area, although there are small ephemeral channels that capture run–off during and after large rainfall events. Significant temporary water bodies exist along the southern margins of the Thar Desert, particularly in the Great Rann of Kutch, approximately 30 km from the edge of the Study Area (see the Ecology Baseline in **Section 4.4**).

Exhibit 4.2: Topography

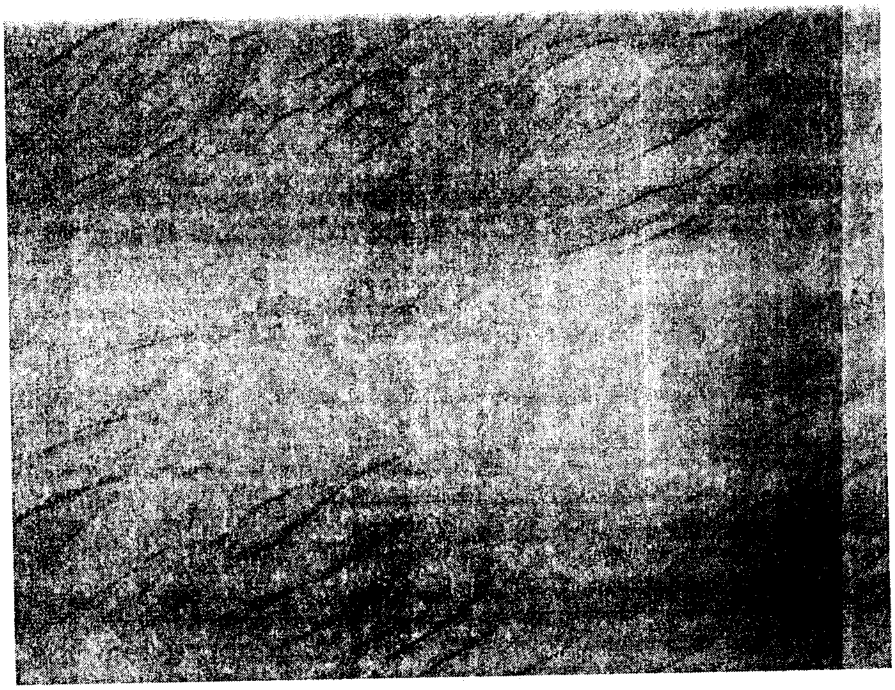


4.3.2 Geology

Elongate parabolic dunes are dominant within the Study Area, often with small playas within their noses (see **Exhibit 4.3**)[11]. The entire Study Area is covered by these, with little to no outcrop of rock. The last major phase of extended aeolian accumulation of the higher dunes in Thar occurred about 13,000 years ago[12].

The Thar Desert is covered by parabolic sand dunes and intervening playas[13].A map of the surface geology and the extent of the Thar Coalfields area is shown in **Exhibit 4.4**. The entire surface of the Study Area is covered by aeolian sands of the Quaternary.

Exhibit 4.3: Characteristic Parabolic Sand Dunes in Study Area[14]



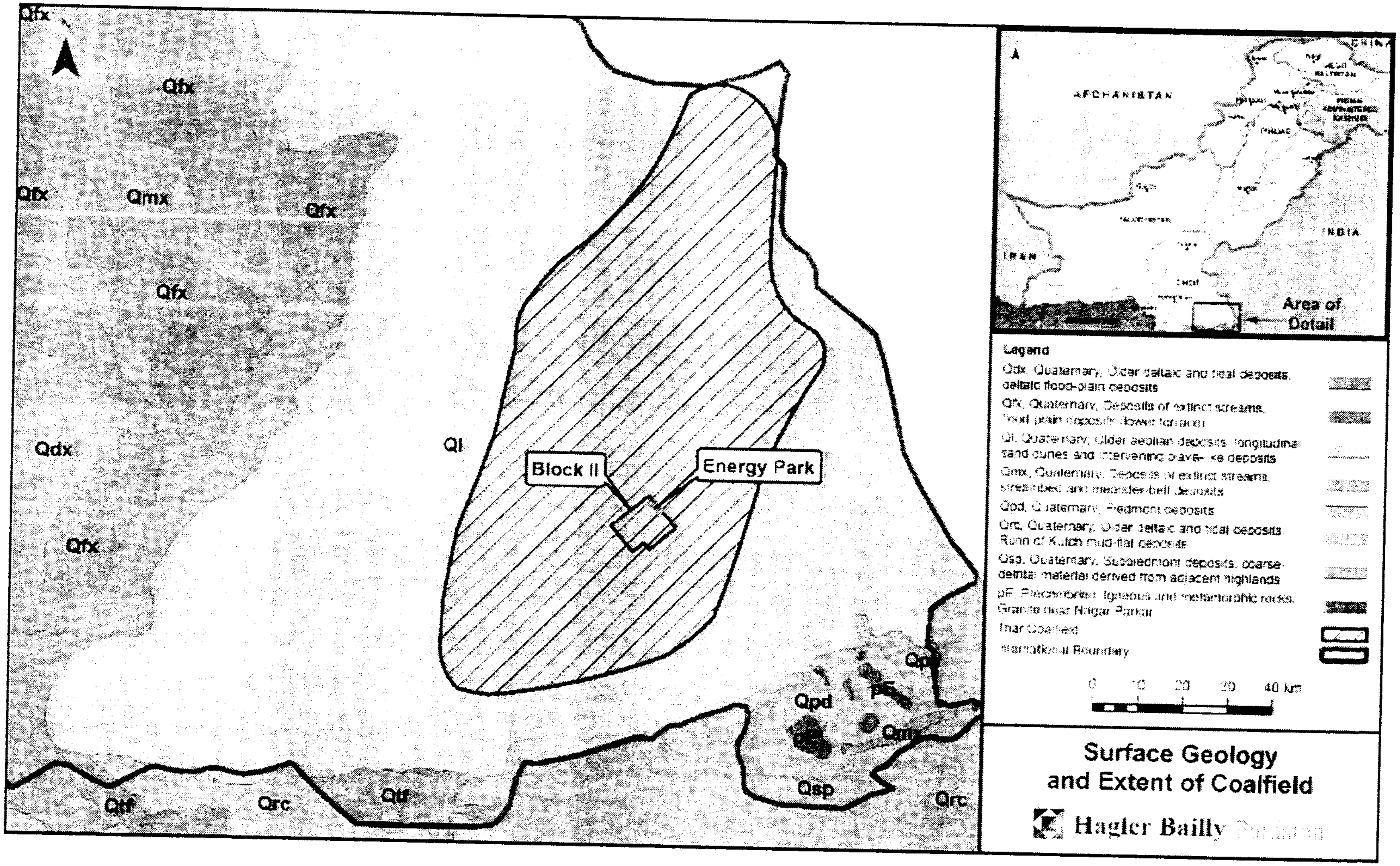
11 J. Laity, Deserts and Desert Environments (Wiley-Blackwell: 2008)

12 Chawla, S., et al., "Thermoluminescence chronology of sand profiles in the Thar desert and their implications," *Quaternary Science Reviews* 11 (1992), 25–32

13 Playa is a typically desert basin with no outlet which fills with water to form a temporary lake after rainfall

14 Google Earth Imagery

Exhibit 4.4: Surface Geology and Extent of Thar Coalfields



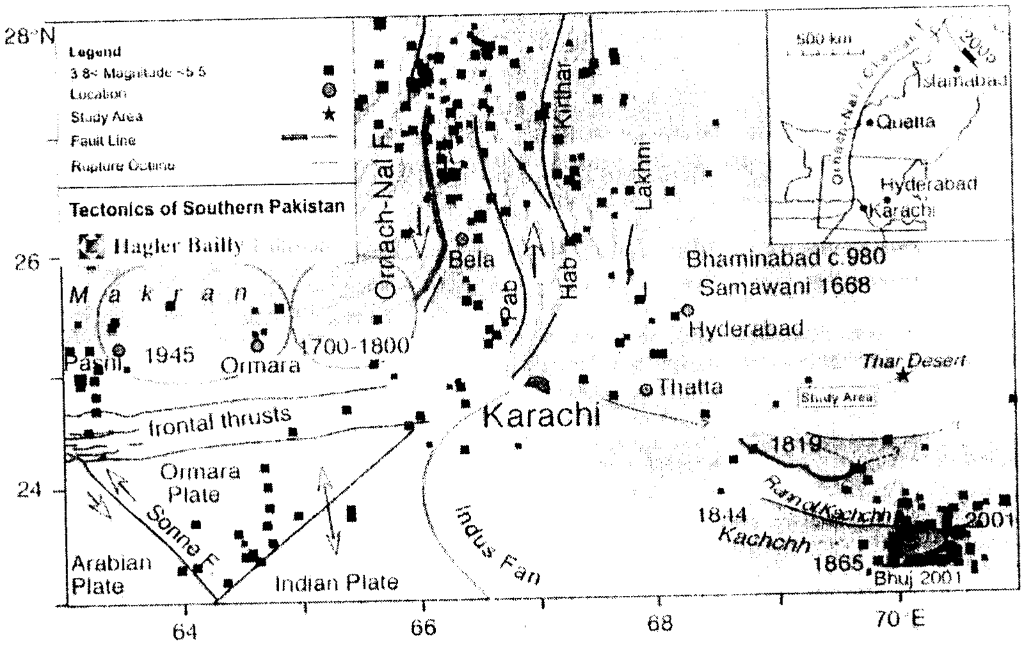
4.3.3 Tectonics, Earthquakes and Tsunamis

The Thar Desert lies at the northwestern corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults southwest of Karachi (**Exhibit 4.5**).

Based on the Global Seismic Hazard Map Project (GSHAP)[15], the peak ground acceleration (PGA) of 10% in 50 years is between 0.8 and 1.6 m/s^2 (**Exhibit 4.6**).

The Rann of Kutch fault extends south of the India-Pakistan border. In 1819 an earthquake of 7.7 to 9.2 on the moment magnitude scale (M_W) and perceived Modified Mercalli Intensity (MMI) scale intensity of XI (extreme) occurred along the fault. This trigged a tsunami causing at over 1,500 deaths along the sparsely populated coastline of Kutch.

Exhibit 4.5: Major Tectonics and Earthquakes of Southern Pakistan



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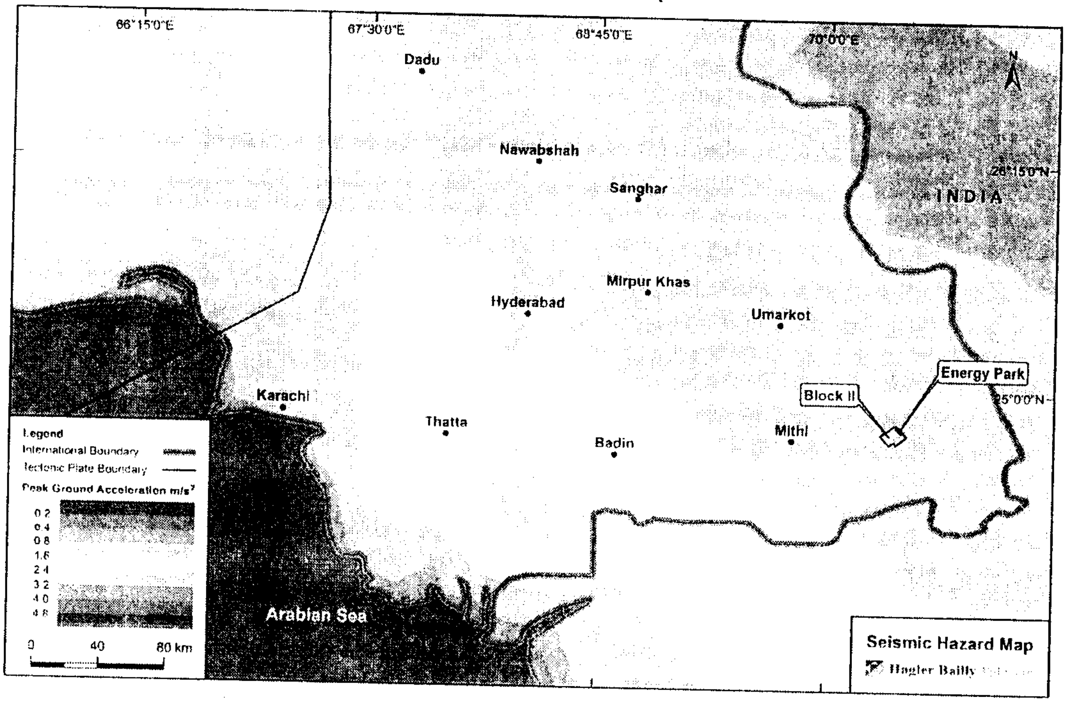
15 Giardini, D., Grünthal, G., Shedlock, K. M. and Zhang, P.: The GSHAP Global Seismic Hazard Map. Annali di Geofisica 42 (6), 1225-1228, 1999.

Exhibit 4.6: Seismic Hazard Map of Pakistan



4.3.4 Visual Character

The visual baseline documents the current aesthetic and visual conditions of the proposed Project site as seen from the nearby receptors.

The information on visual character was collected from a previous survey[16] conducted on May 13 and 14, 2016. The survey locations are listed in **Exhibit 4.7** and shown in **Exhibit 4.8**. The Project view from nearby receptors at the following locations are shown in **Exhibit 4.9**.

Exhibit 4.7: Visual Survey Locations in Literature

ID	*Coordinates*	*Elevation (m amsl)*	*Location*	*Date of Survey*	*Direction of Image Center*	*Rationale*
V1	24° 49' 14.0" N 70° 24' 15.1" E	100	Near Jaman Samo	May 14, 2016	Southwest	View of Project site
V2	24° 49' 29.3" N 70° 23' 04.1"E	139	Bitra	May 13, 2016	Southeast	View of Project site as seen from Bitra (village)

[16] Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant Study, ThalNova Power Thar (Private) Limited, Karachi, Pakistan.

ID	Coordinates	Elevation (m amsl)	Location	Date of Survey	Direction of Image Center	Rationale
V3	24° 47' 41.1" N 70° 22' 18.6" E	107	Aban Jo Tar	May 13, 2016	Northeast	View of Project site as seen from Aban Jo Tar (village)

Exhibit 4.8: Visual Survey Locations in Literature

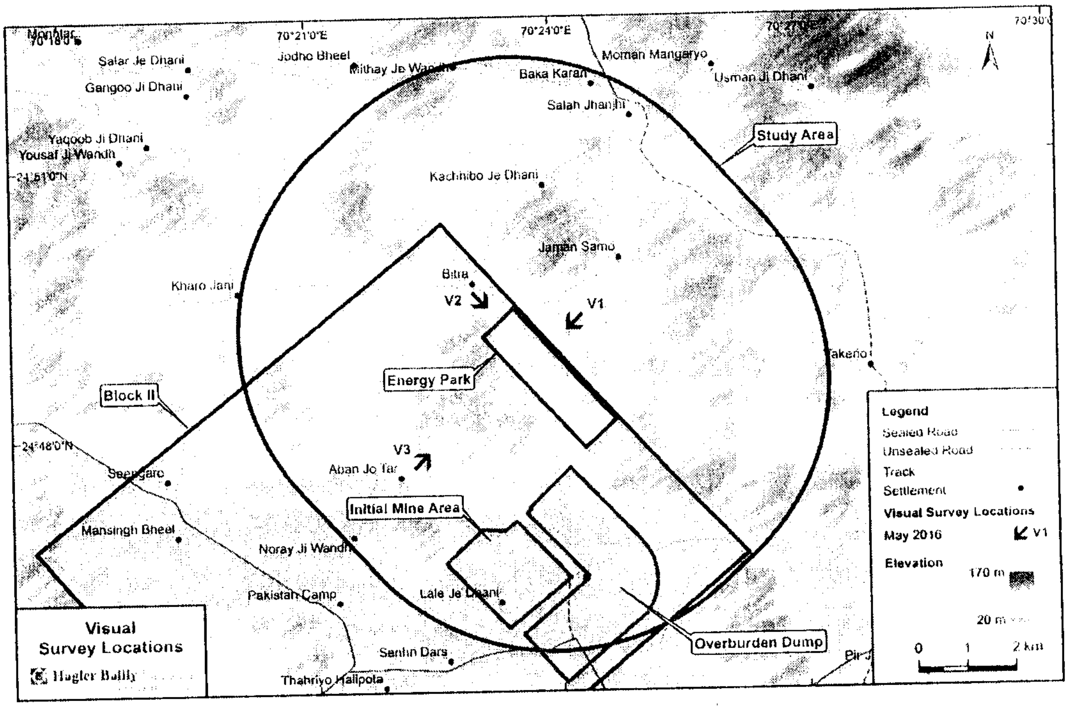


Exhibit 4.9: View of the Project Site from nearby Receptors

View from V1 (180 degree view, at 100 meters elevation, centered southwest). The undulating landscape and shrubs block visibility to the site.

View from V2 (180 degree view, at 139 meters elevation, centered southeast). Project site is visible on the plains at a distance.

View from V3 (180 degree view, at 107 meters elevation, centered northeast). Dunes block visibility of Project Site from Aban Jo Tar

4.3.5 Climate

This includes characterization of the monthly trends in weather parameters (temperature, precipitation, relative humidity, wind speed, wind direction and total cloud cover) in the Study Area.

Data from the Pakistan Meteorological Department (PMD) operated weather station at Mithi (24° 45' N, 69° 48' E) is the closest PMD weather station (64 km east) from Project site, with relatively long term data record (11 years from 2004 to 2014). Weather data from this station was used to develop the baseline. The Study Area has mild winters and there is consistency of temperature between the remaining of the seasons. Considering the climate data presented below, the seasons in the Study Area are classified as:

Summer (mid-March to mid-June)

Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.

Summer Monsoon (mid-June to mid-September)

The summer Monsoon, hereafter referred to as the Monsoon, is characterized by high temperatures (milder than summers), high rainfalls with high atmospheric humidity and moderate speed-winds.

Post-Monsoon Summer (mid-September to mid-November)

Characterized by moderately high temperatures, low rainfalls and low speed-winds blowing from southwest towards northeast.

Winter (mid-November to mid-March)

Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

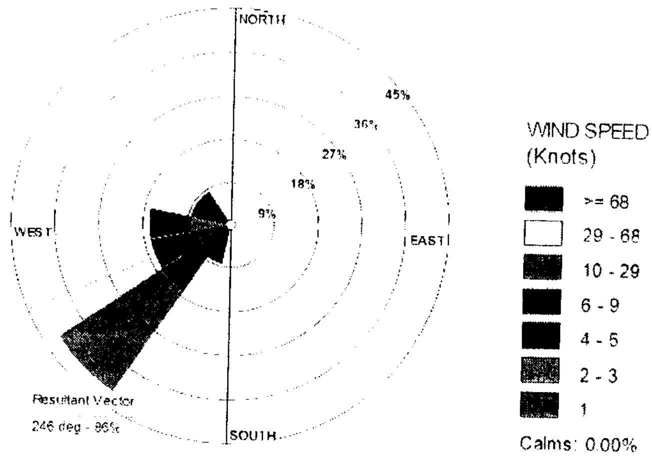
A summary of the climate in the Study Area based on the data from the Mithi weather station is presented in **Exhibit 4.10.** A wind rose is provided in **Exhibit 4.11**.

Exhibit 4.10: Summary of Weather Data for Study Area

Month	*Temperature (ºC)*		*Relative Humidity at 1200*	*Rainfall*	*Cloud Cover*
	Max	*Min*	*% at 12:00 UTC*	*mm*	*oktas at 12:00 UTC*
January	27	6	27	1	2
February	31	10	21	2	1
March	36	16	18	2	1
April	40	22	19	3	1
May	41	25	29	2	1
June	40	27	40	22	3
July	37	27	49	59	5
August	35	25	56	162	5

Month	Temperature (°C)		Relative Humidity at 1200	Rainfall	Cloud Cover
	Max	Min	% at 12:00 UTC	mm	oktas at 12:00 UTC
September	36	24	50	129	4
October	38	20	27	14	1
November	34	13	25	3	1
December	29	7	24	1	1

Exhibit 4.11: Wind Rose



4.3.6 Air Quality

The air quality baseline specifies the concentration of pollutants in the ambient air without the Project. The Project is assumed to become operational in 3 years. Other developments, such as the Block II and Block VI mines, are planned around the Project and are also likely to affect air quality. Therefore, the concentration of pollutants in the ambient air in, say, 2020 when the Project comes in operation, is likely to be different from the concentration at present.

The air quality baseline was developed using measured concentration and modeled concentration. The modeled concentration shows the expected impact of the proposed developments around the Project. The concentrations were modeled using air dispersion modelling (AERMOD).

The pollutants selected for evaluation, based on the expected emissions from the planned operations and the level of risk to human health posed by these pollutants, are as follows:

- Sulfur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Particulate matter (PM_{10} and $PM_{2.5}$)

Measured Baseline

To document the measured air quality baseline the data herein was taken from the literature. The measured air quality baseline supposed to be developed using primary as well as secondary data. However, herein the baseline is developed only by using secondary data as the primary investigations are in process.

Secondary Data

The secondary data is summarized in **Exhibit 4.12**. The previous sampling locations are shown in **Exhibit 4.13.**

Exhibit 4.12: Air Quality Sampling Locations in Literature

Sample ID	*Coordinates*	*Description*	*Source*
D1	24° 45' 55.3" N 70° 23' 08.8" E	Lale Je Dhani	ESIA of 330 MW coal-fired power plant in Block II[17]
D2	24° 48' 42.3" N 70° 28' 00.2" E	Vakerio	
D3	24° 49' 58.3" N 70° 24' 46.1" E	Jaman Samo	
D4	24° 45' 15.1" N 70° 21' 43.9" E	Thahriyo Halipota	
C1	24°49' 12.19" N 70°17' 08.83" E	Ranjho Noon	ESIA of Block VI coal mine. (Oracle Coalfields Limited)[18]
C2	24°53' 51.32" N 70°19' 04.57" E	Meghay Jo Tar	
C3	24°51' 21.78" N 70°24' 45.21" E	Salah Jhanjhi	
B1	24°44' 14.56" N 70°13' 14.32" E	Mehari Bajeer	ESIA of Block II coal mine[19]
B2	24°51' 47.63" N 70°24' 54.39" E	Salah Jhanjhi	
B3	24°46' 11.39" N 70°21' 23.94" E	Pakistan Camp	
B4	24°45' 08.94" N 70°21' 25.76" E	Thario Halepota	

17 Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant Study, ThalNova Power Thar (Private) Limited, Karachi, Pakistan.

18 Hagler Bailly Pakistan, April 2013, Environmental and Social Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

19 Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project, Sindh Engro Coal Mining Company

Sample ID	*Coordinates*	*Description*	*Source*
A1	24°39' 22.51" N 70°19' 01.10" E	Open Field Tilwai	ESIA of Block I coal mine)[20]
A2	24°40' 48.48" N 70°17' 56.62" E	Open Field Varvai	
A3	24°40' 11.39" N 70°22' 01.06" E	Open Field Khario Ghulam Shah	

Results and Analysis

The results of the previous sampling are tabulated in **Exhibit 4.14** and compared against SEQS and IFC EHS limits.

[20] Environmental Management Consultants (EMC), May 2012, Environmental and Social Impact Assessment of Thar Coal Mining Project, Sinhar Vikian Varvai, Block 1 for Sino-Sindh Resources

Exhibit 4.13: Air Quality Sampling Locations in Literature

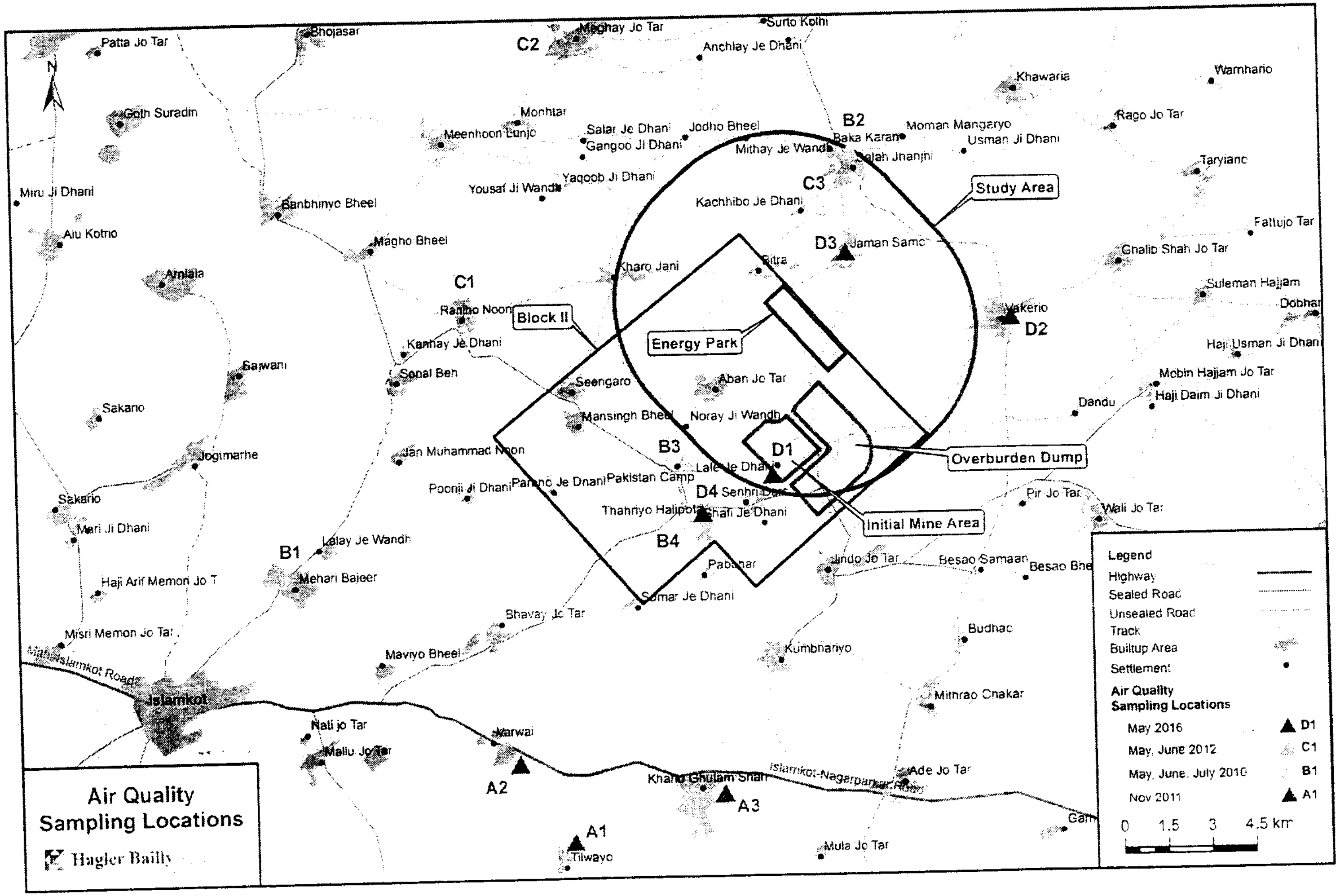


Exhibit 4.14: Results of Previous Sampling (µg/m³)

Sample ID	Date	NO_2	SO_2	PM_{10}	$PM_{2.5}$
D1	May, 2016	–	–	114.3	63.5
D2	May, 2016	–	–	109.3	68.3
D3	May, 2016	–	–	104.7	52.4
D4	May, 2016	–	–	84.6	36.3
C1	May, 2012	–	3.6		
	June, 2012	–	2.7	333.0	112.0
C2	June, 2012	–	2.1	776.0	129.0
C3	May, 2012	–	6.6	–	–
	June, 2012	–	11.4	406.0	98.0
B1	May, 2010	6.9	12.4	–	–
	June, 2010	2.9	5.8	138.9	13.9
	July, 2010	3.3	2.9	83.3	13.9
B2	May, 2010	4.7	9.1	–	–
	June, 2010	3.4	5.4	180.6	27.8
	July, 2010	4.6	6.8	97.2	13.9
B3	May, 2010	2.4	4.5	–	–
	June, 2010	2.8	2.2	166.7	27.8
	July, 2010	2.7	8.1	97.2	13.9
B4	May, 2010	3.2	NA	–	–
	June, 2010	2.2	3.4	222.2	55.6
	July, 2010	2.9	1.6	111.1	27.8
A1	Nov, 2011	16.1	27.0	140.6	20.8
A2	Nov, 2011	5.8	10.1	228.0	34.2
A3	Nov, 2011	6.7	11.2	205.6	30.8
Median Value		**3.3**	**7.4**	**139.8**	**32.5**
SEQS (annual)	–	40	80	120	40
SEQS (24-hour)	–	80	120	150	75
IFC (annual – interim target 1)	–	–	–	70[a]	35[a]
IFC (annual – guideline)	–	40	–	20[a]	10[a]
IFC (24-hour – interim target 1)	–	–	125	150	75
IFC (24-hour – guideline)	–	–	20	50	25

Note: – means the data was not available

a means annual does not apply to particulate matter data reported above.

From the measured values the following conclusions can be drawn:

- The median value of SO_2 concentration is 7.4 µg/m^3 which complies with SEQS (24 hour and annual) and is within IFC EHS limits. The maximum recorded SO_2 in the area is 27.0 µg/m^3 which is also well below the SEQS and IFC EHS limits.
- The median value of NO_2 concentration is 3.3 µg/m^3 which complies with SEQS (24 hour and annual) and is within IFC EHS limits. The maximum recorded NO_2 in the area is 16.1 µg/m^3 which is also well below the SEQS and IFC EHS limits.
- The median value of PM_{10} and $PM_{2.5}$ concentrations are 139.8 µg/m^3 and 32.5 µg/m^3 respectively. The $PM_{2.5}$ concentration complies with SEQS and IFC interim target value. The median value of PM_{10} concentrations are within the 24-hour limits of the SEQS and the IFC EHS target values but exceeds the guideline value. The particulate matter concentrations are very high due to the natural background influence of the desert environment. Human sources of particulate matter (PM) include the use of wood as fuel and vehicular traffic on unpaved roads and dirt tracks.

Based on the above exercise, **Exhibit 4.15** presents the current pollutant levels of the Study Area that are established based on the median of the measured results. These values are used for development of the modelled cumulative baseline. The error bars are of one standard deviation.

Exhibit 4.15: Baseline Ambient Air Quality in the Study Area (µg/m^3)

	NO_2	SO_2	PM_{10}	$PM_{2.5}$
Baseline Levels	3 ± 3	7 ± 6	140 ± 93[21]	30 ± 40
SEQS (annual)	40	80	120	40
SEQS (24-hour)	80	120	150	75
IFC (annual – interim target 1)	–	–	70	35
IFC (annual – guideline)	40	–	20	10
IFC (24-hour – interim target 1)	–	125	150	75
IFC (24-hour – guideline)	–	20	50	25

Even though the standard deviation of NO_2 and SO_2 is large the level of these pollutants are much lower than SEQS and IFC EHS limits. However, the PM readings are both high, but also have high variation, due the intense variation in background levels depending on the season.

Modeled Baseline

Approved developments in the Study Area that may influence the air quality baseline of the Project are summarized in **Exhibit 4.16** and locations are shown in **Exhibit 4.17**

21 The reading of 780 µg/m^3 is removed as it was 5 times the median value and is likely a low occurring outlier.

Exhibit 4.16: Approved Developments in Study Area

Block No.	*Source*
Mine	
Block II	Environmental and Social Impact Assessment of Thar Coal Block II Mining Project [a]
Block VI	Environmental and Social Impact Assessment of Block VI Lignite Mining Project [b]
Power Plants	
Block II	1. Environmental and Social Impact Assessment of Thar Coal Block II Power Project (660 MW) [c]
	2. Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant [d]
	3. Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant [e]

Notes:

a. Hagler Bailly Pakistan, January 2012, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Sindh Engro Coal Mining Company, Karachi, Pakistan.

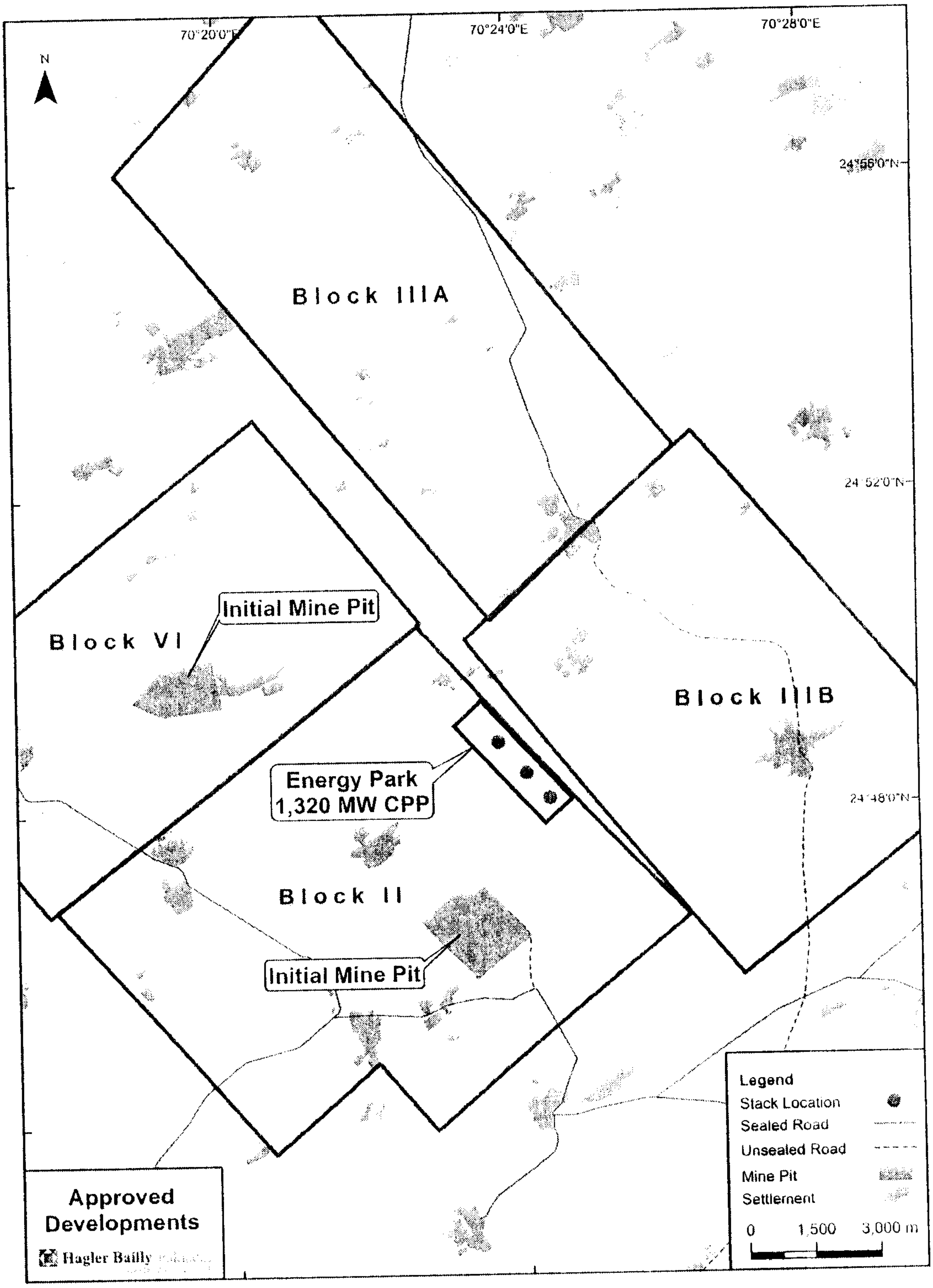
b. Hagler Bailly Pakistan, April 2013, Environmental and Social Impact Assessment of Block VI Lignite Mining Project, Sindh Carbon Energy Limited, Karachi, Pakistan.

c. Hagler Bailly Pakistan, January 2014, Environmental and Social Impact Assessment of Thar Coal Block II Power Project, Sindh Engro Coal Mining Company, Karachi, Pakistan.

d. Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant in Energy Park, Block II, Thar Energy Limited, Karachi, Pakistan.

e. Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-Fired Power Plant in Energy Park, Block II, ThalNova Power Thar (Private) Limited, Karachi, Pakistan.

Exhibit 4.17: Approved Developments



Modelling Area

The modeling area was defined as circle of radius 15 km centered at the center of the Energy Park. The area was taken considering the distance of receptors and expected impact of the Project. As Block I is farther than 15 km it was not included in the modelling exercise.

Model Details

These activities were modeled using USEPA approved regulatory model AERMOD. AERMOD provides predicted pollutant concentrations for hourly, daily, monthly, and yearly averaging periods, and complies with the USEPA's guidelines on air quality models. Weather data from the Mithi weather station from 2012-2014 was used.

Modeling Approach

There is a large variability in the natural dust concentrations. This can be observed from the large standard deviation in the particulate matter readings. This could be due to the following reasons:

- Seasonal influence such as the monsoons, that result in large amounts of greenery in the Thar Desert which suppress dust emissions to dry and windy dust storms that result in large dust emissions.
- Location of measurement with reference to sand dunes, which can both shade receptors from the wind but are also a source of dust emissions depending on whether the receptor location is upwind or downwind of the dune.

This natural spatial and temporal variability is not captured in the average value of 140 $\mu g/m^3$ for PM_{10} and 30 $\mu g/m^3$ for $PM_{2.5}$.

Initial modelling using AP-42 methodology shows that under unmitigated mining operation, areas within 3 to 5 km of the active coal mine and waste dump will be dominated by the dust emissions from the mining activity. The mining activity is not included further in this assessment.

Only CPP stacks were modelled for annual averaging period. The modeling was based on the parameters discussed in **Section 3.5.1**.

Combined Baseline

The measured baseline was added to the modelled results to uniformly elevate the current modelled concentrations. It should be noted that the existing pollutant concentrations are not uniform and this is a simplifying assumption. Contour maps for dispersion of each pollutant are presented in **Exhibit 4.18** to **Exhibit 4.21**. The measured and modeled results are compiled in **Exhibit 4.22**.

Exhibit 4.18: Baseline SO_2 Concentration (Annual)

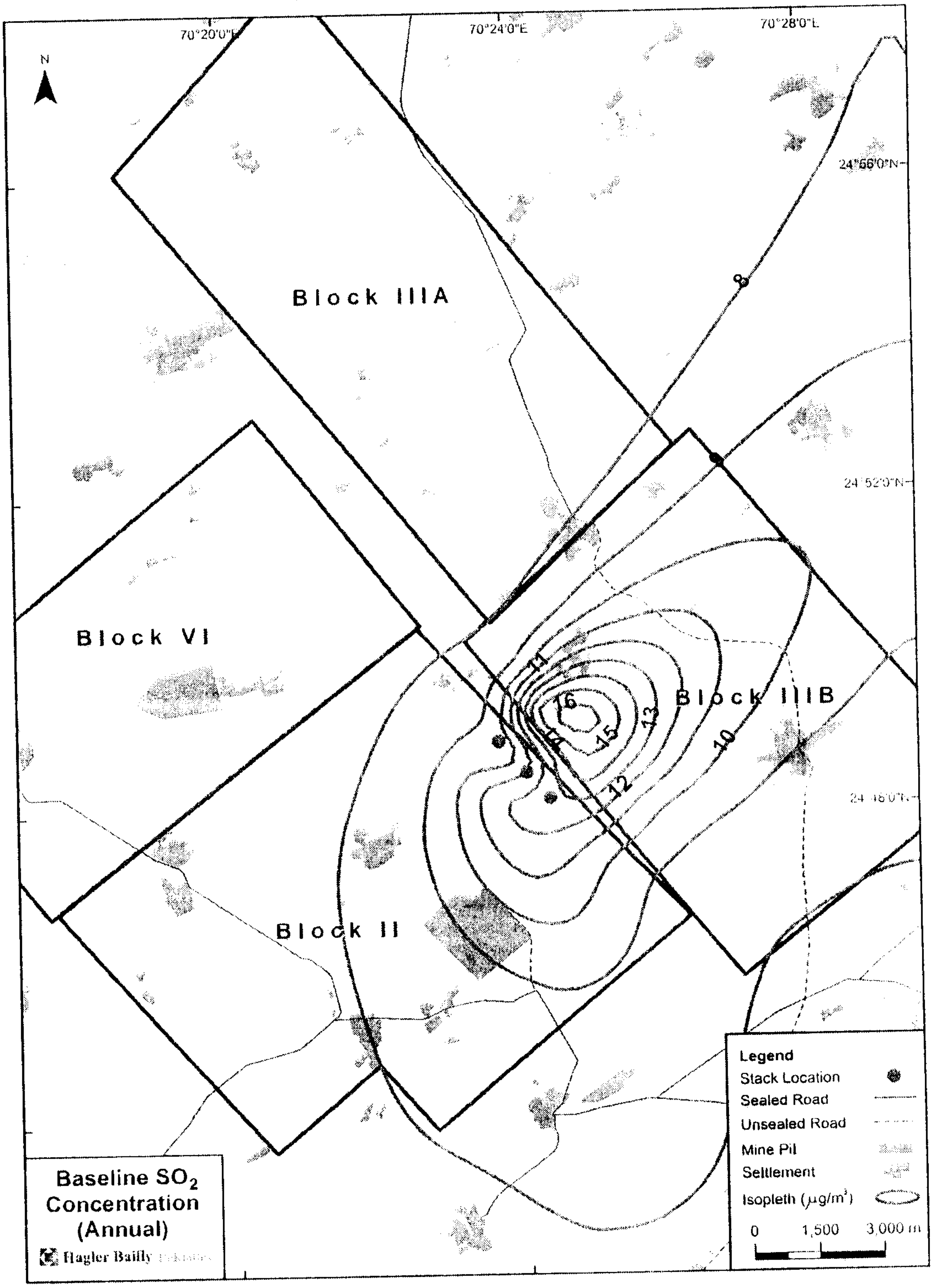


Exhibit 4.19: Baseline NO_2 Concentration (Annual)

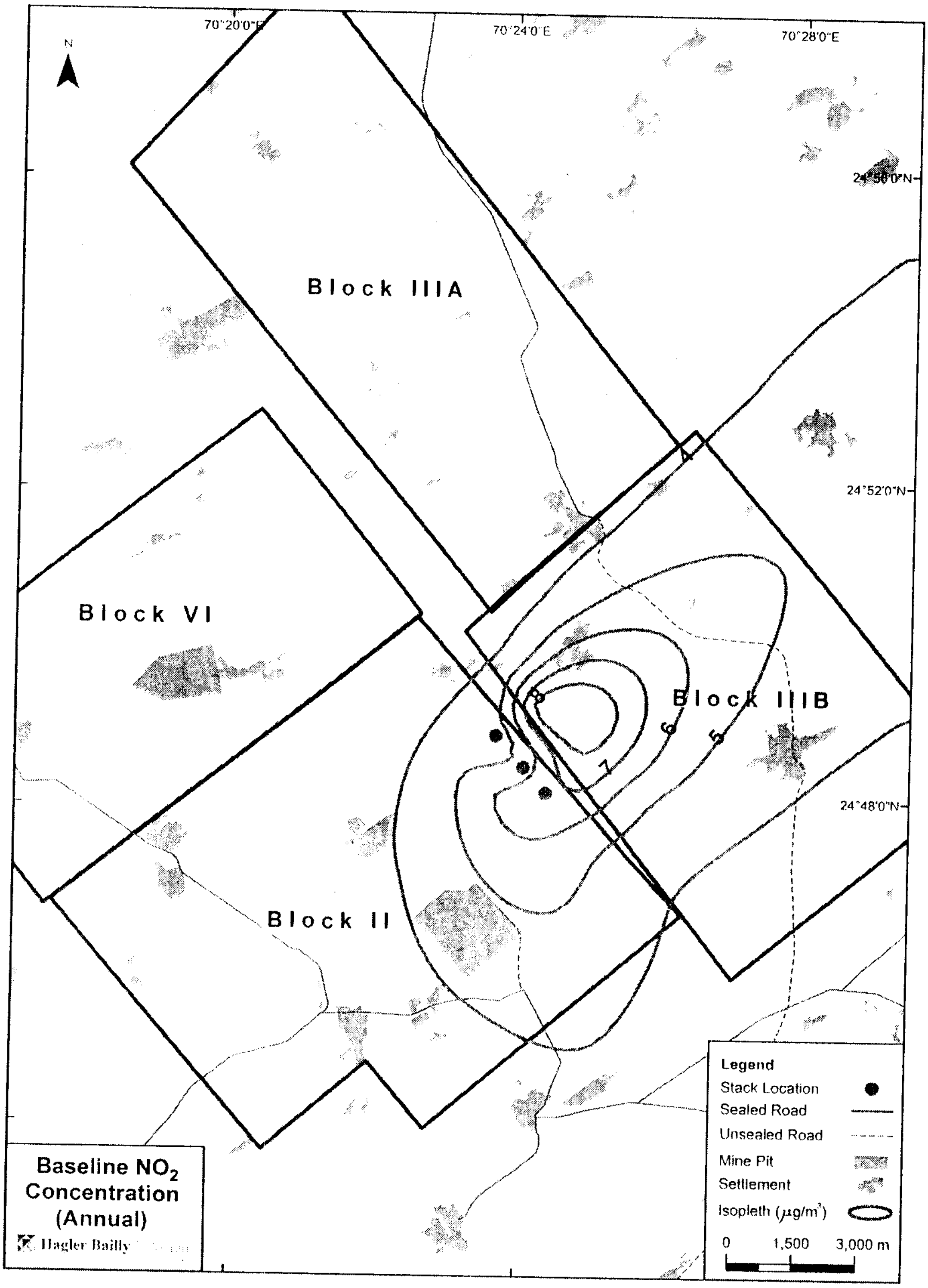


Exhibit 4.20: Baseline PM_{10} Concentration (Annual)

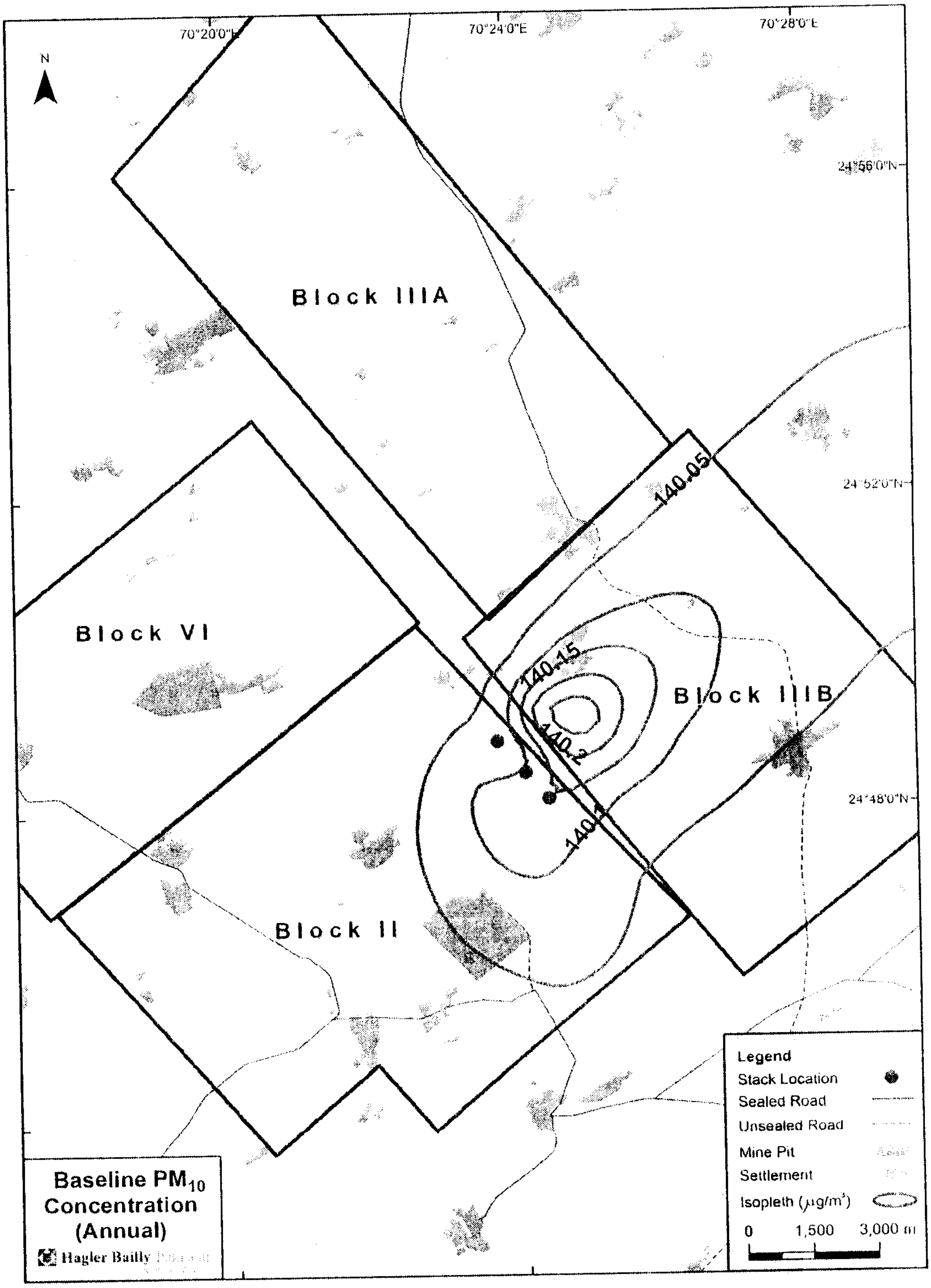


Exhibit 4.21: Baseline $PM_{2.5}$ Concentration (Annual)

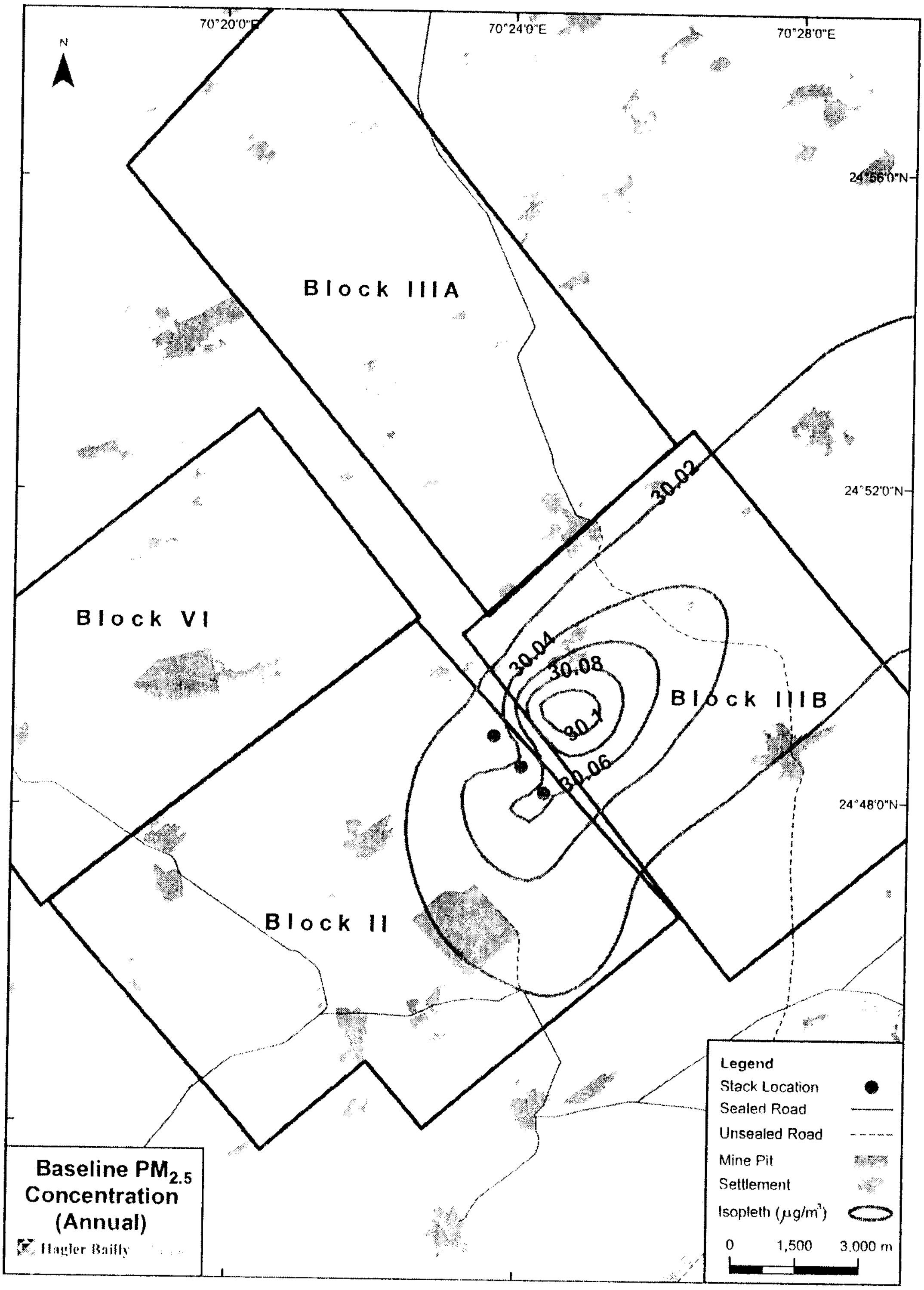


Exhibit 4.22: Combined Baseline Results (µg/m³) – Annual

Pollutant	*Measured Baseline*	*Modeled Increment*	*Simulated Baseline*	*SEQS*	*IFC EHS target limits*
SO_2	7	9.7	16.7	80	-
NO_2	3	5.9	8.9	40	40
PM_{10}	140	0.2	140.2	120	70
$PM_{2.5}$	30	0.1	30.1	40	35

The following conclusions can be drawn:

- The annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits.
- The annual PM_{10} concentrations have a higher value than the limits. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average. Furthermore, the standard allows the limits to be exceeded on 8 days of the year. The modelled annual PM_{10} concentrations due to the developments are not a significant cause for exceedance. The background levels of PM_{10} are high due to naturally dusty desert environment.
- The annual $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits.

4.3.7 Sound Levels

This section defines the baseline ambient sound levels in the Study Area in a manner that can be used for the assessment of the noise impact of the proposed Project.

Data Sources

The primary as well as secondary data sources serves as baseline for determining noise in the Study Area. Herein, only secondary data was used as primary investigations were in process. The previous sampling locations are given in **Exhibit 4.23** and sampling locations are shown in **Exhibit 4.24.**

Exhibit 4.23: Sound Level Sampling Locations in Literature

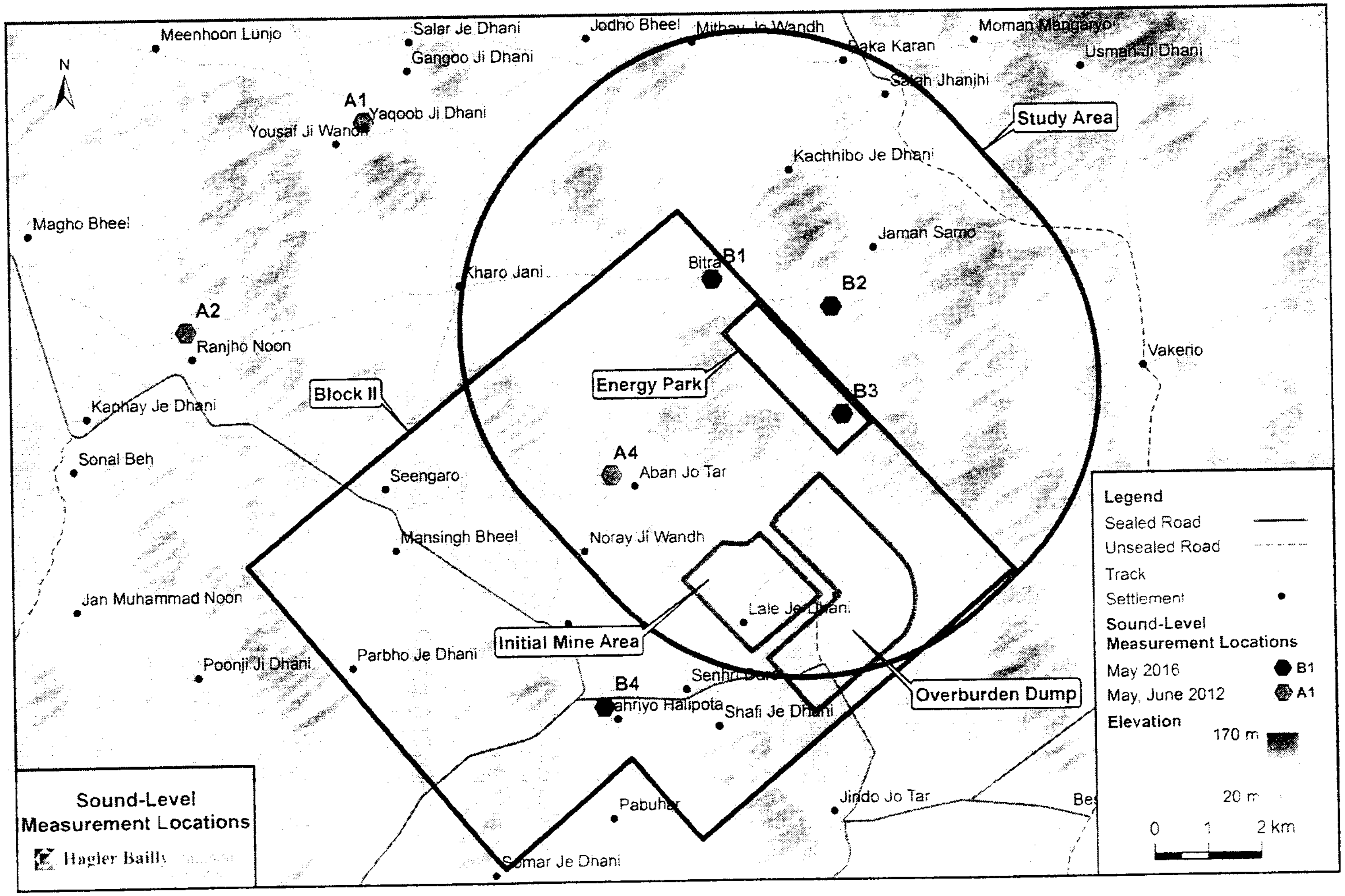
Sample ID	*Coordinates*	*Dates of Survey*	*Description*	*Source*
B1	24° 49' 37.8" N 70° 22' 59.5" E	May, 2016	Bitra	ESIA of 330 MW coal-fired power plant in Block II[22]
B2	24° 49' 19.4" N 70° 24' 19.1" E	May, 2016	Jaman Samo	

[22] Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant Study, ThalNova Power Thar (Private) Limited, Karachi, Pakistan.

Sample ID	Coordinates	Dates of Survey	Description	Source
B3	24° 48' 12.2" N 70° 24' 24.8" E	May, 2016	South of Energy Park	
B4	24° 45' 15.6" N 70° 21' 38.9" E	May, 2016	Thahriyo Halipota	
A1	24° 51' 18.9" N 70° 19' 02.8" E	October, 2012	Yaqoob Ji Dhani	ESIA of Block VI coal mine. (Oracle Coalfields Limited)[23]
A2	24° 49' 12.1" N 70° 16' 55.8" E	October, 2012	Ranjho Noon	
A4	24°47' 37.5" N 70° 21' 47.3" E	October, 2012	Aban jo Tar	

[23] Hagler Bailly Pakistan, April 2013, Environmental and Social Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

Exhibit 4.24: Sound-Level Measurement Locations in Literature



Measurement Results and Analysis

A summary of the results and SEQS for noise are provided in **Exhibit 4.25**. Reported results include:

- L_{90} is the sound level exceeded 90% of the time. The L_{90} is representative of the background sound level.
- L_{10} is the sound level that is only exceeded 10% of the time (higher than L_{90}).
- L_{eq} is the average of the total sound level in decibels.

Reported sound levels are on the A scale, which covers the full audible range and is relatable to human hearing.

Exhibit 4.25: Summary of Sound Levels

Point	*Description*	*24 hour (dBA)*			*Daytime Averages (dBA)*	*Nighttime Averages (dBA)*
		L_{90}	L_{10}	L_{eq}	L_{eq}	L_{eq}
B1	Village (Bitra)	31.8	52.4	51	51.8	46.0
B2	Background, no human presence	35.8	46.8	45	46.2	43.0
B3	Background, no human presence	29.0	41.1	40	41.9	34.2
B4	Road + Village	36.0	50.2	50	49.8	50.1
A1	Village	31.6	44.2	46.8	48.6	41.1
A2	Village	25.8	44.5	43.9	45.5	38.6
A4	Village + Road	34.0	55.5	52.4	53.7	46.2
SEQS					**55.0**	**45.0**
IFC Limit[24]					**55.0**	**45.0**

Conclusion

The previous sound level data are averaged[25] to obtain the sound level baseline as presented in **Exhibit 4.26** and discussed below.

