Application for Generation License

To

National Electric Power Regulatory Authority

For

330 MW Mine-Mouth Lignite Fired Power Plant Project at Thar

of

Thal Nova Power Thar Private Limited

ThalNova

ThalNova Power Thar (Private) Limited

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

Ref: TN/01/0012/08-2016

Subject: **Application for Generation License of 330MW Thar Coal Based Power Plant at Thar Block II, Sindh**

I, Mustufa Bilwani, being the duly authorized representative of the **ThalNova Power Thar (Private) Limited** by virtue of Board Resolution dated June 21st, 2016, hereby apply to the National Electric Power Regulatory Authority for the grant of a **Generation License** to the **ThalNova Power Thar (Private) Limited,** pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act 1997.

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

A **Demand Draft** in the sum of Rupees 729,240, being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Date: 10th Aug 2016

Signature
Mustufa Bilwani
Chief Executive Officer

ThalNova Power Thar
(Private) Limited

ThalNova

Extract of the Resolution passed by the Board of
Directors in their meeting held on June 21, 2016

"**RESOLVED** that an application for the Generation License (the "**GL Application**") be filed by and on behalf of ThalNova Power Thar (Private) Limited (the "**Company**") with the National Electric Power Regulatory Authority ("**NEPRA**"), in respect of the Company's 330 MW coal-fired power project at Thar, Sindh (the "**Project**")."

"**RESOLVED FURTHER** that an application for the acceptance of the Up-Front Tariff for Thar Coal power generation projects with assumptions and conditions as approved by NEPRA vide its determination dated 09 July 2014, be made to NEPRA with regards to the Project (the "**Up-Front Tariff Application**")."

"**RESOLVED FURTHER** than an application for Letter of Support be filed by and on behalf of the Company with the Private Power Infrastructure Board (the "**PPIB**"), in connection with the Project."

"**RESOLVED FURTHER** that the Chief Executive and/or Mr. Rizwan Diwan and/or Mr. Saqib Haroon Bilwani and/or Syed Firdous Shamim Naqvi and/or Mr. Muhammad Salman Burney, Directors and/or Mr. Mahad Asim Hamza, Executive of the Company be and are hereby authorized singly or jointly to sign the GL Application, the Up-Front Application, the application for the Letter of Support and any documentation ancillary thereto, pay all filing fees, and provide any information required by NEPRA or PPIB in respect of the Project, and do all acts and things necessary for the processing, completion and finalization of the GL Application, the Up-Front Application and the application for the Letter of Support."

"**RESOLVED FURTHER** that M/s. Riaa Barker Gillette be and are hereby appointed as legal counsel to the Company, to represent the Company before NEPRA and/or PPIB in respect of any hearings before NEPRA and/or PPIB relating to the GL Application, the Up-Front Tariff Application and/or application for the Letter of Support."

Certified True Copy

(Chief Executive/Director)
ThalNova Power Thar (Private) Limited

CERTIFICATION

CERTIFIED, that, the above resolutions were duly passed by the Board of Directors of ThalNova Power Thar (Private) Limited in their meeting held on June 21, 2016, for which the quorum of directors was present.

FURTHER CERTIFIED, that the said resolution has not been rescinded and is in operation and that this is a true copy thereof.

(Chief Executive/Director)
ThalNova Power Thar (Private) Limited

A020702

SECP

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. **0099023**

I hereby certify that **THALNOVA POWER THAR (PVT.) 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 **Eighteenth** day of **April,** Two Thousand and **Sixteen**.

Incorporation fee Rs. **322,000/=** only

Company Registration Office Karachi
Securities and Exchange Commission of Pakistan

(Zia-ul-Rasheed Abbasi)
Joint Registrar of Companies
Karachi

Issued 19/8/16

3(5)(a)(ii) CERTIFIED COPIES OF MEMORANDUM AND ARTICLES OF ASSOCIATION (CERTIFIED BY SECP)

THE COMPANIES ORDINANCE, 1984

A PRIVATE COMPANY LIMITED BY SHARES

MEMORANDUM

AND

ARTICLES OF ASSOCIATION

OF

THALNOVA POWER THAR (PRIVATE) LTD.

THE COMPANIES ORDINANCE, 1984

(A PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

of

THALNOVA POWER THAR (PRIVATE) LIMITED

NAME

I. The name of the Company is ThalNova Power Thar (Private) Limited.

REGISTERED OFFICE

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

OBJECT

III. The Object for which the Company is established is as under:

To carry on at suitable locations at Thar, Sindh and other places in Pakistan the business of power generation, distribution, transmission and sale in all its branches and aspects and by the use of such forms of energy and in such manner as may be deemed feasible and sell and deliver the electricity thus generated.

In order to carryout and fulfill the above object, the company shall be authorized:

1. To generate power from coal and conversion of coal into various chemicals. gasification of coal, conversion of coal into liquid fuels and palletisation of coal for generation of power.

2. To set up and generate power as independent power producer of wind, thermal, hydel, nuclear, steam, and/or any other alternative/renewable energy sources, and bio-energy and to carry out the construction and manufacture of wind, thermal gas, hydroelectric and thermal energy projects such as gas energy, coal, bio-thermal energy and to construct, establish and fix necessary power stations.

3. To set up, operate and manage one or more Power Generation Plants from different means and sources and to generate and supply electricity to industrial and other consumers, through distribution networks established, owned and operated by the company itself or by any other person, corporate body, autonomous or semi-autonomous corporation or authority or local body, and for that purpose to acquire land, whether freehold or leasehold, machinery and equipment, and construct, install, operate and maintain thereon power houses, civil and mechanical works and structures, grid stations, transmission towers, power lines, buildings, workshops and other facilities as may from time to time be necessary for the attainment of the object of the company.

4. To undertake the business of storing, transporting, transmitting, distributing, and supplying goods for lighting, heating, motive power for generation of power.

5. To undertake business in the power generation areas related to hydel, thermal, LNG, coal, solar energy and wind power installations, controls, protection, communication and instrumentation system for power plants, substations, industrial installation and pumping compressor stations, energy conversation system.