[24] For IFC EHS limits, daytime is from 7 am to 10 pm, whereas for SEQS daytime is from 6 am to 10 pm. Values in this study were calculated based on SEQS daytime classification. Furthermore, IFC requires hourly Leq to comply with the limit.

[25] dB cannot directly be averaged due to the log scale of the unit.

Exhibit 4.26: Sound Level Baseline of the Study Area

Location	*Average L_{eq} (dBA)*	
	Daytime	*Nighttime*
Desert Background	44.6	40.5
Village	49.4	43.0
Village & Road	52.2	48.6
SEQS	**55**	**45**
IFC Limits	**55**	**45**

The desert background, is very quiet and approximately 10 dBA below SEQS for both day and nighttime. Observed noise sources included passing livestock herds, braying donkeys, and birds.

Villages have slightly higher noise levels due to the limited village activities. These include a few vehicles that pass through the villages, livestock, and human activities.

Villages near major roads record the highest noise levels. This is because of the road traffic, which includes a large fraction of trucks, jeeps and busses. Moreover, villages near roads often have shops where passengers stop to rest. This has resulted in the exceedance of the nighttime SEQS.

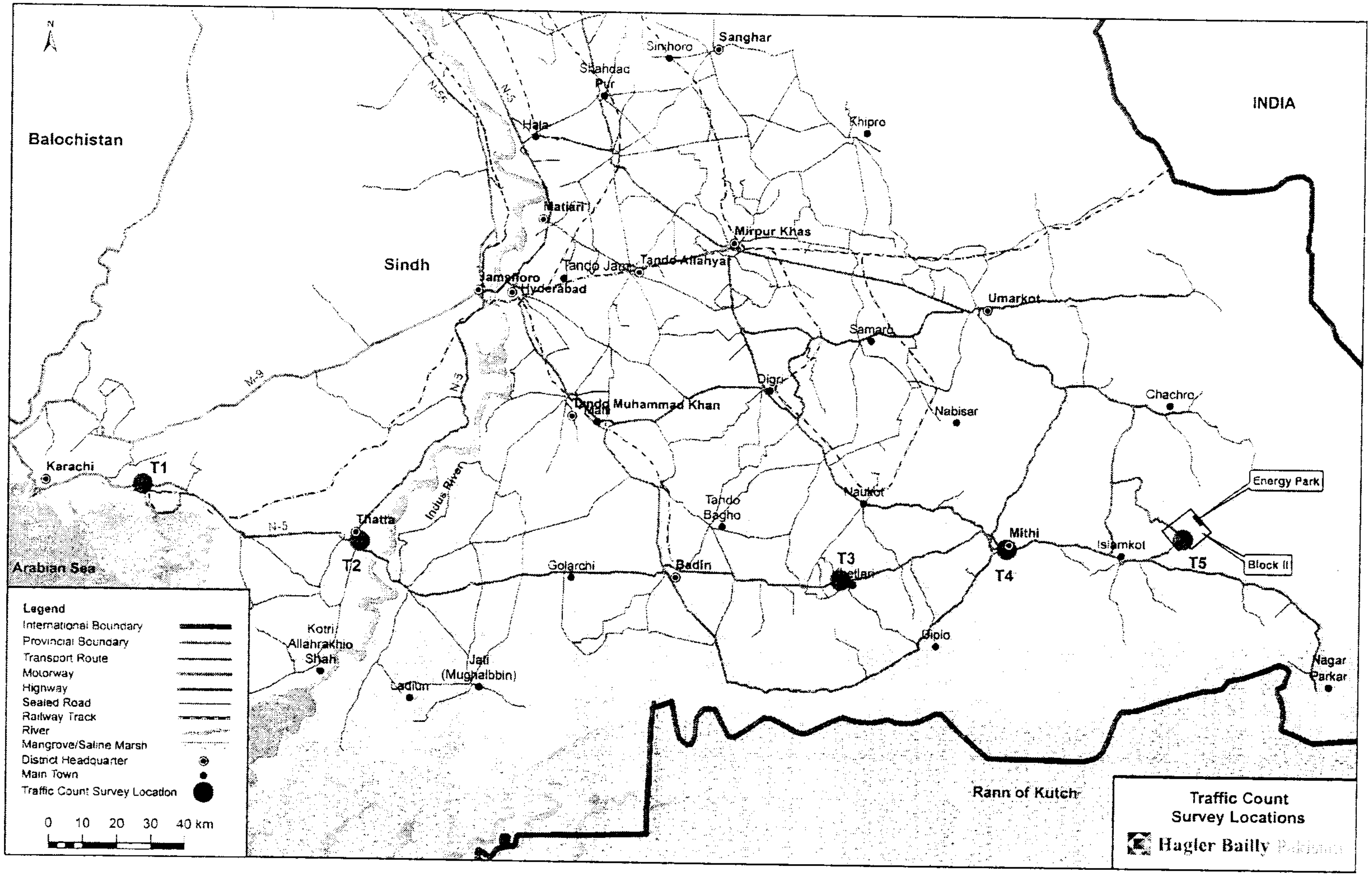
4.3.8 Traffic

The traffic baseline was prepared to assess the current traffic conditions on the road route that could be used for Project related transportation of goods and services during construction and operation of the Project.

The selected transport route from Karachi to the Project site is shown in **Exhibit 4.27**. The route, is 366 km long and passes through the following towns:

National Highway N-5 75 km Two lane 7.3 m wide	Provincial Highway 105 km Two lane 6.1-6.7 m wide	Provincial Road 114 km Two/One lane 4-6 m wide	Provincial Road 44 km Two/One lane 4-6 m wide	Provincial Road 28 km Two/One lane 4-6 m wide

Exhibit 4.27: Transport Route and Traffic Count Survey Locations from Literature



Traffic counts are reported at five points as shown in **Exhibit 4.27**. The data at survey locations was taken from the previous studies.[26,27] The previous surveys were conducted between 2012 and 2016. To ascertain the present traffic condition, traffic counts from previous surveys were extrapolated using an annual growth rate of 2.58%[28]. The results are shown separately for each direction in **Exhibit 4.28**.

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26 Hagler Bailly Pakistan, August 21, 2015, "Environmental Impact Assessment of 660 MW Coal Fired Power Plant Construction Project at Lakhra in Islamic Republic of Pakistan", GENCO Holding Company Limited, Pakistan.

27 Hagler Bailly Pakistan, July 2016, Environmental and Social Impact Assessment of 330 MW Coal-based Power Plant Study, ThalNova Power Thar (Private) Limited, Karachi, Pakistan.

28 Pakistan Sustainable Project, "Principle policy guidelines for Sindh urban transport policy", December, 2014.

Exhibit 4.28: Traffic on the Transport Route (Karachi to Nagar Parkar Road) in both directions

Sub-segments	*Location ID*	*Survey Date*	*M-cycles*	*Cars*	*Pickups*	*Buses*	*Trucks[a]*	*Trailers/ Trolleys*	***Total***	*% of Light Traffic Vehicle*	*% of Heavy Traffic Vehicle*
Karachi – Thatta	T1	Jul 2012	1,862	3,405	941	892	1,289	20	**8,409**	74	26
Thatta - Karachi			2,613	4,477	1,022	799	1,247	11	**10,169**	80	20
Thatta – Badin	T2	May 2013	1,503	1,582	383	78	1,033	NA	**4,579**	76	24
Badin - Thatta			1,721	1,734	468	130	1,121	NA	**5,174**	76	24
Badin – Mithi	T3	Mar 2014	107	91	112	8	133	3	**454**	68	32
Mithi - Badin			127	106	116	12	109	6	**476**	73	27
Mithi – Islamkot	T4	Mar 2014	177	80	124	47	108	2	**538**	71	29
Islamkot - Mithi			230	87	144	52	120	1	**634**	73	27
Islamkot – Project Site	T5	May 2016	74	77	55	4	27	3	**240**	87	13
Project Site – Islamkot			74	78	49	3	31	1	**236**	87	13

Note: NA means data not available

a includes all truck categories from 2 axle to 5 axle.

4.3.9 Soil

The soils in Thar are generally coarse-textured, well drained and calcareous in nature. At varying depths a thick accumulation of lime may also be encountered. The soils usually overblown with sand due to severe wind erosion. In general, these are infertile soils.

There are seven main groups of soils found in the Thar. [29]These are:

- Desert soils
- Red desertic soils
- Sierozems (rowinsh gray soils)
- Red and yellow spoils of the foothills
- The saline soil of the depressions
- Lithosols (shallow, weathered soils)
- Rigosols (soft loose soils) found in the hills

4.3.10 Groundwater

There are no major rivers within the Thar Desert. Rainwater flows (mostly as sheet flow) to the nearest topographic low, and either evaporates there or infiltrates[30]. The inactive Nara River used to flow in the west of the Thar Desert. The old bed of the Nara River is now utilized as part of the Nara Canal.

Three main aquifers and two aquitards have been identified in the Thar region. These units comprise (from the surface downwards):

- Upper aquifer (Top Aquifer), which is located in the base of the dune sands;
- Fine grained siltstone aquitard;
- Middle alluvial sand aquifer (Middle Aquifer) of sub-recent age;
- Claystone and lignite aquitard in the top part of the Bara Formation; and
- Deep aquifer (Deep Aquifer or Bottom Aquifer) of marine sands belonging to the bottom part of the Bara Formation.

A groundwater census was carried out around the Study Area for a previous study[31]. The results are summarized below and the locations shown in **Exhibit 4.29**.

- The wells are open dug wells; no mechanically drilled boreholes were found in the Study Area. Most of the wells are brick-lined.

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[29] Ihsan H. Nadiem: Thar, the Great Pakistan Desert: Land, History, People. Sang-e-Meel Publications, Lahore. 2001

[30] Bender, 1995, Geology of Pakistan

[31] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

- The minimum, maximum and average depths of the well with respect to ground are 48.0 m, 86.4 m, and 60.9 m, respectively; 90% of the wells are between 50 and 70 m in depth.
- The minimum, maximum and average depths of the well with respect to mean sea level are –10.38 m, 31.43 m, and 19.26 m, respectively; 95% of the wells are between 10 and 30 m in depth.

Water quality samples were obtained from the 40 wells and were analyzed for common chemical parameters and heavy metals. The results indicate that in general the water is unfit for human consumption. Sodium, sulfate, chlorides, and hence the total dissolved solids (TDS), exceed the drinking water standards for almost all the wells. The results of these tests are presented in **Exhibit 4.30**.

Exhibit 4.29: Groundwater Well Census Locations from Literature

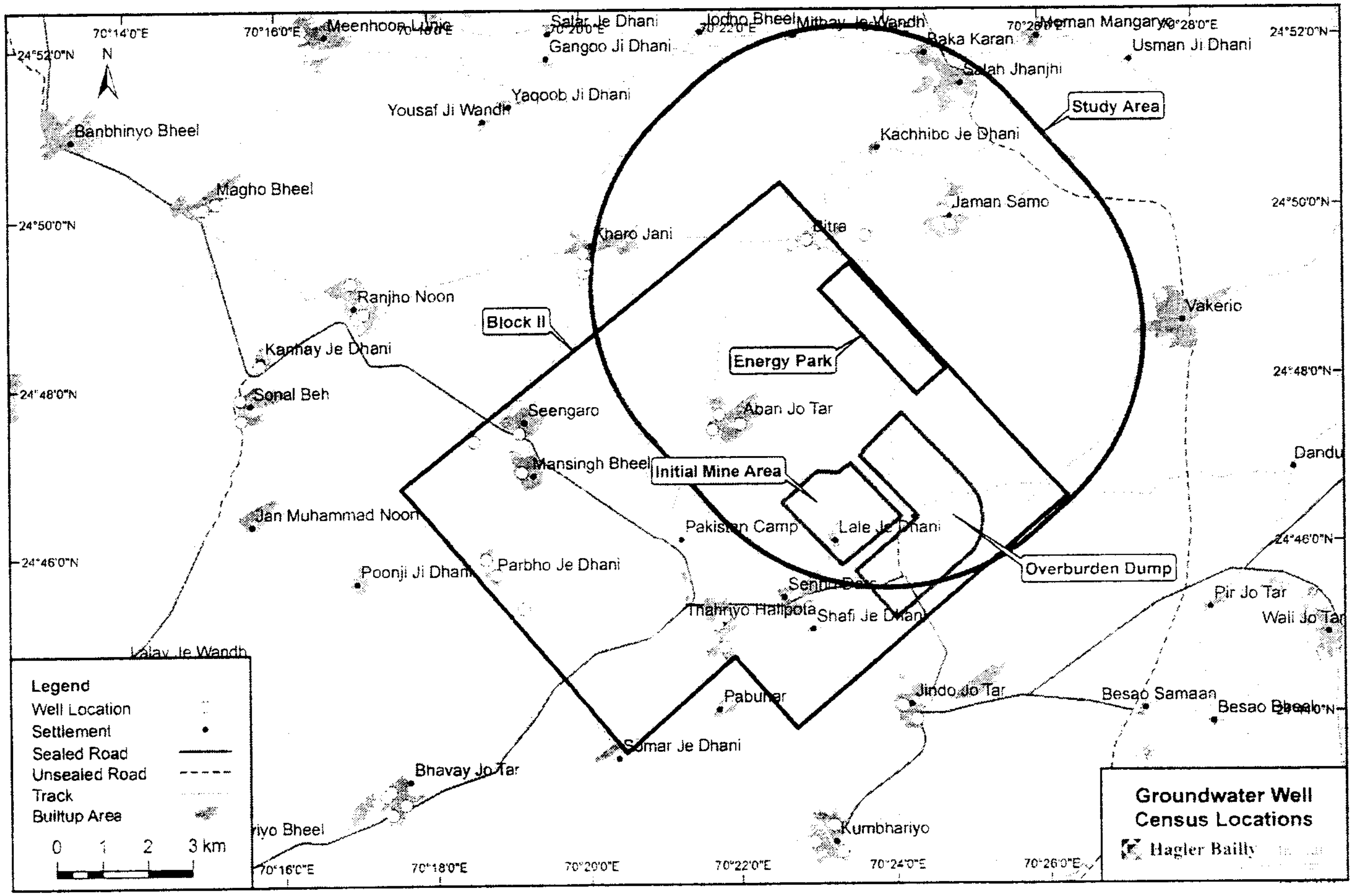


Exhibit 4.30: Water Quality in the Study Area from Literature

Parameters	*Unit*	*NEQS* [a]	*WHO* [b]	*Min* [c]	*Max* [d]	*% Over* [e]
pH	-	6.5–8.5	6.5–8.5	7.48	8.42	
EC	µS/cm	–	–	3,280	14,500	
Sodium	mg/l	–	200	500	2,460	100%
Magnesium	mg/l	–	–	10	240	
Calcium	mg/l	–	–	11	320	
Potassium	mg/l	–	–	9	58	
Sulfate	mg/l	–	250	150	712	90%
Chloride	mg/l	250	250	975	5,599	100%
Bicarbonate	mg/l	–	–	185	729	
Silica Dioxide	mg/l	–	–	11.2	15.4	
Hardness (as $CaCO_3$)	mg/l	500	–	68	1,705	40%
Sulfide	mg/l	–	–	<1.00		
Fluoride	mg/l	1.5	1.5	0.495	1.14	0%
TDS	mg/l	1,000	1,000	1,996	9,584	100%
Iron	mg/l	–	0.3	0.05	0.675	15%
Aluminum	mg/l	0.2	0.2	0.075	0.28	39%
Manganese	mg/l	0.5	0.1–0.5	0.025	0.08	0%
Arsenic	mg/l	0.05	0.01	0.005	0.01	0%
Copper	mg/l	2	1 – 2	0	0	0%
Lead	mg/l	0.05	1	0.02	0.1	20%
Zinc	mg/l	5	3	0.025	0.05	0%
Cadmium	mg/l	0.01	0.003	0	0	0%
Nickel	mg/l	0.02	0.02	0.025	0.25	60%
Chromium	mg/l	0.05	0.02	0	0	0%
Cobalt	mg/l	–	–	0		
Selenium	mg/l	0.01	0.01	0	0	0%
Mercury	mg/l	0.001	0.001	0	0	0%

a National Environmental Quality Standards for Drinking Water
b World Health Organization Drinking Water Quality Guidelines
c Minimum value among the 40 wells
d Maximum value among the 40 wells
e Percent of wells among the 40 wells that exceed the target limit

4.4 Ecological Baseline

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

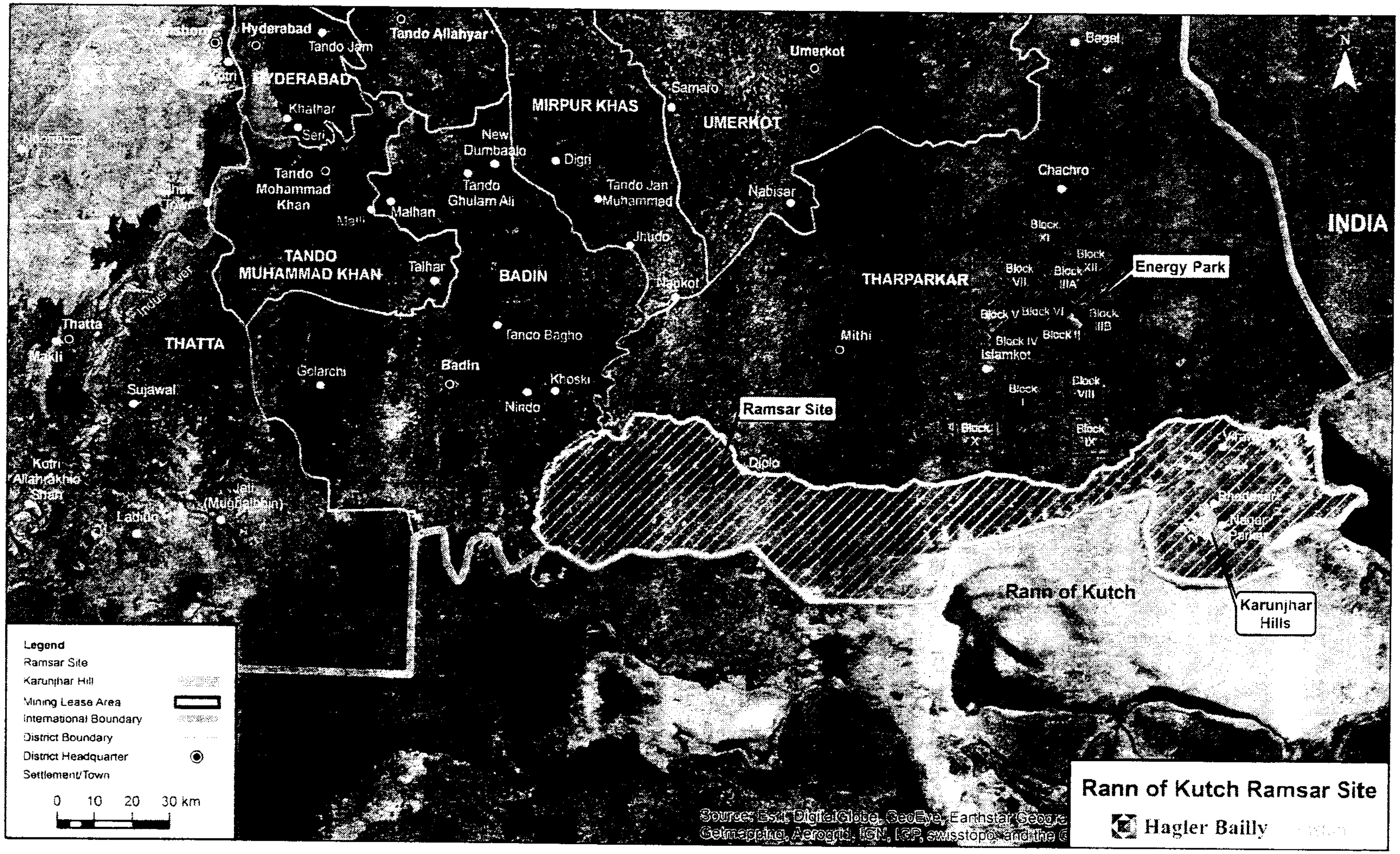
4.4.1 Protected Areas in the Vicinity of the Study Area

The Protected Area closest to the Study Area is the Rann of Kutch Wildlife Sanctuary. It is located 32 km from Study Area. The Rann of Kutch Ramsar Site is the only designated area of global conservation importance present in the vicinity of the Study Area, being a part of the 1.6 million hectares of wetlands of international importance stretching across the two countries of India and Pakistan.[32] The Rann of Kutch Ramsar Site information sheet provides a list of species present within the Ramsar Site which includes a total of 154 plant species, 26 mammal species, 14 reptile species (no amphibian species) and 107 bird species.[33] Based on these figures it can be concluded that the Rann of Kutch Ramsar Site is an area richer in biodiversity compared to the Study Area. The location of the Project relative to the Rann of Kutch Ramsar Site is shown in **Exhibit 4.31**.

32 World Wildlife Fund (WWF). Desert wetlands, World Wildlife Fund Global, News and Stories (February 2003)

33 Hussain Bux Bhaagat, Information Sheet Ramsar Wetlands, Sindh Wildlife Department, (September 2002). Available at <http://www.ramsar.org/>, accessed January 27, 2016

Exhibit 4.31: Rann of Kutch Ramsar Site and Project Location



4.4.2 Habitat Types in the Study Area

Habitats within the Study Area were classified relying primarily upon geomorphology and soil texture, with consideration of variations within habitat types. The Study Area was classified by geomorphological characteristics into agricultural fields, sand dunes with agriculture, sand dunes, plains and settlements. The relative percentage of each habitat type has been provided in **Exhibit 4.32**.

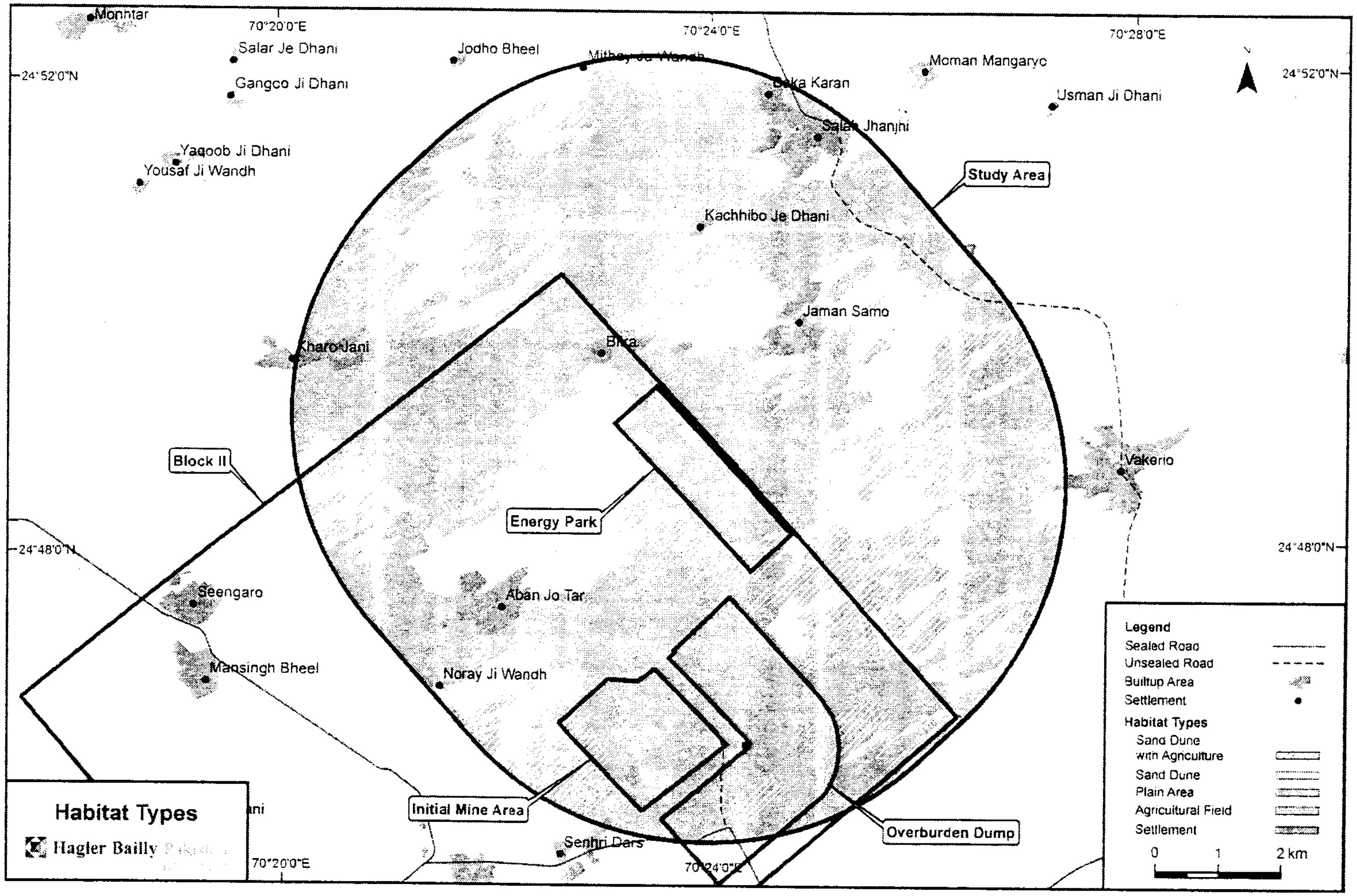
A map showing the distribution of the different habitat types has been shown in **Exhibit 4.33**.

Exhibit 4.32: Habitat-type Distribution

Habitat Type	*Percentage of Study Area (%)*
Agricultural Fields	46
Sand Dunes	24
Sand Dunes with Agriculture	15
Plain	13
Settlements	2

Agriculture Fields are the dominant habitat, constituting 46% of habitats of the Study Area. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. Sand dunes are the second dominant habitat, constituting 24% of the total habitat. They vary in height, ranging from a few meters to over a hundred meters. Sand Dunes with Agriculture are the third most dominant type making up 15% of the Study Area with Plains constituting 13% and Settlements constituting 2%. An established tradition of preservation of trees contributes to maintaining the vegetation cover in the Thar Desert. Grazing pressure, however, is significant and the ground vegetation in terms of grasses, scrubs and bushes can be considered as uniformly degraded.

Exhibit 4.33: Habitat Types within the Study Area



4.4.3 Ecological Resources

Information about the ecological resources in the Study Area has been obtained from the surveys carried out as part of other studies done both within the Study Area as well as nearby areas. The following reports have been used to collect information about the flora and fauna present within the Study Area:

- Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Block VI Lignite Mining Project, Main Report for Sindh Carbon Energy Limited, April 2013
- Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012
- Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

Vegetation

The vegetation of the Thar Desert can be classified as Tropical Thorn Forest.[34] It comprises mainly scattered trees and bushes.[35] These are mainly thorny, drought resistant species and grasses. Following rains, lush green grasses sprout providing a rich source of fodder.[36] The vegetation is typical of arid regions with adaptations to survive the extreme conditions of the desert environment.[37]

A total of 137 plant species have been reported from the Tharparkar area. These plant species are the base for the animal and human life in the desert. The plants are used for a variety of purposes, including production of medicines, resins, dyes and fibers, and for construction, forage and fodder making. The habitat in the Thar Desert is influenced by the extreme climate. The vegetation consists of xerophilious grasslands of *Eragrostis sp. Aristida adscensionis, Cenchrus biflorus, Cympogon sp., Cyperus sp., Eleusine sp., Panicum turjidum, Lasiurus scindicus, Aeluropus lagopoides, and Sporobolus sp.* Scrub vegetation consists of low trees such as *Acacia nilotica, Prosopis cineraria, Prosois juliflora, Tamrix aphylla, Zizyphus mauritiana, Capparis decidua,* and shrubs such as *Calligonum polygonoides, Calotropis sp., Aerva sp., Crotalaria sp.. Haloxylon salicornicum* and *Haloxylon recurvum* are also present. The region comprises 9.1% of the total flora of Pakistan, making it poor in terms of floristic diversity.[38]

None of the plant species found during the survey is listed under either the IUCN Red List of Threatened Species or under the Pakistan legislation.

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34 Nisar Ahmad Khan. Deserts in Pakistan. Pakistan Geographic, <http://pakistangeographic.com/deserts.html>, accessed December 17, 2015

35 Ibid

36 Ibid

37 Chapter 1: Biological Adaptations to Aridity. Global Deserts Outlook, United Nations Environment Programme. Available at, <http://www.unep.org/geo/gdoutlook/028.asp>, accessed December 17, 2015.

38 Nasir, Yasin J., and Rubina A. Rafiq. "Wild flowers of Pakistan." Karachi: Oxford University Press xxxiii, 298p. 104p.of plates-illus., col. illus. ISBN195775848 (1995).

The only plant species included in the CITES Species List is Leafless Milk Hedge (Thor) *Euphorbia caducifolia* that is included in Appendix II.[39] It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[40]

The data for the vegetation survey carried out for the Thar Coal Block II Mining Project[41] has been provided in **Appendix B** along with information about their phytosociological attributes.

Mammals

Thirty-five (35) mammalian species have been reported from the Tharparkar area, which includes large mammals from the Family Canidae (dog family), Felidae (cat family), Hyaenidae (hyena family), Mustelidae (e.g. badgers, weasels etc.), Bovidae (rumenant mammals such as gazelle), Equidae (such as wild ass) and Suidae (artiodactyl mammals such as boars, pigs etc.). Small mammals reported from the Study Area include members from the Family, Erinaceidae (e.g. hedgehogs), Soricidae (e.g. shrews), Herpestidae (e.g. mongoose). Rhinopomatidae (insectivorous bats), Vespertilionidae (e.g. Common Bat), Manidae (pangolins), Leporidae (rabbits and hares), Sciuridae (squirrels), Hystricidae (porcupines) and. Muridae (family of rodents).[42]

The mammal species observed during the surveys carried out as part of the environmental and social impact assessment of the Thar Coal Block II Mining Project[43] included both small and large mammal species. The small mammal species, the Balochistan gerbil *Gerbillus nanus* was found to be the most abundant followed by *Tatera indica* and Indian desert jird *Meriones hurrianae*. Common medium sized mammals included the Long-eared Desert Hedgehog *Hemiechinus collaris* and Five-striped Palm Squirrel *Funambulus pennantii*. The large mammal species, Fox *Vulpes sp.*, Indian Hare *Lepus nigricollis* and Indian Hedgehog *Paraechinus micropus* are the abundant species in the Study Area while the rest of the species are comparatively less common. The Striped Hyaena *Hyaena hyaena* is listed as Near Threatened in the IUCN Red List of Threatened Species. It was not sighted but signs (foot print) indicating its presence were seen during the April 2010 survey for the environmental and social impact assessment of the Thar Coal Block II Mining Project.[44] Dens of this species were not observed in the area. None of the mammalian species observed is exclusively found in the Study Area and the habitat of the species found is widespread across the Thar Desert.

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[39] UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed November 20, 2015

[40] LLifle, Encyclopedias of living forms, The Encyclopedia of Succulents, *Euphorbia caducifolia*, <http://www.llifle.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/28041/Euphorbia_caducifolia>, accessed December 18, 2015

[41] Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

[42] Khan, Abdul Aziz, Waseem Ahmad Khan, and Abdul Aleem Chaudhry. "Mammalian Diversity in Thar Desert Habitat of Tharparkar District, Sindh, Pakistan." Pakistan J. Zool 47, no. 5: 1205-1211, (2015)

[43] Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

[44] Ibid

The data for the mammal survey carried out for the Thar Coal Block II Mining Project[45] has been provided in **Appendix B** with information about their conservation status based on National Status, the IUCN Red List of Threatened Species and the CITES Appendices.

Avifauna

There is no permanent wetland close to the Study Area; therefore avifauna of the area predominantly consists of terrestrial birds. During the surveys carried out for the environmental and social impact assessment of the Thar Coal Block II Mining Project[46] 50 bird species were observed of which 43 are classified as resident, five as passage migrants and irregular year round visitors, one as a summer breeder and one was an isolated or occasional breeder in the Study Area.

A total of seven nests of Egyptian Vultures *Neophron percnopterus* were identified in the Study Area during the surveys for the environmental and social impact assessment of the Thar Coal Block II Mining Project[47], of which five were empty and two were occupied. A further three empty nests were located on *Prosopis cineraria* trees, which are thought to be nests of either the White-backed Vulture *Gyps bengalensis* or the Egyptian Vulture *Neophron percnopterus*. One active nest of a Tawny Eagle *Aquila rapax*, one active nest of a Spotted Owlet *Athene brama* and a further 10 nests of unknown bird species were identified in the Study Area.

The subfamily *Aegypinae* contains 15 species of old world vultures, 8 of which are reported in Pakistan. Of the four belonging to the genus *Gyps*, three including Oriental White-backed Vulture *Gyps bengalensis*, are listed as Critically Endangered in the IUCN's Red List of Threatened Species. The Egyptian Vulture *Neophron percnopterus* is listed as Endangered (IUCN Red List of Threatened Species). The Greater Spotted Eagle *Clanga clanga* is listed as Vulnerable in the IUCN Red List of Threatened Species. It was seen in the Study Area in the April 2010 survey. The Laggar Falcon *Falco jugger* is listed as Near Threatened in the IUCN Red List of Threatened Species and was also seen in the Study Area during the April 2010 surveys.

The data for the avifauna survey carried out for the Thar Coal Block II Mining Project[48] has been provided in **Appendix B** along with information about their conservation status based on the IUCN Red List of Threatened Species and the CITES Appendices.

Herpetofauna

Of the 32 species of reptiles reported in the literature and likely to be found in the area, 17 were observed during the surveys conducted in the Study Area for the environmental and social impact assessment of the Thar Coal Block II Mining Project.[49] Of these, common species were the Indian fringe-toed sand lizard *Acanthodactylus cantoris*, Three-toed snake skink *Ophiomorus tridactylus*, garden lizard *Calotes versicolor*, yellow-tailed

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45 Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

46 Ibid

47 Ibid

48 Ibid

49 Ibid

sand gecko *Crossobamon orientalis* and brilliant ground agama *Trapelus agilis*. The species found were evenly distributed across three habitats in the Study Area, namely, Agricultural Fields (including Sand Dunes with Agricultural Fields), Sand Dunes and Plains during the surveys carried out for the Thar Coal Block II Mining Project.[50]

The three species of amphibians known to occur in the Study Area include the Indus Valley toad *Duttaphrynus stomaticus*, the Common Skittering Frog *Euphlyctis cyanophlyctis* and the Indian Bullfrog *Hoplobatrachus tigerinus*.[51] None of these amphibian species are of conservation importance based on the IUCN Red List of Threatened Species,[52] however, the Indian Bullfrog is listed in Appendix II of the CITES Species List.[53]

None of the species observed or reported in the area are on the IUCN Red List of Threatened Species. However, according to one reference[54], three species are endemic to Pakistan which include the Red-throated Ground Agama *Trapelus rubrigularis*, the Sindhi Krait *Bungarus sindanus* and the Cholistan Desert Lacerta *Eremias cholistanica*. However, according to the Reptile Database online resource only the Cholistan Desert Lacerta is endemic.[55]

The data for the herpetofauna survey carried out for the Thar Coal Block II Mining Project[56] has been provided in **Appendix B** along with information about their conservation status based on Pakistani guidelines and CITES Appendices.

4.4.4 Conclusions

- Vegetation – there are no plant species of conservation importance in the Study Area, based on the IUCN Red List. The only plant species included in the CITES Species List is Leafless Milk Hedge (Thor) *Euphorbia caducifolia* that is included in Appendix II.[57] It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[58]
- Mammals – there are no mammal species of conservation importance based on the IUCN Red List of Threatened Species. Some of the mammal species are on Pakistan's Mammals National Red List. However, their distribution is widespread and not limited to the Study Area.

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50 Ibid

51 Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

52 IUCN 2015. *The IUCN Red List of Threatened Species. Version 2015-4*. <http://www.iucnredlist.org>. accessed December 14, 2015

53 UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed 19th November 2015

54 Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

55 Uetz, P. (editor), The Reptile Database, http://www.reptile-database.org, accessed May 9, 2016

56 Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project. Final Report for Sindh Engro Coal Mining Company, September 3, 2012

57 UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed November 20, 2015

58 LLifle, Encyclopedias of living forms, The Encyclopedia of Succulents, *Euphorbia caducifolia*, <http://www.llifle.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/28041/Euphorbia_caducifolia>, accessed December 18, 2015

- Birds – the main concern is with respect to vulture species, including the Oriental White-backed Vulture and the Egyptian Vulture which are listed as Critically Endangered and Endangered respectively according to the IUCN Red List of Threatened Species. Another bird species of conservation importance includes the Laggar Falcon listed as Near Threatened on the IUCN Red List of Threatened Species.
- Herpetofauna – there is concern with respect to three endemic reptile species. There is some debate over the number of endemic reptile species; according to one source there are three endemic reptile species including the Red-throated Ground Agama, the Sindhi Krait and the Cholistan Desert Lacerta. According to another source only the Cholistan Desert Lacerta is an endemic species. In either case the distribution of these species is widespread and they are not restricted to any habitat type, therefore, there is no species of conservation importance in the Study Area amongst herpetofauna.
- The only protected area near the Study Area is the Rann of Kutch Wildlife Sanctuary. This is 32 km from the Study Area and will not be adversely affected by the Project.

4.5 Socioeconomic Baseline

The socioeconomic condition of the Study Area, in the context of the socioeconomic conditions of the Tharparkar Desert are discussed in this section.

There are ten villages in the Study Area. The population of the area is estimated to be a little over 6,000 individuals.

The area has a weak infrastructure when compared to other districts provincially and nationally. Water supply is one of the major problems faced by villages in the area. Most of the underground water is brackish. The villagers travel to the nearby towns of Mithi and Islamkot for health facilities.

The baseline was developed using a combination of secondary sources. The main data source was the ESIA Thar Coal Block II Power Plant Project, for which the Study Area covers the same villages as this study. Ground verification was performed during consultations with the villages in the Study Area.

Other key secondary sources of information for this baseline study include official statistics, such as maps, census reports and other available documentation on the history of the people and the area from a broad selection of recent and reliable sources, both published and unpublished. These sources of information include:

- Information collected from the Thardeep Rural Development Programme offices;
- Development Statistics of Sindh, 2006;
- Pakistan Social and Living Standards Measurement Survey (PSLM) 2006-07;
- District Census Reports, 1998, published by Population Census Organization, Government of Pakistan;

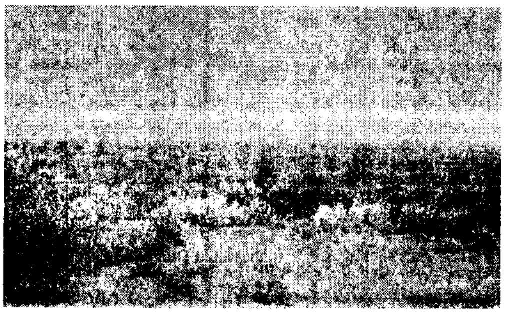
- Development statistics published by the Federal Bureau of Statistics, Government of Pakistan;
- Other published material from the private sector, including NGOs working in the Sindh province.

4.5.1 Land Cover and Land Use

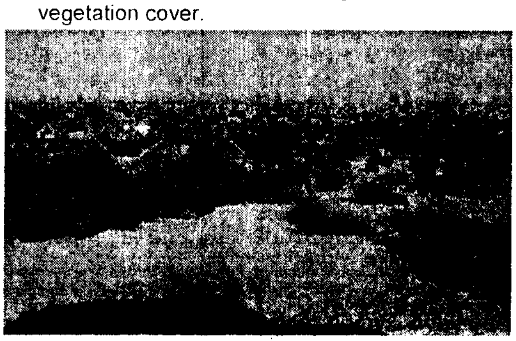
The Study Area covers 111 km^2 of which sand dunes cover 43 km^2 (38%) and plains cover 69 km^2 (62%)[59]. Major land uses in the Study Area consists of settlements (2%), agricultural fields (61%) and grazing areas (37%) (See **Section 4.4.2**). Sand dunes are permanent with significant vegetative cover and therefore are suitable for use as grazing lands. Once the crop is harvested livestock is also grazed on the agricultural fields. Photographs of different land uses are shown in **Exhibit 4.34**. The distribution of these uses is given in **Exhibit 4.35**.

Exhibit 4.34: Photographs of Different Land Uses in the Study Area

Sand dunes are permanent with significant vegetation cover.



Uncultivated plains are used for grazing livestock.



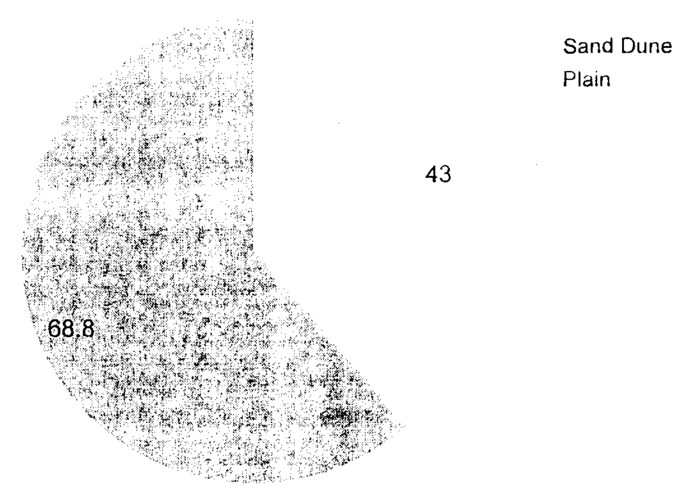
A village on the plain, nestled between dunes.

Agriculture field on the plains.

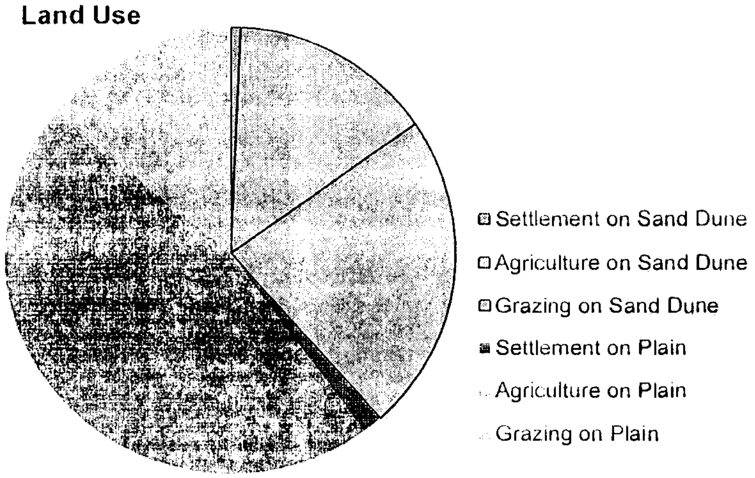
[59] As indicated by digitized Google Earth imagery dated April 10, 2013.

Exhibit 4.35: Land Cover and Land Use Distribution in the Study Area

Land Cover



Land Use



4.5.2 Demography

The estimated population of the Tharparkar District ('District') as compared to Sindh and Pakistan is given in **Exhibit 4.36.** Although the Thar Desert is considered as one of the most densely populated deserts in the world, the population of Tharparkar District represents less than one percent of the country's population and three percent of Sindh's population. The population density of the District is low at 47 persons per square kilometer, nearly 6.7 times lower than the provincial average of 326 persons per square kilometer. However, the density is on the rise since 1998.

Exhibit 4.36: Population and Growth[60]

	Population, 000'				*Land Area*		*Density (persons per sq. km)*	
	1998	*%*	*2015**	*%*	*sq. km*	*%*	*1998*	*2015**
Study Area	NA	NA	6.2**[61]		112	0.01%	NA	55
Tharparkar (District)	914*	0.7%	1,273	0.7%	19,638	2.5%	47	65
Sindh	30,440	23.0%	45,988	24.0%	140,914	17.7%	216	326
Pakistan	132,352	100.0%	191,708	100.0%	796,096	100.0%	166	241

Note: * 2010 for Tharparkar
** 2014 for Study Area

The Study Area, as with the majority of Tharparkar is rural, and contains ten villages with an average of approximately 600 persons per settlement. The distribution of the population by settlement is given in **Exhibit 4.37**.

Exhibit 4.37: Population of Settlements in the Study Area[62]

No	*Village*	*Population*
1	Baka Karan	500
2	Salah Jhanjhi	1,500
3	Kachhibo Je Dhani	210
4	Jaman Samo	900
5	Bitra	600
6	Mithay Je Wandh	120
7	Kharo Jani	1,200
8	Aban Jo Tar	1,100
9	Lale Je Dhani	30
10	Noray Ji Wandh	60
	Total	**6231**

Size of Settlements and Households

A comparison of village and household sizes as recorded in the Study Area with those recorded by the 1998 district statistics for Tharparkar is presented in **Exhibit 4.38** and **Exhibit 4.39** respectively. The population density map in **Exhibit 4.40**, shows the

60 Ministry of Finance, Government of Pakistan, Statistical Appendices of Chapter 12, Population, Labour Force and Employment, Pakistan Economic Survey 2014-2015, (Government of Pakistan, 2015)

61 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

62 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

population of each village in the Study Area. Village sizes, in terms of population in the Study Area, range from 60 to 1,500 for the smallest and largest settlements respectively.

Exhibit 4.38: Average Population per Settlement in Tharparkar and Study Area[63]

	Number of Settlements	*Total Population*	*Average Population per Settlement*
Study Area	10	6231	623
Tharparkar (1998)	2000	914,291	4,57

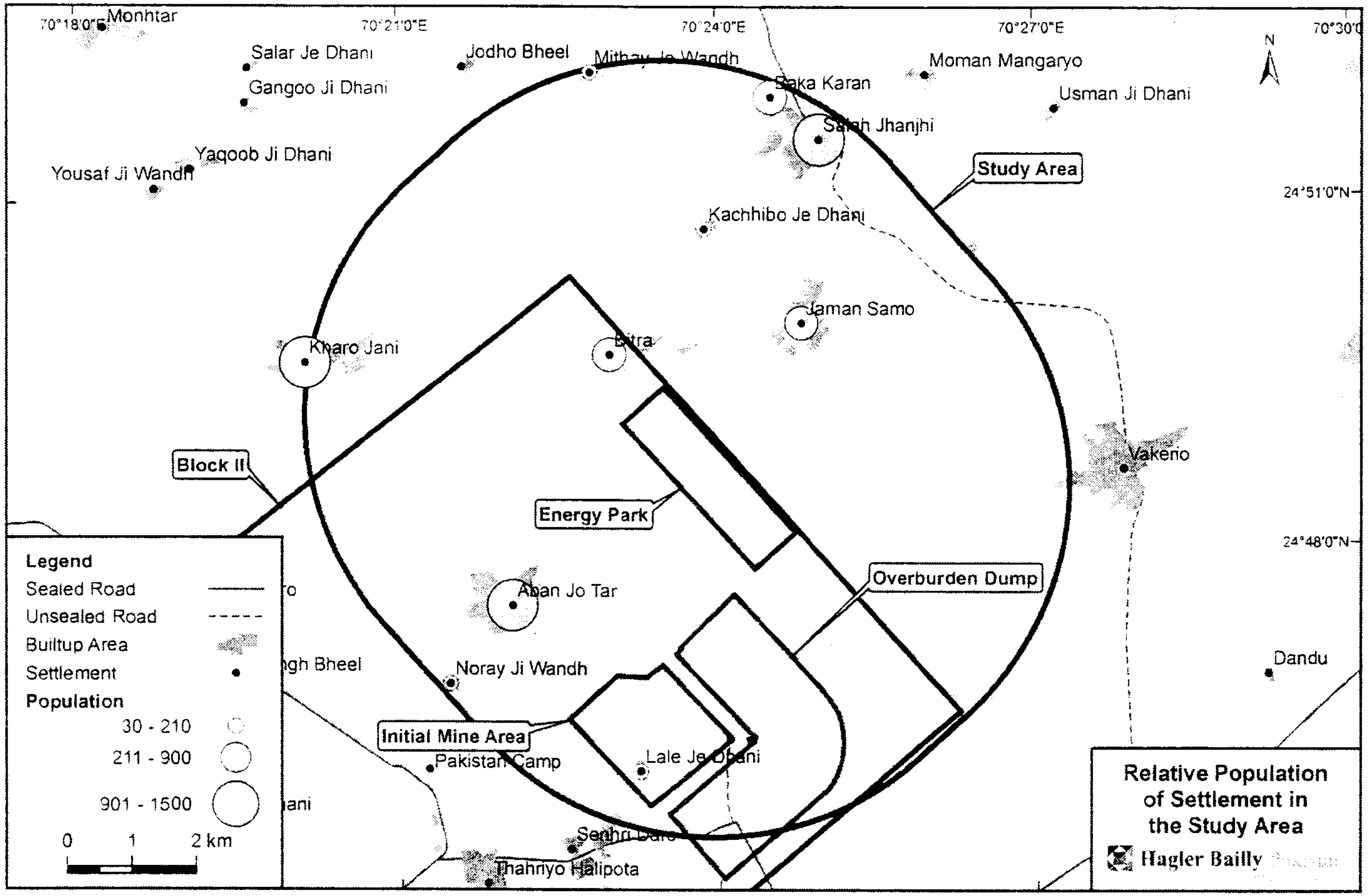
Exhibit 4.39: Average Household Size

	Sample Size	*Average Household Size*
Previous Study[64]	81	6.2
Rural Tharparkar (1998)	156,591	5.6
Save the Children	383	8.3

[63] Ibid

[64] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

Exhibit 4.40: Population Distribution in the Study Area [65]



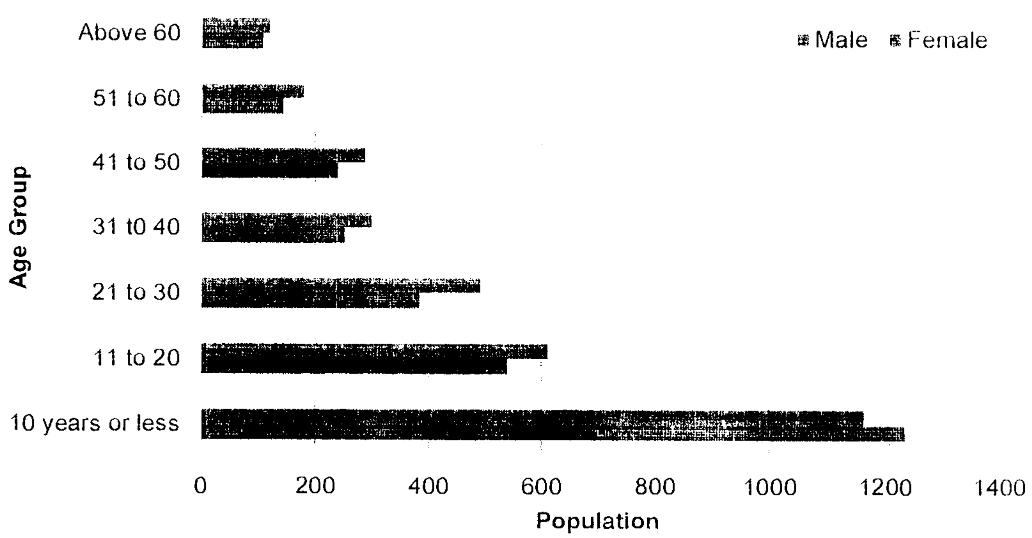
65 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

Gender and Age Profile

The population pyramid of the Study Area is shown in **Exhibit 4.41**. The population pyramid has a broad base with a relatively large number (40%) of children (10 years of age or less), which indicates high birth rates. The sharp decline of the pyramid signifies a low life expectancy amongst the population of the Study Area, as those above 60 years of age account for only 4% of the population. The structure also shows that more than half (around 60%) of the population is 20 years of age or younger.

While there are more female than male children 10 years or younger, this trend reverses for the other age brackets. This indicates a possible higher death rate for female children which could indicate a disparity in care or facilities available to the different sexes.

Exhibit 4.41: Age and Sex Composition of Study Area[66]



4.5.3 Ethnology and Religion

The inhabitants of the Study Area, as those of the larger Thar Desert, belong to different religions, sects and castes which gives the area a rich multifaceted culture.

Religion

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes. **Exhibit 4.42** provides the percentage distribution of population by main religious groups in Tharparkar District. Muslims are in the majority, forming 59.4% of the District's population. However, the ESIA of the Block II coal mine, which

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66 Based on Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

surveyed a larger but overlapping Study Area than this study, noted that the area has a Hindu majority (55.6.% Hindus as compared to 44.4% Muslims).[67]

Exhibit 4.42: Percentage of Tharparkar District Population by Religion, 1998

Religion	*District wide*	*Rural*	*Urban*	*Study Area*
Muslim	59.4%	60.8%	29.5%	44.4%
Hindu	40.5%	39.1%	69.6%	55.6%
Others	0.1%	0.1%	0.9%	0.0

Source: District Census Report of Tharparkar, 1998, Population Census Organization, Statistics Division, Government of Pakistan

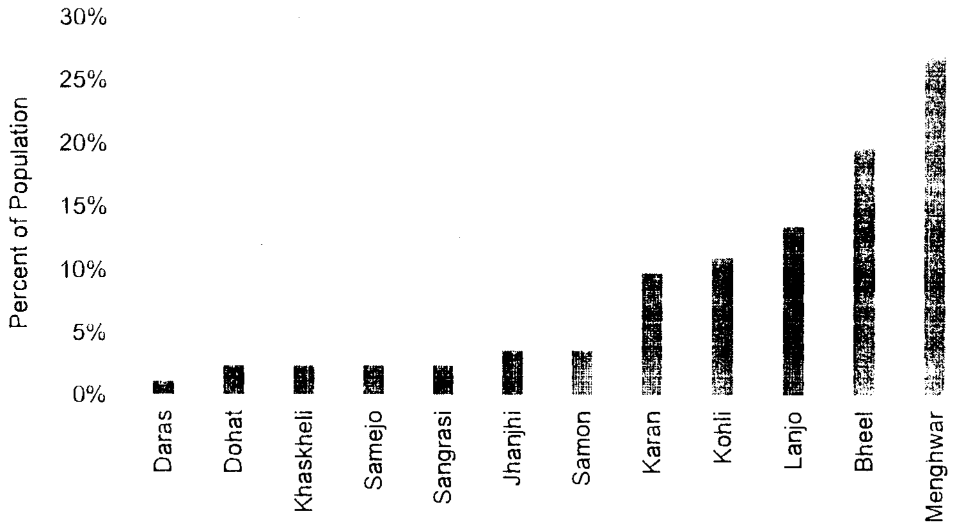
Castes

A caste is a social class separated from others by distinctions of hereditary rank, profession, or wealth. In this study, the term caste has not been used in its strict definitional sense. It carries a different meaning for the Hindus and Muslims. Therefore, for the two ethnic groups, the term caste should be understood in light of the explanation provided in the statements to follow. The Hindu castes were established under the Hindu religion and not only on social grounds. On the other hand, the Muslim castes are not recognized by the religion, but are differentiated on religious, social or hereditary basis.

The distribution of the households in the Study Area by Hindu and Muslim castes is provided in **Exhibit 4.43**. Blue represents Muslim castes whereas orange represents Hindu castes.

[67] Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

Exhibit 4.43: Distribution of Population in the Study Area by Castes[68]



Language

The main languages spoken in the Tharparkar District are Sindhi and Dhatki. In the Study Area, Muslims typically speak Sindhi and/or Dhatki as their primary language while Hindus primarily speak Dhatki only

4.5.4 Family Structure

The division of labor in the villages of Tharkparkar is gender based and clearly demarcated, as is the case with most traditional communities (**Exhibit 4.44**). A household usually contains two gender-based positions of authority: the first is the position of the head of the household. This position belongs to the oldest, able-bodied male member of a household. The second, which is subordinate to that of the household head, is the position of the senior woman.

Exhibit 4.44: People of the Study Area

Village elders

Indigenous women

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[68] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

4.5.5 Governance and Administration

Thar Desert has been governed by various rulers of Sindh over the last millennium. In 1843, the British rulers merged it into the Kutch Political Agency. In 1882, the Thar Desert was upgraded to the Tharparkar District and made a part of the Hyderabad Collectorate. In December 1990, the district was bifurcated into two districts including Mirpurkhas, and Tharparkar with headquarters at Mithi.

The Study Area falls within the Tharparkar District of Sindh Province. The District lies between 24° 10' to 25°45' N latitudes and 69' 04' to 71°06' E longitudes. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*zila*) Council Chairman. The District administration comprises District offices including sub-offices at UC and town level (includes municipal and town committees).

The District is bounded on the east by India (Jaisalmer District), whereas the northern and western peripheries are bounded by the Mirpurkhas and Badin districts respectively. In the south of Tharparkar, there is an extensive marsh, known as Rann, and the Indian district of Kutch.

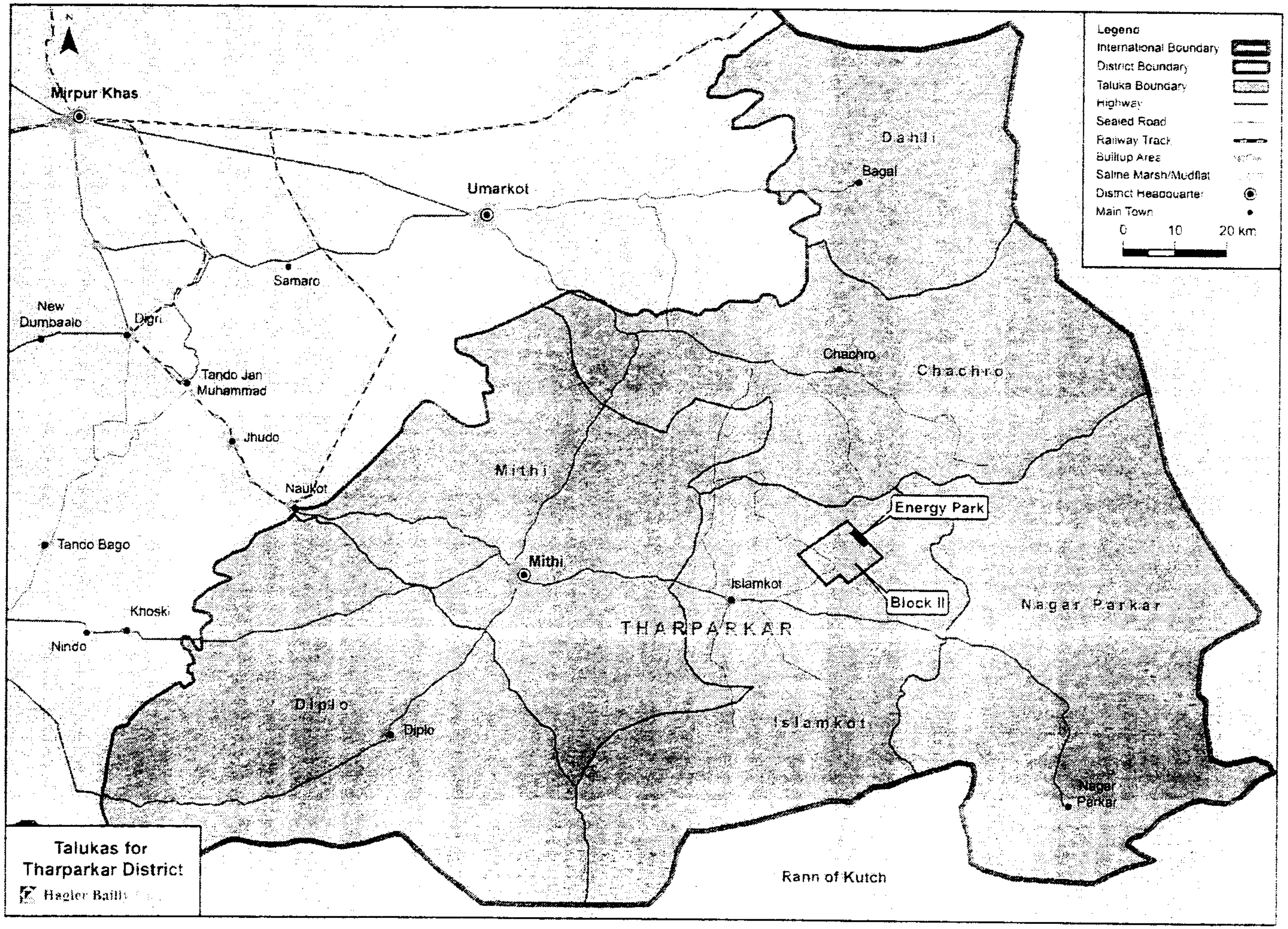
Tharparkar is administratively divided into six *talukas*, namely Mithi, Diplo, Nagarparkar and Chachro, Dhali and Islamkot. The taluka are further sub-divided into Union Councils, town committees and municipal committees. Each Union Council has villages (*dehs)* under its administration, while the municipal and town committees have municipal or town subdivisions called *wards*. The Energy Park falls within the Islamkot *taluka* as shown in **Exhibit 4.45**.

Social Organizations

Civil society organizations have been active in Tharparkar District since the 1960s. Save the Children Fund, now transformed into Thardeep Rural Development Program (TRDP), is the largest NGO in Sindh. It has staff, offices and programs in all *talukas* of the Tharparkar district, and a field office in the town of Islamkot near Thar coal field. and Participatory Village Development Programme (PVDP) works mostly with the *Kolhi* and *Bheel* scheduled castes. Other NGOs working in Tharparkar include the Trust for Voluntary Organizations (TVO), Baanhn Beli (helping hands) organization and the Marooara Coordination Council. Civil society groups in the area include the Press Club Mithi, Press Club Islamkot and Sindhi Adabi Sungat among others.

The performance of these social and political organizations is perceived to be above average by the locals in the Study Area.

Exhibit 4.45: Talukas for Tharparkar District



4.5.6 Livelihoods and the Local Economy

Types of Occupations

The majority (77%) of the employed population of the District was engaged in primary occupations such as agriculture and livestock according to the 1998 population census. Other occupations in the district include woodwork, wool-weaving, leather work, jewelry-making, cloth-dyeing, embroidery, and snake-charming. The number of artisans has increased over the last decade to meet the demand for handicrafts.

The Thar Desert is considered to be one of the greenest deserts in the world. The alluvial silt-mixed sands, relatively flat ground surface and summer monsoon rain (see **Section 4.3.5**) encourage agriculture and recharge groundwater for natural scrub vegetation thereon. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. About 27,000 hectares (60,000 acres) within the district are irrigated through the Thar Minor of Jamrao canal. Crops grown using irrigation include cotton, wheat, sugarcane, rice, chilies, fodder and vegetables. Crops grown in rain-fed lands include sorghum (*jowar*), millet (*bajra*), sesame, guar, moth beans, mung beans and sesame.[69] The average annual yield, usage and average income from crops grown shown in **Exhibit 4.46.**

Exhibit 4.46: Average Annual Yield, Usage and Average Income from Crops Grown[70][71]

Type of Crop	*Average Annual Yield kg/Acre*	*Consumed (%)*	*Sold (%)*	*Average Income (Rs/kg)*
Millet	377	86%	14%	20
Guar	444	14%	86%	36
Mung Beans	150	10%	90%	49
Moth Beans	182	8%	92%	37

The natural scrub vegetation and harvested agricultural lands serve as grazing grounds for the large animal herds for most of the year. Dug wells are the major source of water for livestock. **Exhibit 4.47** shows images of livestock in the area. Due to recent droughts, which reduced ground water levels substantially, large numbers of livestock herds have moved from the desert to the canal fed lands to the west. An estimate of the population levels of livestock in Tharparkar is given in **Exhibit 4.48** and average livestock held by each household in **Exhibit 4.49**.

69 Development Statistics of Sindh, 2006

70 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

71 Average income (Rs/kg) taken from Resettlement Study Sample Household Survey

Exhibit 4.47: Typical images of Livestock

Camels

Livestock use roads to access grazing areas.

Exhibit 4.48: Livestock Population in Study Area

Type of Livestock	*Livestock Population in Study Area*[72]	*Livestock Population in Tharparkar (2000)*[73]
Total Population	10,559	3,806,000
Goats and Sheep	77%	79%
Camels	6%	3%
Cows/Oxen	13%	14%
Donkeys	4%	4%
Horses	0.03%	0.26%

Exhibit 4.49: Average Livestock Population and Average Price of Livestock[74]

Type of Livestock	*Average Number/Household*	*Average Price (Rs/Animal)*
Goats and Sheep	23	6,000
Camels	1	120,000
Cows/Oxen	2	43,333
Donkeys	2	4,000

Small businesses within the Study Area, shown in **Exhibit 4.50**, include shops that are located in larger settlements or on the roadsides.

72 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

73 Development Statistics of Sindh, 2006

74 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

Exhibit 4.50: Small Businesses within the Study Area

A village store

A roadside tea stall

An oil and air pump for bikes

A wheat mill and granary

Income, Expenditure and Poverty

Tharparkar has been consistently ranked as one of the most deprived districts provincially and nationally. The Annual Report on Poverty 2001 by the Social Policy Development Center (SPDC) ranked Tharparkar as the most deprived district in Sindh and 84th out of 98 districts in Pakistan in terms of depravation. A more recent analysis by SPDC in 2005 showed that the provincial ranking for Tharparkar improved marginally, with the district being ranked 15th out of 16 districts in Sindh[75]. National rankings for 2005 were unavailable. The same report by SPDC gives the predicted percentage of population below the poverty line at 30% for Tharparkar in 2005; 44% in urban areas and 24% in rural areas.

The estimated annual income per household in the Study Area, as reported in the literature is about Rs. 142,000[76]. For an average household of 6.2 this amounts to Rs. 1700 per person per month. The poverty line of Pakistan is based on a consumption of 2,350 calories per adult equivalent per day. The latest estimate of the inflation-adjusted poverty line for 2006 as reported in the FY 2008 Economic Survey of Pakistan[77] was Rs

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75 Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Center, Karachi

76 Ibid

77 Government of Pakistan, Economic Survey 2007-2008, Finance Division, Pakistan

944 per adult equivalent per month. Inflating this number for inflation estimates of 2007, 2008, 2009, 2010 and 2011, the poverty line of Pakistan in FY2011 has been calculated as Rs 1,755. Based on this estimate, the average household is just below the national poverty line.

Average annual household expenditure in the surveyed population was around Rs 119,000. Thus, on the average, the average annual income per household is around 19% above the average annual expenditure per household. Food expenditures contribute the most (over 50%) to the overall household expenditures. This is in line with the Pakistan Household Integrated Economic Survey 2010-11,[78] which indicates that food items contribute around 55% to total household expenditures in rural areas of the country. After food, farm related expenditures have the largest share in the overall household budget.[79]

The ratio of indebtedness in Tharparkar is reported as very high (more than 80%) due to droughts and poverty. Though borrowing from relatives is a preferred source of credit for many families, more than half of the loans are advanced by money lenders and shopkeepers. Because options are so limited, local money lenders tend to trap poor families in loans with interests ranging as high as 40% to 120%[80]. In recent years, microfinance loans by the TRDP and other Pakistan Poverty Alleviation Fund (PPAF) partners have been introduced as a way to reduce poverty.

4.5.7 Physical Infrastructure and Services

The area has a weak infrastructure when compared to other districts provincially and nationally. It is discussed in this section.

Roads and Communication

The 1998 census reported that Tharparkar had 11 telephone exchanges. Cellular phones are the main mode of communication in the Study Area. Some homes, in larger villages connected to the electricity grid, receive television channels through satellite dish connections as shown in **Exhibit 4.51**.

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78 Government of Pakistan, Pakistan Household Integrated Economic Survey 2010-11, Federal Bureau of Statistics, Islamabad.

79 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

80 Reaching Out from Thar to Other Arid Zones of Sindh, Annual Report 2004-05; Thardeep Rural Development Programme (TRDP)

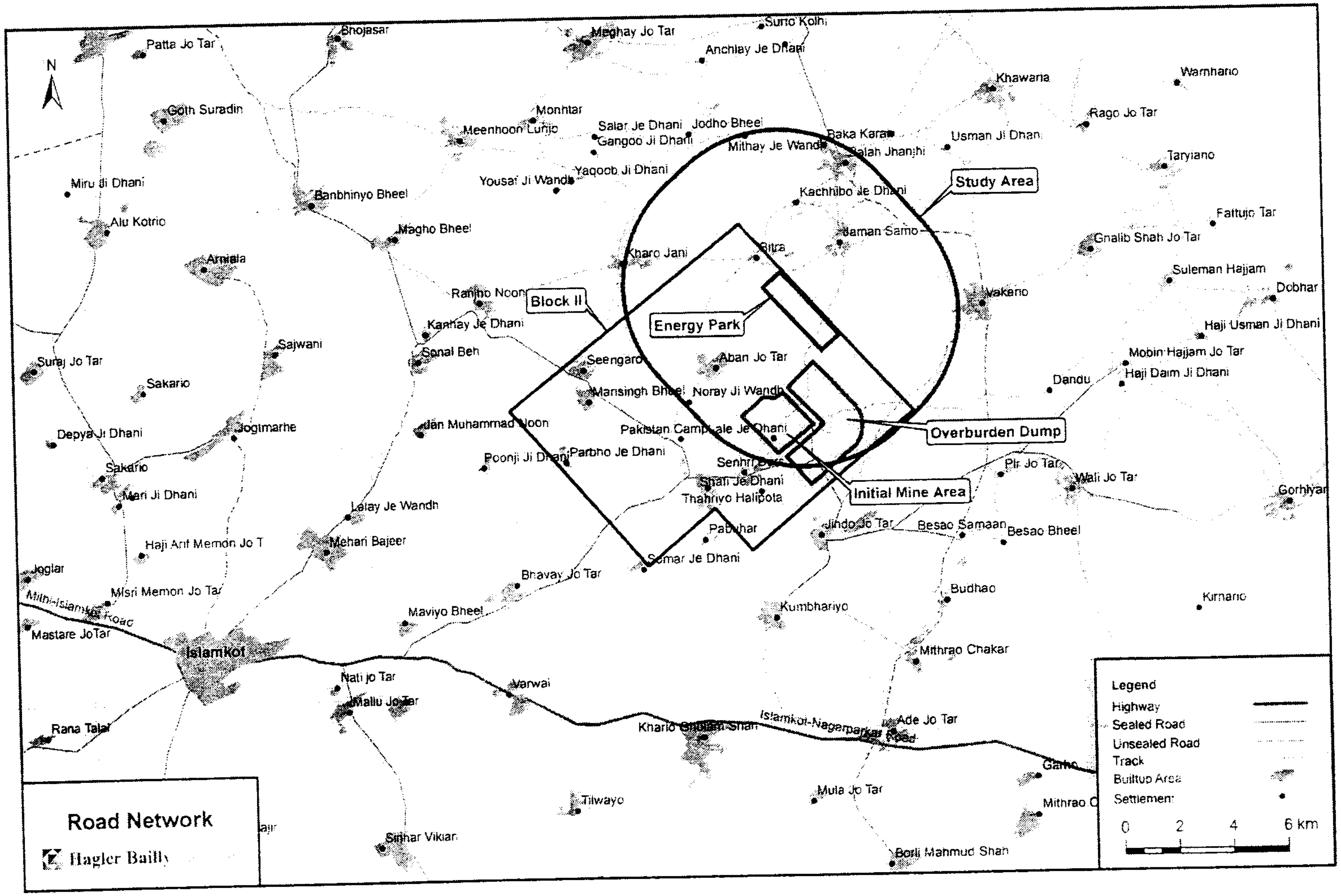
Exhibit 4.51: Satellite Dish Connections[81]

According to a 2006 report the District has a total of 737 km of roads, 529 km of which are of low quality[82]. Regular transport facilities to nearby towns in the form of private jeeps and buses is available at most villages. Road connectivity in the Study Area is mapped in **Exhibit 4.52**.

[81] Source: HBP Library

[82] Development Statistics of Sindh 2006

Exhibit 4.52: Road Network



Community Water Supply and Quality

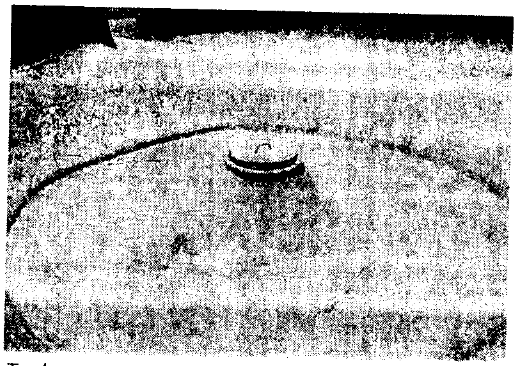
Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais,* and small underground tanks called *tankas*. There are also wells in lower lying areas that collect rainwater.

The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season. Water is extracted from dug wells, through ropes attached to pulleys pulled by a pair of donkeys or a camel. It is tedious two person job, where one person leads the animal and the other unloads the large container once it has been pulled up. The water from wells is emptied into ponds for use of livestock. Wells are mostly communal and villagers take turns extracting water.

Recently, solar powered reverse osmosis systems have been installed in larger villages. Types of water sources in the Study Area are illustrated in **Exhibit 4.53**.

Exhibit 4.53: Water Sources in the Study Area

Tarai[83]



Tanka

Dug Well

Collecting water in a pond for the livestock

[83] Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan, April 30th 2013

Sanitation and Waste Disposal

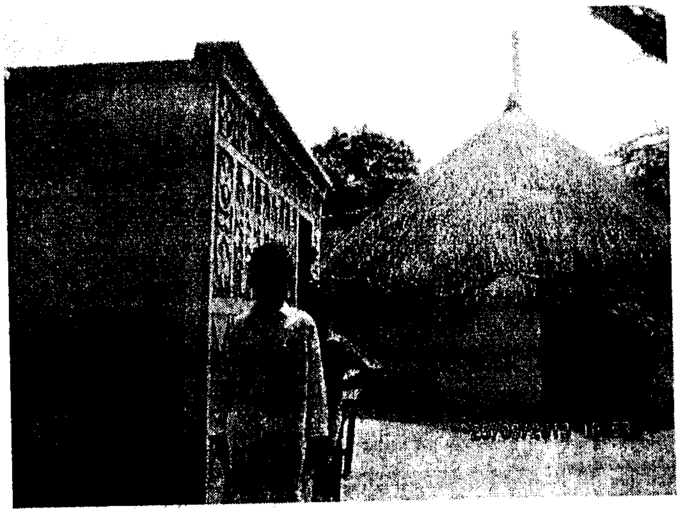
Pakistan Social and Living Standards Measurement Survey 2010-11 (PSLM 2010-11) reported that 43% of the households in rural Tharparkar had no toilet, while 53% had a non-flush toilet. Only 4% of the households in rural Tharparkar had a flush toilet.

Sewerage or storm water drainage systems were not reported in any of the villages in the Study Area, and only open air pit latrines were available which were mostly constructed to facilitate women. Villagers reporting that waste is normally disposed of into open spaces at some distance from houses due to the absence of any solid waste management system.[84]

Housing

The main mode of construction in rural Tharparkar consists of huts called *chaunras* with pointed thatched roofs of shrubs and grasses they are built on mud plastered platforms. The 1998 population census reported that 85% of all housing units in rural Tharparkar were of *kacha* or adobe construction, while a mere 5% were of *pakka* or masonry construction. Examples of houses within the Study Area are shown in **Exhibit 4.54**.

Exhibit 4.54: Housing Structures in the Study Area[85]



A masonry or *pakka* house adjacent to the left of an adobe *chaunra*

Power and Fuel Supply

The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar. Electricity usage in the urban areas was much higher at 68.38% of housing units, compared to only 4% in rural areas. An improvement in this number was seen with 44% of rural houses in Tharparkar using electricity in 2011.[86]

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84 Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

85 Source: HBP Library

86 Pakistan Social and Living Standards Measurement Survey 2010-11

Locals do not cut trees for fuelwood, rather harvest fast growing shrubs and bushes for cooking. There is no natural gas supply in the Study Area and most villages do not use of liquefied petroleum gas (LPG), kerosene or diesel to meet domestic fuel requirements.

4.5.8 Social Infrastructure

An overview of the health and education facilities that are available in the Tharparkar District are discussed.

Health

A high maternal mortality rate of 800 deaths per 100,000 live births in 1992, and a high infant mortality rate (IMR) of the district in 1992 at 150 (deaths per 1,000 live births) indicates a lack of health facilities in the area. These figures can be compared to the 8 times lower national IMR rate of 100 and that for Sindh at 98[87].

Health services are mainly provided through basic health units (BHUs), rural health centers (RHCs) and district head quarter hospitals that are equipped for primary health care services and to some extent comprehensive emergency obstetric care services[88]. **Exhibit 4.55** shows a comparison of the number of government health facilities present in Tharparkar in 1998 with the number of facilities present in 2005[89]. Rural health centers and basic health units have increased whereas other facilities have either declined in number or stayed constant. The number of private local clinics has, however, increased over the past decade.

Exhibit 4.55: Health Facilities in Tharparkar District

Health Facility	*1998*	*2005*
Hospitals	3	3
Rural Health Centers	3	10
Basic Health Units	21	32
Dispensaries	38	31
Maternity and Child Welfare Centers	2	1

As reported in a study conducted by Thardeep Rural Development Programme (TRDP)[90], the Thar coalfield area had just one BHU and four government dispensaries in 2003. The villagers mostly travel to the nearby towns of Mithi and Islamkot for health facilities. Islamkot has a rural health center (RHC), while Mithi has a district hospital facility.

87 Thardeep Rural Development Programme (TRDP); Pakistan Economic Survey, Finance Division, Government of Pakistan; Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Centre

88 Emergency obstetric care (**EmOC**) refers to the care of women and newborns during pregnancy, delivery and the time after delivery

89 1998 District Census Report of Tharparkar; Development Statistics of Sindh, 2006

90 Thardeep Rural Development Programme (TRDP), 'Socioeconomic and Environmental Aspects of Coal Mining in Tharparkar District' (2003)

Education

Literacy[91] in Tharparkar district is low and shows high gender disparity. The 1998 population census reported the literacy rate of Tharparkar district at 18.32%; 28.3% for males and 6.9% for females. In rural areas, the literacy rate was 25.72% for males and a mere 4.8% for females.

There has, however, been a distinct upward trend of literacy in the district, as shown by literacy rates of rural localities in 2010-11 reported in the PSLM. Both male and female literacy have increased significantly in rural Tharparkar since 1998 and are now at par with the literacy rates in rural Sindh and rural Pakistan, although the overall literacy rate of Tharparkar (46%) remains below the overall literacy rates of Sindh (59%) and Pakistan (58%).

Adult literacy[92] was recorded at 57% for males and 13% for females in rural Tharparkar in 2011[93].

Tharparkar fares better nationally and provincially in terms of net primary enrollment rate, with PMDG 2006 ranking Tharparkar 51st out of 98 national districts, and 7th out of 16 provincial districts. A comparison of the net primary enrollment rate for 2010-11 for rural localities shows that Tharparkar now fares better than Sindh (**Exhibit 4.56**). The gender disparity in enrollment at the primary level, though present, is less pronounced.

Exhibit 4.56: Net Primary Enrollment Rate in Rural Localities, 2010-2011[94]

	Male	*Female*	*Total*
Tharparkar	70%	54%	63%
Sindh	63%	43%	54%
Pakistan	**68%**	**56%**	**62%**

Considering the gender imbalance in enrollment in educational institutions, community support programs should give attention to improving access to education for girls.

4.5.9 Cultural Heritage

There are a large number of religious, archeological and cultural sites of significance in the Thar area. These include temples, forts, and tombs.

The site closest to the Study Area is the Gad of Mirs (Talpurs) in Block II. It is located in the south of Seengaro Village about 10 km southeast of the Energy Park. The Gad of Mirs (Talpurs), which belongs to the Talpur period (1784 to 1843),[95,96] had a square plan.

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91 Literacy is defined as "all those persons ten years of age and above who could read and write in any language with understanding, as percentage of the population ten years and above."

92 Literacy in population aged 15 years and above

93 Pakistan Social and Living Standards Measurement Survey 2010-11

94 Pakistan Social and Living Standards Measurement Survey 2010-11

95 Ursani, M.I., *Ser Registan (Travels into desert)* 2nd edition, Jamshoro, Sindhi Adabi Board (1995)

96 Baloch, N.A., Sindh: Studies Historical, Jamshoro, University of Sindh (2003)

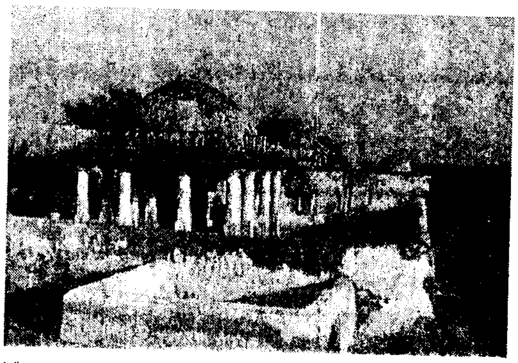
It had four bastions with a main gate opening to the east and a well in the center of the fortress. Close to the northern ramparts there were a few buildings used as residence. The condition of the fortress is poor due to lack of proper maintenance.

The Gori temple is said to be built around 1376 AD, in the golden era of the Sodhas. Images of the temple are shown in **Exhibit 4.57**. Other important cultural sites that are close to the Study Area are mapped in **Exhibit 4.58**.

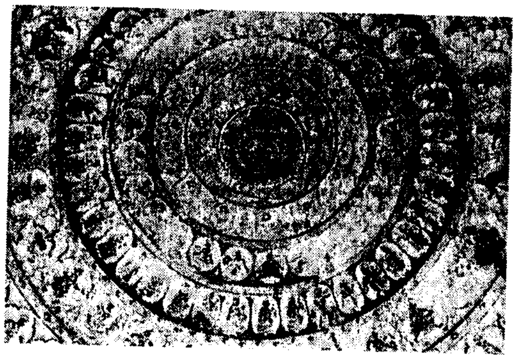
Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. However, the Thakurs first cremate their dead and the ashes are buried.

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

Exhibit 4.57: Gori Temple[97]



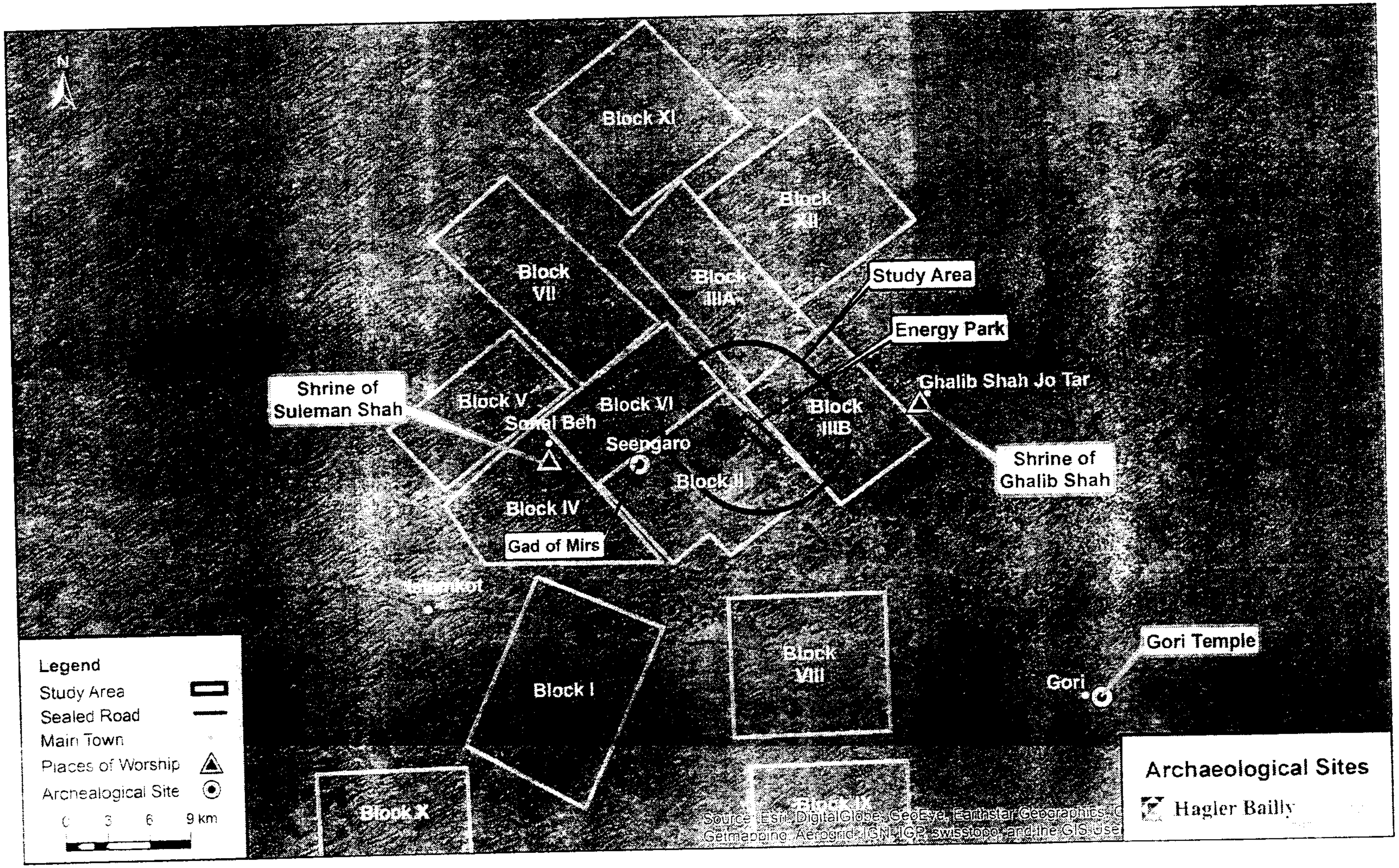
View of the Gorri Temple



View of roof inscriptions inside the Gorri Temple

[97] Source: HBP Library

Exhibit 4.58: Archeological Sites and Major Places of Worship



5. Public Consultation and Disclosure

This section is pending subject to public consultations and will be included in final ESIA.

6. Project Impacts and Mitigation Measures

This chapter predicts the magnitude of the Project impacts, assesses their significance, and identifies mitigation measures to minimize the adverse impacts. Where possible impacts are quantified.

6.1 Identification of Significant Environmental Aspects

This section covers the assessment of potential environmental impact of the proposed power plant activities. The potential impacts are discussed in **Exhibit 6.1**. These are categorized into three categories as follows:

- High risk (H): Definite impact, major deterioration and/or long–term impact and/or large footprint
- Moderate Risk (M): Likely impact, medium magnitude, medium-term activity and/or relatively smaller footprint
- Low Risk (L): Low likelihood of impact, minor magnitude, generally reversible, and small footprint

Based on this categorization the potentially significant issues are identified according to anticipated risk to environment due to the Project activity. The significant issues are then further discussed in the following sections.

For the purpose of this discussion, impacts are defined where there is a plausible pathway[98] between the project aspects[99] and receptors.[100] The aspects, pathways and receptors are identified based on previous environmental or social studies; review of the evolving Project description to identify aspects; consideration of the area of influence to determine pathways and receptors; experience of the ESIA and Project specialists; consideration of issues raised by stakeholders; and findings of baseline investigations as they become available.

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[98] Pathway is the mechanism by which the aspect affects the receptor (such as inhalation of air or drinking of water).

[99] Aspect is the mechanism by which project activities may cause impacts (for example, gaseous emissions to the atmosphere or effluent discharges to a water body).

[100] Receptor is a person, natural ecosystem, structure or infrastructure system that experiences the impact.

Exhibit 6.1: Potential Environmental and Socioeconomic Impacts of the Proposed Activities

Project Activity	Description	Impacts	Risk	Discussion
Construction Phase				
Land acquisition	The land for the construction of power plants in Energy Park will be acquired as part of the Block II mining project. The land will be purchased by the Project proponents from the developers of the mine.	Refer to ESIA of Block II mining project[101]	L	Land acquisition is not included in the scope of this study as the land will be acquired as part of the Block II coal mine project. However, all applicable laws will be followed as per regulation.
Transportation of equipment	The equipment for the power plant will be imported via Karachi Port or Port Qasim. It will then be moved to Thar via the national highway (N-5), Thatta-Badin Road, and then Badin-Mithi Road. The load will comprise dozens of 40-feet (12.2 m) flat-bed trucks. In addition some large equipment will be carried on over-sized articulated trucks.	During the main phase of equipment transportation, the additional traffic generated on the road can potentially result in the different types of impact including, road congestion and inconvenience to existing road users, additional noise and emissions and impact on the nearby community, and community safety issues. For the over-sized consignments, it may be necessary to remove obstructions, such as toll plaza, and low level power and telephone lines, to allow the equipment to pass through. Further, the heavy load may also damage the road surface particularly the shoulders.	L	GoS is carrying out the improvement, development , widening of roads and building of bypasses on the mentioned route to facilitate the transport of heavy machinery to Thar
Site construction activity	Construction activities include construction and operation of staff camp, storage of equipment, civil works,	Potential environmental impacts of construction activities include: Camp waste disposal; disposal of camp wastewater; spills and leakages of oil and	L	Construction related impacts can be kept low if managed properly. A construction management plan (CMP) is included in the Environmental Management Plan (EMP) in **Chapter 7**.

[101] Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

Project Activity	Description	Impacts	Risk	Discussion
	installation of equipment, and disposal of waste.	contamination of soil and potentially surface water; and noise and vibration		
		Industrial construction activities pose an occupational health and safety risk to the workers. Improper management of this aspect can lead to fatalities and health issues.	M	Requirements for occupational health and safety are discussed in relevant sections of **Chapter 7**
Socioeconomic impacts	Contribution of the Project to the local livelihoods in the construction phase.	Additional local employment opportunities, resulting in increased prosperity and wellbeing	M (Benefit)	The Project will employ several thousand persons during the construction phase.
		Inflation may be caused by large amounts of cash entering the local economy through direct spending by Project developers or through salaries of employed locals.	M	
	Influx of outsiders into the area for Project construction and management.	Women currently have easy mobility outside the village and collect fuel wood, tend to livestock etc. and the family is not concerned about their safety. As indicated during male consultations (see **Chapter 7**), with the increase of outsiders the freedom of movement for women will be reduced.	M	
Ecological Impacts	Project activities will disrupt the biological setting of the area.	Project activities will cause direct loss of habitat due to site clearance and influence a broader zone due to noise and air emissions and other activities	M	Other than vultures, which are endangered, the impact on other flora and fauna will be limited.
Grievances of stakeholders due to construction activities	Unaddressed grievances of Project stakeholders due to absence of grievance redress mechanism	Ill will of local people and other stakeholders towards the Project	M	A formal system for addressing the grievances will be developed to ensure that closure on the issues is achieved expeditiously as a priority.. A Grievance Redress Mechanism to be followed in Project implementation and is included in **Chapter 7**.

Project Activity	Description	Impacts	Risk	Discussion
Operations Phase				
Emission from Power Plant	Emission of SO_2, NOx, PM_{10}, and $PM_{2.5}$	Health issues due to Project related pollution, resulting in increased health expenses and affecting deprived segments of the local populace.	M	Mitigation measures such as installation of control equipment on boilers have been incorporated in the plant design.
	Greenhouse Gas (GHG) Emissions	High levels of GHG emissions from coal based power generation leads to global warming causing climate change.	L	Pakistan currently has one of the lowest GHG emissions per capita in the world, estimated at 0.8 metric tons per capita in 2013 by the World Bank. For comparison Sub- Saharan Africa has similar emissions of 0.8 metric tons per capita, whereas South Asia emits 1.4 metric tons per capita, the European Union 6.7 metric tons per capita, and North America 16.1 metric tons per capita. Therefore the contributions of this Project nominally increases the already very low GHG emissions from the country.
Effluent discharge from the Power Plant	Discharge from the power plant including cooling tower blowdown, boiler blowdown, washing effluent, sanitary waste, and some other effluents	Contamination of soil and groundwater	L	The waste generated by the different waste streams will be disposed through proper disposal and treatment systems.
Water consumption	Large quantities of water are required for power generation through the steam turbine as well as for coal dust suppression and other construction activities.	The area is water scarce and extensive use of local water can cause water shortages.	L	Water from the LBOD will be used for power generation. The maximum possible water from the plants will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping.

Project Activity	Description	Impacts	Risk	Discussion
Ash disposal	Large quantities of fly and bottom ash will be generated from the power plant.	Emission of dust particulates from ash handling activities at the ash disposal site. Leachates and rainwater runoffs contaminating water supplies.	L	Ash will be stored temporarily on the power plant site until it is transported to the mine area where it will be used as backfill in the spent mine pit. The dumped ash will be compacted, mixed with sand and given leaching protection by lining the area.
Socioeconomic impacts	Contribution of the Project to the local livelihoods and economy of the country.	Increased power generation due to the Project, reducing energy shortfall and reviving associated economy.	H (Benefit)	In the long-run the Project will provide significant support to the local economy. The power generated from the Project will help in reducing power outages which are affecting growth of the economy. It will also lower the average cost of power generation in the country by shifting the fuel mix in power generation from fuel oil to coal.
	. Influx of workers due to operation of the Project.	Stress on limited infrastructure and employment due to increased population	M	The in-migrants are likely to be economically poor. The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing stock. The informal settlements developed in this manner would lack basic infrastructure and services, such as adequate sanitation systems and health facilities and put pressure on the limited existing infrastructure.
Ecological Impacts	Project activities will disrupt the biological setting of the area.	Noise emissions due to operation of the Project will influence surrounding habitat.	M	Other than vultures, which are endangered, the impact on other flora and fauna will be limited.

6.2 Construction Phase Impacts

Impacts, together with proposed mitigation measures, related to the construction phase are discussed in this section.

6.2.1 Impacts with Low Risk

Low risk impacts that arise during Project the construction phase, including land acquisition, transport of equipment and construction are discussed below.

Land Acquisition

No settlements will need to be replaced due to the Project footprint. The developers of Block II have drafted a Resettlement Action Plan (RAP) to cater to the communities of Block II that will need to be resettled.[102] The company is also in the process of engaging town planning and architect firm for the design of resettled villages & associated infrastructure.

Transportation of Equipment

The maximum traffic load is expected during the construction phase. Impacts of transportation of construction equipment and plant machinery to the Project site are:

- Queueing and longer commute times
- safety hazards especially for pedestrians and livestock due to large volume of traffic on the roads;
- Deterioration of ambient air quality and increase in noise levels in settlements located alongside the route selected for transportation;
- Degradation of the existing roads.

Even at its peak, the estimated volume of traffic shall not be more than 20-30 trucks per day. This is low as compared to the existing traffic (see traffic baseline in **Section 4.3.8**) up till Thatta. However, it will be approximately a 20% increase in traffic at Mithi and Islamkot and a large increase near the Project site which has very low levels of baseline traffic.

Site Construction Activity

Some of the environmental and social impacts of construction activities relate to activities at the construction site whereas others relate to the setting up and operation of the construction crew camp. Typical issues include:

- Site clearance leading to dust emission
- Removal of vegetation leading to loss of vegetation cover
- Erosion and sedimentation due to large scale earthwork
- Deterioration of air quality from operation of construction machinery and earthwork and movement of construction vehicles

[102] SECMC director's report, December 31, 2014

- Noise and vibration from machinery and construction work
- Generation of waste and its disposal
- Disposal of wastewater from construction camp
- Cultural impact related to presence of non-local workers

Typically, the construction impacts are temporary and end with the completion of the construction activity. However, poor management can result in long-term residual impacts. To avoid adverse impact of the construction activities on the environment, following measures are proposed:

- To the extent possible, the camp of the construction contractor(s) will be located within the premises of Power Plant Site.
- The construction contractor will develop a specific construction management plan (CMP) based on the CMP included in the EMP (**Chapter 7**). The CMP will be submitted to the TPC for approval.
- The CMP will clearly identify all areas that will be utilized during construction for various purposes using a site plan.

6.2.2 Socioeconomic Impacts during Construction

Contribution to Local Livelihoods

The Project will create additional job opportunities in the area. During construction period several thousand (typically 1,000- 2,000) people will be hired. To maximize the benefits to the local community the following mitigation, enhancement and good-practice measures are suggested:

- Explain the recruitment process to local communities;
- Preferentially recruit local candidates provided they have the required skills and qualifications for the announced positions;
- Coordinate efforts to recruit unskilled labor, if any are required under the Project, from the adjacent rural areas.
- Include an assessment of the contractor's demonstrated commitment to local procurement and local hiring in the tender evaluation process.
- Maintain a recruitment database that contains information on local candidates and offer these candidates to contractors for consideration.
- Support the training of local people to increase their potential for indirect employment.
- Maximize the benefits of indirect and induced impacts to local communities and businesses by implementing the community development initiatives pertaining to education, training and skill development of the local people.
- Assist employees, local communities and vulnerable groups in improving basic personal financial life skills through training and awareness campaigns.

- Determine what is considered to be 'fair and transparent' in recruitment and in distribution of jobs between different community groups in consultation with local communities and their leaders.
- Set long-term (10 to 15 year) targets for local representation at the managerial level. Implement training and development to meet these targets.
- Promote mechanisms to increase the access of vulnerable groups to Project opportunities through small business development.

Inflation in the Local Economy

Increased levels of income in the Study Area can result in inflation and economic inequality. This, in turn, can adversely affect those within the Study Area who are unable to benefit from the Project, as well as the vulnerable stratum of the population in the Study Area. Economic inequality can deepen social hierarchies and have an adverse impact on social relations as well as create conflict amongst different sections of the society

This is particularly relevant to the Study Area, where the greatest economic growth is expected to occur. Even a small increase in the cost of living, particularly food prices, can have a severe impact on the local community as around half of the households in the vicinity of the Study Area are below the national poverty line.

Proposed mitigation, enhancement and good-practice measures include:

- In association with the training measures indicated elsewhere, develop a training program targeted at local people living below the poverty line.
- In association with the community development measures, develop a program to create alternative employment creation initiatives aimed at local people living below the poverty line.
- Encourage government and NGOs to assist economically poor in strengthening their livelihood options.

Intrusion in Privacy due to the Influx of Outsiders

The influx of workers in the Study Area can result in the deterioration of social values and an increase in social ills in the communities affected by the in-migration of workers and job-seekers. The increase in population and the associated economic inequality can result in increased crime, such as theft and robbery. Communities affected by the in-migration of workers can also witness a rise in drug abuse rates, which, in turn, can lead to increased violence, an increase in promiscuous sexual activities due to the presence of single males with disposable incomes, and the erosion of traditional cultural values. The society in Tharparkar is deeply rooted in various cultural ethics and values. Erosion of traditional cultural values can create conflict amongst the existing communities as well as between communities and outsiders. The presence of outsiders can also restrict the movement of women, affecting the traditional division of labor.

The increase in social ills is expected to be more severe during the construction phase than the operational phase and can continue with reduced intensity in the operational phase. However, the magnitude, duration and scale of this impact are difficult to predict accurately as the Project may have little control over managing the complex social change processes associated with in-migration.

Proposed mitigation, enhancement and good-practice measures include:

- Require non-locals employed by the Project to adhere to a social 'code of conduct' in terms of relations with local communities.
- Provide employees and visitors to the site with cultural awareness training.

6.3 Operations Phase Impacts

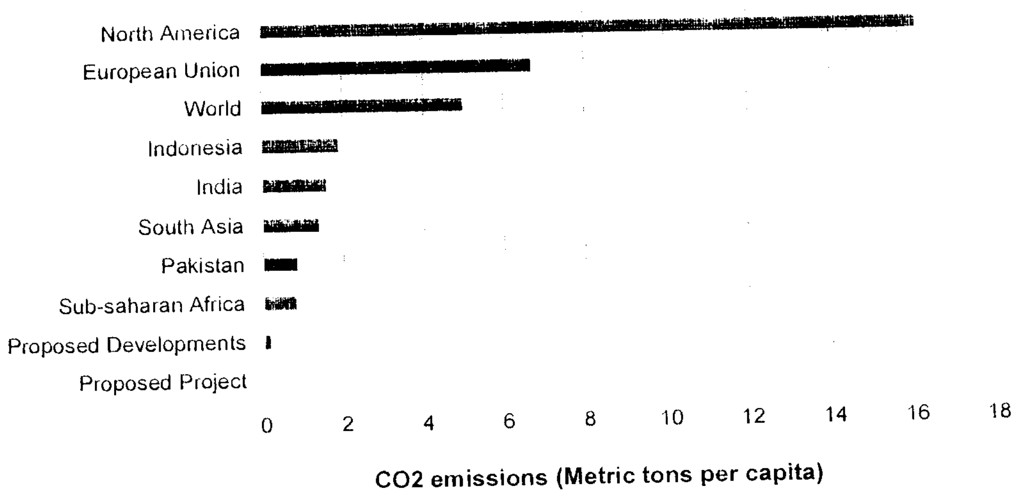
Impacts and proposed mitigation measures that are expected in the operation phase are discussed in this section.

6.3.1 Impacts with Low Risk

GHG Emissions

The estimated greenhouse gas emission from the power plant will be about 1.7 million metric tons per year.[103] This estimate has been developed using the USEPA Greenhouse Gases Equivalencies Calculator that assumes a 7.03×10^{-4} metric tons of CO_2 emission per KWh of energy output. **Exhibit 6.2** shows the per capita tons of CO_2 produced.

Exhibit 6.2: CO_2 emissions (metric tons per capita)



Water consumption

Water from the LBOD will be used for power generation. The maximum possible water from the plant will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping.

103 https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Ash disposal

The annual ash produced from the Project will be about 125,000 tons. The overburden generated by the production of coal at the Block II mine is estimated to be about 160 times the ash generated from the power plant.[104] Therefore, the ash produced from the power plant can easily be mixed with the overburden and disposed with it.

6.3.2 Air Emission from the Coal Power Plant

The methodology used for impact assessment in this section will comprised of the following:

1. Prediction of the magnitude of potential impacts — this step refers to the description, quantitatively (where possible) or qualitatively, of the anticipated impacts of the proposed Project. This may be achieved through the use of models or comparison with other similar activities.
2. Identification of mitigation measures — there is a range of mitigation measures that can be applied to reduce impacts if the emissions exceeds the standards.

As there are a number of existing, approved, proposed and foreseeable gaseous emission sources in the area, it is essential to consider their impacts on the ambient air quality in appropriate manner. This inventory of the sources and the scheme under which they are considered are discussed in **Exhibit 6.3**.

Exhibit 6.3: Gaseous Emission Sources and their Assessment

Additional Sources	*Approach*	*Section*
Existing Natural Biomass Burning Traffic	Measured Baseline Measured	**Section 4.3.6**
Approved Projects 660 MW Plant, Block II 330 MW Plant, Block II 330 MW Plant, Block II	Simulated Baseline Modelled + Measured	**Section 4.3.6**
Proposed Plant 330 MW Plant, Block II	Impact of Proposed Plant Incremental Impact of Proposed Plant + Simulated Baseline	**Section 6.3.2**
Future Developments 2,640 MW Plants, Block II 1,320 MW Plants, Block III 660 MW Plant, Block VI	Cumulative Impact Incremental Impact of Future Developments + Impact of Second Plant	**Section 6.4.1**

[104] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

To evaluate the Project impacts the emissions and dispersion of the pollutants will be modelled through the United States Environmental Protection Agency (USEPA) approved regulatory air quality model AERMOD[105]. The objective of the modeling exercise is to predict if the emissions from the proposed Project will comply with the SEQS and IFC limits. The results of AERMOD will provide the incremental increase in the concentration of pollutants generated from the proposed Project. This concentration will then added to the baseline concentration to determine the ambient concentration of the pollutants during the operation of the Project.

*As the location plays a key role in the dispersion and ground concentration of pollutants, the final modeling results will be included in the final ESIA once the location of the plant is decided. However, based on previous ESIAs in the Energy Park having similar coal specifications and project design (see **Chapter 3**), an estimated concentration of the pollutants is presented below.*

The predicted ambient concentration of the pollutants is calculated by adding incremental concertation to the simulated baseline. These estimated concentrations are then compared against the standards see **Exhibit 6.4**.

Exhibit 6.4: Predicted Annual Ambient Concentration (µg/m³)

Pollutant	*Simulated Baseline*	*Estimated Concentration*	*Predicted Ambient Concentration*	*SEQS*	*IFC EHS target limits*
SO_2	16.7	0.9	17.6	80	-
NO_2	8.9	0.5	9.4	40	40
PM_{10}	140.2	<0.1	140.2	120	70
$PM_{2.5}$	30.1	<0.1	30.1	40	35

It can be seen that the SO_2, NO_2 and $PM_{2.5}$ annual concentrations are within standards. Only the PM_{10} annual concentration exceeds the standards. It should be noted that particulate matter concentration is already high in the background due to dusty environment of the area. The contribution of anthropogenic sources to the ambient concentration as compared to the natural sources is negligible.

6.3.3 Socioeconomic Impact during Project Operation

The major socioeconomic impact of the Project includes increased electricity generation capacity which will help alleviate Pakistan's energy crisis. Locally, the Project activities will stimulate the local economy thus creating jobs in the area.

105 US Environmental Protection Agency, "Support Center for Regulatory Atmospheric Modeling, Recommended Models," last modified on April 8, 2015, http://www.epa.gov/scram001/dispersion_prefrec.htm.

Employment Impact

The Project will create additional job opportunities. It is expected that more than 100 staff positions will be created under the Project. Most of these positions will be skilled, having expertise in handling the new equipment and processes.

To maximize employment of people from within the Study Area in the operational phase of the Project, the Project will invest in training programs that focus on the Study Area. This investment will be needed to overcome the lack of education and skills in the labor force of the Study Area. The training programs will be implemented in time for local people to at least benefit from unskilled employment opportunities that are available during the construction phase of the Project. The proportion of locals in the workforce of the Project will increase over time as training programs are completed. Training and preparation of local people for jobs will also increase their access to indirect and induced employment opportunities.

Increased Power Generation and Diversified Fuel Mix

Pakistan is suffering from an acute energy crisis. The unreliable power supply is affecting the productive end-uses of power due to which the direct and multiplier benefits of productive activities are foregone and the economy incurs a loss.

Due to the Project, 300 MW will be added to the system. The power generated by the Project would be supplied to various sectors that are currently impacted by the power shortages and bridge part of the energy shortfall facing the country. This, in turn, will have a positive impact on the country's economy through increase in gross domestic product (GDP). The impact will last through the life of the Project and thus, be of a long duration.

The power plant will also shift the generation mix of the country towards an indigenous fuel source of coal, thereby protecting the country from volatility in international oil prices.

In-Migration

The increased job opportunities offered by the Project and by service providers to the Project, in conjunction with the lack of opportunities available in the rest of Tharparkar District, will lead to an influx of job seekers in the Study Area. Some service providers to the Project may open new offices in the towns of Islamkot and Mithi, which are situated close to the Study Area. This will stimulate the local economy through a trickledown effect.

The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing facilities. The informal settlements developed in this manner would lack basic infrastructure and services, such as adequate sanitation systems and health facilities. Thus, in-migrants would rely on the existing infrastructure and services within the Study Area and in and around the towns of Islamkot and Mithi, which would burden the existing infrastructure and services. This can possibly generate conflict between locals and the in-migrants. To avoid this, infrastructure and services would have to be scaled up in areas where there is in-migration. However, the district and tehsil administration of the Study Area do not possess the necessary resources for this. Conflict can also be caused if the in-migrants occupy land that the inhabitants of the Study Area consider as their own, which can give rise to disputes over the rightful ownership of the land. While SEL will not be able to address such conflicts by itself, SEL will report such cases to the local authorities as soon as they arise and work in collaboration with local authorities to resolve such disputes.

Proposed mitigation, enhancement and good-practice measures include:

- Limit employment of non-locals (persons from outside Tharparkar District). In support of this, establish and raise awareness of recruitment offices for 'non locals' in identified locations outside of Tharparkar District (such as Karachi). Support training of local people in getting the required skills to get employment in the power plant.
- In association with other community development programs, support local authorities in Mithi to increase their capacities to deliver services to an increased population. Determine the nature of support, which may include town planning, waste management and access to basic health care and education.
- Encourage local communities to use the grievance procedure for concerns related to deterioration of local services and conflicts over land ownership.
- Work with the concerned legal and traditional authorities to establish land ownership in the Study Area before commencement of construction.
- Support local government in the management of informal settlement.
- Support NGOs specializing in informal settlements to assist local government.

In-migration of people in the Study Area can result in deterioration in public health due to increased chances of exposure to communicable diseases such as tuberculosis, diarrhea, and malaria. The potential spread of communicable diseases can be exacerbated by factors associated with the development of informal settlements. Such factors would include unsanitary and congested living conditions in informal settlements, lack of potable water, malnutrition and lack of awareness about health prevention measures amongst in-migrants. The in-migration of people would also worsen public health conditions since it would burden the existing health facilities, which are not equipped to handle a large increase in population and thus, number of patients, in the Study Area.

Proposed mitigation, enhancement and good-practice measures include:

- Develop and implement management policies for tuberculosis, diarrhea, malaria and other communicable diseases, focusing on prevention, control, diagnosis and treatment in coordination with NGOs and local government.
- Provide health and hygiene education awareness programs to local communities, educational establishments and employees.
- Undertake health screening of employees.

6.3.4 Ecological Impacts

Any ecological impact from the Project will be incremental over the impact of the mining activities in Block II. In the ESIA for the Block II Coal Mine, it is stated that other than potential impact on the vulture habitat, no significant impact of the mining on the flora and fauna of the area are anticipated. No threatened mammals or reptiles are found in the Study Area. Although part of the Thar Desert in the project area is cultivated, the agricultural activity is not very intense. Thus the natural habitat is relatively intact. Site clearance for the power plant and related infrastructure will result in immediate and direct habitat loss, however the risk of direct killing of animals is minimal as the animals are likely to move away from the area once the clearance has started.

The habitat in the Thar Desert area is important for survival of vultures as one Endangered and three Critically Endangered species of vultures are breeding in the Thar Desert. Availability of nesting sites and food are principle factors that determine the population of vultures in an area. The vulture population in the Indian subcontinent is declining due to existing threat to the vulture population. The cause of this is presumably poisoning by the veterinary drug Diclofenac, probably combined with other causes (BirdLife International 2010)[106]. The birds feed on carcasses of animals treated with the veterinary drug.

Availability of nesting sites and food are principle factors that determine the population of vultures in an area. Clearing of land for power plant will reduce the potential habitat area of these vultures. While the trees for nesting and the feeding areas are widespread in the Thar Desert, a program for management of vulture population in the immediate vicinity and within Block II supported by the Project will be required to contribute to the ongoing efforts of the Sindh Wildlife Department and other conservation groups in preventing the extirpation of this species from the Thar area. Vultures prefer to make nests on *Prosopis cineraria* trees in the Thar Desert. *Prosopis cineraria* trees can be planted outside the area that will be directly impacted by Project operations so the vultures can have access to alternate nesting sites. Such plantation may be started early during the Project to minimize the potential impact of habitat loss during the construction period.

6.4 Cumulative Impact Assessment

The cumulative impacts of future developments that will affect the environment in the Study Area are discussed in this section. These include developments in Block II, Block VI and Block III A&B of the Thar coalfields.

6.4.1 Cumulative Impacts on Air Quality

As with time the Block II, VI and III A & B will be fully developed and generating electricity to their maximum capacity, they will cumulatively deteriorate air quality of the Study Area.

Future Developments

The future developments in the adjacent blocks to the Energy Park are summarized in **Exhibit 6.5**. The expected location of these developments are shown in **Exhibit 6.6**.

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[106] BirdLife International 2010. Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 27/6/2010.

Exhibit 6.5: Future Developments near Study Area

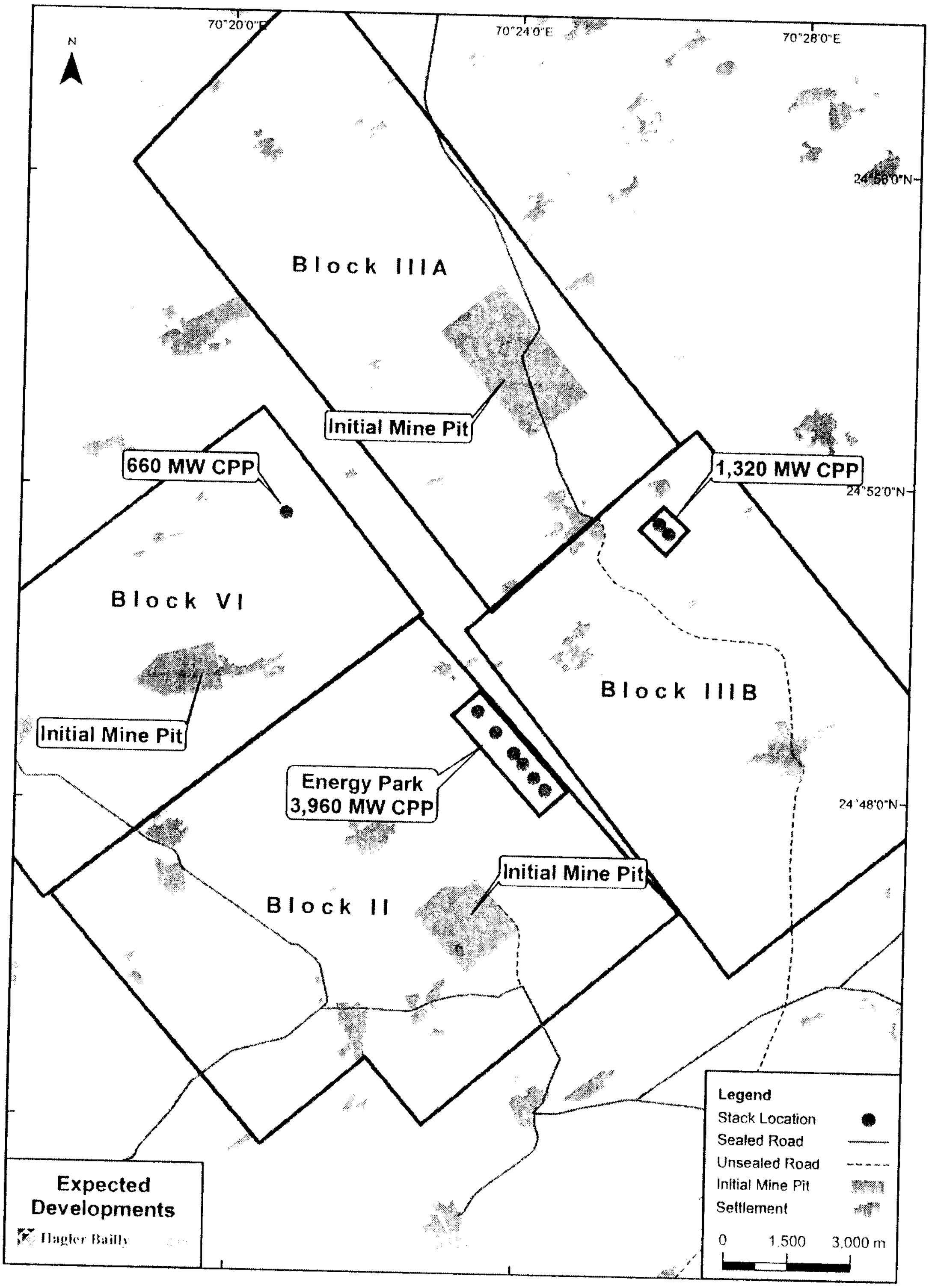
Block No.	*Coal Mine*	*Power Plant*	*Source*
Block II	up to 22 mtpa	3,960 MW	ESIA of Block II Mining and Power Project[107]
Block III A & B	6.5 mtpa	1,320 MW	Background information document for ESIA of Block III A & B Mining and Power Plant Project
Block VI	2.5 mtpa	660 MW	ESIA of Block VI Mining Project[108]
Total	**31.5 mtpa**	**5,940 MW**	

It is assumed that all coal plants follow the same specification as the current Project.

[107] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

[108] Hagler Bailly Pakistan (HBP), April 2013, Environmental and Social Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

Exhibit 6.6: Future Developments



Modeling Results and Discussion

The measured and modeled results are compiled in **Exhibit 6.7.**

Exhibit 6.7: Predicted Annual Cumulative Results (μg/m^3)

Pollutant	*Simulated Baseline*	*Predicted Ambient Incremental Impact*	*Predicted Ambient Cumulative Impact*	*SEQS*	*IFC EHS target limits*
SO_2	16.7	17.6	35.5	80	-
NO_2	8.9	9.4	21.6	40	40
PM_{10}	140.2	140.2	140.8	120	70
$PM_{2.5}$	30.1	30.1	30.3	40	35

The following conclusions can be drawn:

- The annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits. There is significant increment in SO_2 and NO_2 concentrations due to addition of more coal power plants. This leaves narrow room for developments in other blocks.
- The $PM_{2.5}$ concentrations comply with both SEQS and IFC EHS limits.
- The PM_{10} concentrations exceeds the standards. This increase is due to the dusty environment of the area.

6.4.2 Cumulative Impacts on Water Resources

The mining activities will result in ground water dewatering which will lower the ground water table in the area. The combined impacts are expected to be significant. However, as mining is beyond the scope of this Project, this impact is not quantified further. There should be a collective action plan developed between mine developers to quantify and address the potential impact on communities that a lowering of the ground water table will have as these communities depend heavily on ground water wells for water.

Water consumption for the proposed 330 MW power plant is expected to be between 1,200 to 1400 m^3/hr. Therefore the total water consumption for all power plants can be roughly estimated to be around 20,400 to 23,800 m^3/hr (200 – 233 cusecs). While the source of water for initial projects will be from the LBOD, it is likely that future projects utilize water from the dewatering of coal mines. Similarly, while initial projects will dispose water via the effluent channel to the Runn of Kutch it is likely future projects dispose water via re-injection of water into the Sub-Recent Aquifer. A synergistic plan should be adopted between various mine and power plant developers for the use and disposal of water to minimize the impact on the local water resources.

6.4.3 Cumulative Impacts on Employment

Employment in the construction and initial phases of the projects is expected to be the highest. However, the cumulative impact is assessed based on the operational phase of the projects.

The Proposed project is expected to employee 100 permanent staff positions. Therefore, it can be estimated that the combined employment generated by the power plants will be approximately 1700 persons. However, this figure may be lower due to efficiencies of scale once all plants are operational.

The ESIA of the Block VI mine estimates permanent positions for 340 people as the number of shovels and dump trucks are reduced in line with a reduction in overburden stripping and a move to conveyors.[109] This is 136 persons per mpa coal extracted for a total estimated 4284 staff for the future developments. As with the power plants economics of scale of larger mines may result in a lower number of persons employed.

The total direct permanent employment is therefore estimated at 6000 persons. There is expected to be significant indirect employment to provide services for the projects.

6.4.4 Cumulative Impacts on Traffic

The impacts of Thar coal development on the transport network could result from the transport of coal to the rest of the country, and the transport of goods and labor to and from the Thar coalfields.

Coal Transport

The export of coal from the Thar coalfields to the rest of the country could significantly impact the traffic situation of the area. Two proposed coal power plants (a 660 MW power plant in Lakhra and 1320 MW power plant in Jamshoro) are designed based on a coal mix of imported and Thar coal. However, it is unlikely that the coal will be transported to these power plants by road for the following reasons:

1. These projects are funded by the Asian Development Bank (ADB) which has stipulated that the Thar coal be transported by rail.
2. The design of these power plants is based on an 80% imported to 20% Thar coal mix. This reduces the requirement of transport for Thar coal.
3. Thar coal is of low quality and has a high moisture content, therefore transport over long distances is expensive.

Therefore, the transport of coal away from the Thar coalfields is not expected to have a major impact on traffic.

Project Activities

Assuming that employees stationed at the mine and power plant are on a 21 day work 10 day leave schedule they will use transport on roads twice a month. This translates to 600 busses per month (with 20 person capacity) or 20 busses per day. Local roads should be able to handle this increase in traffic. Increase in traffic due to short trips, indirect increase in population, and transport of goods and services will also impact the traffic conditions.

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[109] Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan, April 30th 2013

7. Environmental Management Plan

The main objective of the Environmental Management Plan (EMP) is to identify mechanisms to implement the environmental mitigation measures discussed in **Chapter 6**. It is the fundamental tool that ensures that all mitigation measures are consolidated, their implementation responsibilities identified and the resources required to implement the measures are provided. Further, the EMP includes monitoring measures as a feedback mechanism on implementation and effectiveness of the mitigation measures.

EMP is prepared for all the identified environmental impacts during design, pre-construction, construction, operation, and closure stages. The methodology followed for preparing the EMP consists of the following steps:

- Identify mitigation and enhancement measures for each identified impacts and risks,
- Identifying the organization or person that would be responsible for implementing the measures, and
- Developing a mechanism for monitoring the proposed mitigation measures.

The EMP will be included in all bid documents of the Project and will become a part of the EPC works contract. The strict implementation of the EMP and project management's strict enforcement of the adequate construction practices and standards will greatly reduce the negative impacts of the Project.

The EMP contains the following elements:

- An institutional framework for effective implementation of the plan
- The Mitigation Plan which summarizes the mitigation measures to be implemented.
- A monitoring plan with guidelines on reporting and feedback
- Suggested training programs to build capacity for the implementation of the EMP
- A framework for the establishment of a grievance redress mechanism
- Guidelines for the development of supplementary, content specific plans including:
  - Construction Management Plan
  - Coal Dust Management Plan
  - Emergency Response Plan
  - Waste Management Plan
- Guidelines on how changes to the EMP and Project with be handled.