6. To acquire and hold any kind of interest in, or to provide any form of capital for, any person or undertaking of any kind and to co-ordinate and manage the activities of, and to provide finance, services and facilities to, any power generation company or undertaking controlled directly or indirectly by the company or in which the company is interested.

7. To locate, establish, construct, equip, operate, use, manage and maintain thermal

power plants and coal fired power plants, power grid station, transforming, switching, conversion, and transmission facilities, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cabal bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops, dispensing machines for per-payment cards and other devices, showrooms, depots, factories, workshops, plants, printing facilities, warehouses and other storage facilities.

8. To ascertain the tariff for bulk supply that will secure recovery of operating costs, interest charges and depreciation of assets, redemption at due time of loans and other than those covered by depreciation, power generation expansion projects, payment of taxes, and reasonable return on investment, to quote the tariff to bulk purchasers of electrical power, and to prefer petition to the appropriate authority for approval of the schedule of tariff and of adjustments or increases in its bulk supply tariff, where desirable or necessary.

9. To offer and to engage in supply, implementation and installation of Extra High Voltage (EHV) and (High Voltage) HV transmission lines, medium and low voltage overhead and underground distributions network, high voltage underground cables, and low voltage AC and DC installations, rectifier, capacitor installations and consumer services in connection with power generation.

10. To set up the work of heavy steel fabrication for power plants, transmission lines and other steel structures within the scope of the object of the Company in connection with power generation.

11. To carry out construction, installation, erection of hydel, steam, thermal, LNG, coal, nuclear, geothermal power station, solar energy projects and wind farms in connection with power generation.

12. To apply for and obtain necessary consents, permissions and licenses from relevant government, state, local and other authorities for enabling the company to carry on any of its object into effect as and when required by law.

13. To apply for, tender, offer, accept, purchase or otherwise acquire any contracts and concessions for or in relation to the projection, execution, carrying out, improvements, management, administration or control of works and conveniences

and undertake, execute, carry out, dispose of or otherwise turn to account the same.

14. To import, purchase, supply and acquire all kinds of plants, raw and other materials for generation of energy/electricity and sell, transmit and deliver the same thus generated anywhere in Pakistan.

15. To enter into any arrangements or agreements with any authorities, Central or any Provincial Government, Municipal, Local or otherwise and to obtain from any such authority any rights, privileges, rebates, licenses, permits and concessions which the company may consider desirable to obtain and to carry out exercise and comply with such arrangements, agreements, rights, privileges, rebates and concessions.

16. To carry out joint venture agreements with other companies or countries within the scope of the object of the Company.

17. To purchase or otherwise acquire, produce, manufacture, refine, treat, purify, blend, reduce, distil, store, transport, market, distribute, supply, sell and otherwise dispose of in any and all kinds of petroleum and petroleum products, oils, coal, gas, hydrocarbons, petrochemicals, asphalt, bituminous substances and the products and by- products which may be derived, produced, repaired, developed, compounded, made or manufactured there from and or acquire and take over the running or likely to be running business of alike nature with or without assets, liabilities, rights, privileges, goodwill, registration, trade mark, import and export registration, or any other facilities in connection with power generation

18. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building, easements, trademarks, patents, patent rights, copyrights, licenses, machinery, plants, stock-in-trade and any movable and immovable property of any kind necessary or convenient for the purposes of or in connection with the company's business or any branch or department thereof and to use, exercise, develop, grant licenses in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.

19. To acquire by concession, grant, purchase, barter, license either absolutely or

conditionally and either solely or jointly with others any lands, buildings, machinery, plants, equipment, privileges, rights, licenses, trademarks, patents, and other movable and immovable property of any description which the Company may deem necessary or which may seem to the Company capable of being turned to account.

20. To buy, sell, manufacture, repair, alter, improve, or otherwise treat, exchange, hire, let-out on hire, import, export and deal in all works, plant, machinery, tools, engines, tanks, cylinders, valves, regulators, testing equipment, tools, utensils, appliances, equipment, stoves, heaters, apparatus, utensils, 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, appliances, equipment, apparatus, products, materials, substances, articles and things capable of being used in any such business or required by any customers of, or persons having dealing with the company, or any such other company or body as herein mentioned, or commonly dealt in by, persons engaged in any such business, or which may seem capable of being profitably dealt with in connection with any of the said business and to manufacture, experiment with, render marketable and otherwise treat and deal in all products and residual and bye-products incidental to, or obtained, or capable of being made use of, in any of the business carried on by the Company or any such other company or body herein mentioned.

21. To sell or otherwise dispose of the whole or any part of the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any Company purchasing the same.

22. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion and establishment of the Company and to remunerate any person, firm or company for services rendered or to be rendered in or about the formation or promotion of the Company or the conduct of its business.

23. To remunerate any person, firm or company rendering services to this Company, under a contract of employment, management or otherwise, whether by the payment of cash or by the allotment of shares or securities of the Company, during the continuation of such services, the furtherance thereof, or termination of such services howsoever.

24. To give any servant or employee of the Company commission in the profits of the Company's business or any branch thereof and for the purpose to enter into any agreement as the Company may deem fit and to procure any servants or employees of the Company to be insured against risk of accident in the course of their employment by the Company.

25. To advance, lease or deposit money to any person with or without taking any security therefore and upon such other terms as may be thought fit by the company. but only in furtherance of object of the company.

26. To accept securities of any person or any property or interest therein of whosoever nature, in payment or part payment for any services rendered, or for any sale or supply made to, or debt owing from, any such person.

27. To represent persons at meetings of local, national and international organizations, and bodies concerned with business activities connected or associated with any of the business of the company, to provide services of all kinds to such organizations and bodies and to negotiate and enter into national and international agreements, and standards relating to matters of concern or interest of the company or persons represented by, or having dealings with the company.

28. To establish, provide, maintain and conduct or otherwise subsidize research laboratories and experimental workshops for scientific and technical research, experiments and tests of all kinds; and to promote studies and research, both scientific and technical investigations and inventions by providing, subsidizing, endowing or assisting laboratories, workshops, libraries, lectures, meetings and conferences and by providing or contributing to the scientific or technical professors or teachers and by providing or contributing to the award of scholarships, prizes, grants to studies or otherwise and generally to encourage, promote and reward studies, researches, investigations, experiments, tests, and inventions of any kind that may be considered likely to assist any business which the Company is authorized to carry on.

29. To establish, promote or assist in establishing or promoting and subscribe to or become a member of any other company, association or club whose object are similar or in part similar to the object of this Company or the establishment or promotion of which may be beneficial to the Company, as permissible under the

law.

30. To apply for purchase or otherwise acquire any patents, patent rights, brevets d'invention, licenses, secret marks, commercial names and designs, copyrights, trademarks, service licenses, concessions, and the like, conferring any exclusive or nonexclusive or limited right to use, or any secret or other information as to any invention 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, or grant licenses in respect of, or otherwise turn to account the property, rights or information so acquired as permissible under law.

31. To invest and deal, from time to time, with the surplus moneys of the Company not required for its main business in any manner and in particular to accumulate funds or to acquire or to take by subscription absolute or conditional, purchase or otherwise howsoever and to hold, and dispose of shares and other securities of any other company, association, undertaking in Pakistan or abroad.

32. To invest and deal with the moneys of the Company in such new projects, companies, works and research as may be directed by the Government of Pakistan.

33. To enter into partnership, to amalgamate or merge movable with immovable and/or to buy on all interests, assets, liabilities, stocks or to make any arrangement for sharing profits, union of interests, co-operation, joint-venture, reciprocal concession or otherwise with any person, firm or company carrying on or proposing to carry on any business which this Company is authorized to carry on or which is capable of being conducted so as directly or indirectly to benefit this Company and to have foreign collaborations and to pay royalties/ technical fees to collaborators.

34. To open accounts with any Bank or Banks and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit and other negotiable instruments and securities.

35. To arrange local and foreign currency loans from scheduled banks, industrial banks and financial institutions for the purpose of purchase, manufacture, market,

supply, export and import of machinery, construction of factory, building and for the purpose of working capital or for any other purpose.

36. To borrow money by means of loans or other legal arrangements from banks, or other financial institutions, or Directors in such manner as the Company may think fit and in particular by issue of debentures, debenture stock, perpetual or otherwise convertible into shares and to mortgage, or charge the whole or any part of the property or assets of the Company, present or future, by special assignment or to transfer or convey the same absolutely or in trust as may seem expedient and to, purchase, redeem or payoff any such securities.

37. To guarantee the performance of contract and obligations of the Company in relation to the payment of any loan, debenture-stock, bonds, obligations or securities issued by or in favor of the Company and to guarantee the payment or return on such investments.

38. To distribute any of the property of the Company in specie among the members in the event of winding up or otherwise.

39. To do all or any of the above things in any part of the world as principals, agents (except managing agents), contractors, sub-contractors, otherwise and by or through trustees, agents, subsidiary company or otherwise and either alone or in conjunction with others.

40. To cause the Company to be registered or recognized in any foreign country.

41. To create any reserve fund, sinking fund, insurance fund, or any other special fund, whether for depreciation or for repairing, insuring, improving, extending or maintaining any of the property of the Company, or for any other purpose conducive to the interests of the Company.

42. To capitalize such portion of the profits of the Company as are not distributed among shareholders of the Company in the form of dividends, and as the directors of the Company may think fit and to issue bonus shares, as fully paid up, in favor of the shareholders of the Company.

43. From time to time, to subscribe or contribute (in cash or in kind) to, or to promote, any charitable, benevolent or useful object of a public character, or any object which may in the opinion of the company be likely, directly or indirectly, to further the interests of the company, its employees or its employees or its members.

44. 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 object 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 appurtenant to or arising out of or connected with the business or powers of the Company or part thereof, provided the same be lawful.

45. It is hereby undertaking that the company shall not engage in Banking Business, Business of an Investment Company, Non-Banking Finance Company, Leasing Company and Insurance Company, Business of managing agency or any unlawful business and that nothing in object clauses shall be construed to entitle company to engage in such business, directly or indirectly. The Company shall not launch

46. It is further declared that the company shall not do any kind of pyramid scheme, brokerage and lottery business or such other business through which money from the public can be collected and interest of the public at large is jeopardize.

47. Notwithstanding any thing stated in any object clause, the company shall obtain such other approval or license from competent authority, as may be required under any law for the time being in force, to undertake a particular business.

LIABILITY OF MEMBERS

IV. The liability of the members is limited.

CAPITAL

V. The authorized capital of the company is Rupees 100,000,000/- (Rupees One Hundred Million) divided into 10,000,000 (Ten Million) ordinary shares of Rs.10/-(Rupees Ten) each with power to increase the capital of the company and to divide the shares in the capital for the time being into several classes 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 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.

We, the several persons whose names and addresses are hereto subscribed, are desirous of being formed into a Company in pursuance of these Memorandum of Association, and we respectively agree to take the number of Ordinary Shares in the capital of the Company set opposite our respective names.

Sr. No.	Name and Surname (Present, Former) in full (In Block Letter)	Computerized National Identity Card No.	Father's Name in Full	Nationality	Occupation	Residential Address	No. of Shares taken by each Subscriber	Signature
1	Thal Power (Pvt) Limited Represented By: Mr. Ali Suleman Habib And Mr. Muhammad Salman Burney	CUIN 890085 42201-0580064-9 42301-0193986-7	 Suleman Habib Ashfaq Azim Burney	 Pakistani Pakistani	- Business Man Business Executive	4th Floor, House of Habib, 3-Jinnah Cooperative Housing Society, Block-7/8, Karachi. House No. B-58, KDA Scheme No. 1, Karachi. House No. 41, Khayaban-e-Bharia, Phase 5, D.H.A, Karachi	500 (five hundred) ordinary shares of Rs.10/- each	
1(a)	Mr. Ali Suleman Habib	42201-0580064-9	Suleman Habib	Pakistani	Business Man	House No. B-58, KDA Scheme No. 1, Karachi.	1 (One) ordinary share of Rs.10/- each	
1(b)	Mr. Muhammad Salman Burney	42301-0193986-7	Ashfaq Azim Burney	Pakistani	Business Executive	House No. 41, Khayaban-e-Bharia, Phase 5, D.H.A, Karachi.	1 (One) ordinary share of Rs.10/- each	
1(c)	Syed Firdous Shamim Naqvi	42201-0822599-9	Syed Shamim ul Hasan Naqvi	Pakistani	Business Executive	House No. C-141, KDA Scheme A-1, Karsaz Road, Karachi.	1 (One) ordinary share of Rs.10/- each	