7.1 Institutional Framework for Implementation of EMP

Institutions responsible for executing and monitoring the environmental aspects of this Project are:

- The top management of SEL will be ultimately responsible to ensure that the EMP is implemented. For this purpose, SEL will develop and maintain internal institutional capacity for environmental management.
- Engineering, Procurement and Construction (EPC) and other contractors (the 'Contractors') will be primarily responsible for monitoring of the implementation of the EMP. EPC will monitor all activities of all contractors procured under the Project. As several contractors will be working simultaneously for timely and speedy implementation of the project, it is important that EPC has to effectively supervise and monitor the environmental activities being implemented in the field. The EPC is also responsible to update or make necessary changes to the EMP if required based on the revised designs and locations.
- Each contractor procured for this project will be responsible for implementation of the EMP to the extent that it applies to the contractor's area of work. Each contractor will be expected to have an environmental management system, preferably compliant with ISO 14001:2004 Environmental Management System (EMS) certification. The EPC contractor will be required to have one Environmental Specialist and one Occupational Health and Safety Specialist, who will be working in close coordination with the environmental staff of SEL.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 7.1**.

Exhibit 7.1: Roles and Responsibilities for Environmental Monitoring

Aspect	*SEL's Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Contracting	Ensuring that monitoring and mitigation requirements are included in the contract between SEL and the construction contractor(s).	Understanding the requirements and estimating the required resources	Contract between SEL and the contractor(s)
Monitoring plan	Ensuring finalization of monitoring plan and construction management plan before construction commences.	Prepare a construction management plan	Finalized Monitoring plan and Construction Management Plan
Resources	Ensuring availability of resources required for environmental monitoring	Ensuring availability of resources required for environmental monitoring	Project budgets

Aspect	SEL's Responsibilities	Contractor's Responsibilities	Relevant Documentation
Environmental staff	Designating an Environmental Manager for the project	Designating an Environmental Manager for the project (may be combined with health and safety)	Job descriptions
Monitoring surveys and inspections	Undertaking regular inspections and carrying out further measurements when necessary	Undertaking regular inspections and collecting data on environmental performance, and carry out surveys	Inspection and survey reports
Environmental audit	Conducting periodic audits of the construction site and commissioning third party audits	Conducting periodic internal audits	Audit reports
Reporting	Ensuring that periodic environmental monitoring reports are received from the construction contractor(s) and reviewing those reports	Producing environmental monitoring reports periodically and distributing those among the Owners management and appropriate staff members	Environmental monitoring reports
Corrective actions	Verifying that activities carried out comply with the ESIA/EMP and identifying corrective actions if needed	Carrying out corrective actions as required	Corrective action record
Maintenance of record	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Maintaining monitoring data and recording all incidents of environmental significance and related corrective measures	Environmental databases

7.2 Mitigation Plan

The environmental and social mitigation plan includes the following:

- The measures that are required to be implemented during the design, construction and implementation phases of the Project are identified
- For each mitigation measure the person responsible to implement and monitor the implementation is identified
- The timing to implement and the location to implement

Exhibit 7.2 shows mitigation plan for design, construction, operation and closure of the Project.

Exhibit 7.2: Mitigation Plan for Design, Construction, Operation and Closure of the Project

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
A. Design Phase				
Project Disclosure	Statutory compliance with Sindh Act 2014.	Submit ESIA to Sindh EPA and obtain approval.	Before start of construction	SEL
Stack Emissions	SO_2, NOx and PM emissions from the stack	Ensure that the following equipment are included in the project design: ▸ ESP (High efficiency 99.9%) to limit the total PM emissions ▸ Dry low NOx burners to minimize NOx generation ▸ Limestone injection to limit SO_2 emission ▸ Continuous stack emission monitoring equipment The equipment type and details may be changed as long as the objectives are met.	During design	Design Contractor, SEL
Plant Wastewater System	Pollution of soil and receiving water body; compliance with standards	Ensure that an appropriately sized evaporation pond is included in the design to receive all waste other than the cooling tower blowdown.	During design	SEL
		Ensure that the plant wastewater streams, in particular the cooling tower blowdown, boiler blowdown, floor washing, storm water runoff, and domestic waste, are designed in a manner that all waste streams are segregated.	During design	Design Contractor, SEL
		Ensure environmental friendly disposal of cooling tower blowdown by making arrangements with the GoS or alternate disposal scheme.	During design	SEL
		Ensure that the effluent disposal mechanism used has been approved by the SEPA.	During design	SEL
		Ensure that the effluent complies with the requirements of the waste water disposal scheme.	During design	Design Contractor, SEL

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
Hazardous waste	Unsafe handling of hazardous waste	Ensure that an appropriately sized hazardous waste handling facility is included in the power plant to handle low-volume hazardous waste such as batteries	During design	SEL
Land transformation	Surface disturbance for construction of infrastructure and topographic change	Avoid unnecessary disturbance of natural ground cover (e.g. prevent unnecessary off-road driving) and rehabilitate disturbed land (e.g. by rock cladding) as soon as possible to avoid erosion. Incorporate wind and water erosion control measures and dune management where necessary into project design. Require drainage facility designs to be adequately sized for expected storm events. Ensure maintenance of drainage systems.		
B. Construction and Implementation Phase				
Construction management	Construction activities although temporary can potentially have adverse impact on the environment.	Ensure that a detailed Construction Management Plan (CMP) based on the skeleton plan included in **Section 7.6.1** is developed	Before construction	Contractor
		Ensure that the CMP is implemented	During Construction	Contractor
C. Operation and Maintenance Phase				
Water and Effluent Waste				
Wastewater from plant	Pollution of receiving water bodies.	Complete segregation of wastewater streams to ensure that all streams other than the cooling tower blow down are routed to the evaporation pond Recycle wastewater as much as possible to conserve water	During operation	SEL
Storm Water	Typically storm water runoff contains suspended sediments and may contain metals and petroleum	Route the runoff to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for dust suppression system.	During operation	SEL

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
	hydrocarbons, if it includes water from operation area	Separate storm water from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge Install and maintain oil water separators and grease traps as appropriate at refueling facilities, workshops, parking areas, fuel storage and containment areas. Provide adequate storm drains along the boundary of the plant area and within the plant area to drain off the storm water during monsoon period. Keep limestone and gypsum storage areas covered so that there will be no contaminated runoff		
Wastewater from Housing Colony	Soil and receiving water body pollution	Treat the low-hazard colony wastewater (non-toilet wastewater or the gray water) and use it for sprinkling and for plantation purposes.	During operation	SEL
Fugitive Emissions				
Coal Storage Areas	Dust emissions	Provide dust extraction/suppression system at transfer points of conveyor system and ventilation system to supply fresh air; Roof extraction fans will be provided in essential areas like crusher house and boiler bunker floors. Provide water sprinkling system at material handling and storage yard; All roads within the plant shall be asphalted; and Develop greenbelt around the plant to arrest the fugitive emissions.	During operation	SEL
	Fire hazards from auto generated combustion	Limit the coal stockpile height to 15 meters and compact coal to avoid air passages to prevent self-combustion of coal.	During operation	SEL
Emissions from fuel		Periodically inspect mechanical seals in pumps; Maintain valves, flanges, joints, roof vents of storage tanks; and Ensure submerged filling of liquid fuel storage tanks.	During operation	SEL

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
Ash Disposal				
Fly ash	Dust emissions	The following strategies will be adopted: ▶ SEL may initiate a study to assess the feasibility of promoting the manufacturing of cement and brick blocks as a local industry ▶ In case such industry is developed, SEL will provide incentives such as making ash available without any payment, to the local manufacturers. ▶ Basic technology, as well as initial expert advice for using fly ash in making bricks and cement blocks, will be provided to local brick and cement block makers free of charge. ▶ Where feasible, SEL will use fly ash building materials in future construction to instill confidence in local people regarding fly ash building materials. ▶ All ash that is not utilized for brick and cement block manufacturing will be disposed of with the coal mine overburden.	During operation	SEL
Air and Noise pollution				
Air Pollution	Changes in ambient air quality due to stack emissions	Regularly monitor ambient air quality as recommended in the environmental monitoring plan (**Section 7.3.1**). Continuous emission monitoring (CEM) of emission from stack of coal-fired boilers	During operation	SEL
Noise pollution	Noise from the equipment	The following strategies will be adopted: ▶ Occupational noise exposure to workers in the form of 8–hourly time weighted average will be maintained well within the applicable NEQS limits. ▶ Acoustic enclosures will be provided wherever required to control the noise level.	During operation	SEL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation and Management Measures	When	Responsibility
		▶ Anywhere not possible technically to meet the required noise levels, personal protection equipment will be provided to the workers.		
Health and Safety				
Boilers	Higher exposure to electric and magnetic fields	The following strategies will be adopted: ▶ Train workers in the identification of occupational EMF/EMI levels and hazards. ▶ Establish and identify safety zones to differentiate between work areas with expected elevated EMF/EMI levels compared to those acceptable for public exposure, and limit access to properly trained workers. ▶ Implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations such as the International Commission on Non–Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE). Personal exposure monitoring equipment will be set to warn of exposure levels that are below occupational exposure reference levels (e.g., 50 percent). Action plans to address occupational exposure may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials. ▶ Identify potential exposure levels in the workplace, including surveys of exposure levels and the use of personal monitors during working activities.	During operation	SEL
	Heat Exposure	Provide adequate ventilation in work areas to reduce heat and humidity; Reduce the time required for work in elevated temperature environments and ensure access to drinking water;	During operation	SEL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation and Management Measures	When	Responsibility
		Regularly inspect and maintain pressure vessels and piping Shield surfaces where workers come in close contact with hot equipment, including generating equipment, pipes etc.; Use warning signs near high temperature surfaces and personal protective equipment (PPE) as appropriate, including insulated gloves and shoes.		
Socioeconomic Impacts				
Changes to society	Creation of job opportunities	The following strategies will be adopted: ▶ Develop policy and procedures for preferred employment for locals (from within the Study Area or within the Tharparkar District) and limiting employment of non-locals. ▶ In association with other community development programs, support local authorities in Mithi to increase their capacities to deliver services to an increased population. Determine the nature of support, which may include town planning, waste management and access to basic health care and education. ▶ Encourage local communities to use the grievance procedure for concerns related to deterioration of local services. ▶ Require the Project employment to be free of child and forced labor.	During design and planning and throughout construction and operation	SEL
Increase in local population	Unsanitary and congested living conditions in informal settlements Lack of potable water Malnutrition Lack of awareness about health prevention measures among in-migrants	▶ Develop and implement management policies for tuberculosis, diarrhea, malaria and other communicable diseases focusing on prevention, control, diagnosis and treatment in coordination with NGOs and local government. ▶ Provide health and hygiene education awareness programs to local communities, educational establishments and employees.	During design and planning and throughout construction and operation	SEL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation and Management Measures	When	Responsibility
Local culture	Increase in social ills in communities affected by in-migration of workers and job-seekers	▶ Require non-locals employed by the Project to adhere to a social 'code of conduct' in terms of relations with local communities. ▶ Provide employees and visitors to the site with cultural awareness training. ▶ Establish local CBOs and NGOs relating to women's issues.	During design and planning and throughout construction and operation	SEL
Economic growth and inflation	Unequal empowerment and reduced resilience amongst the vulnerable groups due to Project related economic activities	▶ Increase access to support equipment and training for specific jobs for disabled people. ▶ Increase access to support and training for specific jobs for vulnerable communities.	During design and planning and throughout construction and operation	SEL
		▶ Provide skill training for people lacking formal education either to access Project related jobs or to participate in alternative employment programs. ▶ Develop and implement a gender education program promoting participation of women in economic activities while protecting their dignity and culture. ▶ Through induction training, promote awareness of vulnerable groups and how they should be treated. ▶ Include provisions on a safe and enabling working environment for women workers in the human resource policies. ▶ In partnership with other developers in the area, develop a training program targeted at local people at or below the poverty line. ▶ Develop a program to create alternative employment initiatives aimed at local people at or below the poverty line. ▶ Encourage government and NGOs to assist economically poor in restoration and strengthening of their livelihood options.	During design and planning and throughout construction and operation	SEL

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
Conflict	Project actions leading to tension and discord in local communities	▶ Implement a local employment policy and community development program. ▶ Maintain regular communication with communities and other stakeholders to minimize tensions arising from Project activities. ▶ Establish a Grievance Redress Committee, and encourage and facilitate stakeholders to use the mechanism to express concerns. ▶ Provide sufficient resources to the community development program to enable them to monitor negative perceptions and associated tensions, and to address them in a timely fashion. ▶ Establish a community based monitoring and evaluation strategy to monitor the potential impacts on communities, especially those to be relocated. ▶ Consider vulnerable groups for alternative livelihood opportunities arising due to the Project.	During construction and operation	SEL
Local employees	Skills development and capacity building of potential local employees	▶ Establish a baseline to assess levels of literacy and skills and to determine local interest in literacy and vocational training to complement existing skills. ▶ Support the establishment of a 'feeder program' providing basic literacy, health & safety and personal life skills for potential candidates of unskilled positions. ▶ Prepare and implement a training and skills development plan for the Project workforce. ▶ Support a 'vocational training program' to assist local people to qualify for semi-skilled positions. ▶ Create technical training opportunities/programs for local communities according to technological needs and provision of employment after completion of training.	During detailed design and planning Throughout construction and operation	SEL

7.3 Monitoring, Reporting and Feedback

Environmental monitoring is a vital component of an EMP. It is the mechanism through which the effectiveness of the EMP is gauged. The feedback provided by environmental monitoring is instrumental in identifying any problems and planning corrective actions.

7.3.1 Monitoring Plan

Monitoring of environmental components and mitigation measures during implementation and operation stages is a key component of the EMP to safeguard the protection of environment. The objectives of the monitoring are to:

1. Monitor changes in the environment during various stages of the project life cycle with respect to baseline conditions.
2. Manage environmental issues arising from construction works through closely monitoring the environmental compliances.

A monitoring mechanism is developed for each identified impact and it includes:

- Location of the monitoring (near the Project activity, sensitive receptors or within the Project influence area)
- Means of monitoring, i.e. parameters of monitoring and methods of monitoring (visual inspection, consultations, interviews, surveys, field measurements, or sampling and analysis)
- Frequency of monitoring (daily, weekly, monthly, seasonally, annually or during implementation of a particular activity)

The monitoring program will also include regular monitoring of construction and operation activities for their compliance with the environmental requirements as per relevant standards, specifications and EMP. The purpose of such monitoring is to assess the performance of the undertaken mitigation measures and to immediately formulate additional mitigation measures and/or modify the existing ones aimed at meeting the environmental compliance as appropriate during construction.

The proposed monitoring plan is provided in **Exhibit 7.3**.

Exhibit 7.3: Environmental Monitoring Plan during Construction and Operation

Aspect	*Location*	*What to monitor*	*Frequency*	*Responsibility*	*Trigger for Corrective Action*
Hydrocarbon and chemical spill	Construction camps and storage sites	Visual Inspection of storage facilities	Monthly	Contractor	Evidence of spills
Air Quality	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (spraying of waters) are in place.	Daily	Contractor	Evidence of non-compliance
	Villages of Bitra, Saleh Jhanji, Jaman Samo and Aban Jo Tar and one reference site	Air quality monitoring (Total PM, PM_{10}, $PM_{2.5}$, NO_X, SO_2)	Annually, starting as early as possible before construction One continuous monitoring station	SEL	SEQS (for gases) and baseline value as given in the ESIA and any data collected before start of construction
Noise	Construction sites	Visual inspection to ensure good standard equipment are in use	Weekly	Contractor	Evidence of non-compliance
	Village of Bitra and one reference site	Hourly, day and night time noise levels (dB) monitoring using noise meters	Annually, starting as early as possible before construction	SEL	NEQS and baseline value based on data collected before start of construction
Waste Management	Construction camps and construction sites	Visual inspection that solid waste is disposed at designated site	Monthly	Contractor	Evidence of non-compliance
Drinking water and sanitation	In construction sites and construction camps	Ensure the construction workers are provided with safe water and sanitation facilities in the site	Monthly	Contractor	Evidence of non-compliance
Reinstatement of Work sites	All work sites	Visual Inspection	After completion of all works	SEL	Evidence of non-compliance

Aspect	Location	What to monitor	Frequency	Responsibility	Trigger for Corrective Action
Safety of workers	At work sites	Usage of Personal Protective equipment	Monthly	Contractor	Evidence of non-compliance
Wastewater	After waste water treatment and at the final disposal point	Parameters in NEQS (only those which are likely to exceed)	Annually	SEL	NEQS
Stack Emissions	Boiler stack	Continuous monitoring of SO_2, NOx, and PM.	Continuous	SEL	NEQS to the extent applicable
Groundwater	All wells in the village of Bitra	Water level and TDS	Monthly	SEL	More than 10% change in water level or TDS as compared to seasonal average
Employment	All hiring undertaken directly by SEL or its contractors	Domicile, age, qualifications and salary of all employees in management, technical, skilled and unskilled category	Quarterly	SEL	Non-compliance with the employment policy
Grievance	Villages in the Study Area	Nature and frequency of grievances and time taken to address them	Quarterly	SEL	Increase in number of grievances or delay in addressing them
Hydrocarbon and chemical storage	Storage area	Visual Inspection of storage facilities	Monthly	Contractor and SEL	Spills and leakages
Traffic Safety	Haul Roads	Visual inspection to see whether proper traffic signs are placed and flagmen for traffic management are engaged	Monthly	Contractor and SEL	Lack of facilities
Coal and fly ash specifications	–	Heavy metals (Mainly As, Be, Cd, Cr, Pb, Hg, and Ni)	Quarterly	SEL through recognized laboratory	More than 10% increase over baseline
GHG emission	Stacks	Monitoring of flue gases flow and carbon content	Once in 6 months	SEL	–

7.3.2 Reporting and Feedback Mechanism

The EPC Contractor will prepare a 'Construction Management Plan' (CMP) demonstrating the manner in which they will comply with the requirements of mitigation measures proposed in the EMP of the ESIA Report. The CMP will form the part of the contract documents and will be used as monitoring tool for compliance. Violation of the compliance requirements will be treated as non–compliance leading to the corrections or otherwise imposing penalty on the contractors

EPC Contractor, through the environmental specialist on the team, will prepare periodic (not more once every three months) status reports on the EMP implementation. Such reports will carry information on the main types of activities carried out within the reporting period, status of any clearances/permits/licenses which are required for carrying out such activities, mitigation measures applied, and any environmental issues emerged in relations with suppliers, local authorities, affected communities.

The EPC Contractor's reports will be based on reports prepared by various subcontractors and their own monitoring and supervision. EPC Contractor shall assess how accurate is the factual information provided in the contractor's reports, fill any gaps identified in them, and evaluate adequacy of mitigation measures applied by subcontractor. EPC Contractor must highlight any cases of incompliance with EMPs, inform on any acute issues brought up by contractor or revealed by supervisor himself, and propose corrective actions.

After completion of EPC Contractor's contract, SEL will be in charge of the operation and maintenance of the Project. HSE Department of SEL will be responsible for compliance with the monitoring plan during operations.

Feedback and adjustment will be carried out in two tiers. Upon request for EMP modification by the Subcontractor, EPC Contractor and SEL will review the proposals in detail and consider their acceptance or rejection. Primarily, only those modifications will be considered, which do not contravene the conditions of the environmental approval from SEPA. SEL will consider the recommendations of the EPC Contractor but it will be the final authority on approval of the change. It may decide to undertake studies before approval of the change.

7.3.3 Meetings

An effective mechanism to communicate and record environmental information during the Project is an essential requirement of an EMP.

Two kinds of environmental meetings will take place during the project:

- Kick-off meetings
- Fortnightly meetings

The purpose of the kick-off meeting will be to present the EMP to project staff and discuss its implementation.

A fortnightly meeting will be held during construction phase at site. The purpose of this meeting will be to discuss the environmental issues and their management. The proceedings of the meeting, the required action, and responsibilities will be recorded in the form of a brief report.

7.3.4 Change-Record Register

A change-record register will be maintained at the site, in order to document any changes in EMP and procedures related to changes in the project design, construction plan or external environmental changes affecting the EMP. These changes will be handled through the change management mechanism discussed later in this chapter.

7.4 Training

Environmental training will help to ensure that the requirements of the environmental assessment and EMP are clearly understood and followed by all project personnel in the course of the project. SEL will initiate a training program to ensure that its employees and that of its contractors have the required knowledge and skill to manage the environmental aspects of their respective jobs. The proposed environmental trainings listed in **Exhibit 7.4**, which will be finalized before the commencement of the project.

Exhibit 7.4: Proposed Environmental Trainings

	Type of Training	*Personnel to be Trained*	*Training Description*
1	Occupational Health and Safety	EHS Manager Plant managers and supervisors	Awareness to conform to safety codes. Mandatory use of PPE by the senior administration during all plant visits
2	Occupational Health and Safety	Workers Staff	Health, safety and hygiene Proper usage of personnel protective gear Precautions to be taken for working in confined areas.
3	Health, Safety and Environmental Auditing	Staff responsible for inspection/audits	Procedures to carry out Health, Safety and Environmental Audits Reporting requirements
4	Waste Disposal and Handling	Relevant Workers Relevant Staff	Segregation, identification of hazardous waste, use of PPEs, waste handling
5	Social & Environmental laws & regulations, norms, procedures and guidelines of Government	EHS staff Plant managers and supervisors	Environmental standards and their compliance
6	Implementation of environmental management and monitoring plant	EHS staff Responsible supervisory staff Management	Concepts of environmental management and monitoring plan
7	Defensive driving	All drivers and their supervisors	Safe driving and handling of equipment

7.5 Grievance Redress Mechanism

Timely and effective redress of stakeholder grievances contribute to bringing sustainability in the operations of a project. In particular, it will help advocate the process of forming and strengthening relationships between project management and the stakeholder community groups and bridge any gaps to create a common understanding, providing the project management the 'social license' to operate in the area. The grievance redress mechanism proposed for the Project will help achieve the objectives of sustainability and cooperation by dealing with the environmental and social issues of the Project.

The proposed grievance redress mechanism will be designed to cater for the issues of the people that can be affected by the Project. The population that can be affected by the Project is identified include primarily the villages in the Study Area, which are described in **Chapter 4**. However, it can extend other stakeholders. The potential impacts of the Project are described in **Chapter 6**.

7.5.1 Regulatory Requirement for Grievance Redress Mechanism

The Pakistan EPA, under Regulation 6 of the IEE-EIA Regulations 2000, has issued a set of guidelines of general applicability and sectoral guidelines indicating specific assessment requirements. Under the regulations and guidelines, no specific requirements are laid out for developing a grievance redress mechanism for projects. However, under its Guidelines for Public Consultation, 1997, the proponents are required to consult stakeholders during the implementation phase of the project. In this regards, it is stated that the representatives of local community partake in the monitoring process to ensure a stable relationship between the project management and the community.

7.5.2 Framework for Grievance Redress Mechanism

Under the Project the following will be established or appointed to ensure timely and effective handling of grievances:

- A Public Complaints Unit (PCU), which will be responsible to receive, log, and resolve complaints; and,
- Grievance Focal Points (GFPs), which will be educated people from each community that can be approached by the community members for their grievances against the Project. The GFPs will be provided training by the Project in facilitating grievance redress.

PCU will be set up under SEL corporate structure. A senior official with experience in community and public liaison will lead the unit. Two assistants, one male and one female will be responsible for coordinating correspondence and preparing documentation work and will assist the senior official. The senior official will be responsible to review all documentation.

The PCU will be responsible to receive, log, and resolve grievances. Given that the female community members have restricted mobility outside of their villages and homes, the female PCU staff will be required to undertake visits to the local communities. The frequency of visits will depend on the nature and magnitude of activity in an area and the frequency of grievances.

The GFPs will be literate people from each community that will facilitate their community members in reporting grievances from the Project. The GFPs will be provided training by the Project in facilitating grievance redress. Each community will have a male and female GFP appointed for this purpose.

7.5.3 Operating Principles for PCU

The PCU will operate on the principles of transparency, approachability and accountability. To achieve these, the PCU will be required to:

- Be equipped to handle grievances in the local languages;
- Be equipped to work through all possible modes of communication, such as, emails, by-post and face-to-face meetings at plant site or requiring visits;
- Employ female staff, preferably from the nearby communities, to oversee complaints and issues of the female community members.
- Maintain a log of all grievances, with record of the date and time of the complaint logged and stakeholder information, such as, name, designation and contact details;
- Provide opportunity to the stakeholder to revert with their comments on the proposed plan of action;
- Keep the stakeholder informed of the progress in grievance resolution;
- Obtain stakeholder consent on the mechanism proposed to redress the grievance and document consent; and,
- Maintain confidentiality of the stakeholder, if requested so.

7.5.4 Stakeholder Awareness

The stakeholders will be informed of the establishment of the PCU through an awareness campaign. Under the awareness campaign, the proponent will share:

- Objective, function and the responsibilities of the PCU;
- Means of accessing the PCU and the mechanics of registering a grievance at the PCU;
- Operating principles of the PCU; and,
- Contact details.

Additional awareness campaigns may be organized, if necessary.

7.6 Guidelines for Supporting Plans

Specific management plans, for areas of concern, will be developed by SEL or contractors as specified. The framework, outline and requirements for each plan is discussed in this section.

7.6.1 Construction Management Plan

Every contractor will develop a specific construction management plan (CMP) based on the conceptual CMP shown in the **Exhibit 7.5**. The CMP will be submitted to the SEL for approval before start of construction activities.

Exhibit 7.5: Construction Environmental Management Plan

Aspect	*Objective*	*Mitigation and Management Measure*
Planning	Clearly identify all areas that will be utilized during construction	Clearly identify all areas that will be utilized during construction. These include, but are not limited to the camp site, storage areas for raw material and equipment, waste yard, storage areas for potentially hazardous material such as oil, parking area, loading and unloading of material, septic tanks, housing and construction camp, fuel storage and pipelines, and access routes
Vegetation clearance	Minimize vegetation clearance and felling of trees	▶ Removal of trees should be restricted to the development footprint. ▶ Construction activities shall minimize the loss or disturbance of vegetation ▶ Use clear areas to avoid felling of trees ▶ A procedure shall be prepared to manage vegetation removal, clearance and reuse ▶ Inform the plant management before clearing trees ▶ Cleared areas will be re-vegetated
Poaching	Avoid illegal poaching	▶ Contractual obligation to avoid illegal poaching ▶ Provide adequate knowledge to the workers relevant government regulations and punishments for illegal poaching
Discharge from construction sites	▶ Minimize surface and ground water contamination ▶ Reduce contaminant and sediment load discharged into water bodies affecting humans and aquatic life	▶ Install temporary drainage works (channels and bunds) in areas required for sediment and erosion control and around storage areas for construction materials ▶ Prevent all solid and liquid wastes entering waterways by collecting waste where possible and transport to approved waste disposal site or recycling depot ▶ Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Avoid sediment and contaminant loading of surface water bodies and agricultural lands.	▶ Minimize the length of time an area is left disturbed or exposed. ▶ Reduce length of slope of runoff ▶ Construct temporary cutoff drains across excavated area ▶ Setup check dams along catch drains in order to slow flow and capture sediment

Aspect	*Objective*	*Mitigation and Management Measure*
		▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds) ▶ All the work sites (except permanently occupied by the plant and supporting facilities) should be reinstated to its initial conditions (relief, topsoil, vegetation cover).
Excavation, earth works, and construction yards	Proper drainage of rainwater and wastewater to avoid water and soil contamination.	▶ Prepare a program to prevent standing waters, which SEL will verify in advance and confirm during implementation ▶ Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there
Ponding of water	Prevent mosquito breeding	▶ Do not allow ponding of water especially near the waste storage areas and construction camps ▶ Discard all the storage containers that are capable of storing of water, after use or store them in inverted position ▶ Reinstate relief and landscape.
Storage of hazardous and toxic chemicals	Prevent spillage of hazardous and toxic chemicals	▶ Implement waste management plans ▶ Construct appropriate spill containment facilities for all fuel storage areas ▶ Remediate the contaminated land using the most appropriate available method to achieve required commercial/industrial guideline validation results
Land clearing	Preserve fertile top soils enriched with nutrients required for plant growth or agricultural development.	▶ Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2 m and with a slope of 1:2 ▶ Spread the topsoil to maintain the physio–chemical and biological activity of the soil. ▶ The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites ▶ Topsoil stockpiles will be monitored and should any adverse conditions be identified corrective actions will include: ▷ Anaerobic conditions – turning the stockpile or creating ventilation holes through the stockpile; ▷ Erosion – temporary protective silt fencing will be erected;

Aspect	*Objective*	*Mitigation and Management Measure*
	Avoid change in local topography and disturb the natural rainwater/ flood water drainage	▶ Ensure the topography of the final surface of all raised lands are conducive to enhance natural draining of rainwater/flood water; ▶ Reinstate the natural landscape of the ancillary construction sites after completion of works
Construction vehicular traffic	Control vehicle exhaust emissions and combustion of fuels.	▶ Use vehicles with appropriate exhaust systems and emission control devices. ▶ Establish and enforce vehicle speed limits to minimize dust generation ▶ Cover haul vehicles carrying dusty materials (cement, borrow and quarry) moving outside the construction site ▶ Level loads of haul trucks travelling to and from the site to avoid spillage ▶ Use of defined haulage routes and reduce vehicle speed where required. ▶ Transport materials to site in off peak hours. ▶ Regular maintenance of all vehicles ▶ All vehicle exit points from the construction site shall have a wash-down area where mud and earth can be removed from a vehicle before it enters the public road system.
	Minimize nuisance due to noise	▶ Maintain all vehicles in good working order ▶ Make sure all drivers comply with the traffic codes concerning maximum speed limit, driving hours, etc.
	Avoid impact on existing traffic conditions	▶ Prepare and submit a traffic management plan ▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions.
	Prevent accidents and spillage of fuels and chemicals	▶ Restrict the transport of oversize loads. ▶ Operate transport vehicles, if possible, in non–peak periods to minimize traffic disruptions. ▶ Design and implement safety measures and an emergency response plan to contain damages from accidental spills. ▶ Designate special routes for hazardous materials transport.

Aspect	Objective	Mitigation and Management Measure
Construction machinery	Prevent impact on air quality from emissions	▶ Use machinery with appropriate exhaust systems and emission control devices. ▶ Regular maintenance of all construction machinery ▶ Provide filtering systems, duct collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages
	Reduce impact of noise and vibration on the surrounding	▶ Appropriately site all noise generating activities to avoid noise pollution to local residents. ▶ Ensure all equipment is in good repair and operated in correct manner. ▶ Install high efficiency mufflers to construction equipment. ▶ Operators of noisy equipment or any other workers in the vicinity of excessively noisy equipment are to be provided with ear protection equipment ▶ The project shall include reasonable actions to ensure that construction works do not result in vibration that could damage property adjacent to the works.
Construction activities	Minimize dust generation	▶ Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. ▶ Increase the watering frequency during periods of high risk (e.g. high winds). ▶ Stored materials such as gravel and sand should be covered and confined ▶ Locate stockpiles away from sensitive receptors
	Reduce impact of noise and vibration on the surrounding	▶ Notify adjacent landholders or residents prior to noise events during night hours ▶ Install temporary noise control barriers where appropriate ▶ Avoid working during 21:00 to 06:00 within 500m from residences.
	Minimize impact on water quality	▶ Stockpiles of potential water pollutants (i.e. bitumen, oils, construction materials, fuel, etc.) shall be locate so as to minimize the potential of contaminants to enter local watercourses or storm-water drainage.
		▶ Storm-water runoff from all fuel and oil storage areas, workshop, and vehicle parking areas is to be directed into an oil and water separator before being discharged to any watercourse. ▶ Prepare an Emergency Spills Contingency Plan shall be prepared.

Aspect	Objective	Mitigation and Management Measure
Siting and location of construction camps	Minimize impact from construction footprint	▶ Arrange accommodation in local towns for small workforce ▶ Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view.
Construction Camp Facilities	Minimize pressure on local services	▶ Adequate housing for all workers ▶ Safe and reliable water supply. ▶ Hygienic sanitary facilities and sewerage system. ▶ Treatment facilities for sewerage of toilet and domestic wastes ▶ Storm water drainage facilities. ▶ In–house community entertainment facilities.
Disposal of waste	Minimize impacts on the environment	▶ Ensure proper collection and disposal of solid wastes in the approved disposal sites ▶ Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. ▶ Establish waste collection, transportation and disposal systems ▶ Ensure that materials with the potential to cause land and water contamination or odor problems are not disposed of on the site. ▶ Ensure that all on-site wastes are suitably contained and prevented from escaping into neighboring fields, properties, and waterways, and the waste contained does not contaminate soil, surface or groundwater or create unpleasant odors for neighbors and workers.
Fuel supplies for cooking purposes	Discourage illegal fuel wood consumption	▶ Provide fuel to the construction camps for domestic purpose ▶ Conduct awareness campaigns to educate workers on preserving the protecting the biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Site Restoration	Restoration of the construction camps to original condition	▶ Restore the site to its condition prior to commencement of the works

Aspect	*Objective*	*Mitigation and Management Measure*
Construction activities near religious and cultural sites	Avoid disturbance to cultural and religious sites	▶ Stop work immediately and notify the site manager if, during construction, an archaeological or burial site is discovered. ▶ It is an offence to recommence work in the vicinity of the site until approval to continue is given by the plant management. ▶ Maintain appropriate behavior with all construction workers especially women and elderly people ▶ Resolve cultural issues in consultation with local leaders and supervision consultants
Best practices	Minimize health and safety risks	▶ Implement suitable safety standards for all workers and site visitors which should not be less than those laid down on the international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own national standards or statutory regulations, ▶ Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas, ▶ Provide personal protection equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. ▶ Maintain the PPE properly by cleaning dirty ones and replacing them with the damaged ones.
Water and sanitation facilities at the construction sites	Improve workers' personal hygiene	▶ Provide portable toilets at the construction sites and drinking water facilities. ▶ Portable toilets should be cleaned once a day. ▶ All the sewerage should be pumped from the collection tank once a day into the common septic tank for further treatment.

7.6.2 Coal Dust Management Plan

The coal dust suppression system will be designed during detail design stage. The following is a general description of the system.

Coal dusts from coal stockpile and coal conveyor belt area are the major source of fugitive emissions. Dust suppression using a sprinkler system will be primarily employed to control the coal dust from these areas. Recycled water from the waste water treatment plants and cooling water blow down will be the primary source of water to the sprinkler system.

Coal dust suppression will comprise wetting air–borne dust particles with a fine spray of water, causing the dust particles to agglomerate and move by gravity to the coal stream flow. Once properly wetted, the dust particles will remain wet for some period and will not tend to become airborne again. The dust suppression system in the stockpile yard will consist of swiveling and wide–angle full–cone spray nozzles. These nozzles will be provided on both sides of the pile and at ground level, spaced every 50 m. Ventilation slots are proposed in the top portion of the raw coal bunkers, allowing coal fed into the bunkers to displace any gases that may have formed as a result of resident coal.

In addition coal dust extraction system may also be employed. In this system, dust is extracted from operations area that generates dust in large quantities such as screening, loading and unloading.

Rainfall runoff from the coal pile and runoff from the application of dust suppression sprays will contain mainly suspended solids. This runoff will be routed to the settling basin for retention and settling of suspended solids, and the clear water from there may be used for the dust suppression system.

7.6.3 Emergency Response Plans

SEL will prepare an emergency response for natural and human-made emergencies.

Spill Prevention and Mitigation Plan

Liquid waste spills that are not appropriately managed have the potential to harm the environment. By taking certain actions, the likelihood of spills can be reduced and their effect minimized.

To avoid spills and to help the cleanup process of any spills, the EPC contractors and the management and staff of SEL should be aware of spill procedures. By formalizing these procedures in writing, staff members can refer to them when required thus avoiding undertaking incorrect spill procedures.

A detailed spill management plan will be prepared for the construction phase. A plan will also be developed for specific areas during plant operation. These plans will contain the following:

- Identification of potential sources of spill and the characterization of spill material and associated hazards.
- Risk assessment (likely magnitude and consequences)

- Steps to be undertaken taken when a spill occurs (stop, contain, report, clean up and record).
- A map showing the locations of spill kits or other cleaning equipment.

Fire Emergency Response Plan

A firefighting system will be installed with a standard operating procedure considering the potential fire from the sparks in coal storage and handling.

Other Emergencies

Response plans for other emergencies, including but not limited to the following, will also be developed:

- Vehicle accident
- Earthquake
- Heavy downpour and consequent flooding
- Electrical hazards
- Equipment Failure

7.7 Change Management

An environmental assessment of the proposed project has been made on the basis of the project description available at the time the environmental assessment report was prepared. However, it is possible that changes in project design may be required at the time of project implementation. This section describes the mechanism that will be put into place to manage changes that might affect the project's environmental impacts.

Potential changes in project design have been categorized as first-order, second-order, and third-order changes. These are defined below.

First Order: A first-order change is one that leads to a significant departure from the project described in the environmental assessment report and consequently requires a reassessment of the environmental impacts associated with the change.

In such an instance, the environmental impacts of the proposed change will be reassessed, and the results sent to the Sindh EPA for approval.

Second Order: A second-order change is one that entails project activities not significantly different from those described in the environmental assessment report, and which may result in project impacts whose overall magnitude would be similar to the assessment made in this report.

In case of such changes, the environmental impact of the activity will be reassessed, additional mitigation measures specified if necessary, and the changes reported to the Sindh EPA, at least a month before undertaking the change

Third Order: A third-order change is one that is of little consequence to the environmental assessment reports' findings. This type of change does not result in impact levels exceeding those already discussed in the environmental assessment; rather these may be made onsite to minimize the impact of an activity. The only action required in this case will be to record the change in the change record register.

To illustrate the magnitude of changes within these orders, examples are presented in **Exhibit 7.6**. The types of changes presented encompass a range of scenarios for illustration purposes only, and by no means reflect any intention on the part of SEL to make these changes. The list is also not meant to be comprehensive, ie, inclusive of all possible changes that may potentially take place in the design or operation of the plant as described in the ESIA. For any change not described in **Exhibit 7.6**, the definition of the first, second, and third order changes will be used to determine its category.

Exhibit 7.6: Generic Examples of Changes in the Project Design

Change	*First Order*	*Second Order*	*Third Order*
Power plant location	Relocated such that the villages in the area of influence change	Relocated such that the villages in the area of influence do not change	
Power plant capacity	If increased significantly (for example, by more than 33%) from the proposed capacity.	If increased but not significantly (for example, by more than 20% but less than 33%) from the proposed capacity.	If increased by a small amount (for example, by less than 20%) from the proposed capacity.
Technology	A different technology or process for power generation resulting in altogether different environmental impacts.	A different technology or process for power generation, resulting in environmental impacts of similar nature or magnitude.	

7.7.1 Changes to the EMP

Changes in project design may necessitate changes in the EMP. In this case, the following actions will be taken:

- A meeting will be held between SEL and the contractor representatives, to discuss and agree upon the proposed addition to the EMP
- Based on the discussion during the meeting, a change report will be produced collectively, which will include the additional EMP clause and the reasons for its addition
- A copy of the report will be sent to the head offices of SEL and the contractor
- All relevant project personnel will be informed of the change

8. Conclusion

The proposed Project entails the construction of a 330 MW coal power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

The findings of the study indicate that the Project will have positive impacts on the socioeconomic environment through increased electricity generation, direct and in-direct employment generation; and, increased business opportunities.

Major potential impacts of the Project are associated with air quality and changes to the socioeconomic environment. However, if the field activities, including the implementation of all mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (**Chapter 7**), are carried out as described in this report, the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Chapter 2** of this report.

A cumulative impact assessment of expected projects near the Project area is also presented. Cumulative impacts should be addressed collectively by all developers in the area.

Annexure J

Feasibility Study

FEASIBILITY STUDY
OF 1x330 MW POWER PROJECT AT THAR BLOCK II

Prepared By:

Siddiqsons Energy ltd.

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1. Introduction of Project

1.1. Objective of the study

The Project is being developed under the Power Policy for investment in Power Projects in Pakistan for which a detailed Feasibility study is to be completed as a pre-requisite of PPIB.

This would also serve as a base line document for project development and execution, as this feasibility study is sought to be a BANKABLE FEASIBILITY STUDY, which would affirm the investor confidence in this power project

Specifically the objective of this study is to investigate in principle the feasibility of 330 MW lignite fired power plant based on Thar coal at Thar Block II. The feasibility will consider the requirements , considerations & limitations required for a mine mouth Coal Fired Power Project

The investigation and evaluation of suitable power -plant configurations shall focus on following areas:

- Site & Site conditions
- Description of Plant size and technology selection
- Technical description of proposed plant and equipment
- Review of Available infrastructure
- Review of Resources and its Utilization.
- Plant Mechanical /Electrical / Instrumentation and control System
- Civil Scope of the project
- Assessment of Environmental Impact.
- Financial and Economic feasibility.
- Cost estimates and financial analysis
- Project implementation and scheduling
- Risk analysis
- Recommendations and conclusions.

1.2 Project Background and Letter of Intent

Pakistan has lignite reserves of around 186 Bt. With these huge reserves Pakistan is at the 7th place amongst the lignite (coal) rich countries of the world. The biggest parts are located at Thar-parkar District in south-eastern province of Sindh, where about 176 Bt of total lignite (95%) has been explored. The extension of entire lignite bearing area is about 9100 km2. The Thar lignite is recognized as a major energy source, which has the potential to support the energy production from indigenous resource substantially. The Government of Pakistan (GoP), Government of Sindh (GoS) and Sindh Engro Coal Mining Company (SECMC) have undertaken enormous efforts to increase the lignite production considerably to accelerate industrialization and improvement in the standard of living of a common Pakistani. Lignite throughout the world is mostly used for mine mouth power generation. The GoS and SECMC intended to use parts of the huge lignite reserves of the Thar desert area in a first step to produce energy with 1200 MW mine mouth Power Plant.

As part of the SECMC expansion plan, the current capacity of mine i.e. 3.8 Million ton/ annum will be expanded to upto ~ 19 Mt/a – which will be able to satisfy the requirements of ~ 3000 MW Power plants based on Thar lignite.

Siddiqsons energy limited has already received a Letter Of Support from PPIB for the development & execution of 330 MW Power Project.

1.3. Current Power Sector Situation

For Some recent years Pakistan is facing acute energy crisis, the produced energy is by far not matching with the national demand. Within 2015-2016 shortages from 4000 MW to 6000 MW were registered. The lack for industrial as well as for domestic provision is expected to increase further within the coming years.

A right foot in this direction, Pakistan is developing various projects under CPEC (China Pakistan Economic Corridor) which not only brings an infra-structure network in Pakistan but also solution to its Energy Problems

As bulk of the CPEC funding is directed towards energy projects (~ USD 34mn out of total of USD 45mn), the primary focus of our economic analysis presented below is on Energy Projects. Infrastructure projects are discussed briefly below but owing to their smaller share in CPEC funding and lack of sufficient details available on these projects on government/public-sector website, the scope of their discussion is limited. Towards the end of the section, a detailed analysis of CPEC's impact on country's Key Economic Indicator's is presented.

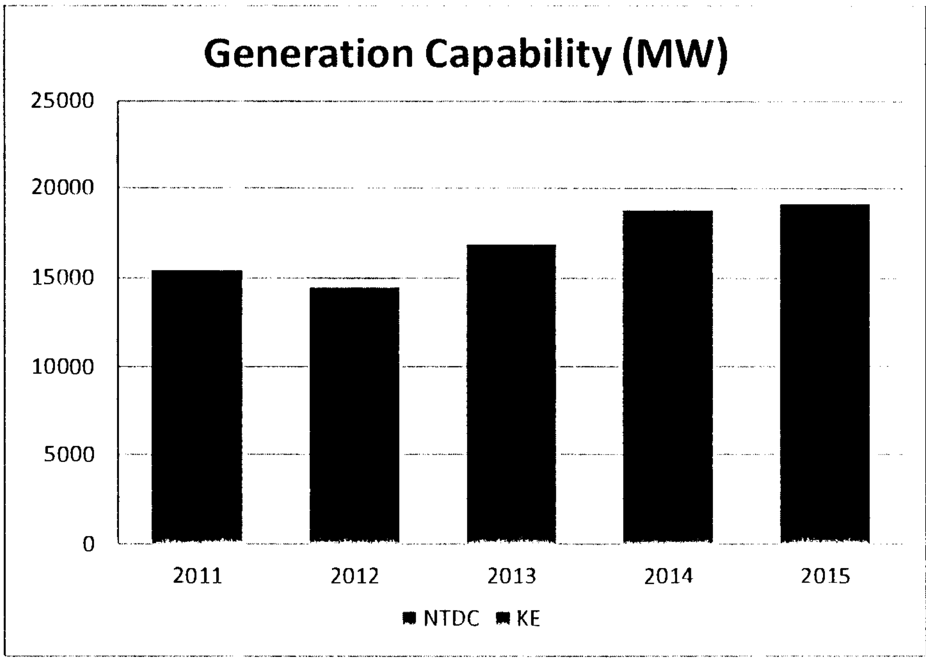
1.3.1 Energy Projects under development & Power Sector Situation:

Affordable power is one of the key elements required for socio-economic development of a country. Severe shortage of electricity has been a major impediment in achieving economic stability and sustainable growth for Pakistan.

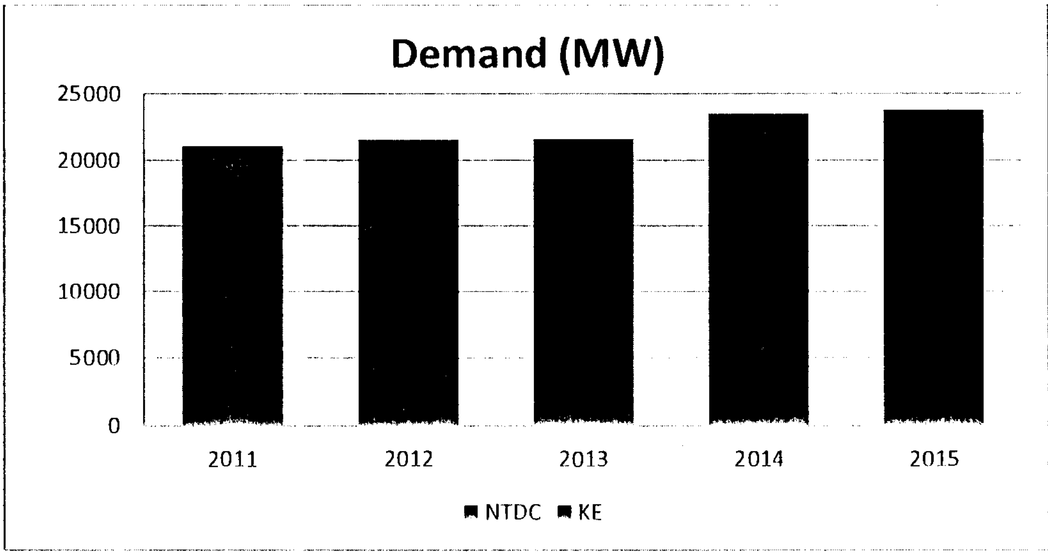
There has been a continuous increase in the demand of Power, while the sources supplying it have remained constrained. For years, a gap in demand and supply of power (up to 6000 MW in Peak times) has been existent. Furthermore, Power Sector is heavily reliant on expensive imported fuels (such as RFO, Diesel etc.) resulting in expensive power generation which requires subsidies from the Government, giving rise to Circular Debt. Circular debt further intensifies the problem of demand & supply, wherein the power generation capability is constrained due to fuel unavailability. It is the need of the hour to install more power plants on affordable and indigenous sources of energy.

Another reason for the gloomy situation of the Power sector has been high transmission losses on the national grid & transmission network. According to an estimate of World Bank (thorough World Bank development indicator) the losses are up to 23% which are expected to further increase unless appropriate measures are taken for the maintenance of the transmission line & countering pilfering.

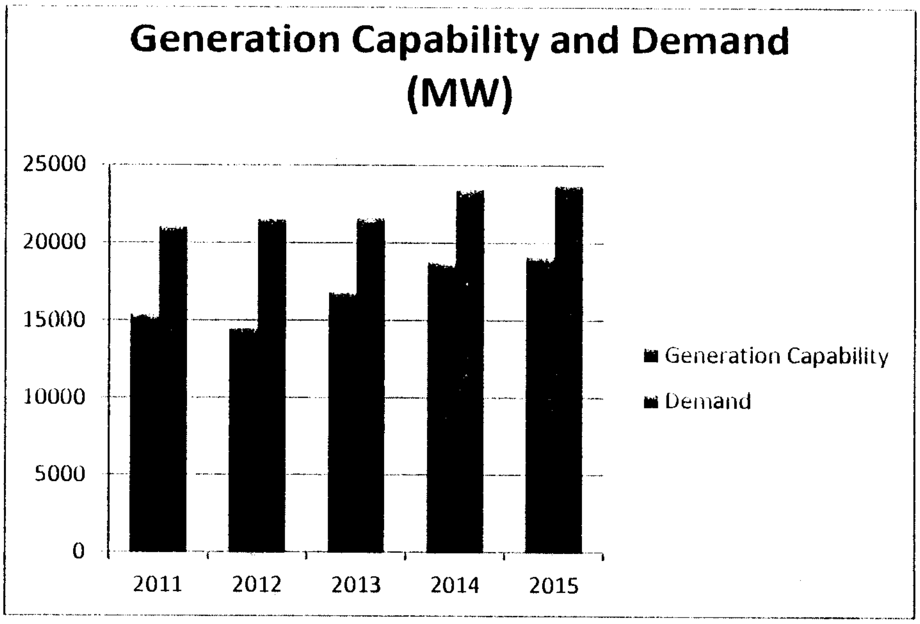
The following figures explore the Demand and Generation Capabilities of the country.



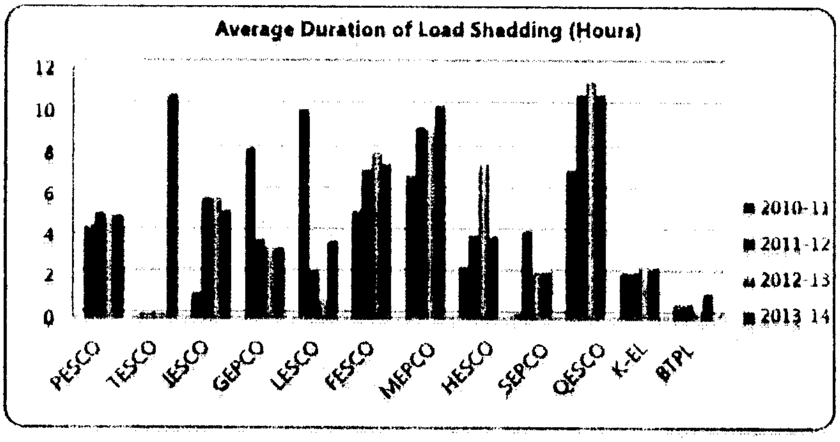
Source: NEPRA State of Industry Report



Source: NEPRA State of Industry Report



Source: NEPRA State of Industry Report



Source: NEPRA State of Industry Report

A report by Dawn estimates that the Chronic power shortages, in the form of load-shedding and power outages, cost the Pakistan economy USD 14bn (7pc of GDP) last year.[1]

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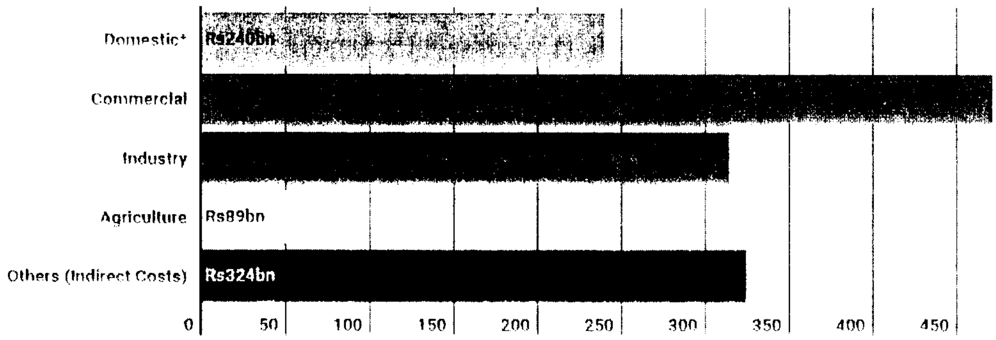
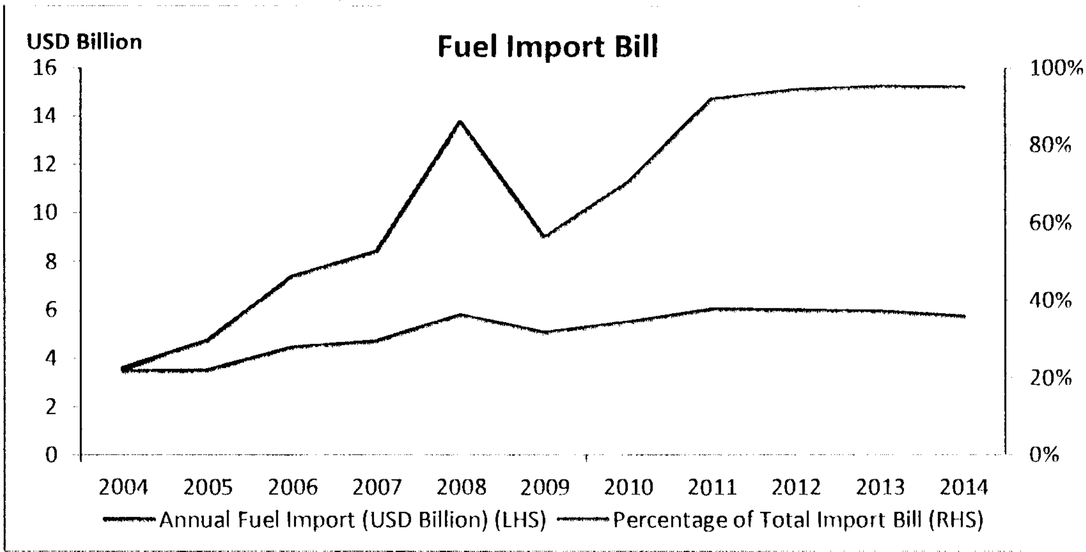
[1] http://www.dawn.com/news/1275116

Cost of power outages by sector



Source: DAWN News

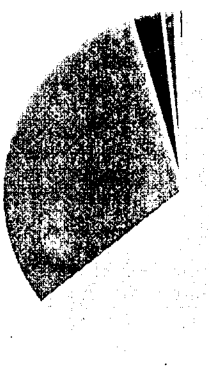
Another major challenge is that a significant portion of the import bill of Pakistan is dedicated to fuel Import (mainly crude oil). Oil consumption over the past 6 years has grown at a CAGR of 2.4% while Gas, Coal & Hydel have grown at an average CAGR of 0.3%. Growing import bill (as shown below), coupled with devaluation of PKR, has put enormous pressure on our foreign exchange reserves.



Source: NEPRA State of Industry Report

Energy mix of Pakistan (incl. the Power Sector & other industrial/ domestic sectors) is dominated by Gas & Oil while Hydel is third most relied source of energy.

Pakistan Current Energy Mix (by installed Capacity in MW)



Source: NEPRA State of Industry Report

Globally, the Base load Power is coming from Thermal sources, with maximum contribution from the Indigenous resources mostly coal in the coal rich countries, whereas the rest of the power generation sources are used as peaking plants.

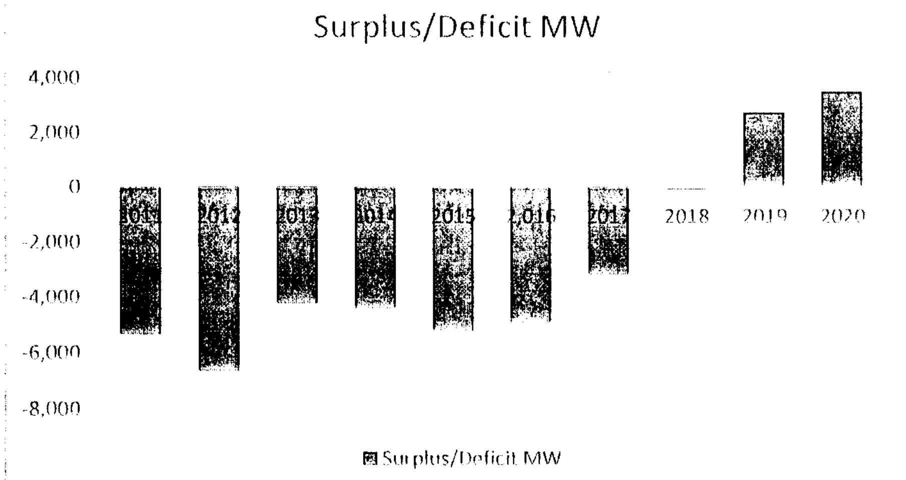
The CPEC, however, is destined to change the bleak scenario. Chinese firms will put up \$35 to \$37bn in the foreign direct investment for independent power production (IPP) under an investment policy that was available to all investors. These projects would be based on wind, solar, coal and hydropower generation of 16,400 MW as well as the transmission system and would be located in all the provinces and Azad Kashmir.

Fifteen energy projects in the CPEC are 'Early Harvest Projects' (EHP). As part of the "Early Harvest" scheme of the CPEC, over 10,000 megawatts of electricity-generating capacity is to be developed between 2018 and 2020. It is agreed that the five guiding principles for the determination of prioritized projects/EHP are significance to bilateral connectivity, socio-economic urgency and impact, maturity, relatively good economic returns and quicker completion time.

The total Project Cost of all CPEC Energy Project is estimated to be approximately \$ 33.7bn. Of this, an estimated ~\$25bn will comprise of debt while the balance ~\$8bn of sponsor equity. Since these projects will be developed under the CPEC mode, the government of Pakistan is virtually looking at contingent liability of ~\$25bn in the form of guarantees to be issued over the next few years to secure NTDC's performance obligations under Power Purchase Agreements.

The major portion of debt will be raised through China (approx. \$18-19bn). Tenor of these loans will range from 12-15 years (with grace periods of 2-5 years) depending on construction periods of individual projects. Most actively promoted projects will come online by 2018/2019 after which projects will be looking at repayment periods of 10 years. By 2030, most projects would have settled their debt obligations and power tariff will come significantly down. Pricing of loans will range from LIBOR + 3.5 - 4.5% in addition to such upfront payments as Sinosure Credit Insurance Premium, arrangement/advisory fees to banks etc.

Once 10,400 MW is added to Pakistan's national grid as part of the early harvest projects, Pakistan will have surplus energy. Not only will Pakistan have a surplus ~ 3,500 MW of energy[2], but Pakistan's energy mix will also improve to become less reliant on imported oil and gas with the two only comprising 44.7% of the total installed capacity in the country.



Source: NEPRA State of Industry Report

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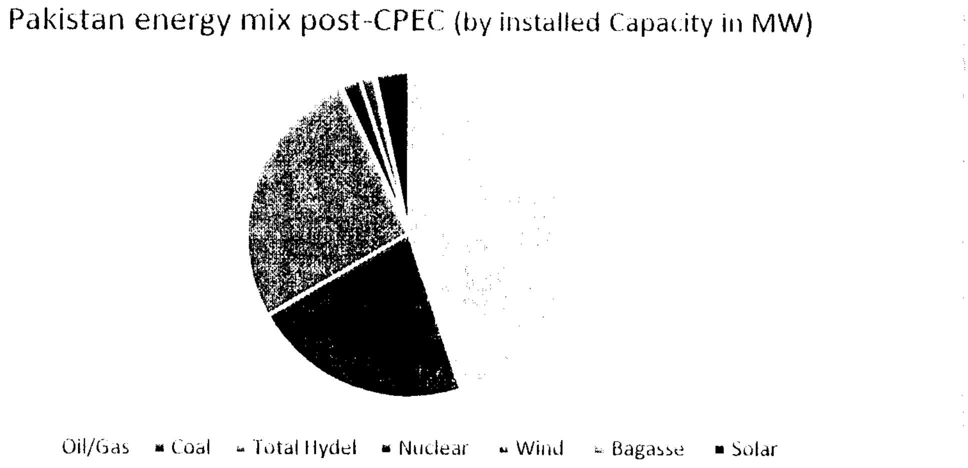
[2] NEPRA State of Industry Report, 2015



Capacities of Early Harvest Projects under CPEC have been added to the existing installed Capacities reported under NEPRA's State of Industry Report to arrive at this pie-chart

As a conclusion, Pakistan will continue to require a major chunk of its Power Generation based on Indigenous fuels – to which Thar coal is a suitable alternate.

Siddiqsons 330 MW Power project is an extension in the same way.

1.4. Project Structure

1.4.1. Project Company

Siddiqsons Energy limited incorporated as an IPP to carry out the project

1.4.2. Feasibility Study Company

Engro Powergen Ltd. is an experienced Power Sector Business development company, which has already developed various Power projects including Gas Fired Power Projects, Thar Coal based Power project etc.