2	Nova Thar Powergen (Pvt) Limited Represented By: Mr. Rizwan Diwan	CUIN 98522 42201-638879 2-9	 Abdul Razak Diwan	 Pakistani	 Industrialist	Room No.50, 2^{nd} Floor, Ahmed Complex, Jinnah Road, Quetta House No.27-B, Street No.3, Gizri,Phase IV, DHA, Karachi	500 (five hundred) ordinary shares of Rs.10/- each
2(a)	Mr. Shabbir Diwan	42201-357812 7-3	Pir Muhammad	Pakistani	Industrialist	House No. 43/6-D, Block-6, P.E.C.H.S., Karachi	1 (One) ordinary share of Rs.10/- each
2(b)	Mr. Rizwan Diwan	42201-638879 2-9	Abdul Razak Diwan	Pakistani	Industrialist	House No.27-B, Street No.3, Gizri,Phase IV, DHA, Karachi	1 (One) ordinary share of Rs.10/- each
2(c)	Mr. Saqib Haroon Bilwani	42301-104761 5-5	Haroon Bilwani	Pakistani	Industrialist	House # 32/1/2/ Gizri Street No.5, Phase IV, DHA, Karachi.	1 (One) ordinary share of Rs.10/- each
					Total Shares Taken		1006 (one thousand six)

Dated: 07^{th} day of April, 2016.

WITNESS TO THE ABOVE SIGNATURES:

NIFT (PVT) LIMITED
5th Floor, AWT Tower
I. I. Chundrigar Road,
Karachi

18/4/16

Bzaid 18/4/16

Bzaid 19/4/16

THE COMPANIES ORDINANCE, 1984

(A PRIVATE COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

THALNOVA POWER THAR (PRIVATE) LIMITED

1. TABLE 'A' NOT TO APPLY

The regulations contained in table "A" in the first Schedule to the Companies Ordinance, 1984, shall not apply to the Company except to the extent and as hereinafter expressly set out.

2. DEFINITIONS

Words or expressions contained in these Articles shall, unless otherwise defined herein or unless inconsistent with the subject or context, have the same meaning as ascribed thereto in the Companies Ordinance, 1984. In these Articles, unless there is something in the subject or context inconsistent therewith:

(A) "**Affiliate**" shall mean, in relation to a Person, (a) a legal entity which controls or is controlled by such Person or which is controlled by an entity that also controls such Person (in this context, 'control' (in all its forms and tenses) means the right to exercise, directly or indirectly, more than fifty percent (50%) of the voting rights attached to the shares of such entity being controlled by such Person); and (b) any other entity mutually agreed between Thal SPV and Nova SPV to be an affiliate of either of them;

(B) "**Articles**" means these Articles of Association as originally framed or as altered from time to time in accordance with the terms of these Articles;

(C) "**Board**" means the Board of Directors of the Company for the time being;

(D) "**Business Day**" means any day (other than a Saturday, Sunday or a public holiday) when banks in Pakistan are open for the transaction of normal business;

(E) "**Chief Executive**" means the Chief Executive Officer of the Company appointed from time to time in accordance with these Articles;

(f) "**Company**" means ThalNova Power Thar (Private) Limited;

(g) "**Dividend**" means the distribution of profits of the Company to its Shareholders in cash or in-kind;

(h) "**Memorandum**" means the Memorandum of Association of the Company as originally framed or as altered from time to time in accordance with the provisions of the Ordinance and these Articles;

(i) "**Month**" means a calendar month according to the Gregorian calendar;

(j) "**Nova SPV**" means Nova Thar Powergen (Private) Limited, a company incorporated under the laws of Pakistan having its registered office located at Room No. 50, 2nd Floor, Ahmed Complex, Jinnah Road, Quetta, Pakistan;

(k) "**Ordinance**" means the Companies Ordinance, 1984;

(l) "**Register**" means the Register of Members / Shareholders to be kept pursuant to Section 147 of the Ordinance;

(m) "**Registered Office**" means the registered office of the Company for the time being;

(n) "**Registrar**" has the same meaning as ascribed thereto in clause (31) of sub-section (1) of Section 2 of the Ordinance;

(o) "**Seal**" or "**seal**" means the common seal of the Company;

(p) "**Section**" or "**section**" means sections of the Ordinance;

(q) "**Shareholders**" means the shareholders of the Company holding Shares whose names are entered into the Register;

(r) "**Shares**" means shares in the share capital of the Company;

(s) "**Special Resolution**" has the same meaning as ascribed thereto in clause 36 of sub-section 1 of Section 2 of the Ordinance;

(t) "**Thal SPV**" means Thal Power (Private) Limited, a company incorporated under the laws of Pakistan with its registered office at 4th Floor, Siddiqsons Building, 3-Jinnah C. H. Society, Block 7/8, Shara-e-Faisal, Karachi - 75350, Pakistan.

3. REGISTERED OFFICE

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

4. PRIVATE COMPANY

The Company is a private limited company and accordingly:

4.1 the number of Shareholders of the Company shall (exclusive of persons in the employment of the Company), be limited to fifty;

4.2 no invitation shall be made to the public to subscribe for the Shares or debentures of the Company;

4.3 the right to transfer Shares of the Company is restricted in the manner and to the extent specified in these Articles.

5. CHANGES TO THE MEMORANDUM AND ARTICLES OF ASSOCIATION

No changes shall be made to the Memorandum and Articles of the Company, except with the unanimous approval of all the Shareholders of the Company (including Thal SPV and Nova SPV) in a duly convened General Meeting of the Company.

6. AUTHORIZED CAPITAL

6.1 The Authorized Share Capital of the Company is the amount set out in Clause V of the Memorandum divided into the number of Shares of PKR 10/- each as set out in the said clause with powers to the Company to increase, reduce, reorganize, consolidate or subdivide the share capital on such terms as the Shareholders may deem appropriate in the capital of various classes from time to time in accordance with the provisions of these Articles and the Ordinance.

6.2 The capital of the Company may consist of ordinary shares, non-voting shares and preference shares (cumulative or non-cumulative, redeemable, convertible or otherwise). Each class of Shares may have such rights as may be determined by the Company in general meeting.

6.3 Except as may be set out in these Articles, the holders of Shares of the Company are entitled to receive notice(s) of general meetings of the Company and to vote at such general meetings and shall have one vote for each Share.

7. SHARES

7.1 Issuance of Shares Controlled by the Board

Subject to the provisions of the Ordinance and these Articles, the Shares of the Company shall be under the control of the Board. The Board shall, as regards any issuance or allotment of Shares, duly comply with the provisions of these Articles and Sections 67 to 73 and Section 86 of the Ordinance as may be applicable.

7.2 **Parity of Initial Shares**

All Shares issued pursuant to these Articles shall have a par value of PKR 10/- each per Share and except to the extent otherwise stated in these Articles, shall rank pari passu in all respects, including voting rights dividends, return on capital and otherwise.

7.3 **Further Issue of Shares**

The Board may, subject to these Articles and Section 86 of the Ordinance, allot or otherwise dispose of any Shares of the Company to such persons, on such terms and conditions and at such times as the Board thinks fit, and at a premium or at par or (subject to the provisions of the Ordinance) at a discount and for such consideration as the Board thinks fit, provided that, where at any time the Board decides to increase the issued capital of the Company by issuing any further Shares, such Shares shall be offered to the existing Shareholders strictly in proportion to the number of existing Shares held by each Shareholder and such an offer shall be made by a notice specifying the number of Shares to which the Shareholder is entitled, and limiting a time (not exceeding sixty (60) days) within which the offer, if not accepted, will be deemed to be declined, and on expiration of such time, or on receipt of information from the Shareholder to whom such notice is given that he declines to accept the Shares offered, the Board may, subject to the provisions of Section 86(7) of the Ordinance, dispose of the same in such manner as it may consider most beneficial to the Company or decide not to allot such Shares to any person.

7.4 **Issuance of Shares for consideration other than cash**

Subject to the provisions of the Ordinance, these Articles and any applicable laws, rules and regulations, including any consents, approvals or permissions that may be required thereunder, the Board may allot and issue Shares in the capital of the Company as payment for any property (tangible or intangible) sold or transferred, goods or machinery supplied, or for services rendered to the Company or expenses incurred on behalf of the Company or in conduct of its business or affairs, and any Shares which may be so allotted shall be issued as fully paid up Shares.

7.5 **Issuance of Shares in book-entry form**

The Shareholders may deposit their Share Certificates with a central depository and the Company may issue the Shares in book-entry form through a central depository in accordance with the provisions of the Central Depositories Act, 1997 with such legend provided on such Share Certificates as is prescribed by Article 8.1 and in such case the provisions of the said Act and any rules or regulations framed pursuant thereto shall apply to all matters relating issuance, registration and transfer of Shares. Provided that the restrictions on transfer of Shares as provided in these Articles shall continue to apply to the Shares in book-entry form.

8. SHARE CERTIFICATES

8.1 **Certificates**

The certificates of title to the Shares shall be issued under the Seal of the Company and signed by two (2) directors (being at least one (1) nominee director of Thal SPV and one (1) nominee director of Nova SPV). Every certificate of Shares shall bear the following legend thereon:

"Any disposition, transfer, charge, sale, pledge, hypothecation, assignment of or dealing in any other manner in the Shares represented by this certificate cannot be transferred without the written consent of Thal Power (Pvt) Limited and Nova Thar Powergen (Pvt) Limited."

8.2 **Shareholders' Right to Certificates**

Every Shareholder shall be entitled, within ninety (90) Days of the allotment of Shares, without payment, to one (1) certificate for all the Shares registered in his name. Every certificate of Shares shall specify and denote the number of Shares in respect of which it is issued, and the amount paid up thereon.

8.3 **Issue of Duplicate Certificates**

If any certificate is worn-out, defaced or rendered useless, then upon production thereof to the Board, the Board may order the same to be cancelled and may issue a new certificate in lieu thereof, and if any certificate is lost or destroyed, then on proof to the satisfaction of the Board, and on such indemnity as the Board deems adequate being given, a new certificate in lieu thereof may be issued on such terms as may be prescribed by the Board.

9. TRANSFER OF SHARES

9.1 **Lock-in Period**

Except as provided in these Articles, no Shareholder shall for the lock-in period under the Implementation Agreement (to be entered into between the Company and the Government of Pakistan) and the Financing Documents (to be entered into between the Company and its Lenders) be entitled to transfer, or agree to undertake or transfer, directly or indirectly, any Shares or any right in or attaching to any of its Shares ("**Lock-in Period**").

9.2 **Expiry of Lock-in Period**

Except as allowed under these Articles, no Shareholder shall be entitled, following the expiry of the Lock-in Period, to transfer or agree to undertake to transfer, directly or indirectly, any Shares or any right in or attaching to any of its Shares, without the prior consent of Thal SPV and Nova SPV

9.3 **Validity of Transfer**

Any transfer or attempted transfer of Shares by a Shareholder (either directly or indirectly) which is not in accordance with the requirements set out in these Articles, shall be void and of no force or effect and the Board shall not be required to register any such transfer or attempted transfer nor any purported transferee shall be recognized as Shareholder of the Company for any purpose whatsoever.

9.4 **Transfer to Affiliates and to a Nominee Director**

(A) Subject to the requirements of the Lock-in Period, a Shareholder may, at any time, transfer all or any number of its Shares ("**Relevant Shares**") to an Affiliate of that Shareholder and such Affiliate may at any time transfer all of the Relevant Shares back to the original Shareholder or to another Affiliate of the original Shareholder. Likewise, a Shareholder may transfer one (1) Share to each of its nominee Directors for providing such nominee Director with the requisite share qualification in terms of Section 187(h) of the Ordinance.