2 Project Details

With over 175 Billion Tons of estimated reserves, Thar Coal offers the most attractive opportunity for Pakistan to overcome the severe energy crisis. Power produced from coal is much cheaper than from furnace oil being currently used in the country. Thar Coal offers a chance for Pakistan to achieve energy security for years to come. It has to be noted that most of the developed nations in the world use coal as their major source of energy and power.

Sindh Engro Coal Mining Company (SECMC), a Joint Venture between Government of Sindh (GoS) and Engro Powergen (EPL), was formed with an aim to realize the GoS ambition of large scale development of Thar Coalfields. SECMC mandate was the large scale mining of the Thar Coal deposits located in Block II of the Thar Coalfield. An initial capacity of the mine of 3.8 Mt/a has acheieved a financial closure and project is under fast track implementation

To match the coal production , Engro Powergen thar Ltd (an IPP) has already initiated execution of 2x330 MW (CFB Sub-Critical , lignite Fired Power Plant) . Subsequently two other projects namely Thar Energy Limited (330 MW Sub-Critical CFB Power Plant) & ThalNova (330 MW Sub-critical CFB power plant) are also under development phase , with LOI/ LOS been issued by PPIB.

Siddiqsons 330 MW Power Project will be situated in near vicinity of the EPTL Project .

Siddiqsons project will have similar CFB technology from Alstom / Foster wheeler to consume Thar lignite at Power Plant.

2.1 Project Site and Site Selection

2.1.1 Site Selection

2.1.1.1 Site Selection Criteria

The criteria used for site selection is listed below:

1. Availability of Adequate Land

2. Fuel Supply
3. Water Availability
4. Equipment Transportation
5. Power Evacuation
6. Waste Disposal
7. Other Infrastructure
8. Social Impacts
9. Environmental Issues

2.1.1.2 Identification of Potential Site

2.1.1.2.1 Introduction

The site selection investigation basically revolves around two regions:

- Thar Coalfield: Power Plant located next to the Coal Mine providing a readily available fuel supply with minimum coal supply complexities
- Port Qasim, Karachi: Power Plant located next to a readily available water source (sea water) and other infrastructure

2.1.1.2.2 Discussion

Availability of Adequate Land

Availability of land for the installation of power plant at lower cost is the primary factor for site selection, along with the provision for future expansion.

Adequate land is available near Thar mine, which appears to be more favorable as the lease has been obtained for the whole block II area, which includes the power plant potential site.

At Port Qasim, land would be available at higher cost & technical risks will be associated with the guaranteeing supply of coal over long distance.

Fuel Supply

Guaranteed fuel supply and ease of the supply are the most important factors in the site selection criteria. Having a mine mouth power plant ensures that the fuel supply is ensured with minimum complexity. Furthermore the fuel – lignite – having a lesser calorific value than Sub-bituminous coal & higher moisture will entail a higher transportation cost (in USD/MMBtu) vs. any other fuel

Installation of a power plant away from the mine site would mean that the coal has to be transported a considerable distance. This would lead to a number of issues:

- **Coal Drying**: Thar lignite consists of about 48% moisture. In order to make transportation of lignite economically feasible, the lignite will have to be dried. However, this would lead to increasing the scope of the Project and increase in the energy cost of the lignite. Coal drying process usually utilizes low pressure steam to evaporate water from finely ground coal. This would require additional installation of crusher, power generating system and boilers which burn lignite to produce steam. This results in increasing the initial cost and final energy price of lignite by 6 – 7%. Further to this , such process will have to be undertaken by SECMC and it is expected to fall beyond their Scope
- **Spontaneous Combustion**: Thar lignite is susceptible to spontaneous combustion posing a risk during the long transportation. This would require preventive measures to be taken during transportation (especially long term transportation).

  As an alternate , a more technically correct approach could be drying the lignite powder & convert into briquettes to decrease its surface area and make it less susceptible to combustion during transportation – this will also improve the energy content (MMBtu/ton) and hence the Cost element will also be improved (USD/MMBtu). Moreover, arrangements to reduce the contact with excess oxygen would also be required.
  Currently no such arrangements are being undertaken by SECMC.

- **Transportation Cost**: Currently there is no functioning railway network close to the mine site. Until a proper railway network is established coal will have to be transported by trucks. It is estimated that truck transportation cost would resulting in increase the energy price by about 20-25%. Although the Transportation price is subject to pass through under tariff , however it is expected to increase the overall electricity price

- **Project Risk**: Transportation of coal would increase the Project susceptibility to external variables including quality of road network, traffic conditions, accidents, strikes and many other variables.

<u>Water Availability</u>

Thar coalfields are located in a remote region with no surface water supply. Currently water is only available from water wells which supply brackish water. This water needs to be treated by Reverse Osmosis (RO) to decrease its salinity to an acceptable manner. During mining activities large quantities of groundwater will be pumped out to keep mine dry. This water can be used after treatment for the power plant

The power plant water demand can only be completely fulfilled by groundwater or by the water being supplied by LBOD (a GOS infra-structure project) to supply water to Power plant in Thar as a backup , the arrangement of Air Cooling instead of Wet Cooling can also be considered. However, employing air cooling in the hot climate will result in decreasing the net efficiency as well as net output of the power plant (due to increase in auxiliary load).

GoS has ensured the supply of treated water from LBOD for the Thar Coal field.

Installation of the power plant at Port Qasim will ensure constant supply of seawater, which can be used directly for power plant cooling (once through cooling). Moreover, such a system allows energy savings and increased efficiency of the power plant.

Equipment Transportation

Thar coalfield is located about 400 KM from the port city of Karachi. The road network in the Thar district has undergone considerable improvement to ensure suitable transportation conditions for heavy power plant equipments. It shall be noted that the Roads will be already tested for heavy equipment transportation by EPTL

Installation of the power plant at Port Qasim will allow savings in transportation cost of equipment; reduce the risk related to heavy equipment transportation and susceptibility to external conditions.

Power Evacuation

Currently no power grid is available at the Thar Block II. However, NTDC is constructing a transmission line with a capacity of upto 1800 MW

Port Qasim area is relatively industrialized which means that connection to the grid will not be major issues.

Waste Disposal

Waste produced from power plant will mainly consist of effluent, ash and gypsum. However, it is possible to sell the ash and gypsum to cement industries.

Ash and gypsum produced from the power plant can be dumped in the overburden. Environmental Impact Assessment of this exercise will be covered later in the report. The effluent from the power plant is planned to be disposed off, by means of Evaporation ponds - the power plant will require to carry out extensive re-use of water.

As mentioned above the power plant installed at Port Qasim can be directly cooled by sea water. The heated sea water can be disposed off directly into the sea. As the quantity of the rest of the effluent is much lower, it can be sent into an evaporation pond on site. Selling of ash and gypsum will be much easier from Port Qasim due to its proximity to cement industries.

Social Impacts

As mentioned above, the Thar region is a remote area with virtually no industry. Developing of a power plant in the Thar region offers an advantage of development of the skills of the local population by getting an opportunity to work in a modern power production facility. EPTL Power project in the nearby vicinity will be also a benchmark available which will test out

Environmental Issues

The main environmental impacts of the power plant will be due to the NO_x and SO_x emissions. Low NO_x burners and Insitu Desulfurization (FGD) will be installed to ensure that the emissions follow local and international guidelines for such a power plant.

The Thar Coalfield is located in a sparsely populated area with no industries present. For this reason the guidelines of the emissions are less stringent in this reason and dispersion of the emissions is less likely to have an impact on the population.

The Port Qasim region already consists of functioning industries meaning that more stringent emission guidelines will be applicable. It will have to be ensured that the emissions dispersion is away from the population area.

2.1.1.2.3 Conclusion

Based on the factors discussed above it has been decided that a Mine Mouth Power Plant will be the most suitable option for utilizing of Thar Lignite. The following are the key reasons:

- Significant increase in lignite energy price due to coal drying and transportation will ultimately result in increasing the final power tariff
- Large risk associated with continuous supply of coal inland covering a distance of 400 KM.

Hence Siddiqsons Project will be located near Mine -- at around 7 km from Mine . The coal will be supplied by Mining Company (SECMC) by means of Trucks .

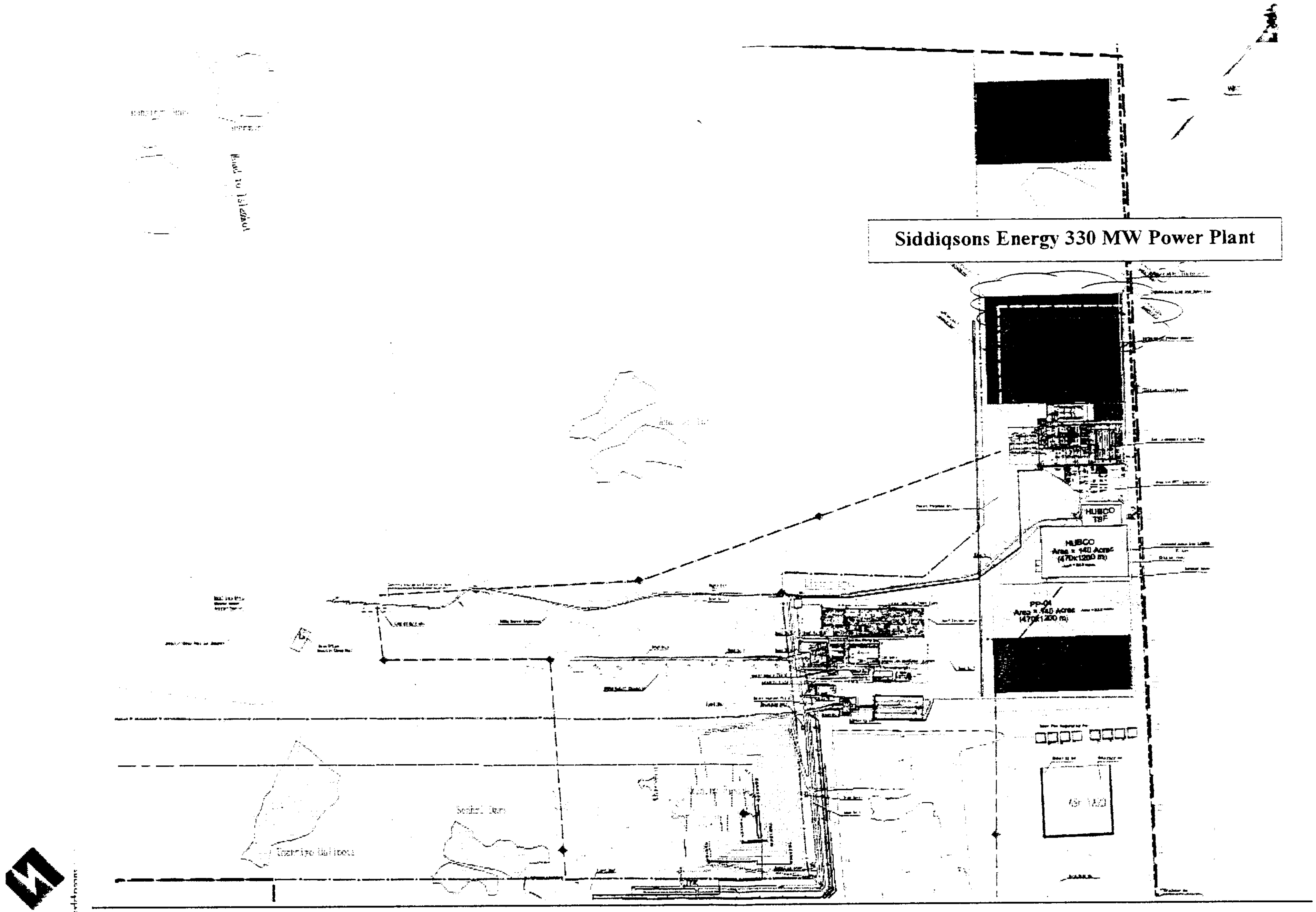
The location of the power plant has been finalized based on the following considerations:

- A flat topography, as far as possible, to facilitate construction of the power plant
- To allow for short transport distances for lignite from the mine to the power plant and for ash from the power plant to the mine
- The Power Plant does not block potentially economic lignite reserves
- Relocation of villages should be avoided.
- The location should ensure a minimum influence of noise and dust on neighboring villages.

Based on the factors discussed above the site selected for the mine mouth power plant is located:

- Approximately 7 KM from the mining region, ~ 1 km from the EPTL Power Plant Facilities
- In a region where the mining stripping ratio (cubic meter of overburden to be removed per ton of coal extracted) is greater than 10, in comparison to 6.6 in the mining area.
- Can get water access by open channel or underground pipeline
- The nearest village, Bitra, is located at a distance of about 600 m from the power plant in the North – Western Direction. However, the prevalent wind is in North-Eastern direction.

The location of Power Plant in Thar Coalfield Block II and Layout of the Power Plant are shown as below:


Siddiqsons Energy 330 MW Power Plant
HUBCO TSF
HUBCO
Area = 140 Acres
(470x1200 m)
PP-04
Area = 140 Acres
(470x1200 m)

2.1.1.3 Site Description

The Project is located in Block II of Thar Coalfields, Thar Parker District, and eastern part of Sindh Province, Pakistan. The location is close to the Indian border.

The coordinates of Thar Coalfield Block II and Power Plant are as following:

Power Plant	Easting (m) *	Northing (m) *
A	640900.2	2745831
B	640510	2746189
C	639609.1	2745397
D	639920.5	2745047

The site is accessible by road from nearest towns of Islamkot

2.1.2 Plant Area and Ultimate Generation

2.1.2.1 Site Area Requirements

The total area of the power plant is approximately 100-140 acres(including the Temporary Site facilities). *The residential site would be constructed with be located in the North-West of power plant at about 1.5 km distance. A road would be constructed to connect the township with the power plant. Further to this, temporary Ash Yard & Evaporation Ponds will be setup separately and area of the same will be evaluated during Basic / Detail Design of the Project.*

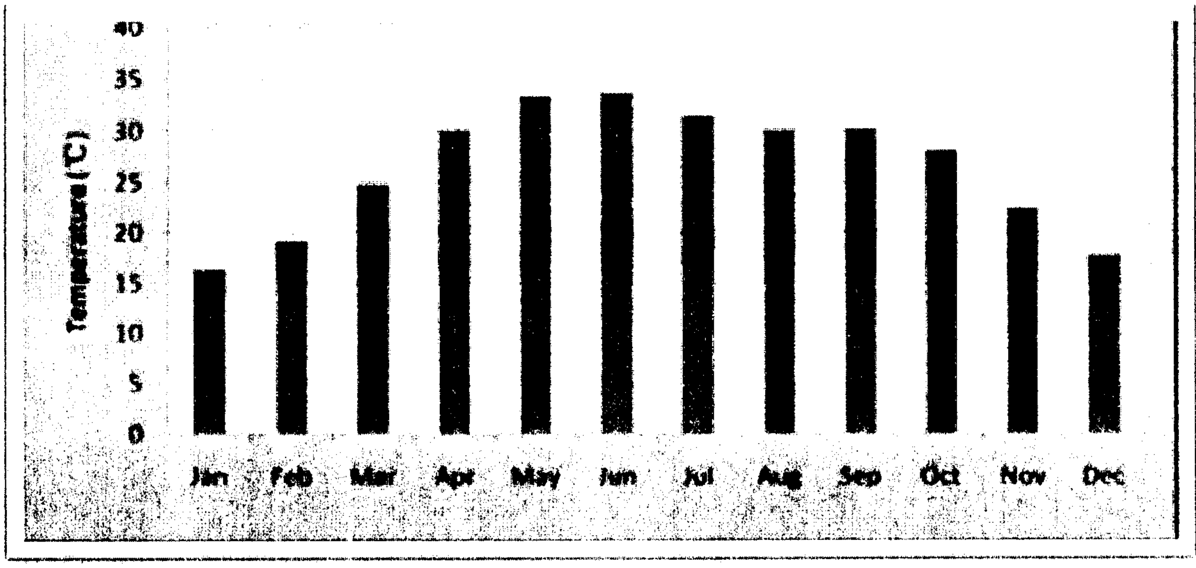
2.1.3 Site Conditions

2.1.3.1 Meteorology

The climate is subtropical, with summer lasting from May to August and winter is from December to January. Rainy season is between July and August (monsoon). During the monsoon season the wind speeds can reach up to 6 m/s (maximum recorded in history is 15 m/s). This can result in dust storms.

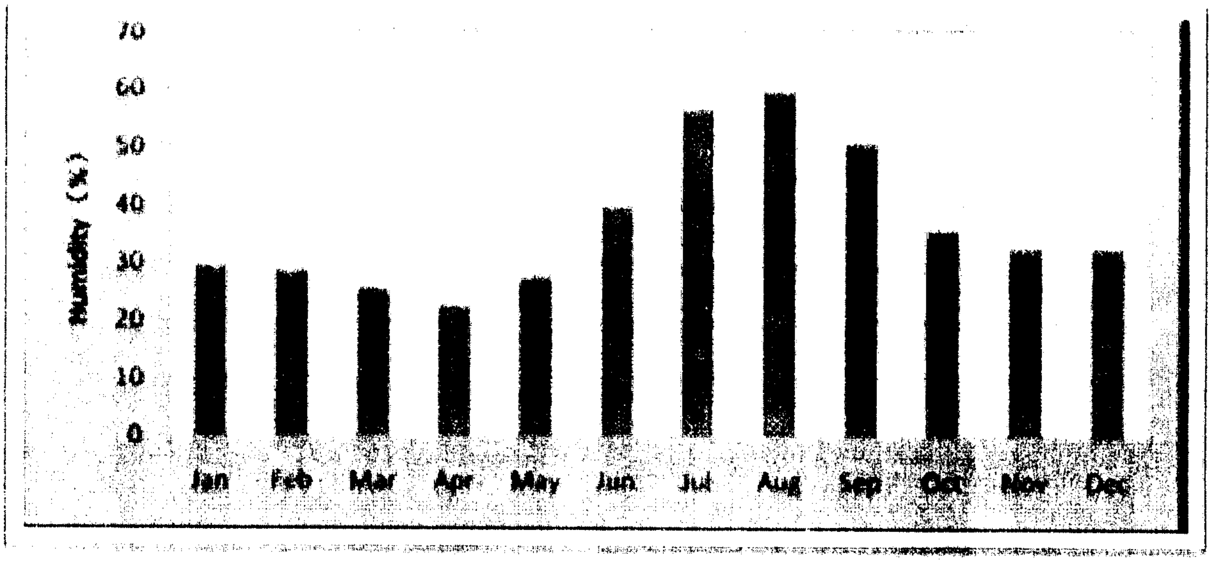
Temperature
Maximum: 50 °C
Minimum: 2 °C
Mean: 27 °C

Average monthly temperatures in Thar Desert are given below:

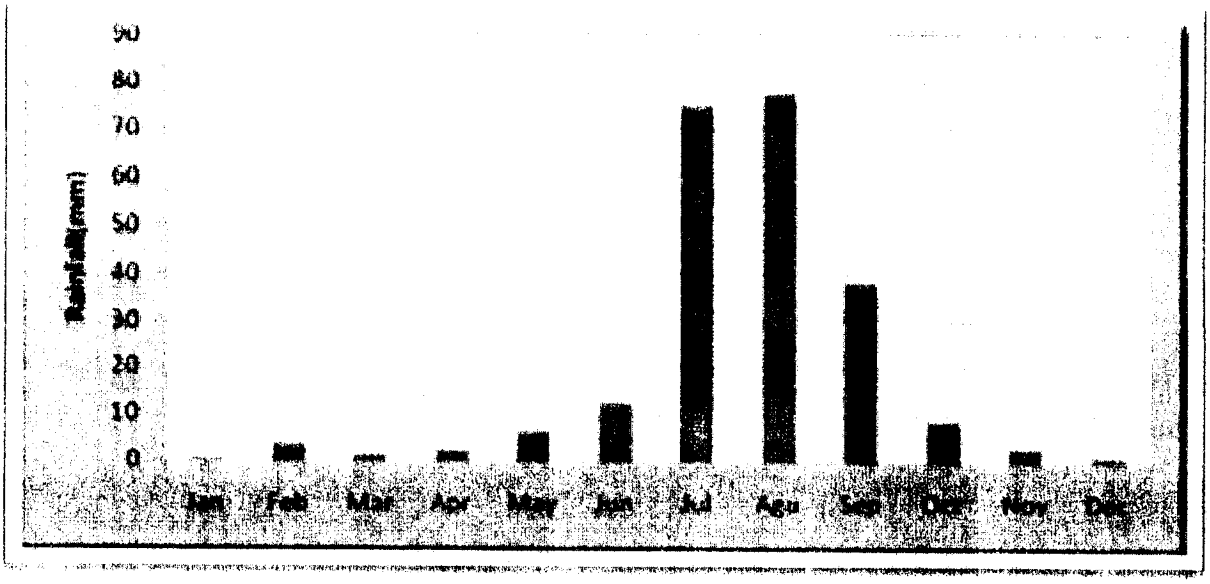


Relative Humidity
Maximum: 88%
Minimum: 11%
Mean: 40%

Average monthly humidity in Thar Desert is given below:

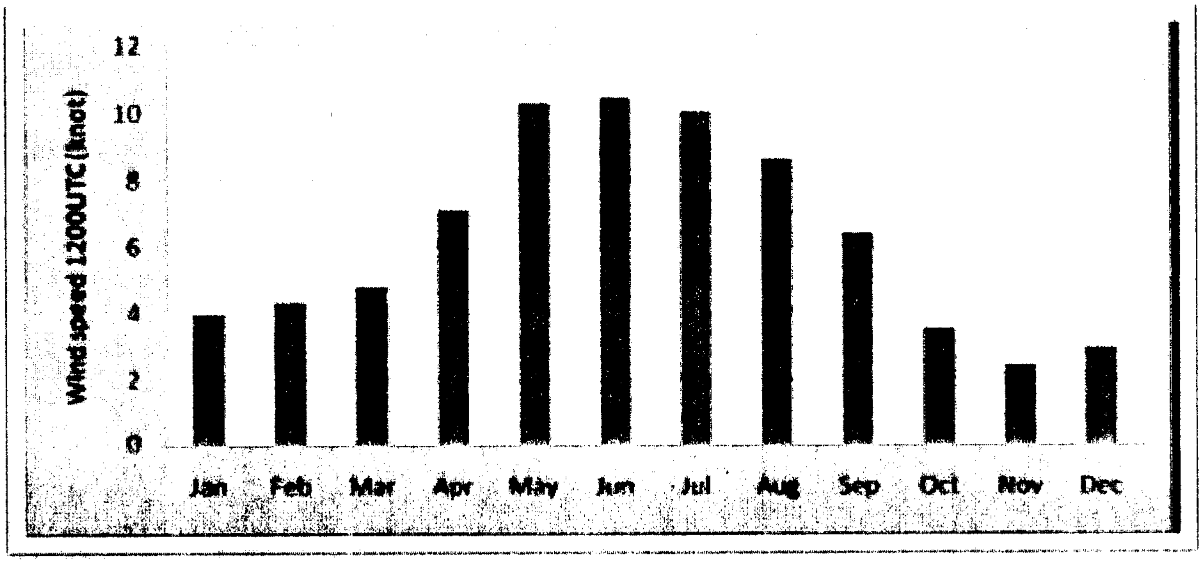


Rainfall
Annual average: 200 mm



Wind
direction in summer = South West to North East
direction in winters = North to North East

Mean wind velocity: 1.5 – 6 m/s (3 – 12 knots)



2.1.3.2 Topography

Thar Desert stretches for about 200 km from north to south and has a width of 200 km at its widest point (at the southern end) and about 80 km at its narrowest point (near the northern end). The dominant feature of this vast expanse of land is the sand dunes aligned in the northeast-southwest direction. However, the area is not uniform as both the size and frequency of the sand dunes vary across Thar.

The area selected for the 330 MW Power plant is relatively flat.

The Power Plant construction will require some clearing & filling in some areas . A detailed topographic assessment will be done as part of Detail design of the Project .

2.1.3.3 Infrastructure

The site is located in a sparsely populated area where houses are mostly made of mud and stones. GoS has built a Rescue Centre inside Block II which is being used as a Security center by SECMC

There is a nearby living arrangement at the entrance of Islamkot City which can be utilized during the project development phase.

As a part of the large scale development of the Thar Coalfields, GoS is currently working on the development of key infrastructure in the area including:

Raw Water Supply

- Water Supply from Left Bank Outfall Drainage (LBOD)

LBOD is a drainage system developed in the Sindh Province for disposal of saline effluent from Industries and Storm Water into the Arabian Sea. This water supply scheme is under construction & includes the following:

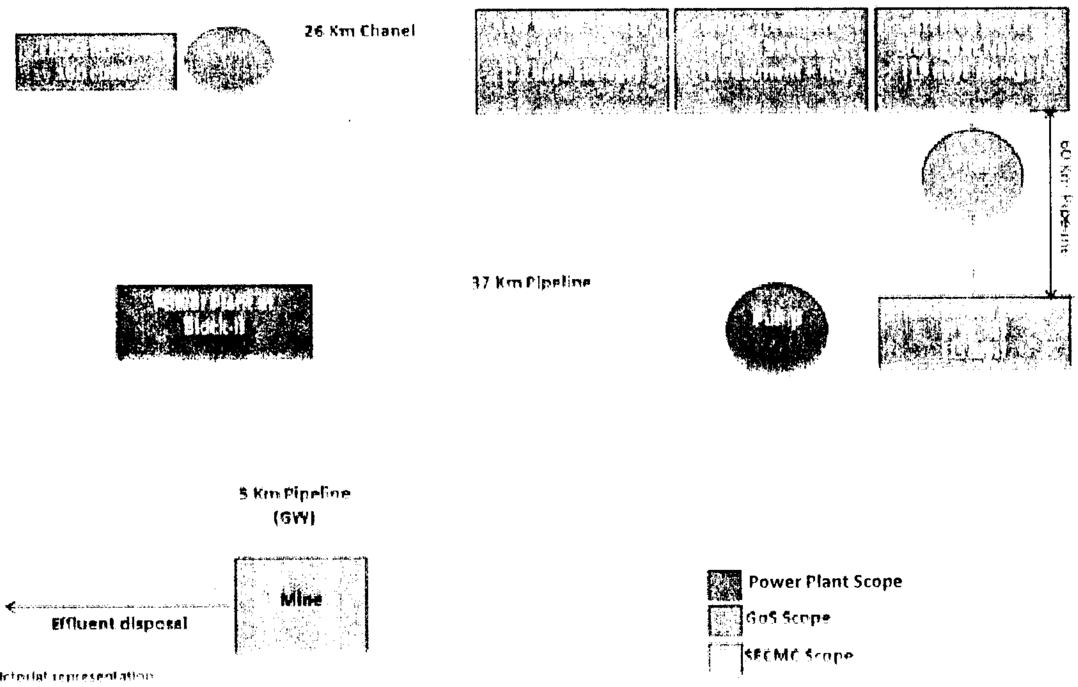
- Construction of CC Lined Channel from RD-362 LBOD to Nabisar to carry 50 CUSEC (5100 m^3/h) of saline water
- RO plant for treating saline water and interim storage at Nabisar .Pumping of 35 CUSEC (3570 m^3/h) of canal water in a 36 inch diameter underground pipeline from Nabisar to Thar Block II
- Transporting line (from Nabisar to Vajihar) & Storage facility at Vajihar
- A subsequent piping from Vajihar to Block II will be laid by Project company

This water scheme is being expanded by GoS to increase to upto 70 cusecs of treated water supply . This will ensure the water requirement for the Power plant are met

- Water Supply from Mine Ground Water

Siddiqsons Energy is also in discussion with SECMC to use the underground water that will be pumped out from the mine – this water will be supplied by SECMC – the consideration are being done to optimize the water supply arrangement

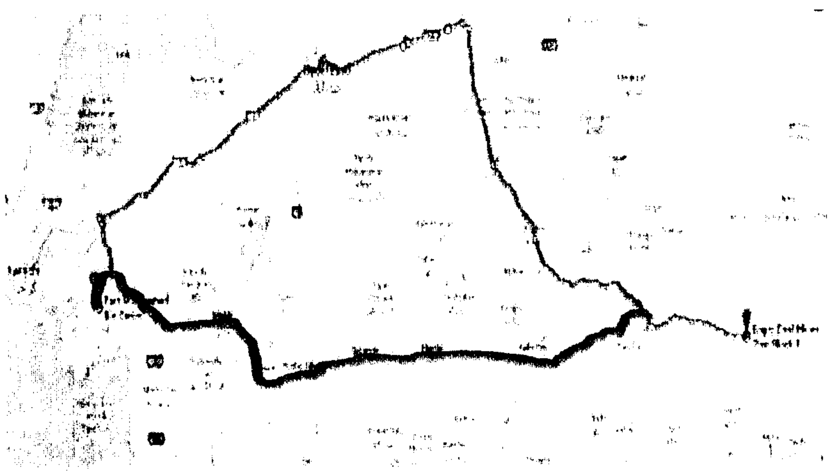
The schematic of water supply options is given below.



Road Network

Development and widening of Karachi - Thatta – Badin - Islamkot road and alternate route from Hyderabad – Mirpur Khas – Naukot – Islamkot, is under construction with a target completion by 1st Quarter, 2018

Below are the possible road networks for accessing the power & mine projects



Airport

The Thar Coalfield is located 410 km away from the nearest airport. For large scale development of the Thar Coalfields construction of an airport close to the Thar coalfield is planned. This Project is being executed by the Civil Aviation Authority, Pakistan.

The construction for the Project has started and target completion is by end December 2017

2.1.3.4 Geotechnical Data, Geology Conditions and Foundation Considerations

The area is generally covered with dune sand mainly consisting of sand, silt and clay. Thickness of dune sand varies from 14 – 93 m there is a downward slope towards the south east direction from the proposed site towards Rann of Kutch.

The soils on the Project site consists of dune sand mainly comprising fine sandstone which is a windborne sediment; the lower part consists of considerable clacareous mineral; the medium part consists mostly of calcareous grain or lumps and some thin clay. The upper part is mostly loose calcareous grain. Below the dune sand there are alluvial deposits of sub-recent age mainly consisting sand, siltstone and claystone .

The Stratigraphic Sequence of the region is given below:

Formation	Age	Thickness	Lithology
Dune Sand	Recent	14 – 93 m	Sand, silt and clay
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Alluvial Deposits	Sub-Recent	11 - 209m	Sand,siltstone,claystone, mottled
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Bara Formation	Palaeocene to Early Eocene	+52m	Claystone, shale, sand, coal, carbonaceous Claystone
~~Unconformity~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			
Basement Complex	Pre-Cambrian	--	Granite and quartz diorite

The power plant has a wide range of building structures and equipment which will be supported on foundations either resting on piles or on the compacted structural backfill. Construction will be done on the basis of minimum leveling/land-filling criteria and will be adjusted to suit specific site conditions and drainage patterns. Land-filling will be done with granular soil excavated from the high elevation areas. The finished grade surface will be sloped away from the buildings to provide surface drainage.

The capacity, length and type of pile will be selected suitable for the project and will depend on the soil data from geophysical work (subsurface profile). The selection of piles will also depend on material that is readily available locally, suitable for long-term performance and are cost-effective. The allowable soil bearing pressure under the structural fill will also depend on the size of the foundation and their settlement tolerances.

2.1.3.5 Hydrological Situation

2.1.3.5.1 Surface Water

Surface water is not present in the Thar desert . Upon heavy rainfalls however water collects in intra-dune depressions and in larger flat areas. There the water can remain up to several weeks as the soil in these areas is rather impermeable. It is also reported that e.g. after the heavy rainfalls during the year 2003 and other years parts of the city of Mithi and other Thar locations were extremely flooded.

Only to the South at the border to the Rann of Kutch salt lakes and pans exist, which may be in connection with the groundwater. They are periodically filled with precipitation run off during the rainy season. The next rivers and channels are about 120 km to the west in the Indus river valley.

2.1.3.5.2 Groundwater

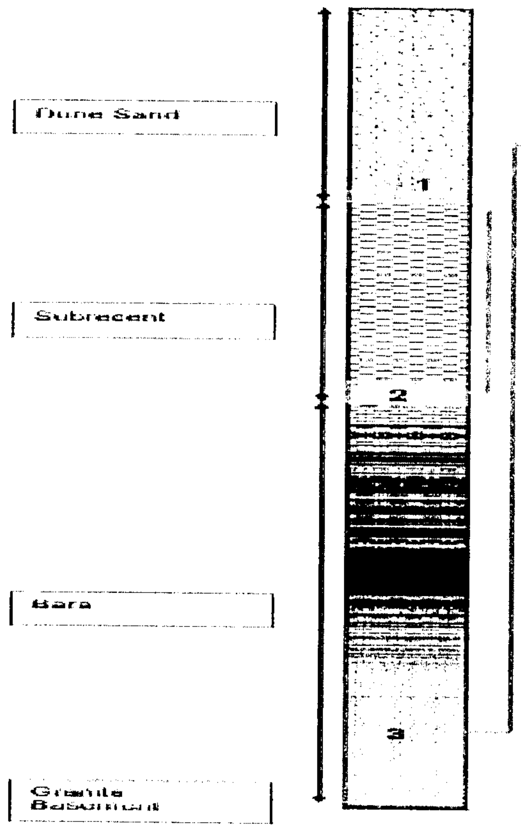
Introduction

Groundwater is present in three horizons:

Top Aquifer: Dune Sand Aquifer (Phreatic)
Middle Aquifer: Coal Seam Roof Aquifer (confined)
Bottom Aquifer: Coal Seam Floor Aquifer (confined)

The groundwater is brackish with TDS values in the order of around 3000 to 8000 mg/l. The quality varies with different aquifers. The main characteristic of all groundwater is a dominant sodium chloride content. Most of the Thar villagers depend on the Dune Sand aquifer for their water consumption both for domestic use and cattle. The other aquifers are used only to a limited extent, in some deep wells.

Figure below gives the general hydrologic situation of the proposed site. However, this scheme is valid for nearly all the Thar desert area.



Dune Sand Aquifer

The Dune Sand aquifer is present all over the Thar desert and also at the Indian side. The water column in this aquifer is only around 1 - 5 meters at maximum. Groundwater fluctuations may rise to about 2 meters.

This aquifer is intensively used by the villagers and every village has got in general three to ten tube wells depending on the village size. The groundwater table is in general about 50 – 60 meters below ground surface just at the contact between Dune Sand Formation and Sub-recent.

Recharge of this aquifer is from precipitation, which due to the low rainfall of around 200 mm per year.

Coal Seam Roof Aquifer

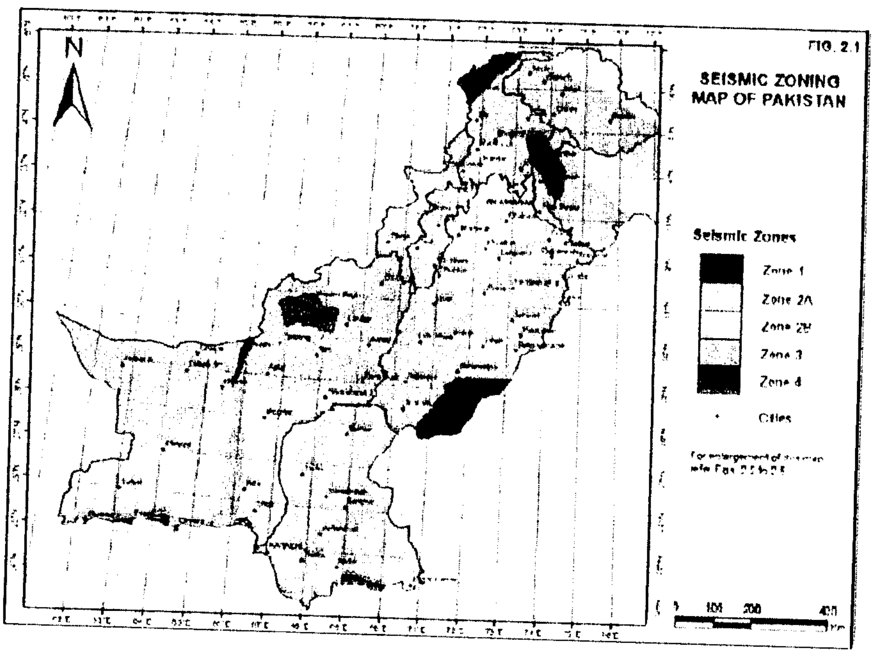
This aquifer is spread out all over the Thar area and consists of silty to coarse sand. The aquifer is at a depth of about 120 m from the surface and has a thickness from almost 0 to about 12 m with an average of 6 m. Recharge of this aquifer is from the Indian side.

Coal Seam Floor Aquifer

This aquifer covers the whole Thar area. It is at a depth of about 180 m and has a varying thickness about 30 – 50 m. The aquifer is made up of medium to coarse sand. This is the main aquifer in the region. Groundwater recharge is from the Indian side.

2.1.3.6 Seismic Intensity

The Project site falls in Zone 2B according to the 2007 classification. This zone corresponds to peak horizontal ground acceleration of 0.16 to 0.24 g (acceleration due to gravity). The seismicity zoning map of Pakistan is given below:



2.1.4 Resources at Site

2.1.4.1 Space of Development

Thar Block II covers at total area of about 95.5 sq. km with most of the area being designated for the mine.

In addition to the area already designated for power plant, the empty area between power plant and colony (~600 acre) can be used for further expansion of the power plant.

2.1.4.2 LIGNITE

The power plant will be fed with lignite from the adjacent mine being operated by SECMC. The power plant will be fed with lignite from this mine. The mine capacity is ~ 9.5 Mt/a. Total annual operating days of mine will be 330 days , which means that around 28,000 t/day of lignite will be available from the mine. A stockyard having a capacity of 1,000,000 tons is planned in the mine. The stockyard would be filled by means of Trucks from Mine stockyard

The power plant will receive coal from the mine stockyard via dedicated conveyor system , however the power plant will also be having a capability to unload by means of trucks (if used incase the belts are not operational).

2.1.4.3 Backup Fuel

High Speed Diesel (HSD) will be used as the power plant ignition fuel. HSD shall be supplied through road tankers at Site oil unloading station under fuel supply agreement.

High Sulfur Furnace Oil (HSFO) will be used as a support fuel, after ignition, during startup until the power plant shifts completely on lignite. HSFO shall be supplied through road tankers at Site oil unloading station under fuel supply agreement.

2.1.4.4 Alternate Coal Fuel

Size of power block should match the mine production schedule so as to start using coal as early as possible from the mine to reduce mine development costs (which would be ultimately borne by the power plant and the consumer).

In this regard alternate coal fuel will be arranged, with similar specifications as Thar coal lignite to make sure that the plant is running even if the mine schedule is delayed. This coal will be arranged from Indonesia

The plant design will have to flexible to permit use of this alternate coal fuel. Specifications of the alternate coal fuel are being finalized.

2.1.4.5 Water

Main source of water will be LBOD water being supplied by GoS , whereas backup water source will be Groundwater (aquifers) that will be pumped out from the mining area to keep the mine dry. The groundwater is brackish. A large quantity of groundwater will be pumped out during the initial years of the project, ~ 5,000 m^3/h, however this will reduce to about 2,500 m^3/h during the later years of the Project. In case of non-availability of canal water, the groundwater can be used, after RO treatment, during the initial years of Power Plant operation.

2.1.4.6 Limestone

Sulfur in the coal results in production of sulfur dioxide (SO_2) during the combustion process. Due to the high environmental impacts of SO_2, international environmental laws make it compulsory to remove most of the SO_2 from the flue gas before it is vented in the atmosphere.

The most extensive method of Flue Gas Desulfurization is by the use of limestone ($CaCO_3$), which reacts with sulfur dioxide and water to form Gypsum ($CaSO_4 \bullet 2H_2O$). This results in scrubbing most of the sulfur dioxide from the flue gas.

The major use of limestone in Pakistan is in the cement industry and they are located close the limestone rocks or mines. Many cement industries own limestone quarries for these sources. The limestone supply for this Project will have to be from any of the near quarry

There are Limestone quarries near Hyderabad as well as near Thatta ,both of which are approximately 300-320 kms from Thar power plant which can be contacted for the supply of limestone via trailers having a capacity of 60-70 tons .

2.1.4.7 Ash Disposal

The ash formed will also be dumped in the outside dump of the mining area, about 6 KM away from Power Plant, and will be carried through trucks/loaders and compacted by use of dozers. The Environmental Impact Assessment (EIA) confirms that the disposal of ash in the outside dump doesn't provide any environmental hazards.

2.2 Design Parameters and Standards

2.2.1 Design Codes and Standards

The plant and its equipment will be designed, manufactured, assembled, and tested in accordance with internationally recognized standards and statutory regulations. The following is a list of the codes and standards envisioned for the Project. The list will be finalized before the execution of the EPC contract. The work will also comply with all applicable national and local codes. The latest revision of any code or standard in effect at the time of EPC contract signing will be used in design and/or construction.

Acronym	Agency, Code or Standard
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AIA	American Institute of Architects
AIJ	The Architectural Institute of Japan
AISC	American Institute of Steel Construction
AISE	Association of Iron and Steel Engineers
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigeration & Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society, including Structural Welding Code (AWS D1.1)
AWWA	American Water Works Association
BS	British Standards Institute
DIN	Deutsches Institut fur Normung
ES	European Standard
FM	Factory Mutual
HEI	Heat Exchanger Institute
HIS	Hydraulic Institute Standard
HASS	Heating Air-Conditioning and Sanitary standard
IBC	International Building Code
ICBO	International Conference of Building Officials

ICEA	Insulated Cable Engineers Association
IEC	International Electrical Code
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
IMC	International Mechanical Code
IPC	International Plumbing Code
IP	Institute of Petroleum
sISO	International Organization for Standardization
JSME	Japan Society of Mechanical Engineers
JIS	Japanese Industrial Standards
JEC	Japanese Electro-technical Committee
JEM	Japanese Electrical Manufacturer's Association
MBMA,	Metal Building Manufacturer's Association
MSS	Manufacturer's Standardization Society
NACE	National Association of Corrosion Engineers
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NERC	North American Electrical Reliability Council
NFPA	National Fire Protection Association
OSHA	Occupational Health and Safety Administration
SDI	Steel Deck Institute
SSPC	Steel Structures Painting Council
SMACNA	Seat Metal and Air Conditioning Contractor's National Association
TEMA	Tubular Exchanger Manufacturers Association
TSPHF	Technical Standards for Port and Harbor Facilities in Japan
UBC	Uniform Building Code -1997 (For Seismic Criteria Only, Zone 2A)

The Project Company reserves the right to adopt any of the international standards not limited to abovementioned list, but also other national standards, such as the Chinese or Korean National Standards, wherever applicable.

If any conflict exists between any code of practice or design standard listed herein and local codes or standards, the more stringent document requirements will be used. Alternative international codes and standards may be used as long as their requirements are not less stringent than those in the codes and standards listed above.

2.2.2 Design Bases

2.2.2.1 Voltage Limits

The power plant will be designed to operate continuously within the operating voltage range of the 500 kV grid system set by NTDC, which is between 475 kV to 525 kV. The plant will also be capable of operating for 10 minutes at a voltage of ±10% of the base voltage of 500 kV. The auxiliary equipment will be capable to operate in a range of ±10% of the nominal voltage under steady-state condition and ±20% of the nominal voltage under disturbance condition.

2.2.2.2 Reactive Power

The plant reactive capability will be determined from the generator ratings:

Lagging power factor - 0.9 measured at the generator terminals
Leading power factor - 0.95 measured at the generator terminals

After deducting the unit auxiliary power load and the reactive loss in the step-up transformers, the plant will be able to supply its rated output at the high-voltage terminals of the 500-kV transformer at a lagging power factor of 0.95.

2.2.2.3 Fuel Data

2.2.2.3.1 LIGNITE

The power plant will be based on lignite from the adjacent mine. The average quality of the coal expected is given below which also forms the basis for the power plant design.

		Thar Lignite
PROXIMATE ANALYSIS		
Total Moisture	%	47.6
Ash	%	7.8
Volatile Matter	%	25
Fixed Carbon	%	19.6
Total Sulfur	%	1.1

Gross Calorific Value	kJ/kg	13.2
Net Calorific Value	kJ/kg	11.6

A detailed Coal quality arrangement will be done as part of Coal Supply Agreement with SECMC.

2.2.2.3.2 High Speed Diesel (HSD)

HSD will be used as ignition fuel. Specifications HSD to be used for Project are given below.

Component	Unit	Data
Specific Gravity @ 15.6 °C	-	0.82 – 0.87
Flash Point (max.)	°C	66
Sulfur Content (max.)	% mass	1.0
Copper strip corrosion 3 hrs. at 100°C (max.)	-	1.0
Kinematic viscosity at 40°C	mm^2/s	1.5 – 6.5
Cloud Point (max.)	°C	6.0
Pour Point (max.)	°C	3.0
Carbon Residue (max.) of 10% distillation residue	% mass	0.2
Ash (max.)	% mass	0.01
Water (max.)	% vol.	0.05
Sediment (max.)	% mass	0.01
Cetan Index (min.)	-	45
Total Acid Number (max.)	mg KOH/g	0.5
Calorific Value (min.)	BTU/lb	19,000
GCV	MJ/kg	44.2
NCV	MJ/kg	41.8

2.2.2.3.3 Not Used

2.2.2.4 Water Data

The following are the approximate specifications of the target water specifications which may be made available for the Project by LBOD or GW treatment plant :

Item	Unit	Value
pH		7.5 – 7.8
TDS	PPM	243 – 320
Suspended Solids	PPM	4 – 10

2.2.2.5 Grid Code Requirements

Siddiqsons plant will be planned, designed, equipped, maintained and operated strictly in accordance with the requirements of the valid Grid Code of Pakistan, issued by the NTDC, dated June 2005, and approved by the NEPRA.

The Pakistan Grid Code includes the following sub-codes relevant for:

Data Registration Code
Operation Code
Planning Code
Connection Code
Protection and Metering Code
Scheduling and Dispatch Code

The sub-codes, which are of some interest of a feasibility study, are described below. In addition, design criteria which have already had some impact on the present planning work are listed and considered in general.

Ref.: Operation Code (OC)

For all generators (thermal) above 100 MW, this sub-code sets out the operational requirements for CCPP generators for:

frequency response and automatic generation control (AGC)

(refer to OC Section 4.8)

control of power system voltage

(refer to OC Section 4.9)

power system stability co-ordination

(refer to OC Section 4.10)

operating margin and contingency reserve

(refer to OC Section 5.2)

Ref.: Planning Code (PC)

This sets out the planning data to be made available by generators to NTDC so that NTDC can prepare grid studies for short circuit, load flow and transient stability etc., to ensure that the grid is able to accommodate the generation plant (refer to PC Appendix A Part 2).

Any such internal studies within the limits of the generation plant have to be provided by the EPC contractor. Preliminary data will be handed over to NTDC at the end of the specification stage.

Ref.: Connection Code (CC)

This sets out the technical, design and operational criteria for connection of the generation plant to the grid for (refer to CC Section 5.4):

range of frequency and voltage variations

power quality (harmonic contents, phase unbalance, voltage fluctuations, etc.)

substation design (fault levels, current ratings, fault clearance time, etc.)

generator requirements (power factor range, short circuit ratio, power and voltage output range, etc.)

generator and generator transformer protection functions and settings

transformer requirements (tap changer setting ranges, impedance values, neutral treatment, etc.)

power system control arrangements (requirements of turbine and excitation controller, primary and secondary frequency response characteristics, etc.).

In addition, the standard network conditions are defined in CC Section 7.

The technical requirements and criteria specified in the relevant Grid Code sections have to be met for the CCPP to make an adequate contribution to grid stability to cater for frequency fluctuations, voltage deviation, reactive power compensation needs, required tap changer ranges and steps, etc.

Data explicitly required in the grid code and having a major influence on the technical design are considered in the feasibility study with respect to system configuration, layout and capital cost.

These are, in particular, and among others:

Generator data:

Power factor range from 0.9 leading to 0.8 lagging; the reactive power output under steady-state conditions should be fully available within the voltage range of +/- 5% at all voltage levels

short circuit ratio not less than 0.5

220 kV substation:

The switchgear shall be rated for a three phase symmetrical short-circuit current of 40 kA (refer to CC Section 7.2).

Furthermore, all design features of the HV systems will be strictly based on the Grid Code design principles, as per CC Section 7, especially with regard to short-circuit currents, insulation coordination, protection and telemetering facilities.

Ref.: Protection and Metering Code (PMC)

All equipment used for substation, generator and main transformer protection as well as for revenue metering and SCADA interfaces shall require review and approval from NTDC.

Metering

Approved revenue metering systems have to be applied for measuring and metering devices for normal and back-up metering.

The electrical energy supplied to or drawn from the NTDC grid will be measured in the generator in feed bays,where the measurement would be made at 500 KV

The accuracy classes have to be chosen as 0.2 for active power meters in order to be adequate for correct billing purposes.

Protection

The design of the interconnection between the CCPP and the NTDC transmission system shall be consistent with the standards of NTDC and with the requirements as specified in the PMC, Section 2.2. Design and settings of the protection system will be co-ordinated in detail between CCPP and NTDC.

SCADA

PMC Section 2.2 requires the provision of remote terminal units (RTU) at the CCPP for remote monitoring and dispatch of the generators and for monitoring and control of the substation.

SCADA and control facilities at the CCPP shall allow dispatching and loading of the generators from the National Power Control Center (NPCC).

All signals and data that have to be transferred from the CCPP to the NPCC and vice-versa will be installed according to Grid Code standards.

In order to determine all relevant system characteristics under normal and disturbed operating conditions, appropriate power system monitoring devices (e.g. transient fault recorder, sequence-of-event printer) will be implemented. Real-time synchronised recording of relevant electrical and mechanical values, like turbine valve position, frequency, 220 kV circuit breaker position, etc., shall be covered. This system will allow the CCPP operator to provide documentary evidence for any later discussions with NTDC if a failure is caused by a grid or a power plant malfunction.

2.2.2.6 Permissible Emission Limits

The air emission limits applicable to Project are given in Table below:

Pollutant	IFC standards (mg/Nm³)	National Environmental Quality Std. (NEQS) (mg/Nm³)
NOx	510	1200
SO_2	850	1700 [1]
PM_{10} (Particulate)	50	500

1 : Based on 1% Sulfur content in fuel. For higher content of Sulfur the emission standard will be pro-rated.

For SO_2 emissions, in addition to the above, the NEQS standards for background level in microgram per cubic meter ($\mu g/m^3$), unless stated otherwise, are given below.

Background Air Quality (SO_2	Annual Average	Max. 24-hr Interval	Max SO_2 Emissions	Max. Allowable Ground Level Increment to ambient

Basis)			(t/d/plant)	
Unpolluted	<50	<200	500	50
Moderately Polluted *				
Low	50	200	500	50
High	100	400	100	10
Very Polluted **	>100	>400	100	10

* For intermediate values between 50 and 100 $\mu g/m^3$ linear interpolations should be used

** No projects with SO_2 emissions will be recommended

2.2.2.7 Permissible Liquid Effluents

National Standards for effluent from power plants in mg/l, unless stated otherwise, are given below:

No.	Parameter	Standards (into Inland Waters)
1	Temperature or Temperature Increase*	$\leq$3 °C
2	pH	6 to 9
3	Biochemical Oxygen Demand (BOD_5) at 20 °C (1)	80
4	Chemical Oxygen Demand (COD) (1)	150
5	Total Suspended Solids (TSS)	200
6	Total Dissolved Solids (TDS)	3500
7	Grease and Oil	10
8	Phenolic Compounds (as Phenol)	0.1

9	Chloride (as Cl^-)	1000
10	Fluoride (as F^-)	10
11	Cyanide (as CN^-) total	1
12	An-ionic detergents (as MBAs) (2)	20
13	Sulphate (SO_4^{2-})	600
14	Sulphide (S^{2-})	1
15	Ammonia (NH_3)	40
16	Pesticides (3)	0.15
17	Cadmium (4)	0.1
18	Chromium (trivalent and hexavalent) (4)	1
19	Copper (4)	1
20	Lead (4)	0.5
21	Mercury (4)	0.01
22	Selenium (4)	0.5
23	Nickel (4)	1
24	Silver (4)	1
25	Total Toxic Metals	2
26	Zinc	5
27	Arsenic (4)	1
28	Barium (4)	1.5
29	Iron	8
30	Manganese	1.5
31	Boron (4)	6

32	Chlorine	1

Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent.
Methylene Blue Active Substances; assuming surfactant as biodegradable
Pesticides includes herbicides, fungicides and insecticides
Subject to total toxic metals discharge should not exceed level given at S.N.25

* *The effluent should result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge.*

Note

Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.
The concentration of pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits

2.2.2.8 Ambient Noise

National Standards

No.	Area/Zone	Day Time	Night Time
		Limit in dB(A) Leq*	
1.	Residential Area (A)	55	45
2.	Commercial Area (B)	65	55
3.	Industrial Area (C)	75	65
4.	Silence Zone (D)	50	45

Day time hours: 6:00 am to 10:00 pm
Night time: 10:00 pm to 6:00 am
Silence zone: An area comprising not less than 100 meters around hospitals, educational institutions and courts

* dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

2.3 Technology Selection

The technology, steam conditions and unit size selected for the Project is typical of modern coal-fired units, and the major equipment is available from several suppliers. There are many similar installations worldwide, which will facilitate EPC Contractor selection.

2.3.1 Methodology

The technology selection is based on the following factors:

- Capital Cost
- Operation & Maintenance (O&M) Issues
- Commercial Demonstration
- Compatibility with Fuel

2.3.2 Investigated Alternatives

2.3.2.1 PC-Fired vs. CFB Technology Comparison

The following section compares Pulverized Coal ("PC") power plant technology using supercritical technology with Circulating Fluidized Bed ("CFB"), technology using supercritical steam conditions. As discussed in the previous section supercritical technology is the preferred steam conditions for this Project. However subcritical steam conditions are used for the CFB option because there are currently no supercritical CFB power plants in operation in any country.

The comparisons are based on the assumption that the capture of CO_2 is not envisaged. (Base case is taken as PC super-critical without FGD).

Issue	CFB	PC Supercritical
EPC Cost	5% higher than base case [1]	5% higher than base case
Net Unit Efficiency	Up to 35% [2] Similar coal consumption per	Up to 37 – 38 % [3] 5 - 7% lower coal

	MWh compared to base case	consumption per MWh compared to base case
Auxiliary Power Demand	4 – 6%; Potentially lower than other options as no FGD systems	7%; slightly higher than base case
Unit Size	350 MW maximum [4]	Up to 1000 MW
Turndown Ratio	35%	40%
Ramp Rate	3 – 5% per minute	2 – 3% per minute
Availability	85 %	85%
Fuel Flexibility	Very wide (Can use a very different types of fuel combination)	Limited fuel flexibility
Environmental	Inherently low NO_x, otherwise equivalent to the PC option.	Due to higher efficiency the quantity of effluent and emissions produced per MWh is lower than other options.
Desulfurization	Direct limestone injection into the boiler, however this produces a solid waste that cannot be recycled and also contaminates the fly ash	Limestone FGD will be required which produces gypsum. Gypsum marketing is possible, otherwise land-filling is necessary
Nitrogen Oxides	Due to low firing temperature thermal NO_x production is in minimal quantities	Low NO_x burners and over-fire air are standard design to meet environmental limits
Power Plant Footprint	Boiler area is typically 10% greater than base case for same size units	Same as PC sub-critical
Ash Disposal Area	Ash disposal area needs to be larger due to unmarketable solid waste produced by FGD If FGD is not required then the fly ash is more readily recycled, however there is a higher % of bottom ash, which is inherently less easy to recycle	Reduced due to higher efficiency Possible to market gypsum to some industries

[1] EPC cost will be nearly equal to PC (sub-critical) option depending on the type of FGD installed in the PC option

[2] Assuming sub-critical steam parameters

[3] Higher efficiencies are achievable with Ultra supercritical PC fired technology

[4] Unit size of 600MW currently under development

Based on the above comparison information, CFB Sub-Critical is preferable for this plant; due to improved suitability with the fuel specifications, acceptable efficiency, higher availability along with better emission control without any exotic equipment .

2.3.2.1 Supercritical vs. Subcritical Technology

The conventional method of generating electricity from coal is to burn it in a thermal power plant, which will raise steam for power generation. Depending on the steam pressure utilized the plant can be categorized as either:

- Subcritical Pressure Boiler
- Supercritical Pressure Boiler

The terms "subcritical" and "supercritical" refer to main Steam operation conditions being either below or above the critical pressure of water (220 bars or 22 MPa, 3,200 PSI-a). The significance of the critical point is the difference in density between steam and water. Above the critical pressure, there is no step increase in the density between water and steam.

The combined effect of high fuel costs and ever tightening emission limits has led to technological development of the power station boilers to have higher capacity and efficiency. This has led to a shift from subcritical to supercritical boiler pressure.

Subcritical Pressure Boiler

In the standard design subcritical boiler, water is heated in the waterwalls of the furnace and the two-phase flow of boiler water/steam goes up to the steam drum. The steam is separated in the steam drum with water being re-circulated to the waterwalls for further heating. In the low-pressure boiler, the circulation can be prompted by the difference in specific gravity between the two-phased flow of the water and the steam (natural circulation boiler). For boilers that operate at higher-pressure the slight difference in specific gravity is insufficient to assist the flow and so circulation pumps are required.

Supercritical Pressure Boiler

Higher steam temperature and pressure of the boiler improves the thermal efficiency of the plant. Super-critical pressure boiler generates steam at a pressure exceeding 22 MPa. Above the critical point there is no differentiation in state between liquid and gaseous form. Accordingly the steam drum for steam separation is not necessary, which means that all supercritical boilers are of once-through design. The lack of a steam drum means a decrease in the holding water quantity in the boiler and thus quicker response time to load fluctuations.

However, prompt control while ensuring safe operation requires highly automated control system. In addition, it requires strict water quality control. Sub-critical units typically use "All Volatile Chemistry", however at the elevated pressures of a supercritical unit this is not practical because the chemicals are prone to coming out of solution therefore a water chemistry regime called "Oxygen Treatment", has to be used.

The increased steam conditions of higher temperature and pressure requires thicker pressure-resisting parts and material upgrade, which will increase material costs, however this is partially compensated for by reduced amount of material required due to greater efficiency in generating power. The greatest cost benefit is in having less pollution control equipment and through reduction in the quantity of coal burnt.

Boiler Type Comparison

Type	Subcritical (drum)	Supercritical (once-through)
Pressure	< 22 MPa	> 22 MPa
Plant Generating Efficiency (Net) – Based on Lignite Coal	Up to 37%	Up to 39 %
Initial cost	~2% lower than supercritical	~2% higher than subcritical
Fuel Cost	5 – 7 % higher than supercritical	5 – 7% lower than subcritical
Advantages	Simple system enabling easier operation and maintenance Globally proven design Lower initial investment	Higher efficiency Reduced emissions/MWh Suitable for large capacity
Disadvantages	No plant larger than 900 MW has been constructed	Skilled operation/maintenance and strict water quality control are required Sophisticated automatic control

		system and high-grade materials are required

After comparing the two technologies from both a technical and economical standpoints, although the Supercritical technology would seem best, however it shall be noted that the super-critical technology with combination of CFB is not a commercial proven concept , there are only one operating reference (one project under execution) which does not provide sufficient reliable operating reference , however for the Subcrticial technology various plants are available in the world which can be seen as a close reference to this project , hence based on the this major factor it has been concluded that Sub-critical technology is the preferred design for this Project.

This is because that currently the proven experience of the Power projects for CFB is only available for the Sub-Critical power plant. Sub-critical power plants are more robust , proven & have sufficient operating experience available in Pakistan .

2.3.2.3 Integrated Gasification Combined Cycle (IGCC)

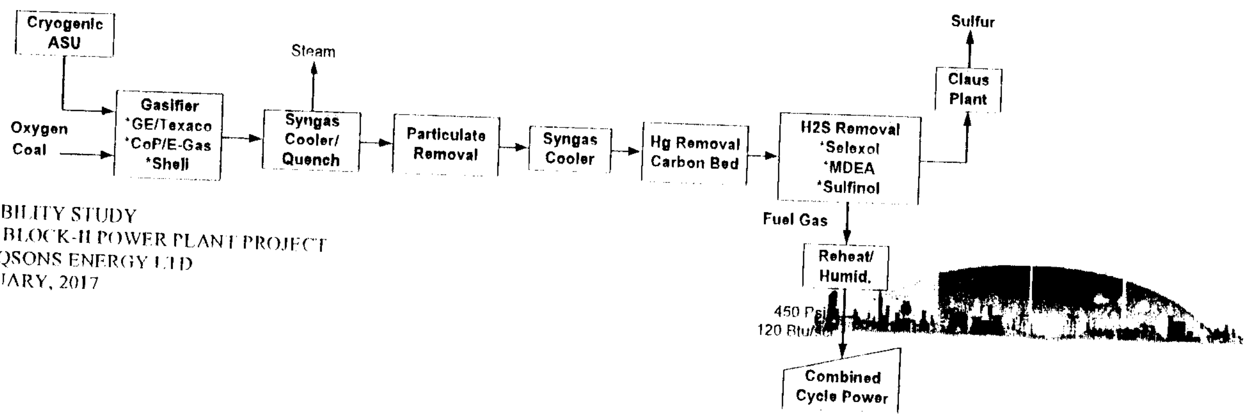
IGCC is a technology that turns coal into synthesis gas (syn-gas). It then removes impurities from the coal gas before it is combusted and attempts to turn any pollutants into re-usable byproducts. This results in lower emissions of sulfur dioxide, particulates, and mercury. Excess heat from the primary combustion and generation is then passed on to a steam cycle, similar to a combined cycle gas turbine, allowing achieving of higher efficiency compared to conventional pulverized coal.