(B) If the Relevant Shares have been transferred under Article 9.4(a) (whether directly or by a series of transfers) by a Shareholder (the "**Transferor**", which expression shall not include a second or subsequent transferor in a series of transfers) to its Affiliate or nominee Director (the "**Transferee**") and subsequently the Transferee ceases to be an Affiliate or nominee Director of the Transferor, then the Transferee shall forthwith transfer the Relevant Shares to the Transferor or at the Transferor's option to an Affiliate or a new nominee Director of the Transferor.

(C) Prior to transferring the Relevant Shares to a Transferee under this Article 9.4 (*Transfer to Affiliates and to a Nominee Director*), the Transferor shall provide to the Board and the Company such information as may be reasonably required by the Board for the purposes of ensuring that the proposed transfer of the Relevant Shares is in accordance with the requirements set out in this Article 9.4 (*Transfer to Affiliates and to a Nominee Director*). If the said information is not provided within thirty (30) days of the request made by the Company, the Board shall refuse to register the transfer of the Relevant Shares in the name of the Transferee.

9.5 **Refusal to Transfer Shares**

(a) The Directors shall refuse to transfer any Shares of the Company if the provisions of these Articles in that respect are not being complied with. The Directors shall also refuse to transfer any Shares if the transfer deed is for any reason defective or invalid, provided that the Company shall, within thirty (30) days from the date on which the instrument of transfer was lodged with it, notify the transferor and transferee of the defect or invalidity, either of whom shall, after removal of such defect or invalidity be entitled to re-lodge the transfer deed with the Company.

(b) If the Company refuses to register the transfer of any Shares, the Company shall, within thirty (30) days after the instrument of transfer was lodged with it, send to the transferor and transferee notice of the refusal indicating the reason for such refusal.

10. ALTERATION OF CAPITAL

10.1 Power to Increase Authorized Capital

The Company may from time to time by way of a resolution passed and approved by the Shareholders of the Company in accordance with the Ordinance (in a duly convened General Meeting), increase its authorized share capital by such sum as the resolution shall prescribe, provided that the nominal value of the Shares remains to be PKR 10/- each.

10.2 Condition of Creation of New Shares

Any capital raised by the creation of new Shares shall be considered part of the authorized capital and the new Shares shall be subject to the provisions herein contained with reference to transfer, transmission, voting and otherwise.

10.3 Power to Reduce Share Capital

The Company may by way of a special resolution passed by the Shareholders of the Company (in a duly convened General Meeting), reduce its share capital in any manner and with and subject to any incidental authorization and consent required by law.

10.4 Power to Cancel Shares

Subject to the provisions appearing after clause (d) of sub-section 1 of Section 92 of the Ordinance, the Company may by way of a special resolution passed by the Shareholders of the Company (in a duly convened General Meeting), alter the conditions of the Memorandum as to cancel any shares which at the date of passing of the resolution in that respect have not been taken or agreed to be taken by any person, and diminish the amount of its authorized share capital by the amount of Shares so cancelled.

11. GENERAL MEETINGS

11.1 Holding of Annual General Meeting

An Annual General Meeting of the Company shall be held in accordance with the provisions of Section 158 of the Ordinance once at least in every calendar year within a period of four (4) months following the close of its financial year at such time and place as may be determined by the Board, provided that no greater interval than fifteen (15) months shall be allowed to elapse between two such General Meetings. All such General Meetings shall be called "Annual General Meetings" and all other General Meetings shall be called "Extraordinary General Meetings".

11.2 Extraordinary General Meetings

Subject to the provisions of Section 159 of the Companies Ordinance, the Directors may at any time call an Extraordinary General Meeting of the Company to consider any matters which require the approval of the Shareholders in a General Meeting and shall, on the requisition of Shareholders representing not less than 10% of the voting power on the date of the deposit of the requisition, forthwith proceed to call an Extraordinary General Meeting.

11.3 Notice of Meetings

Twenty one (21) days notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which the notice is given) specifying the agenda, place, the day and the hour of meeting and, in case of special business, the general nature of that business, shall be given in the manner provided by Section 160 of the Ordinance for the General Meetings to such persons as are under the Ordinance or these Articles, entitled to receive such notices from the Company.

11.4 **Special Business**

All business shall be deemed special that is transacted at an Extraordinary General Meeting, and also business that is transacted at an Annual General Meeting with the exception of (i) declaring dividends; (ii) the consideration of accounts, balance sheet and reports of Directors and Auditors; (iii) the election and appointment of Directors; and (iv) the appointment, and the fixing of the remuneration of, the Auditors.

11.5 **Shorter Notice**

In the event of an emergency affecting the business of the Company, the Board may, in accordance with the provisions of Section 159(7) of the Ordinance, make application to the Registrar for a shorter notice period, and, if the Registrar authorizes a shorter notice period, then an Extraordinary General Meeting may be convened upon such shorter notice as authorized by the Registrar. Notwithstanding the foregoing, where a Special Resolution is to be passed at a General Meeting, the Board may call such General Meeting by such notice of less than twenty one (21) days as is acceptable to all the Shareholders.

11.6 **Waiver of Notice**

A Shareholder who does not timely receive notice of a General Meeting, but attends and participates in such General Meeting, shall be deemed to have waived timely receipt of such notice.

11.7 **Quorum and Decision at General Meetings**

(a) Subject to Article 11.9 (*Adjournment of Meeting for Lack of Quorum*), the quorum for any General Meeting of the Shareholders (be it the Annual General Meeting or an Extraordinary General Meeting) shall be at least two (2) Shareholders, including Thal SPV and Nova SPV, present through their duly authorized representatives. For sake of clarity, the presence of Thal SPV and Nova SPV through their authorized representatives shall be required to constitute quorum at a General Meeting.

(b) No action shall be taken by the Company which is required under the Ordinance or these Articles to be approved by the Shareholders of the Company, unless consent or approval for such action is given at a General Meeting of the Shareholders duly convened and held in accordance with these Articles.

11.8 **Who is to preside at General Meetings**

The Chairman of the Board shall also be the Chairman of the General Meetings, but if there is no such Chairman, or if at any meeting the Chairman is not present within thirty (30) minutes after the time appointed for holding the Meeting or if the Chairman is not willing to take the chair, the Shareholders present may choose one of the Directors nominated by the Shareholder, whose nominee is the aforesaid Chairman, and present at the Meeting, to be the Chairman of the General Meeting, and if none of the nominee Directors of such Shareholder is present or, being present, is unwilling to act as the Chairman, the Shareholders present shall choose one of the authorized representatives of such Shareholder to be the Chairman for that meeting and proceed accordingly.

11.9 **Adjournment of Meeting for Lack of Quorum**

If within thirty (30) minutes after the time prescribed for a General Meeting a quorum is not present or ceases to exist, the meeting shall be adjourned for a period not less than seven (7) days, to the same place and time. At such adjourned meeting, Thal SPV and Nova SPV, present through an authorized representative or by proxy shall form quorum and may conduct the business of the meeting.

11.10 **Voting on Resolution by Show of Hands and When Poll Demanded**

At any General Meeting a resolution put to the vote of the General Meeting shall be decided by a show of hands, unless a poll is demanded (before or on the declaration of the results of the show of hands) by Shareholders present (subject to the quorum requirements being met) in person or by proxy or by the Chairman of the General Meeting and unless a poll is so demanded, a declaration by the Chairman that a resolution has been carried or lost and an entry to that effect in the books of the proceedings of the Company which is approved by the Shareholders, shall be conclusive evidence of the fact without further proof of the number or proportion of votes recorded in favour of or against such resolution. The demand for a poll may be withdrawn at any time by the person or persons who made the demand.

11.11 **Poll**

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 General Meeting directs, and either at once or after an interval or adjournment of not more than fourteen (14) days from the day on which the poll is demanded. When a poll is taken, the Chairman or his nominee and a representative of the Shareholder(s) demanding the poll shall scrutinize the votes given on the poll and the result shall be announced by the Chairman. The Chairman shall, subject to the provisions of the Ordinance, have power to regulate the manner in which a poll shall be taken. The result of the poll shall be deemed to be the resolution of the General Meeting at which the poll was held.

11.12 **Poll on Election of Chairman and Adjournment**

Any poll demanded on the election of a Chairman of a General Meeting or on any question of adjournment shall be taken at the General Meeting and without adjournment.

11.13 **Effect of Demand for Poll**

The demand for a poll shall not prevent the continuation of a General Meeting for the transaction of any business, other than the question on which the poll was demanded.

11.14 **Minutes**

Minutes shall be made in books provided by the Board pursuant to Section 173 of the Ordinance for the purposes of all resolutions and proceedings at the General Meetings, and any such Minutes if signed by the Chairman of the General Meeting or of the next following General Meeting and approved by the Shareholders shall constitute sufficient evidence of the facts therein stated without further proof. The Minutes shall be recorded and maintained in the English language along with a Chinese translation thereof; provided that in the event of any discrepancy or difference between the two versions, the English language version shall always prevail.

11.15 **Inspection of Minute Books**

The books containing Minutes of proceedings of General Meeting of the Company shall be kept at the Registered Office and shall, during business hours (subject to such reasonable restrictions as the Board may from time to time impose but so that not less than two (2) hours each day is allowed for inspection), be open to the inspection of any Shareholder.

12. VOTING

12.1 **Votes of Shareholders**

Except as to voting for the election of the Directors as provided in Section 178 of the Ordinance, every Shareholder entitled to vote may vote, either in person or by proxy, and upon a poll every Shareholder entitled to vote and present in person or by proxy shall have one (1) vote for every Share conferring voting rights as aforesaid held by him.

12.2 **Meeting called by the Court under section 271(1)(iii) of the Ordinance**

At any General Meeting directed to be called by the Court under section 271(1)(iii) of the Ordinance, where any appropriate remedial actions are proposed to be taken, decisions in that respect shall only be taken by a special resolution and with the affirmative vote of both Thal SPV and Nova SPV.

12.3 Representative of Corporate Shareholders

A corporation, foundation or a company being a Shareholder may by a resolution of its directors authorize any of its officers or any other person to act as its authorized representative at any General Meeting and the person so authorized shall be entitled to exercise the same powers on behalf of the Shareholder which he represents as if he were an individual Shareholder.

12.4 Poll by Proxy

On a poll, votes may be given either personally or by proxy, provided that no corporate body shall vote by proxy as long as a resolution of its directors in accordance with the provisions contained in Article 12.3 (*Representative of Corporate Shareholders*) is in force.

12.5 Proxy

Every proxy shall be appointed in writing under the hand of the appointer or by an agent duly authorised under a power of attorney. A proxy holder must be a Shareholder of the Company.

12.6 Filing of Instrument of Proxy

No person shall act as proxy unless the instrument of his appointment, duly executed, or other authority (if any) under which it is signed, or a notarially certified copy thereof, shall be deposited at the Registered Office of the Company at least forty-eight (48) hours before the time appointed for holding the General Meeting at which the person named in the proxy proposes to vote.

12.7 Instrument of Proxy

An instrument of proxy shall be in the form specified in Regulation 39 of Table A of the First Schedule to the Ordinance, or in any other form as the Board may approve

12.8 Validity of Proxy

A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the previous death of the principal or revocation (where permissible) of the proxy or of any power of attorney or the other authority under which such proxy was signed, provided that no intimation in writing of the death or revocation shall have been received at the Registered Office of the Company before the General Meeting or the adjourned General Meeting at which the proxy is used.

12.9 Validity of the Vote

No objection shall be made to the validity of any vote except at the General Meeting or at the poll at which such vote shall be tendered, and every vote whether given personally or by proxy not disallowed at such General Meeting or poll shall be deemed valid for all purposes of such General Meeting or poll.

12.10 Chairman to Decide

If any question is raised, the Chairman of the General Meeting shall decide the validity of every vote tendered at such General Meeting in accordance with the Ordinance and these Articles.

12.11 Chairman not to have Casting Vote

The Chairman shall not have a casting vote.

13. DIRECTORS

13.1 First Directors

The following are the first directors of the Company:

1. Mr Ali Suleman Habib
2. Mr. Muhammad Salman Burney,
3. Syed Firdous Shamim Naqvi
4. Mr. Shabbir Diwan,
5. Mr. Rizwan Diwan
6. Mr. Saqib Haroon Bilwani

13.2 Appointment of Chairman

(a) The Directors shall appoint a Chairman of the Board from amongst the Directors nominated by Thal SPV and Nova SPV by rotation every year at the first meeting of the Board convened after the Annual General Meeting of the Board. A retiring Chairman shall be eligible for reappointment and shall preside over the General Meeting at which an election of Directors shall be held.