There are about 15 different Technologies available for the Gasification on commercial scale for all of the synthesis gas applications (IGCC, Methanol, Methane, DME, Ammonia/Urea and FT liquids). The Major players having extensive experience in gasification filed are:

- Shell
- GE Energy (Chevron Texaco)
- Conocco Philips (E-Gas)
- Lurgi

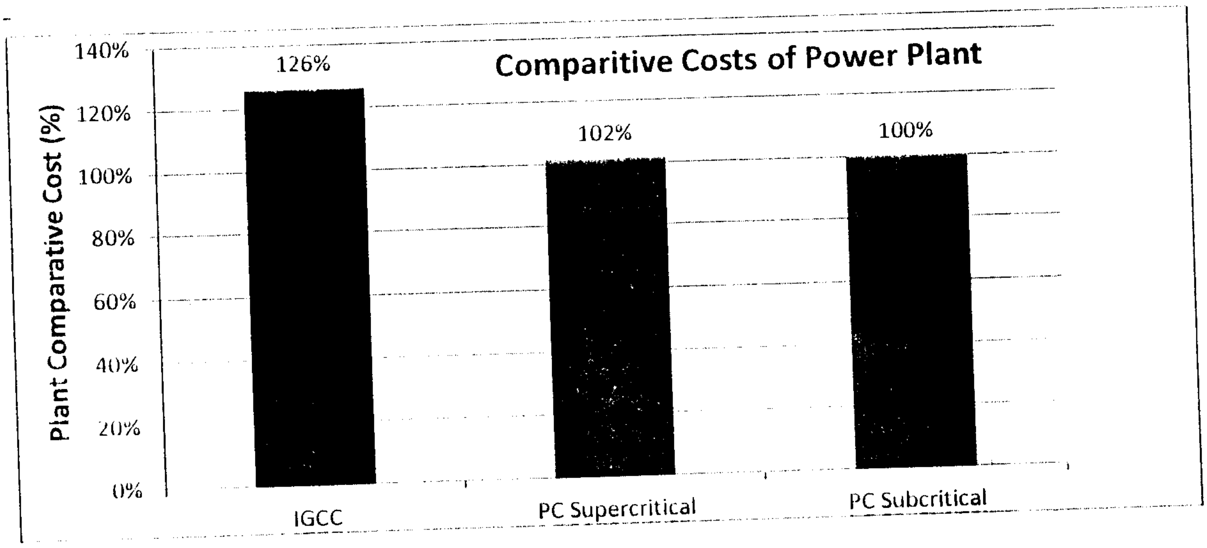
Process Description

Simplified process description is given below:



Coal, water and oxygen are fed into a high pressure gasifier, where the coal is partially combusted and converted into synthesis gas (syngas)
The ash in the coal is converted to inert, glassy slag
The syngas produced in the gasifier is cooled and cleaned of particles
The slag and other inert material may be used to produce other products or may be safely managed in a landfill
Next, the syngas passes through a bed of activated charcoal, which captures the mercury
The sulfur is removed from the syngas and converted to either elemental sulfur or sulfuric acid for sale to chemical companies or fertilizer companies
The syngas is fired in a combustion turbine that produces electricity
The hot exhaust from the gas turbine passes to a Heat Recovery Steam Generator (HRSG)
Steam produced in HRSG, along with additional steam that has is generated during gasification process, drives a steam turbine, which also produces electricity

A comparative cost and efficiency analysis of the different power plant options is given below.



The efficiency numbers in the Figure above are based on Lignite Coal.

To summarize the advantages of using an IGCC are:

- Higher efficiencies resulting in lower fuel cost
- Lower emissions (SO_2, NO_x and Particulates)
- Opportunity in future to utilize plant for production of chemicals (e.g. Diesel, Gasoline, Naphtha, LPG, etc.)

However, as can be seen from the figures above the difference in Capital Cost, of IGCC option vs. Supercritical Power Plant, is much greater than the efficiency difference between the two. However for the power plant at Thar, it is expected that Thar based power plant will be less sensitive to efficiency than to the Capacity prices / availability

For this reason it has been concluded that Sub-critical CFB Power plant will be the preferred power generation option for this Project.

2.3.2.4 Wet Cooling vs. Air Cooled Condenser (ACC)

Thar District is a semi-arid desert, currently having no surface water source in the area. The only water supply currently available is through LBOD or water wells pumping out saline groundwater.

In case LBOD water is not available, treated groundwater will have to be used as Project make-up water. Moreover, as the groundwater quantity available decreases during the later years of the Project, water demand for 330 MW power plants will require extensive re-use & reduce concepts

Major use of water in a conventional power plant is for condensing the exhaust steam from the turbine. It is considered for the efficiency & output targets of Power plant that Wet cooling will be employed however since such a cooling system uses requires significant volume of water also for auxiliary cooling.

For this reason, the option of utilizing Air Cooled Condensers (ACC) for complete cooling of Steam & / or auxiliary cooling is also investigated. In an ACC (dry) the exhaust steam is passed through condenser tubes. Ambient air through fans is passed over the tubes to dissipate the heat from the exhaust steam and condense it to water. The condensate is re-circulated in the feed water system.

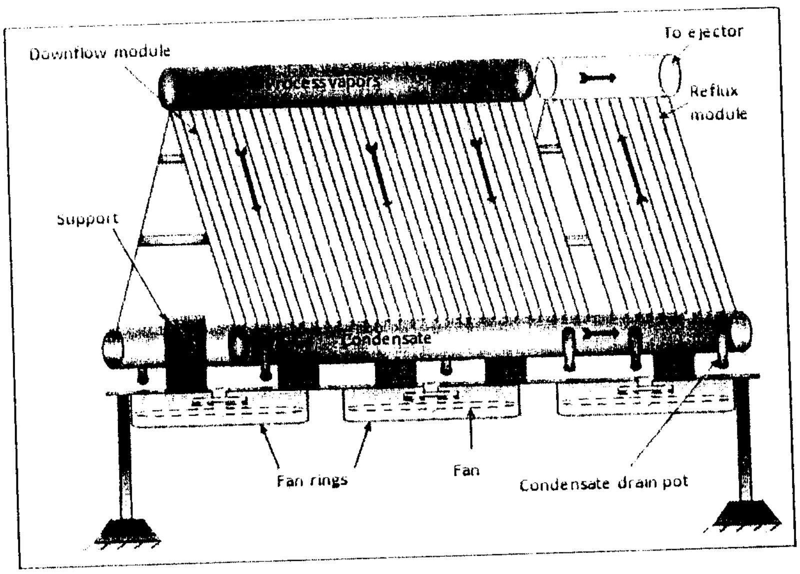
However, using ACC for exhaust steam from condenser would result in having an adverse effect on the final power tariff due to the following reasons:

- Higher Capital Cost of ACC system in comparison to Conventional Wet Cooling
- Higher auxiliary power consumption of ACC fans resulting in power output and efficiency losses
- Higher backpressure in turbine due to condensing of steam at higher temperatures (especially during the summer months in the desert) resulting in output and efficiency losses.
- Plant tripping risk during peak summer months

In spite of these disadvantages, the ACC option is worth considering due to the major water savings possible through it.

Additionally, the dependence on Wet Cooling system with increased number of water reservoirs / buffers can also be a strong possibility which is being studied.

During the detail design of the Project , the shifting of Auxiliary cooling on the ACC will be studied in detail , from preliminary calculation it can save around 1-2 cusec of water demand (if can be converted) -- however this will have some performance & equipment size changes which will be re-evaluated with EPC contractor. A schematic of such – Air cooled condenser is shown as below:



2.3.5 Equipment Redundancy

2.3.5.1 Function

The purpose of this discussion is to summarize the redundancy included in the design to ensure a high availability of the units.

The design of the Project will provide reasonable operational flexibility for the production of electricity. The Project will be designed for safety, easy accessibility and maintainability to allow for fast and efficient maintenance of equipment at minimum cost to the organization. The EPC Contract will be structured to provide design features, equipment, and tools required to achieve these goals. The requirement for a high level of reliability and availability for this Project will be met through a high degree of redundancy in components and systems.

2.3.5.2 Design Basis

The equipment excluding the power train (boiler, steam turbine, and main power transformer) will be designed with an N + 1 criterion[3] except where noted. Where exceptions are taken, it is due to sufficient reliability and that the effect failure of a single component being out of service is deemed acceptable.

The systems designed for this plant will have the following

Equipment	Number [% size]
Boiler Feed Water	2 x 50% ST Driven Pumps + 1 [40%]

[3] Where N represents the number of equipment required.

Pumps	Motor Driven Pump
Condensate Pumps	2 x 100%
Vacuum Pumps	2 x100%
Circulating Water Pumps	2 x 50%
Coal handling system	2x100 %

2.3.6 Vendor List

Below is tentative vendor list for the Power Project – it will be finalized after finalization of EPC Contract

No.	Equipment	Vendor
1.	Boiler	Alstom / Foster wheeler
2.	Steam Turbine	Harbin Boiler Company Limited Shanghai Electric Dong-fang Electric Corporation
3.	Steam Turbine Generator	Harbin Boiler Company Limited Shanghai Electric Dong-fang Electric Corporation
4.	Main Transformer	TEBA Shenyang Shandong Taikai Baoding Tianwei Xi'an XD Transformer Co., Ltd
5.	HGIS	Shandong Taikai Xi'an XD High Voltage Apparatus Co., Ltd.,

6.	DCS	Thermal Power Research Institute Guodian Zhishen GE GE Xinhua ABB Emerson Process Management

2.4 Technical Data

The following are the major technical data for the plant design.

Parameter	Value
Gross Capacity	330 MW (approximately) at annual average conditions at Turbine Rated Load (TRL)
Net Capacity	300.3 MW (target) at annual average conditions at TRL
Net Efficiency	37%
Main Steam Conditions – Per Unit Flow Pressure Temperature	 1098 t/h, 175 Bar 540 °C
Hot Reheat Conditions – Per Unit Flow Pressure Temperature	 907 t/h 36 bar 540 °C,
Coal Burn Rate	250 t/h, THA
Makeup water requirement – Plant Circulating Water Flow – Plant	~ 900 m^3/h ~45000 , m^3/h

Cooling Water Temperature rise (ΔT)	~ 10 °C
Brackish Water Flow to Desalination System – Plant (if applicable)	250 m^3/h
Potable Water Supply to Plant and Colony	10 m^3/h

2.4.1 Technical Limits

The following technical limits are applicable to the Project:

Unit Starts and Loading

Cold Start: A start after more than 72 hours continuous shutdown with boiler unfired and the cylinder metal temperature less than 40% of full load value

Warm Start: A start after more than 10 hours but less than 72 continuous shutdown with boiler unfired and the cylinder metal temperature between 40% - 80% of full load value

Hot Start: A start after less than or equal to 10 hours continuous shutdown with boiler unfired and the cylinder metal temperature above 80 % of full load value

Extreme Hot Start: A start after less than or equal to 1 hour continuous shutdown with boiler unfired and the cylinder metal temperature near full load value

Unit Starts and Loading

Cold start: A start after more than 48 hours continuous shutdown hours with boiler unfired

Warm start: A start after more than 8 hours but less than 48 continuous shutdown hours with boiler unfired

Hot Start: A start after less than or equal to 8 hours continuous shutdown hours with boiler unfired

Start Up Criteria

Hot Start 90 min

Warm Start 180 min

Cold Start 32 hours

Loading Rates and Load Range

Hot Start 10 MW/min above 45% load

Warm Start 10 MW/min above 45% load

Cold Start 10 MW/min above 45% load

Load range: approximately 30 - 45% to 100%

Frequency Limits

Nominal system frequency: 50 Hz

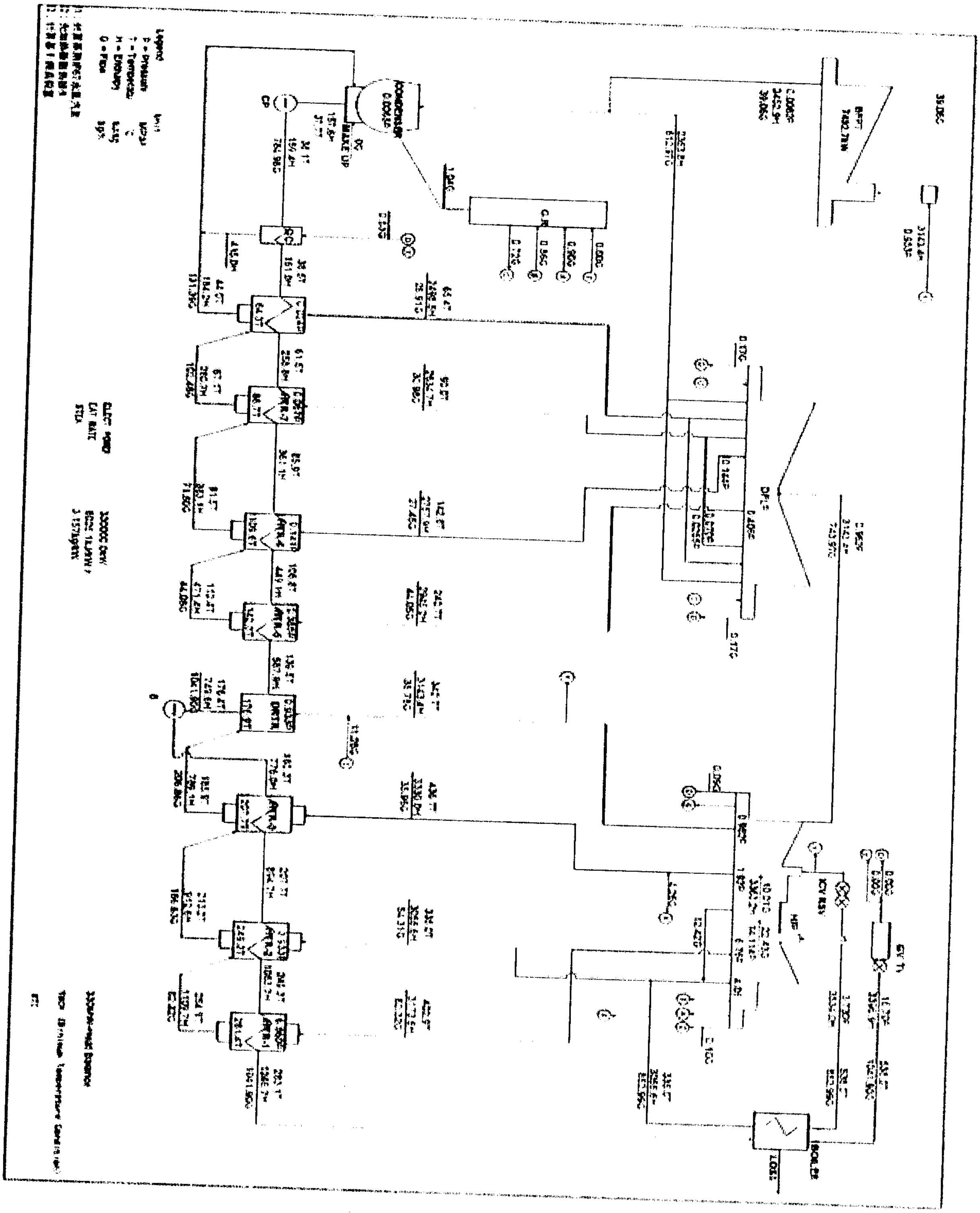
The following are the recommended limits to remove the generating units from the system:

Frequency Range Duration of Excursion (tentative)

Frequency	Permitted duration	Times
51.0 to 51.5 Hz	30 sec	30
48.5 to 51 Hz	Continuous Operation	
48.0 to 48.5 Hz	300 sec	300
47.5to 48.0 Hz	60 sec	60
47.0 to 47.5 Hz	20 sec	10
47.5 Hz or less	Immediate Trip	Immediate Trip
51.5 Hz or more	Immediate Trip	Immediate Trip

2.4.2 Heat Balance

The heat balances for the proposed cycle, , are included as below . The data shown includes Turbine Output and Heat rate and Plant Net Output and Net Heat rate.



2.5 Plant Layout

2.5.1 Basis for Plant Layout Design

The plant layout/plan is based on the following principles:

- Make efficient use of site topography and geological conditions by placing the main power units, cooling system and major buildings in better foundation condition. Plant layout designed to achieve smooth operation with good access to all key locations.
- Evident distinction between different facilities
- Vertical layout planning to estimate amount of earth work, etc
- Rational planning of water ditches and piping system
- Good conditions for construction facilities
- Rational planning of plant's entrance; environmental protection and soil & landscape conservation

2.5.2 Detailed Plant Layout

The layout shall be designed keeping in mind the site topographical conditions and interface point, e.g. water, coal and ash. Different areas are separated to ensure smooth operation.

The site is divided into 5 sections:

Main Power Generation Facility
Cooling Facility
Electrical Facility
Coal Handling Facility
Auxiliaries Facility

Main Power Generation Facility

This area consists of the Boiler building, Steam Turbine building, Boiler bunker, Control Room, Slag & Ash Silos and Air Compressor Unit. This area is arrange in the centre of the power plant to make it most accessible.

Cooling Facility

This section consists of the Wet Cooling Towers and Pumping systems and is arranged in the Northwest of the plant. Main equipments in this section are the Cooling Towers, Water Pumps, Water Dosing Units etc.

Electrical Facility

This section mainly consists of the Transformers, Distribution Equipment and Electrical Control Building.

Coal Handling Facility

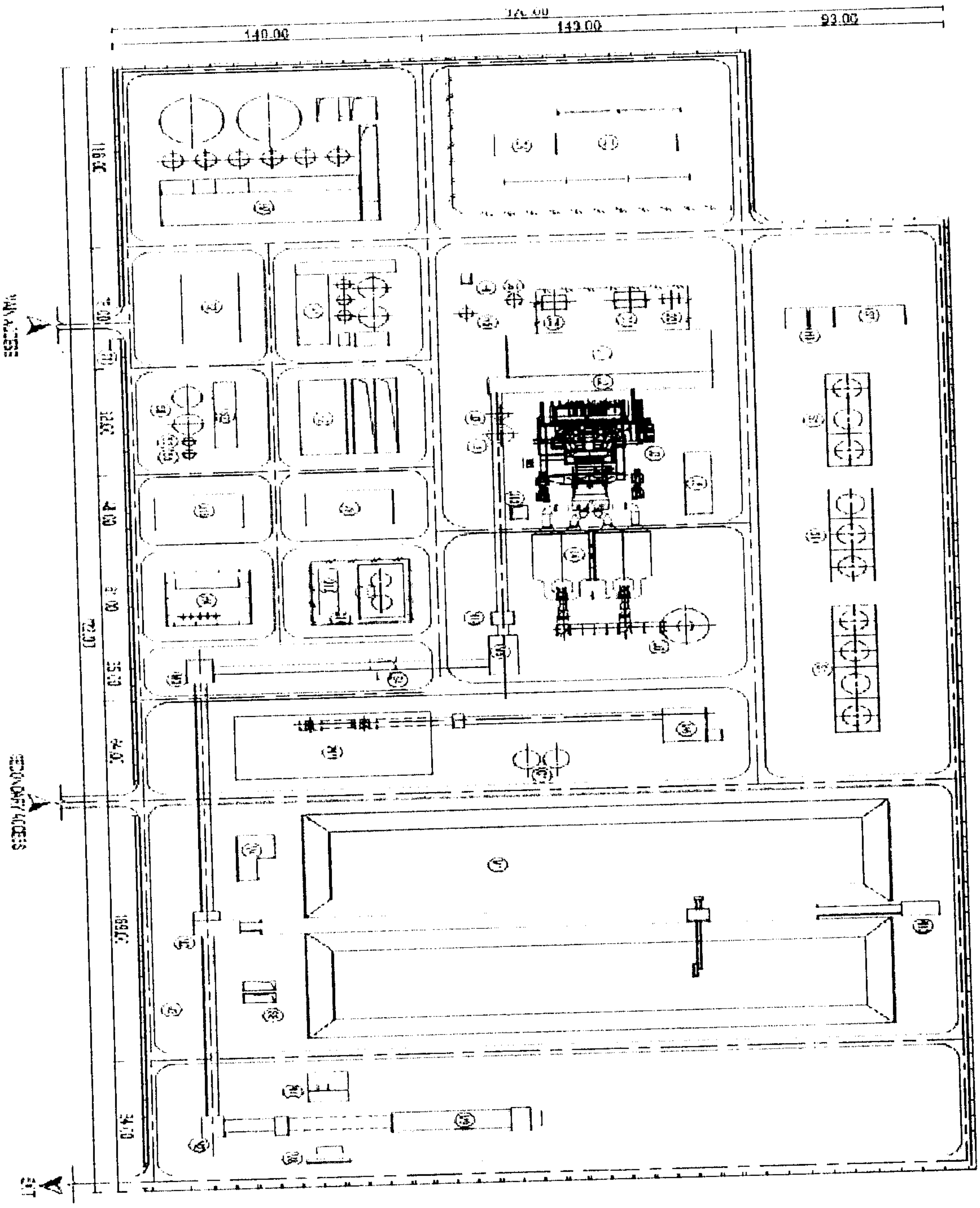
This area consists of the Coal Feeding Conveyor, Stockyard, Coal Stacking & Reclaiming System and Coal Testing Laboratory. The area is polluted due to coal particles and for this reason is located in the East of the Power plant (downstream of prevailing wind condition).

Auxiliaries Facility

This area is arranged in the West of the Plant and houses the Water Workshop, Water/Sewage Treatment Systems.

Hydrogen station is located in the Northwest of the Plant to minimize its impact on other buildings and structures. Coal Conveyors are arrange in the East of the Coal Crushers. Fuel Oil and Start-up Boiler System are arranged close to the Furnace. Offices and Workshops are arranged close to the main entrance.

The plant is designed to have a slope to allow rain water to flow in one direction. The rainwater flows to the side of the roads/pavements and is collected by the shallow trenches. From here the rain water flows in a pipe and is discharged to the outside of the plant.



THAR BLOCK-II POWER PLANT PROJECT
SIDDIQSONS ENERGY LTD
FEBRUARY, 2017

2.5.3 Plant Layout Safety Features

Biggest safety risks of the power plant are the fuel oil storage area and coal stockyard.

Due to the safety distance requirement, the fuel oil storage area is located in the southeast of the site, with ash silos in the north and start up boiler in the west. The oil storage tank is surrounded by a 1.8 m high fence.

Coal stockyard is located in the south of the plant having good access for firefighting trucks by roads.

The plant has two main roads and three secondary roads arranged around the power producing units. These roads provide good access for firefighting. Roads, having at least 4 m width, are arranged around main power building, oil storage area and stockyard.

Fire water main is laid in closed loops to ensure multi-directional flow around the plant. Isolation valves shall be provided so that sections of fire water main can be taken out of service for maintenance or repair. When maintenance or repair, the cut-off hydrants will not be more than 5 (five) sets.

The space of hydrants is as followings:

In main building area, spacing ≤ 80 meters
In oil storage tanks area, spacing ≤ 30 meters
In other areas, spacing ≤ 120 meters
In main building, indoor stand pipe and hose systems should be installed
1 (One) set test hose service should be installed at the main building top

The plant has two entrances, the main entrance is in the northwest corner of the plant, nearby the coal stockyard to facilitate the contact with the outside; the other entrance is located in the southwest corner of the power plant, mainly used for logistics and waste materials. The two entrances are at a distance of approximately 900 m.

2.5.4 Landscaping and Construction Area

The construction facilities for the plant will cover an area of about 10 hectares and will be located in the east side of the plant area. Temporary accommodation facilities for Contractor during construction facilities will cover an area of about 3 hectares and will be located in the west side of the plant.

2.6 System and Equipment

The final generation capability of the unit will be 300 MW (Net). Vendors have units or building blocks that are optimized for their design. To maximize the capacity and reduce costs, the final design needs to remain flexible until the final vendor selection is made.

The scope of the Project will include all work to develop the site including

Generating units:
Steam Generators - Boilers
Turbine Generators
Draft Fans
Stack
Deaeration and Coal Bunker
Air Compressor
Air Cooled Condenser Island
Cooling Tower
Circulating Water Pumps
Water Intake and Discharge Structures
Water Treatment System (for plant cycle makeup and domestic water for the plant and colony)
Wastewater Treatment System
Sewage Treatment System
Electro Static Precipitator
Ash Silo
Slag Silo
Startup Boiler
Auxiliary Power System – Diesel Engine
Auxiliary Boiler (Fuel Oil Fired)
Fuel Oil Pump System
Fuel Oil Storage Tank
Dike for Reservoirs
Oil Unloading Station
Accident Oil Pool
Hydrogen Generation Station
Foam fire equipment rooms

500-kV Gas-Insulated Substation (GIS) Switchyard
Step-up Transformer
Station Transformer
Auxiliary Transformer
Substation Relay Building
Switching Room for Air Condenser Island

Coal Receiving systems:
Coal Conveyor, Transfer Station System
Open Coal Yard
Coal Stacking & Reclaiming and Moving Equipment
Coal Crusher and Inlet Coal Sampling System
Coal Water Treatment System
Coal Bulldozer Maintenance System

Civil works:
Centre Control Room
Site Development
Roads
Drainage
Foundations
Buildings
Offices
Warehouses
Workshops
Colony
Camp for Construction Workers
Ash/Gypsum Storage Area

2.6.1 Mechanical Systems

2.6.1.1 Boiler

2.6.1.1.1 Function

The boiler converts the energy in the coal to high pressure steam. The steam is then discharged to the turbine.

2.6.1.1.2 Design Basis

The boiler is a subcritical CFB, outdoor coal-fired design. The boiler will be designed to burn lignite from the adjacent mine.

The ignition fuel is High Speed Diesel (HSD) and support fuel is Furnace Oil. These fuels will provide initial firing and will stabilize the combustion until the coal flames are stable, about 40% (minimum) load at this point minimum stable combusiton. Details of the design depend on the specific suppler chosen for the Project.

This boiler is expected to operate as a base load unit, but the design will include provisions to allow the units to operate at lower loads if necessary. One such provision will be the capability to operate in a sliding pressure mode. Sliding pressure operation will allow more efficient operation and reduced stress on the turbine and boiler parts.

The steam design conditions are shown in the Technical Data section.

The following major components are commonly supplied :

Boiler
Cyclones
Forced Draft Fans
Primary Air fans
Gas Recirculation Fans
Induced Draft Fans
Pulverizers
Air heaters
Soot blowers

There will be a minimum of two 50% air heaters, forced draft, primary air, and induced draft fans.

The following discussion is general; many of the details will vary depending on the manufacturer selected.

The modern large sub-critical boiler has the following major components:

Furnace
Super heaters
Reheaters
Cyclones

- Economizer
- Air preheater
- Steam Drum
- Burners

The components are discussed individually below.

Furnace

The furnace is an enclosure to provide space for fuel combustion and cooling of the combustion gases before the gases enter the convection pass. In the furnace area the fuel and combustion air are injected in a controlled manner to efficiently control the combustion. In the furnace walls the water is converted to steam.

The heat transfer in the furnace is largely radiant. At the top of the furnace, the tube arrangement changes to a vertical arrangement. The gases then rise to the convection pass, named because the heat transfer is by convection.

The coal will be fluidized & will be combusted across the length of the furnace.

Superheaters and Reheaters

The super heaters, Reheaters, and economizer are in the convection pass. Super heaters and Reheaters are inline tube bundles that increase the temperature of the saturated steam. There may be several superheater sections. These may be arranged as platen, intermediate, final, and primary superheaters.

Reheaters are designed similar to the super heaters except they operate at lower temperatures. The gas flow is from the final to the primary reheater. The steam temperature from the exit of the final super heater and the final reheater is the steam temperature entering the turbine high pressure and intermediate pressure turbines

Economizer

The economizer is a counter-flow heat exchanger for recovery of the heat remaining in the flue gasses at the exit of the primary reheater and/or super heater. The tube bundle is usually a serpentine arrangement of parallel tubes with the water flow opposite to the gas flow. Water enters the economizer from the feed water system and discharges to the furnace walls. Tube spacing is critical. Close spacing has better heat transfer but can result in plugging of the spaces with ash.

Air Preheater

There are several air preheater designs. One of the common designs is a Lungstrom which uses a metallic heat transfer surface that rotates at 1 to 3 revolutions per minute (rpm). Other designs use rotating hoods with a stationary metallic heat transfer surface. Radial and axial seals are required to control leakage between the air and gas sides. These seals must accommodate axial and radial growth in a difficult environment. Some new designs include automatic seal adjustments depending on temperatures.

The air preheater uses hot gases from the outlet of the boiler economizer to warm the inlet air discharged from the forced draft fans. The size of the air heater depends on the evaluation of the manufacturer to balance the size of the economizer and the size of the air heater. The air inlet to the air heater is typically 25 °C (77 °F), and it is heated to about 350 °C (600 °F). The hot gases from the boiler enter the air preheater at about 400°C (750 °F) and exit at about 175 °C (350 °F). Air heaters are usually the regenerative type.

Cleaning of the air preheater is done regularly on-line with sootblowers and off-line loads with water wash.

Soot blowers

At high temperature in the furnace, a part of the coal ash (which doesn't flow out with the flue gas) melts and forms slag. Slag formation occurs if temperature in the furnace exceeds the Ash Deformation temperature.

Slag formation can be problematic for the furnace as it can deposit on the heat transfer surfaces resulting in lowering the heat transfer in the boiler and ultimately decreasing the efficiency and output of the power plant. Slag can also deposit on the burner regions resulting in interfering with coal/air ratio and affecting combustion in the furnace.

Sootblowers are designed to clean soot and slag from the heat transfer surfaces of the boiler and air preheater. The number and location of the soot blowers will be determined by the boiler supplier based on experience with boiler design and similar coals. Steam is supplied at a constant pressure usually from the cold reheat pipe.

There are three general types of sootblowers: wall, retractable, and water cannon. Wall blowers use a stream of high-pressure steam to remove slag from furnace walls. They are inserted into the furnace and rotate in a circular pattern; typically 20 to 30 per furnace. Retractable sootblowers are used to clean convection passes using a long lance that is rotated in to the section to be cleaned; typically 30 to 40 per furnace. Water cannons direct a stream of water across the furnace to the opposite wall and part of the side walls. There are typically two when used to clean furnace walls: one on the front wall and one on the rear wall. Their control systems have become increasingly sophisticated in recent years, and they are commonly used for difficult coals.

2.6.1.1.3 System Operation

In normal operation, the fuel is gravity fed to the feeders from the coal silos. The feeders regulate the coal flow to maintain the steam generation required by the turbine. The coal then drops into the CFB Bed where it is circulated at 900 C. Air is blown into the furnace by primary air where it is combined with secondary air and combustion occurs. Primary air is also used for the fluidization of the bed.

The cyclones separate Fluidized bed with the Flue gas, the flue gas goes through air the rear pass , air preheater and precipitator. If required, a portion of the flue gas is bypassed through the Air Preheater and then to the chimney.

2.6.1.2 Turbine Generator

2.6.1.2.1 Function

The steam turbine-generator converts the energy in the steam to electrical energy. The steam is then discharged to the condenser.

The steam turbine is a tandem-compound design – condensing turbine. The final design is subject to Manufacturer's design

2.6.1.2.2 Design Basis

The steam turbine is designed to accept the steam flows as defined in the Technical Data section. The turbine-generator will operate at 3,000 rpm.

Extraction steam is routed from various sections of the turbine to the feedwater heaters. The cycle of the wet system is based on seven feedwater heaters: four low-pressure heaters, one deaerator heater, and three high-pressure heaters.

The following major components are supplied with the turbine:

- High-pressure turbine
- Intermediate-pressure turbine
- Low-pressure turbine
- Lubricating oil reservoir, pumps and piping

- Electro hydraulic control (EHC) oil system
- Generator
- Hydrogen seal oil system
- Exciter
- Control system

These components are discussed individually below.

High-Pressure Turbine

The High-Pressure (HP) turbine receives steam from the main steam pipe and expands it through several stages of blades. The steam that exits the HP turbine returns to the boiler through the cold reheat pipe. In the boiler, the steam is heated to the design reheat temperature and returned to the Intermediate-Pressure (IP) turbine.

Intermediate-Pressure Turbine

The steam is further expanded in the IP section. It is then brought to the Low-Pressure (LP) turbines after going through Reheaters

Low-Pressure Turbine

LP turbine is double flow, meaning that the steam enters at the center and flows out axially towards both the turbine end and the generator end. Large steam turbines have last-stage blades that are about 1.1 to 1.2 meters (42 to 48 inches) long.

All turbine sections have benefited in the past decades by improved blade designs that have improved efficiency and reliability. The most significant part of the power plant performance improvement is the turbine improvement.

Lubricating Oil System

The lubricating oil system includes the oil tank, pumps, coolers and piping. It controls the supply of clean oil to the turbine and generator bearings. The oil tank contains 7.5 m3 (2,000 gallons) or more of lubricating oil. The pumps are usually vertical pumps with the suction below the low oil level and the electric motors above the tank.

The main, auxiliary, and emergency pumps discharge to a header, where the oil is cooled to the design supply temperature, filtered, and distributed to each of the turbine and generator bearings. The oil discharged from the bearings is collected and drained by gravity to the tank.

Electro hydraulic Control Oil System

The EHC oil is a high-pressure oil system used to control the stop and control valves that regulate the admission of steam to the turbines. The system is constructed of mostly stainless steel components to maintain the required high level of cleanliness required. A fine filtering system also helps achieve the cleanliness.

Generator

The generator is directly coupled to the turbine shaft. The generator converts the mechanical energy developed in the turbine to electrical energy. The generator is filled with hydrogen gas to reduce the windage losses caused by the cooling flow inside the generator.

Hydrogen Seal Oil System

The hydrogen seal oil system seals the shaft ends of the generator rotor to reduce the escape of hydrogen from the generator. This system supplies a constant flow of lubricating oil from its tank to the seals at each end of the generator stator. This oil is collected and drained to degassing systems and the seal oil tank. It is also cooled in a similar manner to the lubricating oil system. Hydrogen gas is explosive, so this system is critical to the safe operation of the plant.

Static Exciter

The static exciter supplies the electrical energy to the generator rotor (field) to control the voltage and phase angle of the power generated in accordance with system needs.

Control System

The turbine control system is supplied by the turbine manufacturer to interface with all parts of the turbine generator. Among the items controlled are the steam stop and control valves.

2.6.1.2.3 System Operation

In normal operation, the steam is admitted to the HP turbine through the stop and control valves. After the steam is expanded through the HP turbine, it is returned to the boiler to be heated to the design temperature in the reheater section. The reheated steam then expands through the IP turbine and the LP turbines.

The control valves limit the steam flow to achieve the load required. Steam is extracted from the turbine at several points for use in the feed water heaters, which improves cycle efficiency. The amount of steam extracted will not be regulated with a control valve and is therefore termed uncontrolled.

The lubricating oil system contains the oil for the bearings of the turbine and generator. Pumps take suction from the tank-and after-coolers deliver the oil to each of the bearings to lubricate the surfaces and remove heat. The oil then returns to the main tank.

The EHC system is a separate high-pressure oil system that is used to open and close the stop and control valves as needed. The valves are opened to add more steam as load is increased and closed to reduce load.

The valves also close quickly to prevent over-speed in case load is reduced quickly or tripped.

The hydrogen seal oil system is a hydraulic seal between the generator stator and rotor to contain the hydrogen gas inside the generator.

2.6.1.3 Main Steam and Reheat Piping

2.6.1.3.1 Function

The major steam systems include the main steam, cold reheat, hot reheat, and extraction steam pipes.

2.6.1.3.2 Design Basis

Main Steam

The main steam pipe will carry the steam from the boiler super heater outlet to the steam turbine stop and control valves. Due to the operating temperature, this pipe is typically made of P91 or P92 material.

Cold Reheat

The cold reheat pipe will transport the steam from the HP turbine outlet to the inlet of the boiler reheater. Due to the operating temperature, this pipe is typically made of carbon steel.

Hot Reheat

The hot reheat pipe will carry the steam from the reheater outlet to the IP turbine inlet stop valves. Due to the operating temperature, this pipe is typically made of P91 or P92 material.

These pipe systems will be designed for the steam conditions established on the heat balances for the specific boiler and steam turbines selected and the requirements of the American Society of Mechanical Engineers (ASME) codes or equivalent Chinese standards. The reheat pipes are sized to result in a low pressure drop that is set by the turbine designer.

Extraction Steam

The extraction steam systems carry the steam from the individual turbine connections to the feedwater heaters.

The extraction pipes will have shut-off valves and air-assisted check valves as required by code and turbine manufacturer requirements.

The condensed steam in the feed water heaters is termed heater drains. These drains are cascaded from the higher pressure heaters to the next lowest operating pressure heater. Condensate from the lowest-pressure HP heater is drained to the deaerator and that from the lowest pressure LP heater is drained to the condenser. All feed water heaters are also provided with emergency heater drains, which can drain any heater to the condenser. This capability is needed when heaters are out of service, if leaks occur in the heater tubes, and at startup.

All the steam systems will have drain systems in accordance with the ASME water damage induction prevention guidelines. These include drain pots, drain pipes, level detectors, and drain valves.

The deaerator heater is a direct contact heater; it has no tubes. Also it has no heater drain; the drain is the suction connection to the feed water pumps.

2.6.1.3.3 System Operation

During normal operation, the steam will flow through the main steam line to the HP turbine inlet. Steam exhausted from the HP turbine will flow through the cold reheat line to the steam generator reheater inlet. The steam is reheated in the steam generator and will flow through the hot reheat line to the IP turbine inlet.

The cold reheat line generally supplies steam to the seventh feed water heater (depends on the turbine design). This, like all extractions, will be uncontrolled.

The extraction steam pipes will carry the steam from the individual turbine connections to the feed water heaters. The isolation and check valves are designed to isolate the feed water heaters from the turbine during a turbine trip. This capability will prevent turbine over-speeding due to the energy stored in the heaters. Feed water heaters installed in the condenser neck do not require this isolation because of the relatively low energy stored.

The heater drains will normally drain to the lower pressure heater. During startup, however, there is commonly inadequate pressure to accomplish this, so the heater is drained to the condenser. Also, if a tube leak occurs in a heater, the higher pressure water will leak into the shell. This will increase the flow of the heater drain. If a high level occurs in the heater shell, the emergency drain will open to the condenser. Relief valves will open to protect the heater shell from overpressure if the pressure exceeds the design pressure.

When heaters are out of service, the maximum load of the turbine may be reduced due to the increased steam flow through the LP turbine. This criterion is set by the turbine supplier and will depend on the project requirements and the supplier's design specifications.

2.6.1.4 Condensate system

2.6.1.4.1 Function

The condensate system transfers the condensed steam from the condenser hotwell, through the low-pressure feed water heaters, and into the deaerator heater.

2.6.1.4.2 Design Basis

The condensate system will be designed to provide a continuous supply of water from the condenser to maintain a constant level in the deaerator heater.

There will be three 50% capacity, or two 100% capacity, motor-driven condensate pumps, which will take suction through strainers from the condenser hot well. These pumps are typically vertical can-type pumps with the cans mounted in the concrete substructure. There will be a margin of 3% in flow and 10% in head in the pump design to account for wear and unknowns. A bypass system, with an automatic control valve, will be provided to ensure the required minimum flow through the pumps.

The system transfers the water through the condensate polisher, gland steam condenser, and all low pressure feedwater heaters. The temperature of the water is increased in each of the feedwater heaters. Also, water is supplied to the turbine hood sprays and other uses as required. The condensate will also be pumped through the steam jet air ejector if that is the system selected by the EPC contractor; rotary vacuum pumps may be used.

The condensate is deaerated in the condenser and is further heated and deaerated in the deaerator. The deaerator is elevated to provide adequate net positive suction head for the boiler feed pumps. Drains from the gland steam condenser and feedwater heaters will be returned to the condenser.

2.6.1.4.3 System Operation

The condensate pumps take suction from the condenser hot well and discharge to a common header. During normal operation, makeup water will be delivered to the condenser from the condensate storage tank to maintain the normal water level in the hot well. This flow is normally accomplished by the elevation in the condensate tank and the negative pressure in the condenser. Pumps will be provided to deliver the required water in cases of low water level in the tank or high demand.

Normally, one pump will operate at startup, and up to 60% load. Above 60% load, a second pump will be started. If a pump trips or if header pressure is below a predetermined level, then the third pump will be started automatically.

The bypass system will be controlled by the DCS system. It is typically wide open at initial startup, gradually closes as flow through the system increases, and is closed when the unit load approaches full toad.

2.6.1.5 Feed water

2.6.1.5.1 Function

The feed water system transfers the water from the deaerator, through the high-pressure feed water heaters, and to the steam drum

2.6.1.5.2 Design Basis

The feed water system will be designed to provide a continuous supply of water from the deaerator heater to the boiler steam drum.

There will be two turbine-driven 50% capacity pumps and one 40% motor-driven startup pump. The final decision on turbine-driven pumps or motor-driven pumps will be up to the EPC contractor. In general, the studies done comparing these designs indicate that there is little or no difference in the total evaluated cost. The capital cost will be higher for the turbine-driven option but operating costs will be reduced. In either case, the net plant output will not be changed.

These pumps are typically barrel-type pumps with the barrel supported on a steel base. There will be a margin of 3% in flow and 10% in head in the pump design to account for wear and unknowns. A bypass system, with automatic control valve, will be provided to ensure the required minimum flow through the pumps.

These pumps typically use a variable-speed drive. The variable speed may be achieved by variable speed motors or fluid couplings, hydraulic coupling will be selected in this project . The variable speed allows the pump to operate at close to the minimum speed required for the load at any particular time. This capability reduces the power requirements, recirculation flow and wear of the pump. The wear on the pump is a particularly significant factor during startup if variable speed is not provided.

The system transfers the water through the high-pressure feed water heaters. The temperature of the water is increased in each of the feed water heaters. Also, water is supplied to attemperators and other uses as required. The water to the reheat attemperators is supplied from an inter-stage connection on the pumps.

2.6.1.5.3 System Operation

The feed water pumps take suction from the deaerator and discharge to a common header. The header is the main feed water line which connects to the HP feed water heaters. The discharge from the last heater connects to the boiler economizer inlet.

For wet system, normally only motor-driven pump will operate till 25 – 30% load after which the turbine-driven pump is also started. If a pump trips or if header pressure is below a predetermined level, the second pump will be started automatically.

The pump speed and the bypass system will be controlled by the DCS system. The bypass is typically wide open at initial startup, gradually closes as flow through the system increases, and is closed when the unit load approaches full load.

2.6.1.6 Circulating Cooling Water System

2.6.1.6.1 Function

In a wet cooled unit, the circulating cooling water system will cool the main condenser and the closed cooling water system. A part of the heated water is lost through evaporation in cooling tower to maintain the temperature of the cooling water system.

2.6.1.6.2 Design Basis

A mechanical draft cooling tower will be used for the Project

The cooling water will be sourced from the plant raw water pretreatment and desalination system. The circulating cooling water system is used for condensing steam exhaust from Steam Turbine and Boiler feed water Steam Turbine Pumps. It is also used for cooling down of closed cooling water system.

In order to reduce the water requirement, the desalinated water quality will allow circulation of water up to 5 times (Cycle of Concentration) before it is extracted by the blow-down system. The blow-down system is used to maintain the chemistry of the cooling water at the desired level. The heated up cooling water is sent to the cooling tower, where it is cooled by evaporation. Makeup water will compensate for the water lost due to evaporation and blow-down

The system will use two 100% pumps. The pumps will be twin suction horizontal pumps and will be installed in the circulating water pump house.

Cooling of closed cooling water system will be carried out in two 50% shell and tube stainless steel heat exchangers.

<u>Condenser</u>

The power plant condenser will be a shell-and-tube heat exchanger. The function of the condenser is to condense exhaust steam from the main power cycle steam turbine and boiler feed pump turbine. The condenser has other functions, as well:

- Recover condensed steam as condensate
- Provide for short-term storage of condensate

Provide a low-pressure collection point for condensate drains from other systems in the plant

Provide for deaeration of the collected condensate

Steam from the turbine is condensed by rejecting the heat of vaporization to the circulating water. The condensate is collected in the condenser hot well from which the condensate pumps take suction.

The total circulating cooling water flow will be about 45,000 m^3/h for the unit, based on a 10 °C temperature rise through condenser.

The system will include expansion joints at the pump discharges and at the inlet and outlet of the condenser. The system will include motor-operated valves that will allow single pump operation and isolation of one half of the condenser for maintenance. The condenser will be a one- or two-pass unit with valves to allow part-load operation with one half the condenser out of service. A condenser tube cleaning system will be provided to permit periodic cleaning with the unit on line.

Cooling Tower

Cooling towers are evaporative towers that derive their primary cooling effect from the evaporation that takes place when air and water are brought into direct contact. A mechanical draft cooling tower will be used for this Project. A mechanical draft cooling tower uses large fans to produce airflow through the tower fill. Water is distributed over the tower fill and heat transfer takes place by evaporation and convection as a result of water to air interface.

There are two types of mechanical draft towers:

Forced Draft Cooling Towers: Have fans mounted at the base of the cooling tower. Air is forced in at the bottom and discharged through the top of the tower. The distinguishing airflow characteristic is a high inlet air velocity and a low exit air velocity. This characteristic can lead to excessive recirculation and decreased stability of thermal performance when compared to the induced draft tower. Recirculation describes the phenomenon of portions of the warm, moist air of the tower exit air plume being drawn back into the tower air intake, raising the inlet wet bulb temperature.

Induced Draft Cooling Tower: Have the fans located downstream of the tower fill section so that the air is pulled through the fill section. The distinguishing airflow characteristic of this induced draft arrangement is a lower inlet air velocity and a higher exit air velocity. Exit air velocities three to four times higher than inlet velocities are common. The higher exit velocity reduces the tendency for a reduced pressure zone to be created at the air inlet by the action of the fan. This greatly reduces the potential for excessive recirculation.

The induced draft tower is by far the most common type of mechanical draft used in utility power plant service. This Project will also use induced draft cooling tower technology.

2.6.1.6.3 System Operation

The circulating water pumps will draw water from the raw water treatment system and discharge through motor-operated discharge valves. One circulating water pump will operate, while the other is in standby.

The tube cleaning system will be operated as needed to optimize the operation of the unit based on backpressure and cleaning system operating costs.

2.6.1.7 Air Cooled Condenser (ACC)

2.6.1.7.1 Function

In case an ACC system is employed in one the units for auxiliary cooling, the condensation of the exhaust steam from the unit's steam turbine is carried out by using ambient air for heat transfer. The cooling of closed cooling water system will be carried out by circulating water system of the other (wet) unit. Design of circulating cooling system of the other unit caters for this heat duty.

ACC transfers heat by convection and radiation instead of evaporation as the wet towers do. The circulating water makeup requirements are reduced to zero, making this an ideal arrangement from an environmental standpoint, particularly in areas of water scarcity. However, efficiency losses are encountered due to high backpressure in turbine (due to higher steam condensation temperature) and higher auxiliary power consumption of ACC.

The final design will be done by the joint collaboration of EPC contractor & Supplier , it shall ensure that the design is desert proof & can hold high temperature variations across an operating envelope.

2.6.1.7.2 Design Basis

An ACC system involves condensing the turbine exhaust steam in air-cooled heat exchanger bundles. ACC can also be either mechanical or natural draft cooling tower designs. A mechanical draft ACC system shall be used for this Project. The following are the specifications of the ACC system to be installed:

Initial Temperature Difference (ITD) between Steam and Cooling Air: 35 °C

2.6.1.8 Closed Cooling Water System

2.6.1.8.1 Function

The closed cooling water system will cool all water-cooled equipment in the plant, except the main condenser. The system will use a portion of the circulating cooling water system flow to cool a closed-loop freshwater system. The heated circulating water will be cooled by evaporation in the cooling tower.

2.6.1.8.2 Design Basis

The system will use demineralized water for initial filling and makeup as needed. The water will be treated with corrosion inhibitors to minimize corrosion in the piping and heat exchangers. Two 100% capacity pumps will pump the fresh water through the two 65% capacity heat exchangers and the cooled equipment, through a closed system, and return to the pump suction. An expansion tank will be provided to accommodate the thermal expansion and provide a supply of water for makeup required by small leaks.

The system will provide cooling water to the following equipment:

Main turbine oil coolers
Generator hydrogen coolers
Exciter coolers
Generator stator oil coolers
Boiler auxiliaries (as needed)
Feedwater pump coolers
Water and steam sample coolers
Large motor coolers (if required)
Air compressors (if required)

The closed cooling water pump design will include at least 5% flow margin. The heat exchangers will include at least 10% heat duty margin.

The heat exchangers will be the shell and tube type with stainless steel material.

2.6.1.8.3 System Operation

In normal operation, both closed cooling water pumps (one working on partial load) will circulate water continuously through the loop. An automatic bypass valve will be provided to maintain at least a 30% flow through the pump and heat exchanger. The low load pump will automatically switch to full load in case the main pump trips.

A low water level in the expansion tank will be alarmed in the control room. Water will be added through a manual valve from the demineralized water system.

A grab sample valve will be used to periodically obtain a sample for testing.

Equipment temperature will be controlled by automatic temperature control valves at each of the major coolers. Small coolers may be manually controlled.

2.6.1.9 Reverse Osmosis Desalination

2.6.1.9.1 Function

As explained in the sections above, the water source will be either LBOD water supplied by GoS or groundwater extracted during the mining operations.

If LBOD water is available, no desalination will be required and canal water can be used directly after clarification.

In case, LBOD water is not available, the power plant will be based on groundwater.

The desalination system removes the majority of dissolved and suspended impurities from raw water, allowing the treated water to be used for service water and makeup to the potable water treatment system and demineralizer systems.

2.6.1.9.2 Design Basis

One common desalination system with two 50% trains will be provided for the plant. The desalination system will be designed based on the following parameters:

- Raw Water analysis in accordance with data available data
- Maximum service water requirement
- Maximum potable water requirement
- Maximum cooling water requirement
- Maximum demineralized water requirement

The desalination system is essentially a two-pass reverse osmosis (RO) system consisting of a first-pass raw water RO unit with pretreatment and a second-pass freshwater RO unit. Based on the above requirements, each 50% train of the brackish water RO unit will be designed to produce half of the maximum flow of desalinate water. Similarly, each 50% train of the freshwater RO unit will be designed to produce half of the maximum flow of treated water suitable as makeup to the demineralization system.

As part of optimization of water system , a reuse concept will be introduced , the reuse & optimization of membrane selection shall result in an improvement in recovery , it is expected that with careful modulation of the water streams – a 75% recovery can be achieved.

Desalinated water requirement of the power plant in this case is around 1200 m^3/h.. The desalinated water quality will be similar to LBOD water (TDS around 400 – 500 PPM).

2.6.1.9.3 Description

As stated above, the desalination system is essentially a two-pass RO system with pretreatment. Raw water from the intake structure that enters the desalination system , first treated in a two-stage, multi-media filtration system that includes coarse and fine filtration, respectively. Coagulants and polymers may be added to the raw water to assist in the filtration process. The filtered water then passes through cartridge filters and enters the suction of the first-pass RO booster pumps that provide the necessary pressure to pump the water through the first-pass RO units. Chemicals are added at the inlet of the first-pass RO units for pH and scale control and dechlorination. The desalinated water that passes through the first-pass RO units enters the service water storage tank. The service water storage tank is provided with various sets of transfer pumps for pumping desalinated water to:

- Various users within the service water system on a near-continuous basis.
- Potable water treatment system on an intermittent basis on demand

Fire water supply system on an intermittent basis on demand
Open cooling water system on a continuous basis
Inlet of the second-pass RO booster pumps and through the second-pass RO units to the demineralized water storage tanks

The desalination system produces wastewater streams associated with filter backwashing and the dissolved solids that are rejected by the first-pass RO units (brine). The backwash and brine streams are sent to a local sump and then routed to the plant's wastewater treatment/effluent disposal system. There is also a relatively good quality brine stream associated with the second-pass RO units that is recovered, stored and recycled to the inlet of the first pass RO units.

The overall Recovery (percentage of desalinated water produced from groundwater) will be about 75%.

2.6.1.9.4 System Operation

<u>Normal Operation</u>

During normal operation, the pretreatment system and first-pass RO units are operated intermittently at their rated capacity based on level in the service water storage tank. Chemicals are automatically added to the pretreatment and first-pass RO units based on flow and signals from analytical instruments for pH, oxidation-reduction potential, etc. Coarse filters are backwashed daily, and polishing filters are backwashed weekly, as required. When the first-pass RO units are operating, there is a continuous stream of brine that is routed to the wastewater treatment system along with the intermittent filter backwash.

The second-pass RO units are operated intermittently at their rated capacity based on level in the demineralized water storage tanks. When the second-pass RO units are operating, there is a continuous stream of brine that is routed to the inlet of the first-pass RO units.

Depending on demand, one or both trains in either the first- or second-pass systems may be on standby for extended periods of time. Provisions are included to periodically flush the membranes in each RO pass to prevent bio-growth and maintain cleanliness.

The RO units are taken out of service and chemically cleaned annually or semi-annually based on operating history and performance. The membranes are replaced at three- to five-year intervals, again depending on operating history and performance.

<u>Abnormal Operation</u>

The plant will be tracking the normalized performance of the desalination system using software that trends output and quality of the treated water and accounts for factors such as the age of the membranes and raw water temperature. When the normalized performance drops below the expected trend line, it will be necessary to take appropriate remedial measures, which may include adjusting the chemical feed rates or product recoveries or taking the units out of service to either chemically clean or replace the membranes.

2.6.1.10 Demineralization

2.6.1.10.1 Function

The demineralizer system provides further treatment of water to make it suitable for Boiler Feed Water and Closed Cooling Water. The demineralizer produces water suitable as cycle makeup CFB subcritical boiler

2.6.1.10.2 Design Bases

One common demineralization system with two 100% trains will be provided for the plant. The demineralization system will be designed based on the following parameters:

Clarified Water quality or second pass RO treated water quality in accordance with supplier guarantees

Net capacity equal to ~5% of main steam flow

Based on the above requirements, each 100% mixed-bed unit will be designed to produce a net output of 50 m^3/hr of demineralized water.

2.6.1.10.3 Description

The demineralization system is essentially a polishing mixed-bed facility complete with the necessary regeneration equipment. Clarified canal water or treated water from the second-pass RO units is pumped from the demineralized water storage tanks through the mixed-bed polishers into the condensate storage tanks.

Instrumentation is included to monitor the quality of water from the demineralizer system and to determine when regeneration of a mixed-bed polisher is required. A complete regeneration facility is provided including acid and caustic storage tanks and metering skids, hot water tank, regeneration water pumps, and mixed-bed blowers. Regenerant wastewater is collected in a local building sump and pumped to the industrial wastewater treatment facility.

2.6.1.10.4 System Operation

Normal Operation

During normal operation, the demineralizer system is operated intermittently at its rated capacity based on the level in the condensate storage tanks. The service cycle continues for a preset time or throughput or until the demineralized water quality indicates that regeneration is required. Under normal operating conditions, mixed-bed regenerations will probably be required weekly or semi-weekly. When regeneration is required, the operating mixed bed is taken out of service and the spare unit is placed in operation. Regeneration is automatic following manual pushbutton initiation and includes several steps for resin separation, regeneration, rinsing, and mixing of the cation and anion resins. After regeneration has been completed, the mixed-bed polisher is placed in standby and is ready for service when the other operating unit becomes exhausted. Wastewater produced during the regeneration process is sent to a local building sump from where it is pumped to the industrial wastewater treatment facility.

Abnormal Operation

Abnormal operation would correspond to a situation in which the mixed bed run length is significantly reduced and/or the demineralized water quality is adversely affected. In this situation, an investigation would need to be performed that would evaluate key parameters including feed water quality, resin condition, quality of regenerant chemicals, etc, in order to determine the appropriate corrective actions.

2.6.1.11 Condensate Polishing

2.6.1.11.1 Function

The condensate polishing system removes ionic and suspended contaminants from the condensate, allowing feed water cycle chemistry to be maintained in accordance with industry guidelines and the requirements of the boiler and turbine manufacturers.

2.6.1.11.2 Design Bases

Two complete condensate polishing systems will be provided, one for each unit. There will be three 50% condensate polisher vessels per unit. The condensate polishing system associated with each unit will be designed based on the following parameters:

Condensate flow rate at 100% load, valves wide open (VWO)
Condensate pump shutoff head
Maximum condensate temperature

2.6.1.11.3 Description

A full-flow deep-bed condensate polishing system is provided for each unit. The system associated with each unit consists of three 50% condensate polisher service vessels. A resin trap is provided at the outlet of each service vessel to remove any resin fines. Each service vessel also includes a recycle pump that is used when a vessel containing a freshly regenerated resin charge is being placed in service. A sampling system is provided to monitor the level of contaminants at the common inlet of the system and the outlet of each service vessel.

The condensate polisher resin is externally regenerated. The exhausted resin is hydraulically sluiced to the external regeneration system. One complete external regeneration system is provided for each unit. The external regeneration system consists of four vessels for resin separation, cation regeneration, anion regeneration and mixing, and holding of the freshly regenerated cation and anion resin. Alternately, the regeneration system may include a resin separation vessel that serves a dual purpose and is also used to regenerate either the cation or anion resin. A freshly regenerated resin charge in the mix-and-hold vessel is eventually hydraulically transferred back to a service vessel. As discussed above, the service vessel that has received the freshly regenerated resin is put in recycle mode for a short period after being returned to service to ensure that any contaminants will not enter the feed water cycle.

2.6.1.11.4 System Operation

Normal Operation

During normal operation, two of the three-condensate polisher service vessels will treat the full condensate flow. When the resin in one of the two operating service vessels is exhausted as determined by either conductivity or differential pressure, the vessel is removed from service and the resin is transferred to the external regeneration system. The standby service vessel containing a freshly regenerated resin charge is slowly placed in service by first recirculating condensate through the vessel until the product water quality is acceptable.

2.6.1.12 Wastewater System

2.6.1.12.1 Function

The wastewater system treats industrial and sanitary wastewater from the power plant to produce effluent of an acceptable quality that can be discharged after being reused upto maximum level.

2.6.1.12.2 Design Basis

One common wastewater treatment system with a single 100% train will be provided to treat process wastewater generated by the plant. The wastewater treatment system will be sized for the maximum expected flow based on the plant water balance.

Details of the effluent disposal specifications are provided in the EIA report. The effluent to be disposal procedure will be in accordance to the National Environmental Quality Standards (NEQS).

A sanitary treatment facility will be provided to treat domestic wastewater from the power plant and colony. The sanitary treatment facility will be sized based on a total population of 500 people and waste production of 100 liters/day/person.

2.6.1.12.3 Description

Industrial Wastewater Treatment

At various locations within the plant, there will be sumps and packaged oil-water separators for the interim collection of wastewater and treatment of oily wastewater, respectively. Mixed bed demineralizer and condensate polisher regenerant wastewater will be treated at the power block in a packaged neutralization system consisting of a tank with internal mixing device, recirculation pumps, pH controls, and chemical addition systems. All remaining wastewater will be pumped to one of two equalization ponds. One pond will provide collection and interim storage of low-volume wastewater and material storage runoff. The other pond will provide collection and interim storage of metal cleaning wastewater.

Wastewater from each pond will be treated separately on an as-needed basis in a common physical-chemical treatment system. The wastewater treatment process is expected to include several steps. Raw wastewater introduced to the treatment process first enters a reaction tank where lime or caustic is added to raise the pH. After pH adjustment, the wastewater enters an oxidation tank with air sparging where metals are oxidized and precipitated as metal hydroxides. The wastewater stream containing precipitated metals and other solids then enters a flocculation tank followed by a lamella (inclined plate) clarifier in which solids are removed.

. The components of the treatment process are arranged to allow gravity flow throughout the entire process into the monitoring basin. The treatment process includes a thickener and filter presses for mechanical sludge dewatering such that a solid waste byproduct is produced that can be land filled.

Sanitary Wastewater Treatment System

Several lift stations will be provided for transporting raw sewage from the main power block and outlying areas to the sanitary treatment system.

The concrete basin extended-aeration type sewage treatment plant equipment contains an integral submerged bar screen at the inlet to the surge tank compartment. Dual sewage pumps provide a flow to the aeration tank chamber based on the depth of water in the surge tank. Flow from the aeration chamber to the dual hopper clarifier is by gravity. Aeration blowers are mounted above the aeration tank and supply air to the biological treatment process. The resulting solids are settled into downstream clarifier hoppers while floating solids are skimmed from the clarifier surface and returned to the aeration chamber. The clarified effluent flows into an integral chlorine contact tank where sodium hypochlorite is added before discharge.

There is an integral airlift system for the return of settled solids from the clarifier hoppers to the aeration basin.

The treated sanitary effluent will be used for watering of the greenbelt (man-made vegetation areas) surrounding the power plant and within the colony.

2.6.1.12.4 Description

Normal Operation

During normal operation the brine produced, if desalinated groundwater is used, will be sent directly to the evaporation ponds . Cooling tower blow-down will be reused

During normal operation, the mixed bed demineralizer and condensate polisher systems are each regenerated intermittently. Interlocks are provided so that only one system can be regenerated at a time. When regeneration occurs, the wastewater is pumped from a local sump to the neutralization system. After the regeneration process has been completed, the wastewater is recirculated through the neutralization tank and acid or caustic is added for pH adjustment. After the wastewater has been sufficiently neutralized, the recirculation step is terminated and wastewater is pumped to the effluent-monitoring basin.

Other low volume and material storage runoff wastewater generated within the power plant will gradually accumulate within the first equalization basin. After a sufficient volume of wastewater has been collected, transfer pumps within the pond are turned on to forward the wastewater to the treatment system. The treatment system is operated at its rated capacity until the pond has been sufficiently emptied. During operation of the treatment system, the monitoring basin is continuously sampled for pH and grab sampled for other constituents as required, and wastewater continues to be discharged as long as the effluent quality is within specification. While the treatment system is operating, dewatered sludge is being produced on a semi-continuous basis and collected within dumpsters that are periodically transported to an on-site landfill.

The second equalization basin is used to store metal cleaning wastewater including air heater wash and boiler chemical cleaning waste. These streams are generated in large quantities on a very intermittent basis, only when these operations occur. After the washing or cleaning operation has been completed, the treatment system is used to process metal cleaning wastewater until the pond has been sufficiently emptied.

Abnormal Operation

Abnormal operation corresponds to a situation in which the treatment system is unable to operate at its rated capacity and/or the effluent quality is adversely affected. In this situation, an investigation would be performed to determine the root cause(s) of the operating deficiencies so that the appropriate corrective actions can be taken.

Abnormal operation may also correspond to a situation in which excessive quantities of wastewater are being generated. This situation is likely to occur during initial startup of the units. To some extent, the equalization ponds as well as the treatment system itself will have some design margin. However, when the levels in the ponds remain high for extended periods despite operating the treatment system at high capacity factor, it would be prudent to determine the root cause(s) and take the appropriate corrective action.

2.6.1.13 Emission Controls

2.6.1.13.1 Low NO_x Combustion

Function

When air is used as the source of oxygen for combustion, the heat of combustion causes significant conversion of nitrogen and oxygen to various oxides of nitrogen (NO_x). The Project will be outfitted with CFB Boiler inherent Low-NO_x combustion technology, designed to keep NO_x generation to a minimum.

Design Basis

As per the IFC Environmental Guidelines (2008), the NO_x emissions should be lower than 510 mg/Nm^3 (248 PPM) for a non-degraded air shed. A guarantee lower than this value will be requested from the supplier.

2.6.1.13.2 In-Situ Flue Gas Desulfurization

Function

During coal combustion virtually all the sulfur is converted to sulfur dioxide (SO_2) gas. The Project will be equipped with In Situ flue gas desulfurization (FGD) system to ensure that the concentration of SO_2 in exhaust is below the limits set by the Local and International Environmental Guidelines.

Design Basis

As per the IFC Environmental Guidelines (2008), the SO_2 emissions should be lower than 850 mg/Nm^3 (298 PPM) for a non-degraded air shed.

2.6.1.13.3 Bag house/Electrostatic Precipitator

Function

Coal is impure, containing significant quantities of non-combustible material. Non-combustible material is known as ash. A portion of the ash forms large particles and falls to the bottom of the furnace. This is known as bottom ash/slag. The rest of the ash (typically 70-80% of the ash in a pulverized coal boiler) forms fine, lighter particles that are carried out of the furnace by the flue gas. This is called fly ash. The Project will be fitted with a particulate control system to remove nearly all the particulates form the flue gas.

Design Basis

The particulate collector is expected to operate at an emission rate of 20 – 30 mg/Nm^3. Conventional means of collecting the particulate matter include electrostatic precipitation (ESP) or a fabric filter bag-house. In this case, either is fully capable of meeting the operating point, as well as a guarantee lower than that.

System Operation

The ESP consists of a box that is an enlarged section of duct, to slow the gas velocity down. Metal plates hang in the box parallel to flow, such that the flow is channeled between them. Also between them are flanging electrodes, either solid ones or weighted wires. Transformer/rectifier (T/R) sets step up the power to high voltage and convert the current to DC. The voltage is applied between the plates and the electrodes, such that the electrodes charge the particles, then the particles are attracted to the oppositely-charged plates. Periodically, the plates are rapped with automatic hammer assemblies, which causes the ash to fall into hoppers below the plates.

The baghouse consists of a compartmentalized steel chamber with an inlet plenum that distributes ash-laden flue gas to the compartments and an outlet plenum that collects the cleaned gas from the compartments. Each compartment has a tube sheet near the top from which the bags hang. Typically, these bags are 150 mm in diameter and 8 m long, though larger sizes have become commercial. The bag is hung from the tube sheet after being stretched over a form-fitting wire basket that prevents the bag from collapsing. Flue gas is admitted at the bottom of the compartment and departs above the tube sheet, such that the ash is captured on the outside of the bags. When the bags have accumulated a heavy cake of ash, a compressed air nozzle at the top of each bag gives a strong puff of compressed air, which momentarily pulses the skin of the bag, releasing the ash cake to the hopper below.

2.6.1.13.4 Noise

The plant is located in a very sparsely inhabited area; therefore, any impact to local residents is minimal. The plant will be designed to control the noise generated to meet international and Pakistan regulations within the plant and at the fence line. Any growth in the area will be industrial, which will also have no or minimal impact. Details will be covered in the EIA.

2.6.1.13.5 Ash

Ash will be stored on site or close by. The fly ash may be sold if a market exists, otherwise it will be dumped in the overburden area of the mine (more details in the EIA). The storage areas will be designed to control water run-off due to rain. This water will be collected and treated before discharge (see the waste water section for more details). Dust will be controlled by mixing with water, spraying with water, and covering with dirt.

A temporary ash yard will be made near the Mine dump area , where the ash for few years may be dumped – however at later part of Project – the ash will be sent to mine for inside dumping.

2.6.1.13.6 Airborne Dust from Coal Storage Yard

The potential dust from the coal piles will be controlled by a combination of water sprays, wind screens, and, if necessary, covers. The wind screens will be fabric fences to reduce the wind that would dry the surface of the pile and pick up the dust. Water sprays will reduce the amount of dust pickup by the wind. In addition, if necessary, fabric covers can be placed over the idle portions of the coal piles to prevent airborne dust.

2.6.1.13.7 Water

All water discharged due to power plant processes and sewage will be treated before to meet regulations before being disposed.

However, in case groundwater is used, brine produced from the RO system will be directly disposed off into the salt lake which will act as a large natural evaporation pond.

More details will be covered in the waste water treatment section and EIA study.

2.6.1.14 HVAC

2.6.1.14.1 Function

The purpose of the HVAC systems is to provide appropriate conditions in all enclosed plant areas including control room, steam turbine building, battery rooms, main electrical interconnection systems, substations, chemical dosing rooms, pumps houses and other buildings. This will include heating (if any), cooling, moisture control and ventilation of all enclosed spaces for personnel comfort and equipment protection. Functions will include the required number of air changes, relative humidity control, temperature control and pressurization.

Air conditioning is required for the switchgear and electrical equipment areas, even if not required by the vendors and the American Society of Heating, Refrigerating & Air Conditioning Engineers (ASHRAE), to ensure equipment reliability.

Dust suppression and collection will be provided for the coal handling areas to protect against fires and explosions due to dust or gas buildup.

2.6.1.14.2 Design Basis

The systems will be designed to meet the intent and specific requirements of the ASHRAE handbooks and standards. If heating is required, electric heating will be used. If Pakistan requirements are more stringent in any aspect, they must be followed. In addition, the following specific considerations will apply.

<u>Ventilation and Air Conditioning</u>

Split packaged air conditioning system(s) will be installed for rooms requiring air conditioning, including the offices, storage areas and battery room.

The air conditioning unit for control room shall be two sets of air-cooling heat-pump type placed on roof-top. One is for operation and the other is for standby. The outdoor unit (condensate and compressor parts) is located on the roof and the indoor unit (air handling part) is located in the HVAC room. The refrigerant is R134a or other non-ozone depleting refrigerant.

Each air conditioning system designed for the central control building, will be a two sets system. One is K-1 system served for the unit control room, engineer room, supervisor room and locker room, etc. The other is K-2 system served for the electrical equipment rooms, relay room and electrical supervisor rooms, etc. The system(s) will provide a constant-volume air supply with a variable outside air supply capability of 10% to 100% (economizer) to achieve energy conservation. The HVAC system will continuously operate round the year.

The control room and equipments should be pressurized by their HVAC systems to provide dust control and the pressurization should not be more than 50 Pa positive to the adjacent areas in spring and autumn and maintain 5 Pa positive in summer and winter.

In the indoor unit, there are return air function, silence function, filter section, fresh air/exhaust air section, cooling section, heating section, humidity section, supply air fan section, return air section, even air distribution and supply air section, etc. In order to keep the treated air clean, preliminary and intermediate filters will be designed for the indoor unit.

Battery Room

There are non-maintenance type batteries in the battery room. Air-conditioning and mechanical ventilation will be so designed that the room air temperature will be kept below 30 °C (85 °F). Exhaust air rate will meet the requirement of not less than ten volume air changes per hour.

The explosion-proof type heat-pump split air conditioners will be used and the ventilation system will use axial fans. The motors and fans are all direct-connected and are corrosion resistant and explosion-proof type. The exhaust system in the battery room will be operated continuously to maintain negative pressure and to avoid accumulation of hydrogen gas or leakage to adjacent rooms.

In the case of a fire, the fire system will cut-off the power of ventilation and air-conditioning equipment.

Steam Turbine (ST) Building

In order to maintain the normal design temperature in summer, general ventilation will be considered for ST building. Mechanical supply & exhaust air system will be designed for steam turbine building.

In summers, the fresh air will be cooled by the evaporation-cooling air handling unit. This will absorb the extra indoor heat and humidity. The treated air will be exhaust to outside by roof fans. Based on the layout, there are 30 sets roof fans in ST building and 15 sets of glass fiber reinforced plastic roof fans in the de-aerator bunker.

Electrical Equipment

There are transformers and high-voltage switch cabinets in 380V & 6KV substations, which will dissipate extra heat. Mechanical ventilation will be designed for such areas. The air exchange design will be based on not less than 10 times/h. The cooling air handling unit with humidity control will be used for reducing the temperature and axial fans will be used for emergent ventilation. In the event of any fire emergency, power of fans and air conditioning will be shut-off automatically.

Mechanical ventilation system will be designed in Cable Room & Direct Current Screen room, where air exchange rates are about 6 times/h in cable room and 10 times/h in Direct Current Screen room. The emergent ventilation system has both the normal ventilation system. Fresh air will be filtered.

Excitation Cubicle

The excitation cubicle is located in the ST building, which is enclosed and independent. Large extra heat will be dissipated, so summer temperature ventilation and emergent ventilation system will be designed. In event of a fire, the fire system will shut-off the power of ventilation equipment automatically. Fresh air will be filtered.

Chemical Dosing Rooms

Natural make-up air will be considered in chemical dosing rooms. Mechanical exhaust air system will be designed to discharge the indoor hazardous gases or vapors (if any) with corrosion resistant and explosion-proof type FRP axial fans. The air replacement rate shall not be less than 15 times/h. The emergent ventilation system has both the normal ventilation system.

Other Rooms

The mechanical ventilation will be designed for emergency diesel generator room with an air replacement rate of 10 times/h. The motors used shall be explosion-proof type. The mechanical ventilation will be designed in air compressor room to expel extra heat and humidity.

Laboratory

One set of VRV air conditioning system will be designed in laboratory, in order to maintain the temperature below 28 °C in the summer and 16 – 18 °C in the winter. The outdoor unit, set on the roof, will be connected with every indoor unit.

Mechanical ventilation system will be designed in the measurement room, heat room, high-temperature furnace room, analysis room, coal sampling room, etc. The air exchange design is based on not less than 15 times/h. The motors and fans are all directly-connected and are corrosion resistant and explosion-proof type. Louver will be set in the wall.

There is local exhaust air system for fume hoods in the analysis rooms. The fans should be explosion-proof and corrosion-resistant type.

Mechanical ventilation system will be designed in force substation, for which the air exchange design is based on not less than 10 times/h. The emergent ventilation system has both the normal ventilation system.

All Kinds of Pump Houses

Mechanical ventilation systems will be designed in circulating water pump house, raw water pump house, make-up water pump house, coal treatment washing pump house. The air exchange is design on the basis of not less than 10 times/h. The duct material used will be of corrosion resistant type.

Oil Pump House

To avoid hydrocarbon content exceeding 350 mg/m^3, mechanical ventilation system will be designed in the oil pump house and oil treatment room. The air exchange design shall not be less than 10 times/h. The motor will be explosion-proof type.

Startup Boiler

Mechanical ventilation system will be designed in startup boiler room. The air exchange design shall not be less than 6 times/h. Explosion-proof & corrosion resistant type FRP axial fans will be designed and louvers will be used in walls for intake and exhaust of air.

Administrative Building

VRV air conditioning systems will be designed in administrative building. The outdoor unit, set on the roof, will be connected with every indoor unit.

Dust and Ash Removal Control Building

Air-conditioners and mechanical ventilation will be designed in the dust removal and ash removal switch rooms. The fire system will be able to shut-off the power of ventilation and air-conditioning equipment automatically in case of any fire.

The air-cooling heat-pump type split air conditioners (wall mounted or cabinet type) will be used in dust removal control room and other offices.

Coal Control Building

VRV air conditioning systems will be designed in coal control building to maintain temperature below 24 °C in summer and 18 – 20 °C in winter. The outdoor unit will be connected with every indoor unit.

The air volume for transformer should be considered to ensure the exhaust air temperature is not higher than 450 °C and the temperature difference between air inlet and air outlet is not higher than 150 °C. The mechanical ventilation will be designed in substation based on air exchange of not less than 10 times/h. Fresh air will be filtered and emergent ventilation will be considered too.

Underground Building

To expel the extra humidity, mechanical ventilation will be designed based on air exchange of 15 times/h in underground buildings.

De-Dusting System for Transfer Stations

Electrostatic Precipitator (ESP) will be designed to avoid high amounts of coal dust in air. The dust acceptable concentration will be as following:

Total dust:

8 mg/m^3 (time weighting even allowable concentration)
10 mg/m^3 (short time contact allowable concentration)

Breathe dust:

4 mg/m^3 (time weighting even allowable concentration)
8 mg/m^3 (short time contact allowable concentration)

Dust concentration to outside should not be more than 120 mg/m^3.

HVAC Control Scheme

In order to keep the equipment operation safe and convenient management, separate control systems will be considered for the central air conditioning systems. The controllers are located in the HVAC rooms (could be installed in the main units). The system will realize the separate control by local Direct Digital Controls (DDC) and start/stop & status signal shall be shown on the DCS. The local DDC will have the central operation and will also have option for selection of automatic/manual operations.

Temperature and humidity sensors in the air conditioning rooms will transfer parameters from rooms to the DDC through cables. This controls the air handling units, which enables meeting the set-values of temperature & humidity.

Differential pressure control will enable regulation of supply/return air volume in the central room to maintain the positive pressure (pressurization should be 50 Pa positive to the adjacent areas).

Split air conditioners will be controlled by their own thermostats. Exhaust air fans will be controlled manually.

Fire Protection & Smoke Exhaust System

Air conditioning system will consider the fire protection measures and will have necessary interlocking with the main fire fighting system for the plant. Fire dampers will be installed on the supply/return air duct through walls. In the case of fire, the air handling units and the fire dampers in supply/return air duct will be closed and interlock to shut-down the air handling units. At the same time, feedback signal will be transferred to the fire control center.

In case of fire in the air conditioning rooms, the fire signal from fire control center will be sent to shut-off the air conditioning equipment and fire dampers so as to stop the whole air conditioning system. Fire dampers can also be closed manually or automatically from the fire control center.

Separate smoke-exhaust system will be designed in the central control building.

The duct for air conditioning system will be galvanized steel sheet with rubber sponge type non flammable insulation material.

2.6.1.14.3 System Operation

In normal operation, the systems will operate with no operator interface. The air conditioning systems will be independent of all other mechanical systems. They will be air cooled and not require the closed cooling water or other systems to function.

Dust collectors will operate whenever coal handling systems are in operation to control the dust generated. Dust that is collected will be conditioned with water or other products to avoid re-entrainment.

2.6.1.15 Compressed Air

2.6.1.15.1 Function

The compressed air system provides a continuous supply of 8.5 bar air for station use. The air is used for maintenance to operate air tools, for air movers and for cleaning. A second piping system provides the instrument air to all instruments, including air-operated valves.

2.6.1.15.2 Design Basis

The compressed air system will be designed to provide a continuous supply of air to all air users at the site. The same compressors supply the service air and the instrument air.

There will be a total of 8 sets of motor-driven screw type oil-free air compressors installed (3 standby). The air systems for both units will be interconnected. These compressors will be packaged units with all controls, coolers, and sound reduction enclosures.

The compressors will discharge to a common header that connects to an air receiver. From the receiver, air will be routed to heatless air dryers sized to reduce the dew point to -29 °C (-20 °F). Two pairs of dryers will be provided: one for service air and one for instrument air. The air is dried to the same level for both instrument air and service air.

Additional air dryers may be required for air users distant from the power block, for example the shops, tractor garage, coal handling areas, etc.

The piping for the service air system will be carbon steel. The piping for the instrument air system will be stainless steel or copper.

Service air will be piped to all areas of the power block area where maintenance work with air tools is anticipated. A loop will be provided around the turbine and boiler areas with isolation valves to allow maintenance on sections of the system without removing the entire system from operation. Valved hose connections will be provided at each location. These locations will include the grade, mezzanine and operating floors of the turbine room, all levels of the boiler room, precipitator hopper level, water treatment area, and all shops and coal handling buildings.

The instrument air system will have a similar design for all areas where air-operated valves or instruments are anticipated.

2.6.1.15.3 System Operation

During normal operation, five compressors will operate. The units will be cross tied to provide added reliability, but can be isolated if required.

The operating compressors will maintain the operating pressure preset for its receiver. If the pressure drops below that level, the standby compressors will automatically start.

The Air dryers will automatically switch desiccant towers as needed to maintain the required dew point. The inactive tower will be purged with a portion of the dry air to return the desiccant to its original effectiveness.

2.6.1.16 Fire Protection

2.6.1.16.1 Function

The fire protection system will detect and suppress fires, minimize hazards to station personnel, and reduce property loss due to fires.

2.6.1.16.2 Design Basis

The fire protection system will include water supply systems, clean agent extinguishing, sprinkler systems, stand pipes and hose stations and hand-held extinguishers.

The system will include a ring header to supply water to fire hydrants spaced throughout the Project. Lines from this ring header will also supply water to sprinkler systems for some equipment and areas. This will include the power block area and major buildings. Two stand pipes will be provided on opposite sides of the boiler with hose stations at all major gallery levels. The design will be to Pakistan standards and to National Fire Protection Association (NFPA) or equivalent international standards.

The underground header will be constructed of cement-lined ductile iron or high-density polyethylene (HDPE) pipe. The maximum spacing between fire hydrants will be 80 meters in main buildings, 30 meters in oil storage tanks and 120 meters in other areas.

Water will normally be supplied by the raw water storage tank. The water tank will be sized for the appropriate standards but no less than 1,100 m^3 (300,000 gallons) available for fire protection.

The system will include a fire pump house which will include the emergency diesel fire pump, the motor driven fire pump, and a pressure maintenance jockey pump. The emergency fire pump has a separate fuel oil tank sized for a minimum of 8 hours operation at full load.

In addition, a diesel fire pump will be installed in the Unit 1 pump house taking suction from the raw water station in the pump house. This an emergency source of water to be used only when all other options have been exhausted or failed. Provisions will be included to allow regular flow tests of this pump without allowing raw water to enter the piping systems

Any detection of a fire, or actuation of a fire suppression system, will be alarmed in the main control room and the administration building.

An open shed shelter (with roof but no walls) will be provided next to the fire pump house for the fire truck.

The major areas to be protected are listed in the following table.

Area	Detection or Actuation Type	Suppression Type	Notes
Turbine Room	None	Hose stations at grade, mezzanine, and main floor	Smoke vents in roof
Boiler Room		Hose stations at each side on all major floors	
Coal Transfer towers, Crusher House, and Tripper Area above Silos	Spot type smoke detectors	Dry-pipe sprinkler fusible heads	Not to include electrical rooms
Conveyors	Linear heat detection	Automatic deluge	
Coal Silos	CO and methane gas monitors	CO_2 manual	
Coal Crusher	Crusher outlet temperature	Internal deluge spray with quarter turn valve outside	
Administration Building, Locker Rooms, Toilet Areas, Telephone and	Spot type smoke detectors	Automatic wet pipe sprinkler system & Hand	

Communications Rooms, Storage Rooms		hoses	
Water Treatment Building	Spot type smoke detectors	Automatic wet pipe sprinkler system, Hose stations, portable extinguishers	
Maintenance Shops, Warehouse	Manual pull stations at each exit door	Hand hoses, automatic wet pipe sprinkler system, portable handheld	
Fuel Oil Storage Tanks 2,000 m^3	None	Foam injection plus foam cannons	
Fuel Oil Truck Unloading Area	None	Foam cannons	
Steam Turbine and Generator Bearings	Spot type smoke detectors	Automatic pre-action sprinkler system, double interlock	
Turbine Oil Tanks, Piping, Conditioner Skid, Hydrogen Seal Oil, EHC System	Linear	Deluge sprinklers	
Turbine Electrical Enclosures	Spot type smoke detectors	None	
Battery Room	Smoke detectors at the ceiling	Pre-action sprinkler system -electric release	
Control Room	Smoke detectors at the ceiling level and beneath all raised floors	Double interlock pre-action wet pipe sprinkler system	Dry chemical system if kitchen area
Electrical Equipment Room, Electronics Room, Cable Spreading Room	Spot smoke detectors	Pre-action sprinkler system -electric release	

Main Power Transformers, Auxiliary or Reserve Transformers	Linear	Automatic deluge, dry pipe	
Gas Insulated substation	Beam smoke detection	Portable extinguishers	
Intake Pump house	None	Hydrants, portable	

2.6.1.16.3 Fire Protection Master Plan

The EPC contractor will be responsible for preparing a Fire Protection Master Plan. This will consist of the following documents:

Building and Fire Codes and Life Safety Compliance Review Report
Fire Risk Evaluation Report
Hazardous Area Classification Evaluation

All three documents are to be submitted to the local statutory authorities and the purchaser for review, comment, and approval. They are discussed individually below.

Building and Fire Codes and Life Safety Compliance Review

The report will identify and address, at a minimum, the following items for each building, pre-engineered and/or pre-fabricated building, equipment enclosure and/or structure, and outdoor process, equipment, and storage areas:

Applicable building and fire codes, standards, recommendations and amendments
Building classification, occupancy and permitted construction types
Building height and area limitations
Fire resistance requirements for floors, exterior and interior walls and structural supports
Egress and exiting requirements
Detailed exit analysis and calculations, includes preparation of exit analysis drawings documenting occupant loads, required exit widths, occupant load distribution, and travel distances.
Combustible and flammable gases and liquids process equipment and storage fire protection, quantity limitations and storage requirements
Accessibility requirements
Fire department access and fire fighting facilities
Occupancy and area separation requirements
Fire alarm and detection systems

Sprinkler/standpipe and fire hose station requirements (including duration, flows, pressures and densities)

Fire protection water supply requirements

Emergency power and lighting requirements

Smoke control and ventilation requirements

Elevator requirements

The Building and Fire Codes and Life Safety Compliance Review is to be performed by a firm experienced in the preparation of fire protection master plans, building code reviews and reports, and exit/egress analysis calculations and diagrams and be qualified in Pakistan.

Fire Risk Evaluation

An NFPA 850 fire risk evaluation is to be initiated as early in the design process as practical to ensure that the fire prevention and fire protection recommendations as described in this document have been evaluated in view of the plant-specific considerations regarding design, layout, and anticipated operating requirements.

The evaluation should result in a list of recommended fire prevention features to be provided based on acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources, and the suppression of fires. The fire risk evaluation should be approved by the owner before final drawings and installation.

Hazardous area Classification Evaluation

The basis for classification evaluation will be NFPA 70, the National Electrical Code (NEC), NFPA 497, American Petroleum Institute (API) 500, vendor information and other standards, as applicable.

2.6.1.16.4 System Operation

The jockey pump will normally be operating to keep all parts of the fire protection piping systems full of water and pressurized. If the pressure drops for any reason, the main motor-driven pump is started automatically. If the pressure is not restored within a predetermined time, the diesel-driven pump is started automatically and will remain operating until manually stopped.

If the diesel fire pump does not start and pressurize the system within a predetermined time, alarms will be given. Operators will then start the back-up raw water diesel fire pump and open the isolation valves.

2.6.1.17 Fuel Oil Storage and Transfer

2.6.1.17.1 Function

The fuel oil storage and transfer system will store the fuel oil and transfer that oil to the main boiler for ignition and warm-up of the main boiler and the auxiliary boiler and to power the black-start generator. The system will include truck unloading facilities. Provisions will be made to supply fuel oil to tractors, trucks, loaders, dozers and other equipment. The storage capacity is adequate to have several start attempts or operate a single boiler at 20% load for 2.5 days.

2.6.1.17.2 Design Basis

There will be two oil storage systems, one for High Speed Diesel (HSD) and the other for High Sulfur Furnace Oil (HSFO).

Get new storage capacities of HSFO and HSD based on new strategy (old was for only HSD). Below is for original proposal.

The system will include two identical 1,500 m^3 welded-steel vertical tanks to store the oil. This amount of fuel is enough for one boiler ignition and one boiler auxiliary firing. The oil is commonly known as #2 diesel or HSD. It does not require heating. The tanks will be inside a berm designed to contain any oil leaks, including complete failure of the tanks. Provisions will be included to remove the rain water that accumulates inside the berm and to provide treatment before discharge.

Floating suction will be provided in each tank. The suction will be designed for the oil specifications for the Project. The float will be designed such that the suction is submerged between 50 and 300 mm below the oil surface during all modes of operation. Suction will be capable of drawing down to 450 mm from the tank bottom. A low-level stop will be provided to prevent drawdown below 450 mm.

All tanks pumps and piping will be designed to API 650 standards or international equivalents and to Pakistan standards. The tanks will be double bottom.

Truck delivery of this oil is expected. A truck unloading station will be included to unload two trucks simultaneously, contain any spills, and measure the quantity of oil from the trucks. Two centrifugal pumps will transfer the fuel to the tanks. The pumps will be designed for at least 100 m^3/h (500 gallons per minute [gpm]).

Pumps will be provided to supply the oil to the burner levels of the boilers, at which point the system will be the responsibility of the boiler supplier.

A day tank will be provided for the black-start generator, which will be designed for 24 hours operation at full load and include all the requirements and recommendations of the supplier, including floating suction, location of fill and suction connections, filters, recirculation, sample connections, and drains.

Three 50% (one standby) capacity multi-stage centrifugal transfer pumps will be installed to pump the oil from the storage tanks to the two boilers. The capacities are based on provision of fuel for the igniters and warm-up burners of a single boiler and the auxiliary boiler.

2.6.1.17.3 System Operation

The tanks will normally be kept full to provide the capacity required to attempt multiple startups of the boilers if there is a forced outage and/or a requirement for a black start. As oil is used for startup, it will be replaced within a few days to ensure that an adequate supply is available.

Drains will be checked periodically for signs of water and other contaminants. Appropriate filtering draining and additives will be used as required to maintain the quality of the oil.

As trucks are unloaded, any oil spilled will be contained and recovered or disposed of in accordance with the environment regulations.

2.6.1.18 Coal Unloading and Handling System

2.6.1.18.1 Function

The function of the Coal Receiving and Storage system is to unload, convey, prepare and store the coal delivered to the plant.

The coal handling system receives coal from the mine stockyard. The coal handling system is configured such that there are options for forwarding the coal to the coal preparation facility or to the power plant stockyard for storage. From the stockyard the coal can be reclaimed and transported to coal preparation facility when required.

2.6.1.18.2 Design Basis

A common coal handling system will be provided to fuel the two units. The coal handling system will be designed based on the following parameters:

Parameter	Value
Capability of handling different types of coals	Lignite
Coal blending capability	To be performed by Mine

2.6.1.18.3 Description

The two 100% capacity feeding conveyors will be carrying coal from the mine stockyard either to the power plant stockyard area or coal silos in the power block.

Power Plant Coal Stockyard

The coal storage system will include all the required conveyors and transfer houses. The system will use a bucket wheel stacker to stack coal in two parallel storage piles. The coal storage capacity in power plant will be 50,000 tons.

No details of coal reclaiming

The reclaim and conveying system will be capable of supplying coal at 100% boiler burn rate. From the stockyard storage piles, the coal will be reclaimed by a stacker-reclaimers and discharged onto the plant supply conveyor system.

The conveying system, consisting of two parallel trains of conveyors, will supply coal from the coal piles ultimately to the coal silos at the boilers. Only one train of conveyors is required to supply coal to both units. However, both trains may be operated simultaneously.

Wind fences will be provided around the coal yard. The coal piles will be equipped with a water spray dust suppression system. Dust suppression systems will also be provided for conveyor transfer points.

Coal Preparation

In the power block the coal will be carried by conveyors to a twin outlet surge bin of the coal crushing system. In the crushing system two 100% screens and crushers are provided (one operating and one standby). The crushing system will include magnetic separators to remove tramp metal. The surge bin will be designed to hold minimum 100 tons of coal and include two hoppers with rod gates and a level monitoring system. Each surge bin hopper will discharge by gravity to a parallel and equal capacity conveying system to the in-plant coal silos. The size of the crushed coal will not be greater than 30 mm.

Each conveyor system will consist of a belt feeder, a crusher, a transfer conveyor to the boiler house, and tripper conveyor. Diverter gates and bypass chutes will be provided at the crusher if size reduction is not required. A free-standing, self-contained, modular-type "as fired" sampling system will obtain samples from the transfer conveyors that supply the boiler house. Both tripper conveyors will traverse over all the in-plant silos for full redundancy.

Dust collection systems will be provided for the crusher house (pulse jet collector) and coal silo ventilation and the tripper conveyor room at the power plant.

2.6.1.18.4 System Operation

The complete coal handling system will be controlled from the coal handling control room located within the coal handling building adjacent to the crusher house. The overall control will be by Programmable Logic Controller (PLC) system. The control boards will include the controls, graphic display and annunciator sections to allow remote operation of the coal handling system. The coal handling building will also house the necessary electrical equipment to distribute power to the coal handling equipment.

2.6.1.19 Ash System and Ash Disposal

2.6.1.19.1 Function

The fly ash collection and disposal system will transfer particulate collected from the boiler flue gas to a fly storage silo for unloading into trucks for disposal. Fly ash entrained in the boiler flue gas will be collected using a baghouse or electrostatic precipitator. Fly ash will also be collected throughout the flue gas system by means of ash hoppers at other locations such as the air heaters.

The bottom ash handling system will collect, store, and transport bottom ash from the boiler furnace, economizer hoppers and mill reject hoppers. The system will include a submerged scraper conveyor (SSC) for collecting, cooling and transporting the bottom ash, a flight conveyor system to convey economizer ash to the SSC, and a sluice system to convey mill rejects to the SSC. The bottom ash, mill rejects and economizer ash will be transported to a concrete bunker for removal by trucks.

2.6.1.19.2 Design Basis

Fly Ash Handling System

Each unit will have a dedicated fly ash handling system. All fly ash collected in the air heater hoppers, baghouse hoppers and in other hoppers as applicable, will be pneumatically conveyed to fly ash storage silo.

The fly ash handling system will be sized for 100% Maximum Continuous Rating (MCR) operation. The design pneumatic transport system conveying rate will be 2.25 times the design makeup rate to allow for catch up conditions.

The fly ash storage silos will have a nominal storage capacity of 3 days (72 hours).

Bottom Ash Handling System

Each unit will have a dedicated a bottom ash handling system. The bottom ash handling system will be sized for 100% MCR operation. The design conveying rate will be 2 times the design production rate to allow for catch up conditions. The bottom ash storage bunker will have a nominal storage capacity for 3 days (72 hours).

Economizer Ash Handling System

The economizer ash will be collected and transferred to the SSC with a Dry Flight Conveyor (DFC) system.

The design conveying rate will be 2 times the design production rate to allow for catch up condition.

2.6.1.19.3 Description

Fly Ash Handling System

The fly ash collection and disposal system will be designed to remove fly ash from the flue gas and hold it in storage silos for unloading into trucks for disposal into a landfill or selling off to consumers. Fly ash entrained in the flue gas will be removed from the flue gas using a baghouse or electrostatic precipitator. Fly ash will also be collected from other various locations throughout the flue gas system by means of ash hoppers located beneath the collection locations where the flue gas becomes stagnant. The fly ash handling system will use pneumatic conveyance to transport the ash to a storage silo. The economizer ash will be collected and discharged into the water filled bottom ash collection trough by drag chain conveyors.

The fly ash settles out of the flue gas duct into various hoppers, where it accumulates into the collection hoppers. The fly ash accumulates in a collection hopper until the hopper's discharge valve opens to allow the ash to flow through a pneumatic pipeline to the storage silo. Each of the hopper valves is cycled open and closed, allowing fly ash to empty from the individual hoppers and into the conveyance pipe to be transported to the fly ash silo. A bin vent filter located on top of the silo will filter and discharge the transport air to the atmosphere.

Fly ash from the baghouse/electrostatic precipitator will be collected in storage silos and will be transported by truck for either disposal to a landfill. If a market for the fly ash is found, the fly ash will be sold. The typical market for fly ash is cement plants or road construction. Each silo will be equipped with a fluidizing blower system and a fly ash conditioner system to support unloading for truck transport. The fly ash from each silo will be conditioned using water spray as required to minimize dusting during truck loading. Each silo will also include a loading spout to load dry fly ash into trucks.

Bottom Ash Handling

The bottom ash handling system will be designed to collect, store, and transport the relatively heavy solid wastes resulting from the combustion of coal in the boiler. This bottom ash includes furnace ash from the boiler

2.6.1.19.4 System Operation

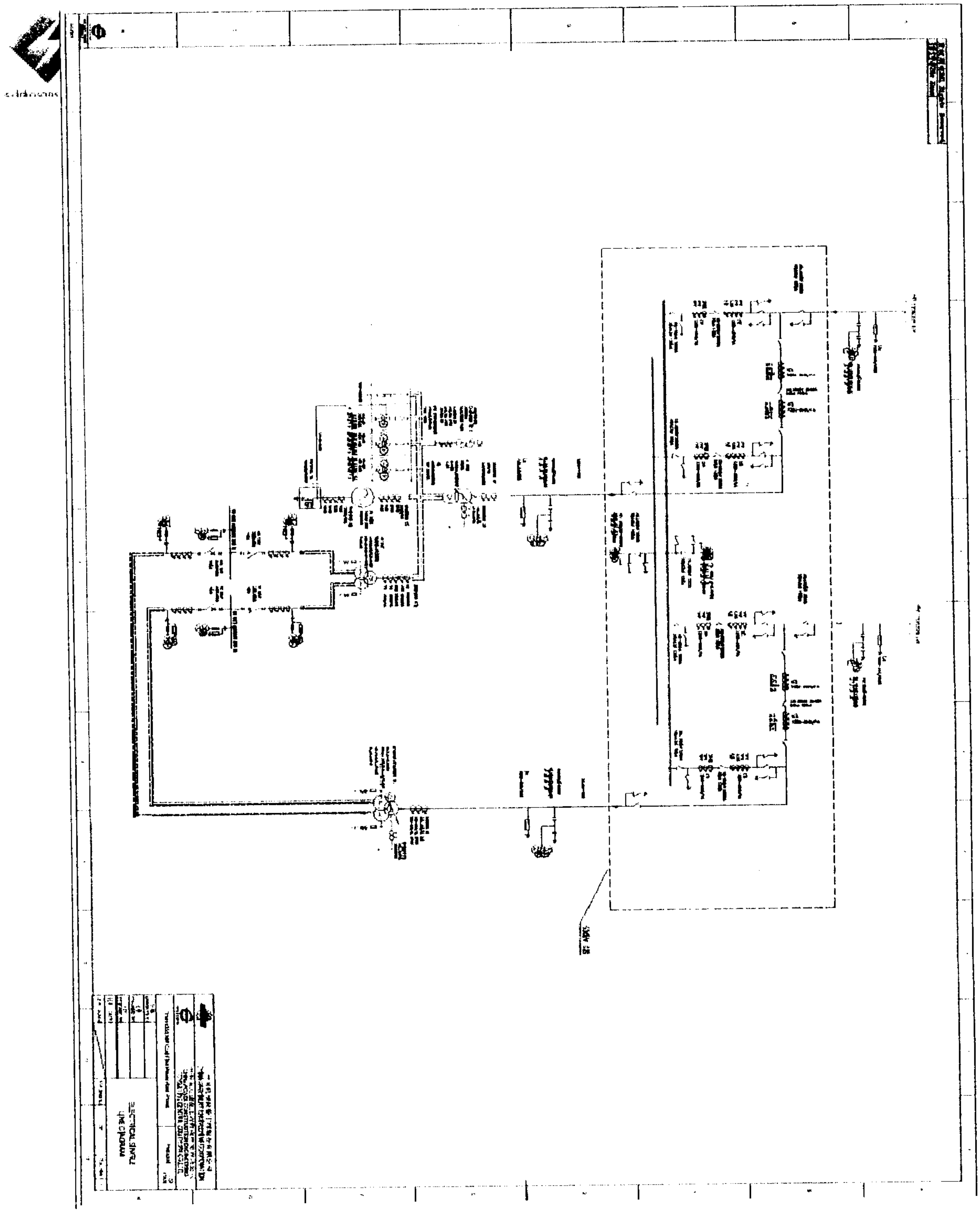
The ash handling system will be controlled in sequence during normal operation. Control of the ash handling system will be accomplished via the plant DCS. All system control, status indications and alarms will be available in the main control room.

2.6.2 Electrical

The following specification defines the minimum requirements for design, construction, inspection, testing, packing and shipment of electrical part and standards and codes referred to.

2.6.2.1 Scope and Tie-In Point

The scope of electrical system includes power supply and distribution, protection, lighting and earthing for Siddiqsons 330 MW Power Plant Project. The tie-in points with the Grid will be at gantries of 500-kV switchyard within the Plant. The preliminary Single Line Diagram is attached as follows :



2.6.2.2 Design Philosophy of Electrical Power System

Plant and equipment shall be designed for an operating life of at least 30 years and shall be suitable for continuous MCR operation.

The design shall incorporate every reasonable safeguard and provision for the safety of all personnel concerned in the testing, commissioning, operation and maintenance of the installation. The design and installation shall be carried out so as to minimize the risk of outbreak of fire and consequential damage. Materials used shall not support combustion and be fire retardant.

Oil used as insulating medium shall conform to IEC60296 and shall not contain any reactive sulphur compounds. The oil must be certified to be free from any Polychlorinated Biphenyls (PCB). The oil will be readily miscible with other oils of the same class in all proportions and from any renowned supplier.

The Electrical Power System design would be such that the failure of any one part of the electrical, AC and DC auxiliary systems shall not cause a loaded generator to trip. The design of the auxiliary systems shall also include reserve capacity that is appropriate to the plant and equipment supplied.

Where electrical equipment is essential for continued running of the installation, the associated auxiliary systems shall be arranged so as to allow recovery from fault conditions and also to permit inspection and maintenance of equipment to be carried out without interference with the normal operation of the power station.

The essential supplies systems shall be capable of maintaining the supply to all instruments, controls and auxiliaries required for the safe and reliable operation of the plant and equipment under all normal and abnormal operating conditions. This includes satisfactory shutdown and the placing of the turbines onto barring gear following the total loss of the grid connection to the station. The design shall require only minimal operator intervention to reconfigure the auxiliary systems upon restoration of normal supplies.

All equipment shall be adequately rated to ensure transfer of the net export output of the prime movers under the full range of loading conditions, operating modes and ambient conditions and will not put a limit in this regards.

Protective relays and systems shall be provided to detect all credible faults on each item of plant and equipment and their primary interconnections. Such faults include, but not limited to, phase and phase to ground faults, overloads, excursions in frequency and voltage, phase unbalance, reverse power, over-fluxing, faults on the excitation system and pole slipping/loss of synchronism. The protection shall operate, as rapidly as possible consistent with maintaining adequate discrimination, to minimize damage to the plant and equipment and disturbance to the system as a whole. It shall be designed to preclude, as far as possible, all possibility of inadvertent operation. However, failure shall not prevent fault clearance. The protection schemes shall generally be arranged according to the main/back-up protection principle.

Except when otherwise specified or agreed, the items provided under this part of the specification shall include all the necessary equipment for the protection of the plant, the associated electrical circuits and the electrical equipment supplied under other parts of this specification.

The design and all equipment of the 500-kV switchyard, shall be subject to final approval from the POWER PURCHASER. A comprehensive protection manual shall be produced during the design stage of the contract giving a full description of the protective systems and equipment installed, grading details, recommended settings and all relevant information.

The plant and equipment shall be capable of being controlled under normal operation from the Central Control room. Local control facilities shall be provided for testing and maintenance purposes.

The electrical plant and equipment shall be provided with suitable means for electrical disconnection, isolation and earthing of connections to facilitate maintenance and reconfiguration of the electrical power system in the normal operation of the power station.

Interlocks of the preventive type shall be provided as required to enable safe and reliable operation and maintenance of the plant. Interlocks shall be grouped into two categories:

> Operational interlocking shall be provided to prevent operation of the system with prospective fault levels in excess of the switchgear rating and to ensure sequential closing of switchgear for correct operation of the synchronizing and any high-speed transfer schemes.
>
> Maintenance interlocking shall be provided for the safety of personnel in following statutory and EMPLOYER's Safety Rule Procedures or to maintain alternative supplies, e.g. UPS bypass, DC system boost charging or similar. A system of mechanical coded-key figure interlocks shall be provided for this purpose.

In addition to the above requirements, mechanical interlocks of the preventative type, effective as close as practicable to the point at which the force is applied are provided for the following purposes:

> To prevent the closure of a switching device incorporated in a withdrawable part, unless the withdrawable part is located correctly in the connected, disconnected or where appropriate the test position.

To prevent the opening or closing of off-load isolation devices unless the associated load switching device is open, i.e. to ensure that no off-load switching device switches load current.

To prevent access to main circuit parts through door or covers which maybe opened without the use of tools, unless such parts have been isolated (or are fully shrouded) from all potential sources of supply.

To prevent the closure of main circuit isolating devices and switches for motor isolation in contactor equipment, unless the associated contactor is open.

To prevent the introduction of a removable or withdrawable part into a fixed part not intended or rated for that removable part.

To provide positive mechanical indication for the position of isolating devices.

Interlocking shall also be provided:

To prevent simultaneous closure of 'forward' and 'reverse' or 'low-speed' and 'high-speed' contactors.

To prevent the simultaneous closure of both contactors or both switches of a change-over arrangement.

For the above two items electrical interlocking on this type of arrangement may be permissible subject to the interlock being fail-safe.

The auxiliary power supplies systems and associated switchgear shall include a comprehensive interlocking scheme to ensure safety of personnel. In addition to the requisite operational interlocking, all switchgear shall be designed to incorporate a system of isolation and locking such that when an authorized person isolates a circuit he can lock off and make safe. Unique keys shall be provided for the padlocks used in the permit to work system.

In addition to Tariff Metering System, metering and electronic recorder with output to the Plant DCS to record power (MWh) and reactive power (MVArh) consumed by the total Plant auxiliaries shall be provided. The metering shall be driven by current and voltage transformers provided for the purpose with minimum overall accuracy of ±0.5%

2.6.2.3 Power System Studies

2.7.2.3.1 General

The Contractor / Owner shall arrange to conduct studies, by competent companies, to demonstrate that the electrical plant and equipment is adequately rated during detail engineering stage. These studies shall assume 'worse case' values of positive phase sequence impedance for all generators, cables and transformers. For fault level studies, transformer impedances shall be based on the lowest transformation ratio tapping, taking into account the limit of permissible tolerance on this value. The studies shall clearly state the basis for the values of motor fault current contribution.

2.6.2.3.2 Type of studies

The types of studies to be undertaken are as follows:

Load Flow System Studies

To identify that electrical systems are free from potential pitfalls. This study will be used to identify system power factor, transformer tap changer positions, current direction and flow and bus voltages during normal operational modes, as well as emergency operational modes.

Short Circuit Analysis

To perform IEEE/ANSI and IEC calculations, identify critical devices and to check device duty of all circuit breakers and ensure that specifications agree to it.

Motor Starting Analysis

To evaluate the impact on the electrical system while one or more motors are being started. Critical information such as voltage drops on the busbars, motor starting current, motor torque, etc can be extracted and recorded. To evaluate and compare with manufacturers specifications and to decide whether the impact on the electrical system is acceptable.

Harmonics Study

To identify harmonics present in the system, this can distort the voltage and current waveforms. A system that contains harmonics can cause protective devices to trip, transformers to overheat and generally stress the system beyond its design. Study will aim to calculate the total harmonic distortion and determine whether harmonic filters must be installed.

Protection Coordination Study

To avoid mal-operation of a protective device; to ensure coordination of multiple protective devices so that the sequence of trips can easily be followed and graphed on a current vs. time scale

Power Factor Improvement

It is required to maintain station's power factor above 0.9 as required by local laws and to avoid penalties on import energy. A proper system study needs to be developed and the problems must be identified. Need for implementing capacitor banks or SVC's, at specific locations in the electrical system is to be identified. An improved power factor will also reduce the loads in the system.

Arc Flash Hazard Analysis

The arc flash analysis identifies the presence and location of potential hazards and provides recommendations for PPE, boundaries for limited, restricted and prohibited approaches, recommendations for flash protection, and safe work practices.

The National Fire Protection Association Guidelines (NFPA 70E) require facility owners to perform an arc flash hazard analysis prior to allowing a worker to perform a task on energized equipment. NFPA 70E is referenced in the OSHA 1910 standard.

Grounding Grid Design

Grounding grids are essential in providing safety of all personnel in a station and therefore, they must be designed as accurately as possible. Calculations on the ground grid designs should be provided using IEEE 80-2000 formulas and the grid step, touch and absolute voltages be provided on an easily understandable 3D plot.

2.6.2.4 Scope of Supply

The extent of supply of the electrical equipment and auxiliaries comprises mainly the following items:

500-kV Switchgears (HGIS) in the Plant's Switchyard
Step-up Transformers
Station Transformer
Unit Auxiliary Transformers
Associated Unit Auxiliary Equipment for Generators
Neutral Earthing Equipment

Auxiliary Transformers

Auxiliary power supply systems including all MV and LV Switchgear, MCC (Motor Control Centre), AC, DBs

Essential supplies systems including all DC supply systems, DBs and UPS systems

Protective Relaying and Control Metering System

Lighting and small power systems

MV power cables, LV power cables, LV control cables, cable terminations & accessories and cable trays & accessories

Earthing and Lightning protection systems (complying to IEEE and NFPA)

Emergency Diesel Generator complete with associated equipment

2.6.2.5 Codes and Standards

All equipment and accessories covered shall conform to the requirements of the latest edition, unless indicated otherwise, of the following codes and standards:

GB (China National Standards) Codes for Engineering

IEC Standards

Local Statutory Codes (Pakistan Grid Code)

2.6.2.6 Electrical Connection Scheme

This project includes two sets of turbine-generator unit with rated power 600 MW (gross) each. The total net power output will be 1120 - 1114 MW (depending on cooling methodology used) at the point of tariff metering point which will be transferred to NTDC's grid through 500-kV lines. The electrical connection of the Plant is proposed as follows:

One and a half breaker scheme is used in the 500-kV switchgears. The outdoor switchgear adopts HGIS (Hybrid Gas Insulated Switchgear) equipments. As shown in the single-line diagram, each generator-transformer unit and its related outgoing circuit are connected in one complete loop, and station transformer is connected in a half loop.

In this project, the neutral of the generator will be grounded through a single phase transformer which is connected with a resistor at the secondary side. The generator will be connected to the step-up transformer through enclosed isolated phase bus-duct which is self-cooled type.

Step-up transformer adopts three phase two copper windings type. 500kV system neutral point will be directly grounded, which includes step-up transformer and station transformer

2.6.2.6.1 Short Circuit Calculation

Due to absence of the original data about the grid, we assume that the grid short current is 50-kA (rms) and 125-kA (peak). For 6-kV system (tentative), the short circuit level is assumed to be 31.5-kA (rms) and 80-kA (peak). This data will be corrected when the original data will be available.

2.6.2.7 Selection of Conductor and Main Equipments

In this project, the pollution class is considered as IV grade. Creepage distance ratio will be 3.1 cm/kV for all equipment installed outdoor with reinforced insulation. This assessment will be corrected when the original data is available.

The main data of the equipment are proposed as follows:

2.6.2.7.1 Generator

Rated power (gross)	330 MW
Max continuous power	Matched with prime mover
Rated terminal voltage	20.5 -kV
Power factor	0.9 (lagging) and 0.95 (leading)
Frequency	50 Hz
Rated speed	3000 r/min
Short-circuit ratio	> 0.5
Stator winding connection	Y Y
Excitation method	Static self shunt excitation

2.6.2.7.2 Main Bus Duct for Generator

Type	Isolated-phase, metal enclosed, natural air cooled with micro-pressurization
Rated voltage	20-kV
Rated maximum voltage	25-kV
Rated current	20000 A
Rated lightning impulse withstand voltage	(as per IEC) 125-kV
Rated power frequency withstand voltage	(1min rms kV) 50-kV (according to IEC)
Rated short-time withstand current (2s ms)	160/315 kA
Rated short-circuit peak current (peak)	400/800 kA
Distance between phases	Around 1700 mm
Connection	Through flexible links for easy isolation

2.6.2.7.3 Bus Duct for Secondary Connection of HV Unit Transformer & Station Transformer

Connection	Through flexible links for easy isolation
Type	Non-segregated phase, metal enclosed
Rated voltage	6-kV
Max voltage	7.2-kV
Rated current	4000 A
Rated lightning impulse withstand voltage	(peak kV) 60-kV
Rated power frequency withstand voltage (kV)	20-kV according to IEC (rms) for 1 minute
Rated short-time withstand current (4s)	50 kA (rms)
Rated short-circuit making current (peak)	125 kA

2.6.2.7.4 Parameters of Step-Up Transformer

Rated capacity	450 MVA
Rated voltage	550±8×2.5%/22kV
Impedance voltage	Ud=14%
Cooling type	ODAF or OFAF
Connecting type	YNd11
Tap changer	On-load tap changer

2.6.2.7.5 Station Transformer

Rated capacity	63/35-35MVA
Rated voltage	550±8×1.25%/6.3-6.3kV
Tap changer	OLTC
Impedance voltage	Ud1-2'=23%
Cooling type	ONAF
Connecting type	YN, yn0-yn0+d

2.6.2.7.6 HV Unit Transformer

Rated capacity	63/35-35MVA
Rated voltage	22±7×2.5%/6.3-6.3kV
Impedance voltage	Ud1-2'=21%

Cooling type	ONAF
Connecting type	D, yn1-yn1

2.6.2.7.7 6-kV Switchgears

These switchgears will be made in withdraw-able structure. Vacuum Circuit Breaker (VCB) scheme will be applied for all motors and transformers. The VCB will be rated with 50 kA (rms) and 125 kA (peak) Short circuit capability.

2.6.2.7.8 Switchgear/MCC

LV auxiliary power supply system will adopt withdraw-able compartment switchgears and fixed compartment switchgears.

2.6.2.7.9 LV Auxiliary Transformers

LV auxiliary transformer will be dry type.

2.6.2.8 Auxiliary Power Distribution Scheme and Layout

2.6.2.8.1 Voltage Level for Auxiliary Power System

Auxiliary power distribution system includes two voltage levels, which are 6-kV and 380/220-V.

2.6.2.8.2 6-kV Auxiliary Power Supply Scheme

One set of transformer with split windings will be provided for each unit as HV auxiliary transformer which is connected to the generator's IPB at primary side. Each secondary winding of HV auxiliary transformer will be connected with one 6-kV unit bus section which will provide power for HV motors and LV auxiliary transformers of the unit. There are also two sections of bus established for common loads of the Plant. The two 6-kV common bus sections will be connected with two secondary windings of different transformer. The two common bus sections will supply power for water supply system, water treatment system, ash removal system, coal handling system and FGD system. In addition, one set of station transformer is also prepared for the two generators, which can provide start-up power and back-up power for generator.

All buses will be connected with each other through suitable bus couplers. All incomers & bus-couplers shall be provided with manual synchronizing with synchronizing check circuit & automatic changeover scheme on dead bus logic.

2.6.2.8.3 LV Auxiliary Power Supply Scheme

LV auxiliary power supply system consists of Power Center (PC) and Motor Control Center (MCC). The motors which have capacity above 55 kW and some big power consumers acquire power from PC. Other loads will be supplied power by MCC.

2.6.2.8.4 LV Main Connection

The LV auxiliary power transformers will be configured and selected respectively for turbine, boiler and common equipments.

In this project, there will be two 2 MVA LV transformers for each steam turbine and two 1.6 MVA LV transformers for boilers for each unit. Each of the above two transformers will be standby for the other. These power transformers can acquire power from the two sections of 6-kV plant auxiliary power bus system.

Two 800-kVA LV power transformers will supply power for the plant's LV common equipments and the transformers are connected with the section 1A and section 2A of plant's 6-kV BUS. One lighting transformer is also configured for each turbine-generator unit. And each of the two lighting transformers will be standby for the other one. The maintenance system in main workshop will have one section of LV switchgear, which will be supplied power by LV transformer for steam turbine.

2.6.2.8.5 LV Power Supply for Air Cooling Island

6 sets of transformers with 2000-kVA capacity will be equipped for No.2 turbine-generator unit. Two of the six transformers will be standby and they will acquire power from HV plant auxiliary power supply system. They will supply power for air fans of No.2 turbine-generator unit.

2.6.2.8.6 LV Power Supply for Auxiliary Workshop

The power supply for auxiliary workshop will be designed according to process and areas with redundant configuration.

Two 2 MVA transformers will be equipped for electric de-dusting system of each boiler, which will provide LV power for the loads in the nearby areas. Two boilers will share one dedicated standby transformer which is connected with 6-kV common bus.

Two 2 MVA transformers will be equipped for FGD system of two boilers. The two transformers are standby for each other.

Two 2.5 MVA transformers will be equipped for coal handling system. The two transformers are standby for each other.

Two 1.25 MVA transformers will be equipped for water supply system. They can provide LV power for make-up water treatment system, pump station, sewage treatment and similar applications. The two transformers are standby for each other.

Two 0.8 MVA transformers will be equipped for administration area. The two transformers are standby for each other.

2.6.2.8.7 Plant Auxiliary Power System Neutral Grounding

The neutral of 6-kV power system will be grounded by low resistance and grounding fault will be treated as an accident signal to trip the related breakers. The fault current is recommended to be around 400A.

The neutral of 380/220V power system will be directly grounded.

2.6.2.8.8 Emergency Power Supply

To ensure safety of the operators and equipment, some dedicated emergency bus sections will be setup for boilers, steam turbine, UPS, all battery banks. All emergency bus sections are connected with diesel generator set which will start automatically in case of main power failure.

2.6.2.9 Electrical Equipment Layout

2.6.2.9.1 Transformer Yard

As shown in the Plant Layout, step-up transformers, unit (auxiliary) transformers and station transformer are located in the transformer yard near the wall A of the steam turbine house. Each auxiliary transformer will be positioned between wall A and the step-up transformer. Fire-Partition (blast) wall will be set between the step-up transformer and unit (auxiliary) transformer. Station transformer will installed between the two unit (auxiliary) transformers segregated by fire-partition (blast) walls.

2.6.2.9.2 500-kV Switchgears Layout

500-kV switchgears will be outdoor HGIS type and be laid outside of transformer yard and its incoming line connected with step-up transformer's primary side. The width of 500-kV switchgear bay is 28m, the whole area size for 50-0kV switchgears is about 120×110 m. One relay room will be built at the 500-kV switchgear yard, which will house the protection and metering equipments for 500-kV transmission lines and 500-kV bus bars. Dedicated tariff metering rooms will also be built in the vicinity.

2.6.2.9.3 Generator Lead Rooms

Generator lead will be connected to step-up transformer's secondary side through enclosed Isolated-Phase Bus duct (IPB). In addition, there will also be generator potential transformer, lightning arrester cabinet, generator's neutral cabinet and excitation transformer in the rooms. The static excitation equipments will be installed in a dedicated excitation room.

2.6.2.9.4 Plant Auxiliary Power Equipments Layout

Main Workshop

The 6-kV operation bus sections will be installed in the switchgear rooms. Common power sections will be located in the common equipments power-supply rooms. The common bus section will supply power to coal handling system, demin-water system, ash-removal system, and general water treating system. The common power sections will be connected with operation sections by cables.

The LV switchgears and MCC for steam turbine are to be installed in the electrical room at level 0.0m of steam turbine house. The MCC for boiler is located near to boiler room. The lighting power sections and maintenance sections are on the 0.0 m floor in the steam turbine house. Emergency power sections are put on the 6.9m floor in the steam turbine house. Emergency diesel generator will be installed at floor 0.0m in the central control building.

Electrical Equipment Layout in the Auxiliary Workshops

The power transformer for coal handling system and its power center will be laid in the dedicated power distribution room in the coal handling area.

The power transformer for demin-water treatment system and its power center will be laid in the make-up-water treatment building for boilers.

The power transformer and power center for administration area will be laid in the laboratory and maintenance building.

2.6.2.10 DC Supply Units and AC UPS

DC System in Steam-Generator Unit Control Room

Each battery system will consist of battery banks, battery chargers, distribution switchgear and distribution panel boards. The assignment of loads to the various systems will be based on voltage requirements, redundancy and function. In general, loads capable of causing transients on the system such as motors or large solenoids will be placed on systems separate from loads for control and instrumentation.

Three sets of batteries will be equipped for each steam turbine generator unit. One of them will supply power for emergency lighting and power loads. The other two sets will supply power for protection system and control circuit. The DC system includes two kinds of voltage which is 220-V for power load and 110-V for control circuit.

One set of 220-V DC system will be provided for each unit to distribute power for power loads. The DC system consists of 1 set Valve Regulated Lead Acid Battery and two sets of high frequency switching rectifying modules as battery charger.

Two sets of 110V DC system will be provided for each unit to distribute power for unit's control system. The DC system consists of 2 sets of Valve Regulated Lead Acid Battery and two sets intelligent high frequency switching rectifying modules as battery chargers. DC power supply system adopts sectionalized bus scheme.

Battery chargers will be sized on the premise of supplying normal DC system standing loads while concurrently recharging the respective battery from a design minimum to full charge within 10 hours. During the recharge period, the charger output voltage will not exceed the maximum allowable for the connected loads. The float charge rating will be capable of supplying the sum of (i) the float charge rate of the battery and (ii) the continuous (standing) load of the system. The chargers will be equipped with boost charging option with interlocked float / boost charge selector switch. The chargers will also incorporate a current-limiting feature to restrict maximum fault current to 125% of rating. A manually operated, non-automatic output breaker will be provided on the output of each charger to facilitate maintenance.

DC distribution equipment will be rated to withstand the rated DC fault current available. Circuit breakers, fused switches and/or DC starters will be supplied depending on the specific application.

The DC system will be ungrounded and furnished with set of insulation monitoring device to supervise insulation conditions of DC bus and feeders.

The backup time for emergency loads, following complete failure of all incoming supplies, is showed as follows:

4 hours for UPS
1.5 hours for DC Lubrication Oil Pump
3 hours for Sealing Oil Pump
4 hour for Emergency Lighting and Control System

One set of discharge test device will be provided for DC power supply system. The discharge test device will by mobile type.

DC System for Network Supervision

One set of 110-V DC system is equipped for network control and supervision (SCADA) system for 500-kV switchgear yard. The DC supply system will be installed in the relay rooms. It will supply power for control circuit and protection device of 500-kV switchgears. The DC system comprises of 2 sets of Valve Regulated Lead Acid Batteries and 2 sets of high frequency switching rectifying module as battery charger. DC power supply system adopts sectionalized bus scheme.

The batteries will be installed in the dedicated room in the relay rooms. The backup time is 04 hours.

In addition, separate DC supply units would also be provided for coal handling system, water intake station and FGD systems.

Each DC system will be equipped with a set of insulation monitoring device to supervise insulation conditions of DC bus and feeders.

The DC system's scheme shall comply with Power Purchaser's specifications and approval.

AC UPS

1 set of UPS will be provided for each steam turbine generator unit, which will be used to provide reliable power for DCS, process automation and instruments. The UPS will share batteries with DC supply units.

The UPS consists of rectifiers, inverters, static switches, bypass switches, bypass isolation transformer distribution panels, etc. The UPS adopts single bus scheme. The UPS panels will be put in dedicated rooms on 0.0 m floor in boiler rooms.

Independent UPS is also provided for each FGD system, it will supply power for related DCS, process control device and some important loads. The UPS will have its own batteries. A separate UPS will be provided for SCADA of 500-kV switchgears.

2.6.2.11 Control, Protection and Automation

2.6.2.11.1 Central Control

There will be a Central Control Room (CCR) in the Plant, in which electric equipments, in addition to process equipment, are all controlled by DCS. The DCS will be equipped with separate operator computers and CRTs to monitor electrical equipments. The main electrical supervision work will be done by DCS, which includes two parts. One part includes generator-transformer units, excitation system, HV and LV auxiliary transformer, HV and LV power supervision, emergency power, important process motors, etc. The other part includes common power sections of 6-kV for two units and common auxiliary power sections. To ensure safe shutdown, some hard wired control switches/pushbuttons are mounted on the control panel or console in the control room.

Units relay protection and automation panels will be located in the relay room.

2.6.2.11.2 Control and Protection for 500-kV Switchgear Yard

An independent supervision system (SCADA) is designed to monitor and control of the 500-kV switchgears.

The system adopts open and full distributed architecture. There will be redundant operator station for supervision system. The main communication speed is 100 Mbps through double Ethernet.

There will be not dedicated operator room for network SCADA. The equipment of network SCADA will be installed in the relay room at 500-kV switchgear yard. Separate operator stations will be located on the control console in the CCR for the units. The link between relay room and CCR will be via reliable optical fiber cables. The network SCADA can also communicate with DCS. All trip and alarm signals, position indicators and positions will be configured in DCS as well.

2.6.2.11.3 Auxiliary Equipments Control

The electrical equipments of FGD system will be monitored by the FGD DCS. The other auxiliary switchgears will be monitored by unit's DCS.

The motors of water treatment system and ash handling system will be controlled and monitored by its related process control units.

Coal handling system will be controlled by PLC. In addition, there will also be a set of CCTV to monitor the running of coal handling system.

2.6.2.11.4 Automation

Automatic synchronization will be provided for each turbine-generator unit. The synchronization control device will be microprocessor based type. The synchronization will be based on the single phase measurement. In addition, manual synchronization function will also be provided with synchro-check interlock.

Microprocessor type fast switch device will work in the section of 6-kV standby-bus. This kind of equipment can accomplish stably fast-switch between the powers.

The 380-V auxiliary power supply can be switched between the normal power and the standby power by auto switch which is microprocessor based type.

1 set of fault recorder will be provided for each generator-transformer unit as well as for station transformer and auxiliary systems. The fault recorder will automatically record the electrical parameters of generator, transformer and other equipments when disturbance happened to system to pinpoint the problem.

2.6.2.11.5 Relay Protection

Grid protection scheme and all equipments will comply with the specifications and standards provided by the Power Purchaser and subject to approval by the Power Purchaser.

All the main electrical equipments will be equipped with micro-processor based multifunctional type protection devices and will comply with the latest standards of IEC. Generator-transformer unit will be equipped with redundant protection relays.

HV power supplies and HV motors will be protected by the multifunctional relays mounted in the corresponding HV switchgear panels.

The LV motors will be protected by ACB and MCCB as well as overload relays.

Cable protection schemes will be applied wherever required.

2.6.2.11.6 Excitation System

The excitation adopts static self shunt excitation. The system mainly consists of an excitation transformer connected to generator terminal, rectifiers, automatic voltage regulators, de-excitation and over voltage protection equipment, field flashing, Power System Stabilizers and auxiliary equipment.

AVR shall be digital type with reliable performance. Each excitation system is equipped with two auto channels of AVR. The two channels will be standby to each other. They can follow up, communicate and switch to each other.Manual function will be available for each channe, When in Auto mode, the manual channel follows up the Auto mode. If both Auto channels fail, the manual channel will take over the control automatically and smoothly. The excitation equipments will be installed in the generator excitation room.

2.6.2.12 Over Voltage Protection and Grounding

2.6.2.12.1 Over Voltage Protection

To protect the generator, transformer, other electric equipments, buildings and structures from the lightning strike and induction, the following protection will be provided for electrical system:

Lightning rods will be installed in the 500-kV Switchgear area, Air Cooling island top, roof of Steam Turbine house, Chimney top and Cooling Tower top. The fuel storage area and the hydrogen station will be protected by the independent lighting towers. The coal handling system building will be protected by installation of lightning-protection belt. The lightning-protection facilities mentioned above are for the direct lighting protection.

The metallic oxide arrester will be installed to protect the step up transformer, the station transformer, generators, HV switchgears and other electrical equipment.

The oil tank, pipeline in the fuel system and the hydrogen station will be properly grounded for anti-static protection and lightning induction protection.

2.6.2.12.2 Grounding

The grounding system shall conform to latest and relevant sections of IEC 364-5-54, IEEE 80 and IEEE 665.

A detailed study will be conducted to measure soil resistivity and calculation of step, touch and mesh voltages during detailed engineering.

The main grounding network will be composed of the horizontal grounding conductors as well as the metal structures inside building foundations. The grounding material would meet the anticorrosion requirement and withstand fault current. The grounding material would use copper clad steel ground rod and copper wire or copper clad steel conductor.

2.6.2.13 Cable and Cabling Methods

2.6.2.13.1 Cable Selection

The high-voltage and low-voltage power cables all use the Cross-linked Polyethylene insulated (XLPE) and PVC sheathed cable. 6-kV cable minimum size will be determined according to short circuit current during engineering stage.

Main plant, coal transport system and fuel system would use C class fire retardant cable; other auxiliary plant would use common cable. Directly buried cable would be steel-tape armoring cable.

Copper cable would be used for power transmission. For control cables copper PVC insulated, PVC sheathed control cable, copper PVC insulated and PVC sheathed shielding would be used. Where necessary, steel tape armored cables will be used. The cable used for the data communication would be computer cable.

2.6.2.13.2 Cabling Methods

The cables for this project are mainly installed by means of cable trays. The cable trays will be mounted along the pipe-rack and building structure. The individual cable connecting the consumer or equipment will be protected by steel conduit. Part of cables need to run in the cable trench in which cable brackets are used for cable installation. No cable will be left on trench-floor.

The cable laying in underground trenches as well as on cable trays shall comply with applicable IEC or equivalent standards.

Moreover, design of trenches will ensure that no water will be accumulated on its floor. Steel armored cables shall be used where cables are buried directly in soil.

2.6.2.13.3 Cable Fire Prevention

Cables will be segregated to limit the economic loss in the event of a fire. Fire barriers will be provided for segregation requirements to have a minimum of one hour fire rating. The cable routes will be so designed that not more than the output of one generating unit is lost in case of a single cable fire.

Requirements of fire barrier segregation will be taken into account when the civil structure of the power station will be designed. However, where it is impracticable or prohibitively expensive to provide civil fire barriers, prefabricated fire barriers formed from non-combustible fireboard panels shall be used. All cable routes will be so designed and enclosed to prevent release of smoke and fumes into operational areas should a cable fire occur.

The fire-resistant material should be used at the cable shaft, wall opening and the hole under floor and the panel bottom. The fire-resistant material also would be used at the ends of the cable protection conduits.

2.6.2.14 Lighting and Maintenance System

2.6.2.14.1 Lighting System

Lighting system consists of three independent subsystems as follows:

Normal AC lighting system
Emergency AC lighting system
Emergency DC lighting system

2.6.2.14.2 Normal AC Lighting System

The AC lighting system will use 380-V/220-V three phases four lines, neutral point direct grounding system. The rated voltage of the emergency DC lighting system should be 220-V.

The #1 & #2 generator units in the main plant should be provided with 380/220-V normal lighting separately. The two lighting transformers should be backup each other.

The normal lighting of the other auxiliary plants should be supplied by LV switchgears or MCC nearby.

2.6.2.14.3 Emergency AC Lighting System

Each generator unit in the main plant should be equipped with the emergency AC lighting panel. The power source of the panel normally comes from the lighting transformer, however in case of main power failure it will automatically switch over to the security power source from the emergency bus section.

The self-contained EXIT light or direction light will be installed at all exit doors and along the evacuation passages. These lights will be connected with AC emergency lighting panel.

The emergency lighting in the coal handling system building, demin water system building, ESP and FGD building & absorption tower would use the self-contained emergency light equipped with battery pack.

2.6.2.14.4 Emergency DC Lighting System

The DC emergency lighting is provided only for CCR building. The inverter panel will provide power to emergency lighting fixtures. The inverter panel is connected with DC power from the DC supply unit and AC power from the emergency bus section. The emergency lighting is normally powered by AC supply. It can be transferred to DC supply in case of power loss at emergency bus section. Some of the lighting in the CCR may be permanently energized.

Lighting circuits along the building and structures will be installed using PVC insulated copper wires protected in steel conduits. Lighting circuits for road lighting will be installed by directly buried armor cables.

The outdoor lighting will be controlled by photocell device. The indoor lightning will be controlled by local switches in the lighting panels protected by MCBs in the back.

2.6.2.14.5 Maintenance Power System

Voltage should be 380/220-V for maintenance power. In certain areas like condenser and boiler, 24-V DC outlets will be provided. Number of power outlets to be provided in the Plant will be agreed as required by the Owner during detailed engineering. The power outlets will be five poles for three phase power and three poles for single phase power of suitable energy output. The maintenance power outlet circuits will provided with residual current protection.

2.6.3 Instrumentation and Control

This project will consist of 1 × 330 MW CFB coal-fired power generator sets, two sets of Sub critical sliding-pressure operation boilers & wet-type Subcritical turbine generators

The main control system of unit will be Distributed Control System (DCS). Boiler, Turbine and Electrical controls will be implemented in the DCS. Balance of Plant (Water, Coal, etc) will be controlled by Programmable Logic Controllers (PLC). A management layer information and decision support system, Supervisory Information System (SIS), will be provided that will interface with DCS, PLC and other plant networks.

2.6.3.1 Plant Supervisory Information System (SIS)

The SIS will interface with individual unit DCS, centralized supervisory network of the Balance of Plant and other established network communication interfaces. SIS will collect real-time field information and optimize the management of the whole plant real-time process, provide power plant operation managers with operation guidance and basis for decision making and ensure that the entire plant production is in the best condition. The plant-level supervisory information system will be installed in the Shift Supervisor Station placed in Central Control Room (CCR).

2.6.3.2 Distributed Controls and Monitoring Systems

The control and monitoring of Boiler, Turbine and Electrical System will be implemented in a microprocessor-based DCS that encompass the following subsystems:

Data Acquisition and processing System (DAS)

Modulating Control System (MCS)
Sequence Control System (SCS)
Furnace Safety and Supervisory System (FSSS)
Human-Machine CRT-based Operator Consoles (MMI)
Engineer Work Station (EWS)
Data Communication System

The control and monitoring functions for DCS will be configured in dedicated redundant controllers located in system cabinets that interface with each other and with the MMI via redundant data highways. The DCS cabinets will be either centrally located or geographically distributed throughout the plant and will be located in environmentally controlled enclosures.

The DCS will also include provisions for interface with control and monitoring systems furnished by equipment suppliers, such as the following:

Turbine Generators
Feed Water Pumps
Compressors
Coal and Ash Handling Systems
Load Dispatching
Water Treatment and Condensate Polishing Systems
Continuous Emission Monitoring System
FGD System (may be implemented in DCS)

Each of the above systems will use either distributed microprocessor-based systems or PLCs.

DCS will provide scanning, controlling, alarming and logging functions. All DCS subsystems will operate in parallel and all system functions will occur in real-time operations.

The monitoring and management functions will be highly centralized by means of a monitor and keyboard. The functions of control, protection and interlock will be extensively distributed to individual microprocessors or programmable controllers.

The Sequence-Of-Events (SOE) system will have one millisecond resolution covering critical boiler, turbine, generator and plant protection systems inputs. The SOE will be an integral part of the DCS.

The DCS will have self-diagnosing abilities, so that internal faults can be detected within the system before the resulting disturbance to the process and so that measures can be taken to prevent spreading of the fault. Alarming of the fault will also occur simultaneously.

The protection and interlock systems will be provided with redundant channels and multipoint measurement, as well as self-diagnosing functions and adequate test facilities to meet the following criteria against failure:

- No single fault will cause the complete failure of any system
- Redundancy in the control system structure will be provided so that no single fault within a control system can cause failure of the controlled equipment or cause the standby equipment to be unavailable. In case of a failure of in-service equipment, the standby equipment will start up automatically without any system interference.

For critical parameters, three independent measurements will be provided. Control and direct indication will be derived from the median value of measurements. High deviation from the median value will be alarmed and removed from the median signal.

For protection, multi-channel measurements will be provided. All trip circuit will be performed with two-out-of-three logic.

A **historical data collection**, storage and presentation (historian) system will be supplied that will fully automate the collection, storage and presentation of plant data. The historian will provide a centralized collection of information, a real-time database and a historical data archive. The historian will interface with all of the plant real-time systems simultaneously and will be capable of reading and writing to these systems. The system will store data to an adequately sized storage medium with a printer and necessary software.

2.6.3.3 Operator Console

The operator control console will include the following:

- Furniture, material and design based on human factor engineering
- Six operator workstations, including Digital Electro-Hydraulic Control System (DEH) Operator Station, having LCD and Keyboard
- Emergency trip pushbuttons for boiler shutdown and turbine trip
- Two color screens for alarm monitoring
- Pushbuttons for alarm signal acknowledgement, silence, etc
- PLC network integrated into the DCS

One operator workstation with monitor and keyboard for monitoring only will be provided for the shift supervisor's office.

Two engineering workstations, each with a monitor, will be provided. The engineering workstations will include all functions and capabilities available for the operator consoles plus the necessary enhancements for the performance of the required DCS engineering/programming functions. One color graphics printer common to both engineering workstations will be provided.

There will be networked printers, driven from common drivers, to perform the following functionalities:

- Screen copy printer (color)
- Report and SOE printer
- Unit monitoring control panels
- Plant paging communication station

Conventional indicators, meters, communication equipment, alarm equipment and code-required devices used for emergency shutdown, safe unit operation and critical plant monitoring will be provided on the monitoring control panels. Panels will include the following:

- Emergency shutdown control panel, which will include the emergency pushbuttons for boiler and turbine
- Metering / synchronization control panel, which will include revenue metering (including digital displays for unit megawatt, frequency and time), generator breaker control switches and synchroscope
- Plant fire protection and alarming panel
- Plant paging communication station

2.6.3.4 Modulating Control System (MCS)

2.6.3.4.1 General

MCS is composed of unit coordinated control system, its sub systems and other closed loop controls.

Controlled parameters will not exceed permissible limits along the range from lowest coal-fired load (40%) up to 100% MCR load. For parameters required to be controlled throughout the whole range of load variation, full range control will be implemented in the DCS so as to lessen the intermediate intervention of the operator.

2.6.3.4.2 System Description

For adaptation of the unit to the network load and frequency regulation, the turbine-boiler coordination control system will be employed as the unit main controller. The main controller will meet the need under all operating conditions of the unit and control the load variation according to permissible thermal stress value of boiler and turbine, to get the shortest possible ramp time. The unit target load may set by the operator or by the load-dispatching center.

Coordinated Control System

Coordinated control system treats boiler and steam turbine as one organic unit, inspecting and regulating parameters continuously and fulfilling protection control. It coordinates and controls steam turbine power and pressure at turbine inlet to balance power load demand and turbine real power generation.

Runback (RB)

Coordinated control system can quickly reduce the load in case a major auxiliary machine fails, using the RB function. If during normal operation a major auxiliary machine breaks down, coordinated control system will force the unit to decrease load at a pre-set rate to arrive at a preset-value. It will keep unit running safely at a lower load.

The following closed loop controls will be programmed in MCS:

- Unit Coordinated Control (Coordinated Control Mode, Boiler Follow, Turbine Follow and Manual)
- Boiler Fuel Control
- Boiler Air Flow Control
- Boiler Furnace Pressure Control
- Boiler Primary Air Pressure Control
- Boiler Auxiliary Wind Control
- Boiler Superheated Steam Temperature Control
- Boiler Reheat Steam Temperature Control
- Boiler Feed Water Control
- Coal Mill Control
- Boiler Continuous Blow-down and Flash Tank Level Control
- Coal Mill Seal Control
- Deaerator Pressure Control
- Deaerator Level Control
- Generator Stator Cooling Water Temperature Control
- Auxiliary Steam Header Pressure Control

- Water Feed Pump Recycle Flow Control
- High Pressure Heater Level Control
- Low Pressure Heater level Control
- High-Pressure Cylinder Exhaust Steam Temperature Control
- High-Pressure Bypass Temperature Control
- Low-Pressure Bypass Temperature Control
- High-Pressure Bypass Pressure Control
- Steam Seal Header Auxiliary Steam Temperature Control
- Steam Seal Header Auxiliary Steam Pressure Control
- Steam Seal Header Main Steam Pressure Control
- Steam Seal Header Reheat Steam Pressure Control
- Steam Seal Header Overflow Pressure Control
- High pressure Cylinder Axis Sealing Steam Temperature Control
- Low pressure Cylinder Axis Sealing Steam Temperature Control
- Generator Sealing Oil Temperature Control
- Boiler Water Storage Tank Level and Boiler Start Control

2.6.3.5 Sequence Control System (SCS)

SCS includes the control of auxiliary equipments of Boiler and Turbine. SCS also incorporates the control of Generator Transformer and Plant Power Sequence Control and includes equipment interlocks and protections.

2.6.3.6 Furnace Safety Supervisory System

2.6.3.6.1 General

The Furnace Safety Supervisory System (also known as Burner Management System) will be used for:

- Oil Burner Management
- Coal Burner Management
- Furnace Protection

2.6.3.6.2 System Description

The system will provide control of startup/shutdown, fuel feeders, burners and igniters and furnace monitoring and protection. The system will provide the following functions:

- Furnace purge and ignition system leak test before boiler ignition
- Automatic or manual ignition and shutoff of igniters and main flame
- Igniter and burner startup/shutdown monitoring
- Coal feeder and igniter trips (main fuel trip)
- Operating interface for the monitoring and control of fuel feeders and igniters
- Interface for boiler control system and protection system
- Flame detection
- Igniter fuel leak test
- Implosion protection of furnace and flue gas ducts
- Burner response to Runback Condition

2.6.3.6.3 Flame Scanners

The system will be complete with the proper type and quantity of flame scanners for main flame and ignition fuel flame for the boiler. Each scanner will be connected to a flame monitor via individually shielded and armored cable.

2.6.3.7 Steam Turbine Control System (Digital Electro Hydraulic)

2.6.3.7.1 General

The Steam Turbine Digital Electro Hydraulic (DEH) Control System will be provided by Steam Turbine manufacturer. It will be integrated with the unit Distributed Control System (DCS). DEH will have a separate Operator Station and Engineering Workstation.

2.6.3.7.2 System Description

The Steam Turbine DEH system will fulfill steam turbine supervisory and control from turning to full load until normal running. Operator can set value for expected speed, expected load, speed raise rate, load raise rate on operation station and handle relative valves. The basic functions are as follows:

Roll-up and Synchronization

DEH will perform pre-checks to ensure that the roll-up initiation conditions are satisfied. The system will provide turbine roll-up control from turning gear to target load at the maximum rate compatible with the thermal state of the turbine, the steam inlet conditions and the allowable expenditure of turbine life expectancy.

Load Control

The turbine generator output will be automatically regulated according to a target load demand. The system will have maximum and minimum adjustable load limits and a rate limit of changing load. The system will monitor the process variables and equipment status that restricts the output of the turbine generator set. When such conditions occur, the system will limit the load signal and initiate an alarm.

Speed Control and Protection

The system will have speed control and over-speed protection.

Constant Pressure Operation

When the unit operates with constant pressure, the valve management function will be employed by the DEH.

Testing

The TCS system will facilitate on line testing of turbine valves and high-speed trip.

Turbine Emergency Trip System

The turbine generator and auxiliaries will be capable of emergency automatic or manual shutdown from any load.

2.6.3.7.3 Turbine Supervisory Instruments and Turbine Data Management

A whole set of Turbine Supervisory Instruments (TSI), sensors and transmitters required for safe start up, operation and shut down of the turbine generator set will be furnished. TSI will include, but not limited to the following:

- Vibration (amplitude, frequency, and phase) of each bearing
- Rotor displacement
- Eccentricity
- Speed
- Differential expansion
- Thrust bearing wear
- Bearing metal temperature
- Turbine metal temperature
- Cylinder expansion
- Governor valve position
- Turbine water induction detection thermocouple
- Rotor stress and life cycle calculations

Turbine Data Management (TDM) system will monitor turbine steady state and transient status. TDM will collect, process, store and analyze turbine data. It will be used for performance analysis and fault diagnosis of Steam Turbine.

2.6.3.8 Vibration Monitoring

All large rotating machinery driven by medium-voltage motors will have vibration and thrust monitoring. The application of monitoring equipment will be subject to the size and type of rotating equipment. Adequate vibration monitoring sensors will be provided based on equipment manufacturers.

2.6.3.9 Balance of Plant (BOP) Control System

The Balance of Plant (BOP) control systems include:

- Start-Up Boiler (Auxiliary Boiler) Control System
- Boiler Feed Water Treatment Control System
- Ash Handling Control System

- Circulating Water Control System
- Wastewater Treatment Control System
- Hydrogen Generation Station Control System
- Coal Conveying Control System
- Condenser Rubber Ball Cleaning Sequence Control

Local control rooms will be available for Coal Conveying System, Water Treatment System and Ash Handling System. A centralized monitoring and control station will be available in CCR for BOP. All BOP systems will be connected to the centralized network. Additionally the centralized BOP station will be interfaced with DCS for alarming, monitoring and historical storage. The centralized network of BOP will also be interfaced with SIS.

2.6.3.10 Continuous Emission Monitoring System

A Continuous Emission Monitoring System (CEMS) will be provided with flue gas analyzers for SO_2, NO_x, CO_2 and opacity meters for each unit. The CEMS will be furnished with sampling systems, sample conditioning, sample lines, analyzers, a Programmable Logic Controller (PLC) and a shelter to house the CEMS equipment. All parameters and values of CEMS will be interfaced with DCS for monitoring and alarm.

2.6.4 Civil

2.6.4.1 Site General Information

2.6.4.1.1 Description and Location

The Project is located in Block II of Thar Coalfields, Thar Parker District, Eastern part of Sindh Province, Pakistan.

The power plant is planned to be constructed in the North-Eastern part of the Block, located adjacent to EPTL power plant. It is at about a distance of 7km from the mining region and ~ 1 km from the EPTL Power Plant area

The township will be located in the north of township at about 1.5 km distance. A road is planned to be constructed to connect the township with the power plant main entrance.

2.6.4.2 Foundation and Substructure

2.6.4.2.1 Soil Condition

The soils on the Project site consists of dune sand mainly comprising fine sandstone which is a windborne sediment; the lower part consists of considerable clacareous mineral; the medium part consists mostly of calcareous grain or lumps and some thin clay. The upper part is mostly loose calcareous grain. Below the dune sand there are alluvial deposits of sub-recent age mainly consisting sand, siltstone and claystone.

The power plant has a wide range of building structures and equipment which will be supported on foundations either resting on piles or on the compacted structural backfill.

Detailed soil investigation of actual location of supports/ foundations will be done as part of design

2.6.4.2.2 Foundations

Type of foundation should be finalized based upon detailed soil investigation of actual foundations locations

All major building structures, such as the boiler building, turbine building, silo bay, precipitator, chimney, etc. will be supported on pile foundations. Similarly, other structures and vibratory equipment, where total and differential settlements are critical, will be supported on piles. However, structures that are less sensitive to settlement tolerances and are lightly loaded will have spread footings or mat foundations resting on engineered structural backfill.

The capacity, length and type of pile will be selected suitable for the project and will depend on the soil data from geophysical work (subsurface profile). The selection of piles will also depend on material that is readily available locally, suitable for long-term performance and are cost-effective. The allowable soil bearing pressure under the structural fill will also depend on the size of the foundation and their settlement tolerances.

2.6.4.3 Water Intake and Discharge System

2.7.4.3.1 Function

The water intake and discharge system provides a continuous supply of water to the plant and discharges the effluent from the power plant. The major use of water is the cooling water for the condenser. Other uses include other cooling requirements and as the water supply to the demineralization system (and desalination system in case groundwater is used), ash handling system, coal dust suppression, ash dust suppression, and potable purposes.

2.7.4.3.2 Design Basis

Water Intake

The design of the water intake system will be based on the water source.

LBOD Water:

> The water will be pumped from Vajihar area, Sindh Province, towards Thar Block II in underground pipeline. The water will enter the Block from the North-Western boundary. The power plant will receive the water in the water treatment facility

Groundwater

> The groundwater pumped out during mining activities will pumped to the raw water treatment facility of power plant in an underground pipeline The water enters the power plant from the Southern boundary and is received in the water treatment facility. The groundwater will be desalinated using a RO system

System Design:

> The submerged pipe intake is designed to draw water through a velocity cap and deliver the required flow through buried pipes to the plant water treatment system. The number and diameter of the pipes will be selected to maintain a flow velocity of approximately 2 m/s.

Water Discharge:

The discharge from the power plant will include saline cooling tower blow-downs, brine from RO treatment of groundwater (if required) and may also include treated oil water and sewage.

The effluent will be discharged after treatment & reuse towards Evaporation ponds. This pipeline will also carry effluent from the mine and unused groundwater pumped out during mining activities.

2.6.4.4 Buildings

2.6.4.4.1 Function

This section describes the general size, construction and features of all buildings and structures that are part of this project.

2.6.4.4.2 Design Basis and General Descriptions

Turbine and Boiler Buildings

The turbine generator building is a multistory steel structure building approximately 175 meters long, 30 meters wide, and 30 meters high. This building will contain turbine generators for two units and their auxiliary equipment. This building will have a common overhead electric crane for erection and maintenance usage of the turbine generators for both units. This building exterior walls and the roof will be enclosed with un-insulated metal cladding.

Boiler will be supported on steel structures and will be approximately 100 meters long, 70 meters wide and 60 meters high with a metal roof cladding. There will be an elevator at each boiler area for access to various significant floor levels.

Main Control Building

The main control building, common to both units, is a six-story steel structure building attached to the turbine room. The building size will be approximately 55 meters long, 20 meters wide, and 20 meters high.

The building exterior walls and the roof will be enclosed with insulated metal cladding. The top floor contains the control boards that control the plant and supervisor's offices and the floor matches the operating floor of the turbine room. The lower floors contain the electrical equipment including Distributed Control System (DCS), turbine controls, combustion controls at the mezzanine level and a cable spreading room at grade level.

Miscellaneous Buildings

The miscellaneous buildings that form the total plant are listed below along with their approximate sizes:

Building name	Width (m)	Length (m)	Height (m)
Water Pump Structures (Open, no enclosure)	25	15	-
Gas Insulated Substation Building	50	30	10
Administration Building	40	25	20
Water Treatment Building	50	50	15
Auxiliary Boiler Building	20	20	12
Maintenance Shop	50	30	12
Warehouse	50	30	12
Tractor Garage	30	15	10
Fire Truck Shed	10	10	10
Guard House	10	8	5
Coal Transfer Houses (Total-3)	20	15	13
Coal Transfer Houses (Total-5)	20	20	20
Coal Crusher House	35	35	40
Coal Handling Control Building	20	15	12

Water Pump Structures:

The cooling water pump structures for each unit will be of reinforced concrete construction and connected to the water treatment system. Other pumps include auxiliary cooling water pumps and the fire water pumps. The pumps will be outdoors, and a gantry crane will be provided for maintenance of the pumps.

Gas Insulated Substation:

The gas insulated substation is enclosed in a building to protect the breakers and other equipment from the elements. This building will be of steel with insulated metal wall and roof cladding or constructed with concrete block and a concrete roof slab with built-up roofing.

Administration Building:

The administration building is a two-story structure containing the offices for the management and administration of the plant. Other features are lobby, meeting rooms, training rooms, first-aid room, cafeteria, toilets for men and women and a prayer room. This building will be constructed of concrete block with concrete roof slab and built-up roofing. The entire building is air conditioned.

Water Treatment Building:

The water treatment building contains all the water treatment equipment, including desalination and demineralizers, required to produce the water for cooling, boiler makeup, auxiliaries and potable. The equipment will include some switchgear and a control panel. The control panel will be in an air-conditioned room. This building will be a steel structure with un-insulated metal wall cladding except around the air-conditioned room.

Auxiliary Boiler Building:

The auxiliary boiler and all its auxiliaries will be in this building. The auxiliaries include deaerator, feed pumps, chemical addition systems, switchgear and controls. This building will be of steel with metal wall cladding. The control panel will be in an air-conditioned room.

Maintenance Shop:

The maintenance shop includes separate shops for mechanical and electrical equipment repair. The maintenance space will include an overhead crane to move large parts, work benches, instruments, welding areas, and offices and toilets. The shops will be ventilated to maintain air quality. The offices will be air conditioned. This building will be of steel with metal wall cladding.

Warehouse:

The warehouse will protect all the spare parts required. Most of this structure will be on one floor. In some areas two floors will be provided for small parts and offices. The building will be ventilated. The offices and some areas for sensitive parts will be air conditioned. This building will be of steel with metal wall cladding.

Tractor/Dozer/Loader Garages:

The garages will provide an enclosed space for parking the equipment used for the coal and ash handling purposes and perform maintenance on that equipment. An air-conditioned office will be included. This building will be of steel with metal wall cladding.

Fire Truck Shed:

The fire truck shed will provide a shelter for the fire truck. The shelter will be of steel with metal roof cladding and two sides with metal cladding wall to protect the truck from driving rain and sun. No office will be provided.

Guard House:

The guard house will be an air-conditioned single room to protect the guards at the main gate from the weather with a toilet facility. The building will be constructed of concrete block with concrete roof slab and built-up roofing. The entire building is air conditioned.

Coal Transfer Houses:

The coal transfer houses will support the conveyors, dust suppression and control equipment for each of the changes in direction of the coal conveyors. They will be steel structures and the sides of the structures may be enclosed or open depending on the final design.

Coal Crusher House:

The coal crusher house will support the bunkers, conveyors, crushers, dust collectors and related equipment. This building will be of steel with metal wall cladding.

Coal Handling Control Building:

The coal handling control building will house the controls for all coal handling conveyers. The building will include areas for an office, switchgear, locker room and lunch room. The office and control room will be air-conditioned. This building will be of steel with an insulated metal wall cladding or it will be constructed of concrete blocks with concrete roof slab and built-up roofing.

Miscellaneous Buildings

These buildings include the wastewater pump shed and the CEMS building.

2.7 Plant Support Facilities

2.7.1 Construction

A summary of these works follows below:

The plant site requires grading and preparation by cutting and filling as appropriate, according to local standards and codes. All necessary governmental approvals, including resettlement, will have to be arranged.

The access road to site requires improvements to a level suitable for the transportation of power plant equipment, materials and construction machinery. As explained in earlier sections, GoS is currently working on the development of this scheme.

Construction of airport close to the site will be necessary to enable frequent movement of workforce and other teams. Construction for the airport has begun in the city of Islamkot.

An area of about 15 hectares will be made available for lay down and staff accommodations during the construction phase.

Adequate capacity of temporary power and water for construction purposes for the entire duration of construction phase will have to be arranged. Temporary power can be obtained by using Diesel or HFO generator sets or engines. Water can be obtained from 29 RO units currently operational at site and further 31 RO units planned. Total capacity of these will be about 3.5 Million gallons per day (~ 550 m^3/h).

Permanent electrical interconnection will be provided at the plant boundary to deliver power generated from the Project to the national grid (NTDC). Facilities will also be included to import power necessary for startup power. NTDC is currently working on the development of this Project.

Land for and construction of permanent colony housing of permanent operations staff accommodation will have to be completed.

3.0 Fuel Supply

Fuel requirement of Power plant would be covered adequately by Mine, of which the production capacity is 9.5 Mt/a. The mine works would continue to support the uninterrupted supply of lignite to power plant.

Supply

A contract would be done between Siddiqsons Energy and Mine (owned by SECMC) to guarantee the throughput as well as quality of coal (specified primarily with LHV of 11.6 MJ/kg) ,this would ensure a continuous supply during the days of operation to power plant .

Likewise a contract would be done between EPL and PSO for the supply of HSD as well as HSFO.

4. Transmission Interconnection

Keeping in view the possible evacuation of power from Thar coal field , Scheme for 500 KV line from Matiari to Jamshoro has been cleared by CDWP(Central Development Working Party), and is to be approved by ECNEC (. Funds have been arranged by MoW&P (Ministry of Water & Power) through ADB(Asian Development Bank) loan facility (Project cost : PKR 37 Billion)

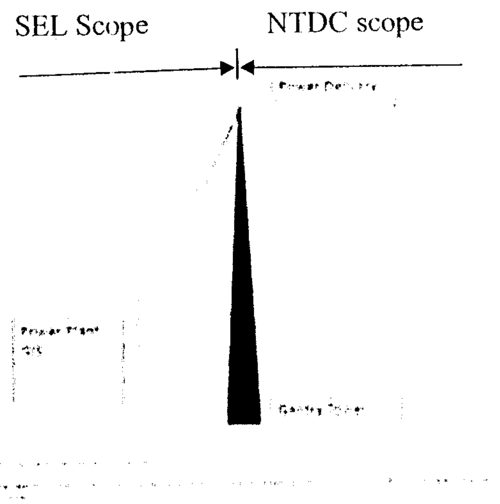
Construction of Thar to Matiari 500 KV line has been approved & is under construction

In addition to that the configuration of transmission system will actually cater for the evacuation of atleast 2x1200 MW of power – so as any additional future expansion can also be catered accordingly.

For this purpose , 1 Double circuit 500 KV High voltage A.C transmission line will be laid from thar coal plant to 500 KV Matiari substation.

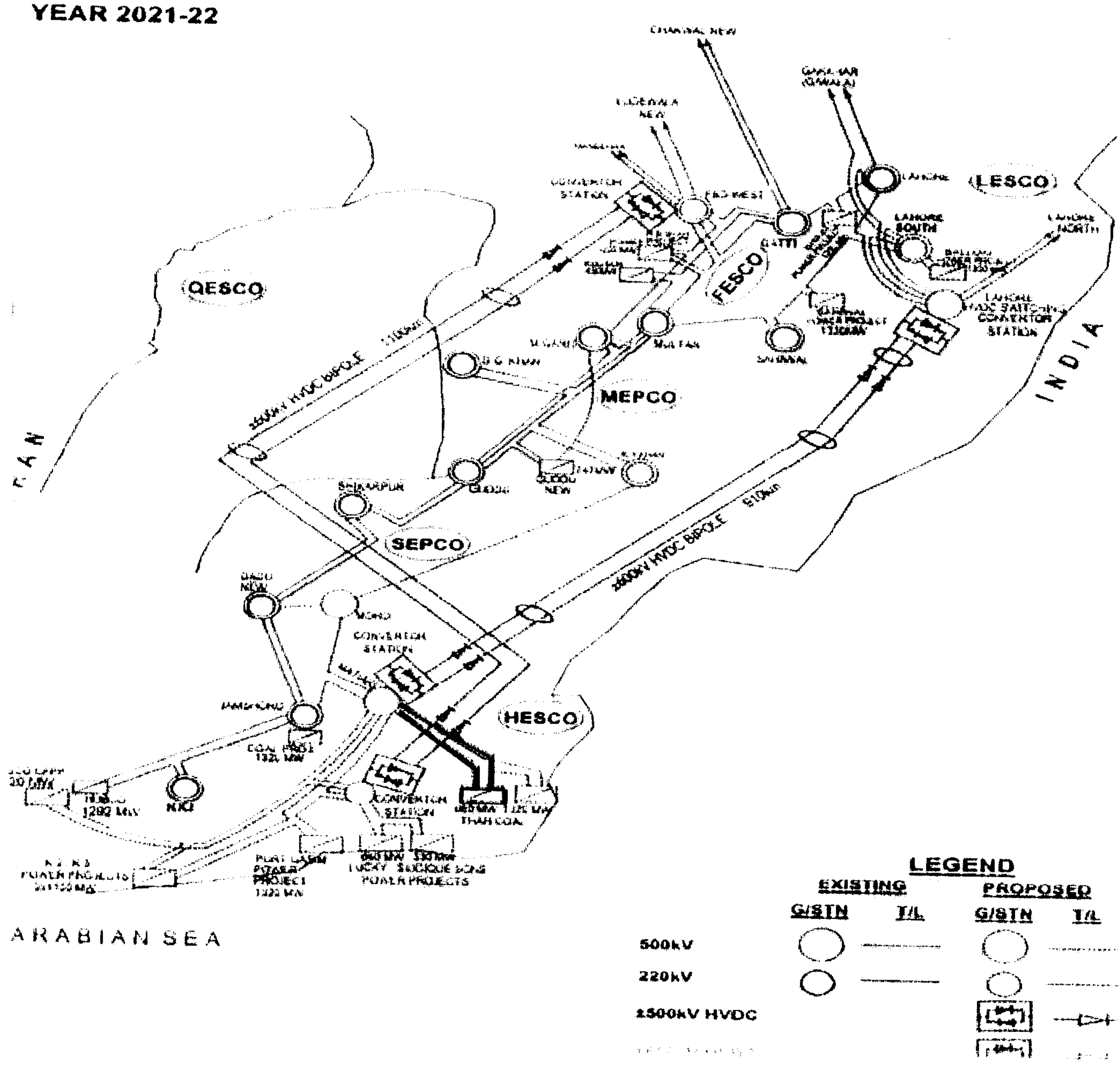
5.2 SYSTEM INTERCONNECTION (WITH NTDC TRANSMISSION FACILITIES)

The feasibility study basis of the interconnection with NTDC is provided in the following diagram:



SEL will cadre Switching , metering using step up transformer and switchgears . As part of Prevailing Power Purchase Agreements (draft available) the evacuation of electricty from the terminal point will be NTDC's responsibility

YEAR 2021-22


QESCO
MEPCO
FESCO
LESCO
SEPCO
HESCO
INDIA
ARABIAN SEA
LEGEND
EXISTING
PROPOSED
G/STN
T/L
500kV
220kV
±500kV HVDC

5. FINANCIAL AND ECONOMIC FEASIBILITY

Key assumptions for the Financial Model are derived from the Upfront Tariff announced by NEPRA for Thar Coal based IPPs in July 2014. The project company is confident that it will be able to complete the project within the following parameters allowed under Tariff.

Assumptions	
Gross Capacity	330 MW
Auxiliary Consumption	9%
Net Capacity	300.3 MW
Thermal Efficiency	37%
Availability	85%
Construction Period	<= 40 months
Project Life	30 years
Annual Generation @ full load	2,631 GWh
Coal Price	USD 46.1/ton

5.1. Tentative Project Cost & Financing Plan

The following project cost has been assumed for the project. This cost will be subject to indexations outlined in the tariff at the time of CoD.

	Amount (USD Mn)
Capital Cost	408.2
Custom Duties & Cess	16.2
Financing Fees and Charges	11.1
Sinosure Fee	33.2
IDC	28.9
Total Project Cost	**497.7**
Water Pipeline (allowed as EPP under Tariff)	**20.0**
Total Project Csot	**517.7**

Total project cost of USD 517.7mn will be financed in a debt to equity ratio of 75:25. Below is a snapshot of the capital structure of the company.

	Amount (USD Mn)
Debt (75%)	388.3
Equity (25%)	129.4
Project Cost	**517.7**

Debt financing is assumed entirely from Chinese sources. In case of a change in company's debt mix, reference parameters shall be updated accordingly.

5.2. Financing Terms:

Financing Amount	USD 388.3 mn
Tenor	10 years + Grace Period
Grace Period	40 months
Repayment Period	In 40 equal installments on annuity basis
Pricing	3M LIBOR + 450 bps 3M KIBOR + 350 bps
Security	Customary for standard project financing transactions which includes encumbrances over project assets, pledge of shareholding, cash waterfall, assignment overall rights under project documents etc.

5.3. Returns for Shareholders:

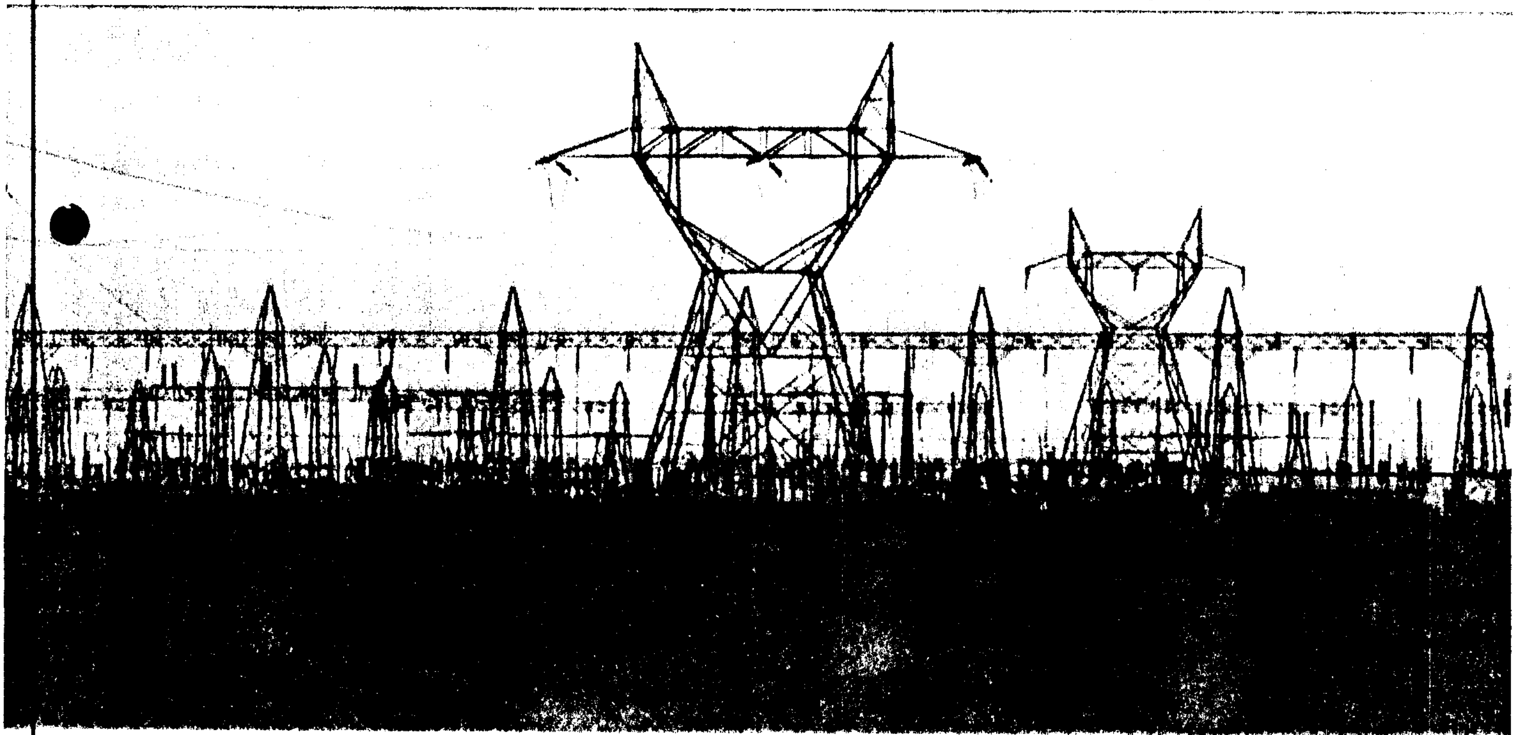
Shareholders of the Project are guaranteed to earn a 20% USD-based IRR on their investment over a 30-year period. In terms of Return on Equity, this return translates into a 30.65% return. Shareholders will earn an annual dividend of ~USD 40mn per annum as shown below:

IRR	20%
ROE	30.65%
Annual Dividend	~ USD 40mn

5.4. Projected Financial Performance:

(USD Mn)	Years 1-10 Levelized	Years 11-30 Levelized
Revenue	**215.9**	**140.7**
Variable Fuel Cost	(26.9)	(26.6)
Variable O&M	(9.8)	(9.8)
Water	(8.1)	(8.1)
Fixed O&M Cost	(8.3)	(8.3)
Insurance	(2.6)	(2.6)
Fixed Fuel Cost	(68.1)	(42.6)
Operating Expenses	**(123.7)**	**(97.9)**
EBITDA	**92.3**	**42.7**
Depreciation Expense	(12.9)	(12.9)
Earnings Before Interest/Taxes	**79.3**	**29.8**
Long term Interest payment	(10.7)	-
Working capital interest	(3.0)	(3.0)
Profit Before Tax	**65.6**	**26.8**
Taxes	-	-
Profit after Tax	**65.6**	**26.8**
Debt Repayment	**(38.8)**	-
Adding back Depreciation	*12.9*	*12.9*
Available for Distribution	**39.8**	**39.8**

Grid system impact study of
330 MW Thar Mine Mouth Coal Power Plant
Thar Block-II, District Tharparkar
Siddiqsons Energy Limited, Pakistan



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green inspiration since 1994

Draft Interim Report
Grid system impact study of
330 MW Thar Mine Mouth Coal Power Plant
Thar Block-II, District Tharparkar

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Table of Contents

Executive summary

The grid interconnection scope for power transfer of '330 MW Siddiqsons Thar Coal Power Plant' to National Transmission and Dispatch Company (NTDC) power system network is projected with 500 kV double circuit transmission line, approximately 0.78 km length on Drake conductor to Engro Thar 500 kV bus. 330 MW Coal power plant has been modeled having it's per unit (p.u) resistance, reactance and susceptance according to 0.78 km line length and 2771 MVA rating.

NTDC grid system, after addition of the coal power plant was analyzed for load flow to determine whether the plant connection with NTDC grid meets the NEPRA Grid Code requirements.

The assumed equivalent NTDC network model base cases have been used. The steady state data for the Siddiqsons coal power plant is processed to build it in PSSE software format.

The load flow analysis has been performed for assumed 2021 year basecase for the interconnection year 2020 of studies. The power flow analysis shows that the bus voltages and line loadings in all the assumed cases, with and without addition of the coal power plant are within acceptable limit as defined in Planning Criteria furthermore overloading is decreased by 1% in one contingency after connecting 330 MW Siddiqsons Thar Coal Power Plant. The results were also validated as per the standards of line loading and bus voltage limits in associated N-1 post-contingency conditions.

Based on the interim study results, it is concluded that proposed generation connection for '330 MW Siddiqsons Thar Coal Power Plant' meets the NEPRA Grid Code and Planning Criteria.

1. Introduction

1.1 Project background

This interim report covers the connection assessment studies of Siddiqsons 330 MW Siddiqsons Thar Coal Power Plant project.

'Siddiqsons 330 MW Thar Coal Power Plant' can be interconnected with the power system network of National Transmission and Dispatch Company (NTDC) at 500 kV voltage level.

1.2 Objective of the study

The principal objective of this study "Grid system impact study of 330 MW Siddiqsons Thar Mine Mouth Coal Power Plant" is to assess the impact of the suggested interconnection for the '330 MW Siddiqsons Thar Coal Power Plant' on the assumed NTDC transmission system and vice versa. In this interim study a most appropriate interconnection with the NTDC network is presented for the project.

The following studies/activities and tests are carried out in order to check the robustness of coal power plant and the interconnection strategy of the desired system.

1. Data processing.
2. Load flow analysis.

The above studies were carried out to demonstrate that the proposed connection plan of this plant meets the National Electric Power Regulatory Authority (NEPRA) Grid Code Planning Criteria for assumed 2021 year basecase. The proposed connection of this coal power plant, operating up to 330 MW, subject to the requirements specified in this interim report, is expected to have no material adverse impact on the reliability of the integrated power system of NTDC.

1.3 Terms of reference

The study package includes load flow study to determine whether the plant connection with the NTDC grid meets the NEPRA Grid Code requirements.

- The load flow study investigates and addresses the voltage profile and overloading issues of the assumed transmission network as a result of the proposed interconnection scheme, with and without contingencies.

2. Methodology and assumptions

2.1 Methodology

The methodology of the gird interconnection study follows the NEPRA Grid Code planning criteria and the studies are carried out in following sequence:

All the technical data, related to the specification of '330 MW Siddiqsons Thar Coal Power Plant' is collected from project sponsor.

- The information and data regarding the interconnection arrangements for the subject power plant involves discussion made with subject plant engineers.
- The power plant data is processed and then modeled in the overall assumed NTDC network model. Updated system network is then reviewed and tested for its validity.
- Different alternatives for evacuation of power from subject power plant have been analyzed and the most appropriate interconnection proposal is prepared and analyzed on the basis of results obtained by system studies.
- Comprehensive load flow analysis has been carried out to determine the adequacy of the proposed interconnection arrangement as per NEPRA Grid Code planning criteria.
- Results are compiled and analyzed in detail for above simulations effectively in order to conclude the interim study and complete the report accordingly.
- All the system data processing, modeling and simulations are carried using PSSE software.

2.2 General assumptions

Following are some of the important assumptions used for this study:

- The assumed WAPDA generation plan used for the subject study, as it has an important role in planning of power system.
- Dispatch of the generation power plants is taken based on the weather and seasonal conditions.
- The assumed transmission expansion plans of NTDC are the optimal ones as per load demand and generation requirements.
- The transmission plans of NTDC would optimistically be implemented as per their expected CODs, especially around the subject study region.
- Applicable seasonal conditions and appropriate study year for the subject system study have been assumed, which is;
    - **Year 2021:**
      2021 peak load Summer basecase of the interconnection year 2020 was assumed as base year case for this study.

3. Interconnection scope

The particular objective of this study is to develop and simulate a grid connection plan for the subject coal power plant with a nearby transmission line/substation such that there is no physical limitation regarding the Right Of Way (ROW) and free available capacity is accessible at the substation. POWER-tek analysed assumed single option for power evacuation of '330 MW Siddiqsons Thar Coal Power Plant' as the same is most suitable and no other option available in the area.

The grid interconnection scope for power transfer of '330 MW Siddiqsons Thar Coal Power Plant' to the NTDC power system network is projected with;

- 500 kV double circuit transmission line, approximately 0.78 km length on Drake conductor from Engro Thar through 500 kV switchgears. 330 MW Coal power plant connected to 500 kV bus bar of Siddiqsons Thar has been modeled having its per unit(p.u) resistance, reactance and susceptance according to 0.78 km line length and 2771 MVA rating

4. Data processing

4.1 Site location and related meetings

330 MW Siddiqsons Coal Power Plant in the year 2020 is located in Tharparkar district of Sindh province, Pakistan.

4.2 Collection of data

Power plant's location with coordinates, generation units and transformation requirements is provided by Siddiqsons Energy. Peak load summer basecase year 2021 was assumed by POWER-tek.

4.3 Processing of power plant data

POWER-tek processed the raw data from into the PSSE software format in order to model the coal power plant in PSSE and to perform the following simulation studies.

i. Steady state data for load flow analysis.

This processed plant data is modeled in the overall NTDC network model as per proposed connection scheme. Assumed network base case is then simulated by considering the N-1 contingency analysis for each case using standard checks like convergence, mismatch, and number of iterations, voltage and thermal limits. Coal power plant data is processed to build the Steady state data for load flow analysis basic model in PSSE software format:

4.3.1 Steady state system modeling

Coal power plant would have the net active power output of 330 MW as communicated by project sponsor.

Steady state models of generator and transformers at Power Plant in PSSE software as under:

- 330 MW Siddiqsons Thar Coal Power Plant has been modeled with 01 synchronous generator, having Pmax= 350 MW and Qmax=175.00 MVAR@ 0.85 lagging power factor, Qmin=-100 MVAR @ 0.9 leading power factor and base MVA of 420 MVA.
- 01 G.S.U transformer1, having rating 420 MVA and transformation voltage level of 500/20 kV.
- 500 kV double circuit transmission line, approximately 0.78 km length on Drake conductor from Engro Thar 500 kV. 330 MW Coal power plant to Engro Thar 500 kV bus bar of Tharparkar has been modeled having its per unit(p.u) resistance, reactance and susceptance according to 0.78 km line length and 2771 MVA rating.

5. Load flow analysis

5.1 Load flow study objectives

A power flow study (or load flow study) is an analysis of the magnitude of bus voltages, line loadings, phase angles of the buses and power flows in a power system under steady-state conditions.

The main goal of load flow analysis is to develop a reliable connection arrangement between the '330 MW Siddiqsons Thar Coal Power Plant' and the NTDC grid system, for the evacuation of 330 MW power from the coal power plant thus satisfying the N-1 contingency conditions.

An assumed equivalent base case model has been prepared, consisting of all 500 kV system, and studies for the entire system have been carried in order to assure that the proposed connection of the coal power plant is realistic for the maximum peak load conditions.

The analysis has been performed for assumed 2021 peak case of the interconnection year 2020. The power flow conditions are studied on the assumed base cases that include up-to-date generation, transmission facilities, and load forecast representing the queue position applicable to this project.

Following are the important objectives of load flow analysis:

- Confirmation that no voltage and thermal loading limits violation as per NERPA Grid Code Planning criteria.
- Voltage profile of NTDC system.
- Transmission line loadings in terms of Active (MW) and Reactive Power (MVAR) flows.
- Active Power (MW) loss in the network.
- Transmission network and transformation reactive losses (MVAR).
- Proposal of remedial solutions to any identified limitations or issues.

A relative approach has been used in the power flow analysis in order to determine the impact of the 330 MW coal power plant project on the performance of the NTDC power system network. First, performance of the base case system without combined cycle power project is evaluated in order to establish the baseline. Later, the analysis was performed with the addition of coal power plant and plotted on single line diagrams.

5.2 Load flow study criteria

Load flow analysis is performed under the following conditions;

- Steady state normal (N) operating conditions.
- N-1 contingency operating conditions around the plant.

The gird interconnection studies are carried out by considering the operational data defined by NEPRA Grid Code, which is listed as under;

5.2.1 Voltage limits

For the purpose of system planning, following voltage limits are defined for steady-state load flow analysis;

Voltages at Buses	0.95 pu ~ 1.05 pu	0.90 pu ~ 1.10 pu
Transmission Line (Branch) Loadings	≤100% of Line MVA Capacity*	≤100% of Line MVA Capacity*
Transformers Loading	≤110% of Transformer MVA Rating	≤110% of Transformer MVA Rating

5.2.2 Power factor

Power plant will manage reactive power control to maintain 0.8 power factor at full active power output at its interconnection point.

(Reference: NEPRA Grid Code).

5.3 Load flow analysis without addition of Siddiqsons coal power plant

The power flow analysis without connecting the coal power plant to the assumed base year 2021 power network of NTDC system was simulated first. This section summarizes the pre-contingent steady state analysis for the NTDC system load flow study.

System study case of following scenario was analysed and presented on single line diagrams (SLDs);

- 2021 assumed peak load summer conditions.

The results of the system are presented for normal (N condition) only, which shows that the power flows on all the circuits are within their defined current carrying capacity and the bus voltages are in the permissible range.

Normal (N) load flow study without addition of Siddiqsons Coal power plant is attached in Figure D-1A of Appendix D.

5.3.1 Overloading without addition of Siddiqsons coal power plant

Following overloadings were observed without connecting 330MW Siddiqsons Coal Plant:

- Matiari-CS (500kV) – Jamshoro (500kV) Line Out.
  Matiari-CS to Moro line 181% overloaded.

- Jamshoro (500kV) – Dadu-Id-1 (500kV) Line Out.
  Jamshoro to Dadu-Id-2 line 106% overloaded.

- Jamshoro (500kV) – Dadu-Id-2 (500kV) Line Out.
  Jamshoro to Dadu-Id-1 line 103% overloaded

5.4 Load flow analysis with addition of Siddiqsons coal power plant

'330 MW Siddiqsons Thar Coal Power Plant' is modeled in power flow using data supplied by Siddiqsons Energy. The assumed power flow cases are developed in order to determine the impacts resulted from this generator addition with proposed interconnection. The analysis has been performed for the following year and plotted on SLDs.

5.4.1 Base year 2021

Base year case is considered for the system impact study that is;

- Assumed basecase year 2021 peak load summer

5.4.1.1 Assumed basecase year 2021 peak load summer

The results of the power flow after connecting a coal power plant to power system shows that the MW and MVAR power flows on all the circuits are within the rated capacities and lies within the allowable range.

Normal (N) load flow study of assumed 2021 Peak Load Summer conditions is attached in Figure E-1A of Appendix E.

Contingency analysis was also carried out to evaluate the power system network under the standard functioning conditions. Contingency conditions were simulated for numerous selected outages. N-1 contingency analysis ensures a power system's capability to meet the demands as well as remain in specified voltage and flow limits even after outage of any one component. The N-1 contingency analysis is carried out for the interconnection of coal power plant with the proposed substation in order to illustrate the maximum impact of the coal power plant on a power system.

Following are some selected contingency simulations that are carried out while performing contingency analysis and results of the analysis are presented on SLDs with referred figure numbers below:

- Engro Thar (500kV) – SSRL (500kV) Line Out. (Figure E-1C)
- Engro Thar (500kV) – Matiari-CS (500kV) Line Out. (Figure E-1D)
- Moro (500kV) – Dadu (500kV) Line Out. (Figure E-1E)
- Matiari-CS (500kV) – K-2/K-3 (500kV) Line Out. (Figure E-1F)

Results of contingency analysis demonstrate that the resulting MW and MVAR power flows on the circuits and transformers after N-1 outage of selected components are within the rated capacities.

N-1 contingency load flow study of assumed 2021 peak load summer is attached in Figure E-1B of Appendix E.

5.4.1.2 Overloadings with addition of Siddiqsons coal power plant

Following overloadings were observed after connecting 330MW Siddiqsons coal power plant:

- Matiari-CS (500kV) – Jamshoro (500kV) Line Out.
  Matiari-CS to Moro line 180% overloaded.

- Jamshoro (500kV) – Dadu-Id-1 (500kV) Line Out.
  Jamshoro to Dadu-Id-2 line 106% overloaded.

- Jamshoro (500kV) – Dadu-Id-2 (500kV) Line Out.
  Jamshoro to Dadu-Id-1 line 103% overloaded

5.5 Conclusions of load flow analysis

No incremental pre-contingent system overloads or voltage violations resulting from interconnection of '330 MW Siddiqsons Thar Coal Power Plant' were found within the local study area or across NTDC transmission system. This finding was also validated through associated pre-contingency steady state system and post-contingency steady state system, overload and voltage violation screening outputs generated for the system model.

The overloading without connecting 330 MW Siddiqsons Coal power plant mentioned in section 5.3.1 doesn't exceed after connecting 330 MW Siddiqsons Coal power plant furthermore overloading is decreased by 1% in one contingency.

Thus, it can be concluded that the power flow on all the circuits in all the cases with and without connecting '330 MW Thar Coal Power Plant' are within defined limits and the voltages and loadings are in acceptable range of defined study criteria except those mentioned in overloading section above. However, it was made sure that no N-1 contingency overloading exceeds by connecting 330 MW Siddiqsons coal power plant.

It is further observed that all the power generated from '330 MW Siddiqsons Thar Coal Power Plant' is evacuated through 500 kV bus bar of SS-Thar further connected to Engro Thar through double circuit lines. This localized generation helps to reduce the losses of distribution network and results in improvement of voltage profile of nearby areas.

6. Conclusions and recommendations

'330 MW Siddiqsons Thar Coal Power Plant' has been proposed a generation connection scheme through a POI at 500 kV bus bar of Engro Thar bus bar from 500 kV switchgears using 500 kV double circuit transmission Line, approximately 0.78 km length on Drake conductor.

Assumed NTDC grid system with inclusion of the coal power plant was analyzed by load flow. The outputs depicts that connecting 330 MW Siddiqsons coal power plant the power in all circuits are within the defined range and the voltages that appears at the bus bars are within acceptable limit of defined study criteria.

Therefore, it is concluded that the proposed generation connection for '330 MW Siddiqsons Thar Coal Power Plant' is appropriate on the basis of detailed grid interconnection studies.

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