(b) The Chairman shall preside over the meetings of the Board. If the Chairman for the time being is unable to attend any meeting of the Board, a Director from amongst the nominees of the Shareholder (Thal SPV or Nova SPV), to whom the then Chairman belongs, shall be appointed to act as chairman of that meeting.

13.3 Number of Directors

(a) Unless otherwise agreed by the Shareholders in a General Meeting with the affirmative vote of Thal SPV and Nova SPV, the total number of the Directors shall be six (6). six (6) Directors on the Board shall be elected by the Shareholders (including Thal SPV and Nova SPV) as follows:

(i) Thal SPV shall have the right to nominate for election (and require removal after election) three (3) Directors; and

(ii) Nova SPV shall have the right to nominate for election (and require removal after election) three (3) Directors.

(b) The Board shall fix the number of Directors of the Company to be elected not later than thirty-five (35) days before convening the General Meeting at which the Directors are to be elected, and the number so fixed shall not be changed except with the prior approval by special resolution of the Company in a General Meeting. It is clarified that in no event shall the number of Directors increase beyond or fall below six (6) until the same has been so approved by the Shareholders in a General Meeting with the affirmative vote of Thal SPV and Nova SPV.

13.4 Election of Directors

(a) After the expiry of the term of office of the first Directors of the Company and at each subsequent election of the Directors, and subject to the provisions of Article 13.3 (*Number of Directors*), the number of Directors fixed by the Board (and such number shall, subject to the opening provisions of Article 13.3(a), not be less or more than six (6)) shall be elected by the Shareholders in a General Meeting. If the number of the candidates is not more than the number of Directors to be elected all candidates shall stand elected without an election. If, however, the number of candidates is greater than the number of Directors to be elected, an election shall take place in the following manner:

(i) a Shareholder shall have such number of votes as is equal to the product of the voting Shares held by him and the number of Directors to be elected.

(ii) a Shareholder 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.

(iii) 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.

(b) No person, whether a retiring director or otherwise, shall be eligible for election as Director unless notice of his candidature for election has been lodged in writing at the Registered Office not less than fourteen (14) days before the date of the General Meeting at which the election of Directors is to take place.

(c) Where the number of candidates is equal to or less than the number of Directors to be elected, it will not be necessary to hold an election as laid down in Article 13.4(a) above and all candidates shall be deemed to have been elected under this Article.

(d) Notwithstanding anything contained in these Articles, it is hereby agreed that the Shareholders shall vote in the General Meeting in such a manner so as to ensure that the Directors to be elected on the Board are elected in accordance with the provisions contained in Article 13.3 (*Number of Directors*).

13.5 **Term of Office**

An elected Director shall hold office for a period of three (3) years, unless he earlier resigns, or becomes disqualified from being a Director or otherwise ceases to hold office under these Articles. An election of Directors in the manner prescribed by the preceding Articles shall be held once every three (3) years at or before the end of such period. A retiring Director shall be eligible for re-election.

13.6 **Removal of Director**

The Company may by resolution in a General Meeting remove an elected Director in accordance with the provisions of Section 181 of the Ordinance.

13.7 **Continuing Directors to Act**

The continuing Directors may act notwithstanding any vacancy in the Board, but if the number falls below the minimum fixed, the Directors shall not, except for the purposes of filling a casual vacancy in their number or for convening a General Meeting, act so long as the number remains below the minimum.

13.8 **Filling of Casual Vacancy**

If any Director resigns or becomes disqualified or otherwise ceases to hold office for any reason whatsoever prior to the expiry of the then current three (3) year term of the Board, then the Board shall appoint any person to be a Director to fill such casual vacancy on the Board within a period of thirty (30) days, provided that the casual vacancy shall be filled through appointment of a nominee of the same Shareholder whose nominee has created such vacancy as a consequence of ceasing to be a Director before the expiry of the three (3) years term for any reason whatsoever, as referred to above. Any Director so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

The Shareholder whose nominee has resigned or removed (on the request of such Shareholder) as a Director of the Company shall indemnify and keep indemnified the Company on demand against all losses, liabilities and costs which the Company may incur arising out of, or in connection with, any claim by such Director for wrongful or unfair dismissal or redundancy or other compensation arising out of such Director's resignation or loss of office.

13.9 **Remuneration**

Subject to any approval or limits required by law, the terms and conditions and remuneration of:

(a) a Director (including each alternate Director) for performing extra services, including holding office of the Chairman;

(b) the Chief Executive Officer; and

(e) any Director (including each alternate Director) for attending meetings of the Board,

shall be determined by the Board

A Director may also be reimbursed all reasonable travelling, hotel and other expenses properly incurred by him/her in attending and returning from meetings of the Directors or General Meetings of the Company or in connection with the discharge of their duties as Directors of the Company.

13.10 **General Management Powers**

(a) The Board shall be responsible for the overall direction, supervision and management of the Company. The Board may pay all expenses incurred in promoting and registering the Company, and may exercise all such powers of the Company as are not by the Ordinance or by these Articles or by a Special Resolution, required to be exercised by the Company in General Meetings, subject nevertheless to the provisions of the Ordinance or to any of these Articles and such regulations (being not inconsistent with the aforesaid provisions) as may be prescribed by the Company in General Meeting but no regulations made by the Company in General Meeting shall invalidate any prior act of the Directors which would have been valid if such regulations had not been made;

(b) A resolution at a meeting of the Directors duly convened and held shall be necessary for exercising the powers of the Company specified in Section 196(2) of the Ordinance;

(c) Subject to approval of Directors required to be present at a meeting of the Board for the purposes of forming quorum under these Articles, all agreements or transactions to be entered into by the Company shall require approval of the Board; and

(d) The Board shall not take any decision in relation to any matter which is within the competency of the Shareholders under the Ordinance, other applicable laws and these Articles and regulations as referred to in Article 13.10(a), and vice versa, unless and to the extent permitted by the Ordinance, other applicable laws, and these Articles and the regulations referred to above and the relevant consent is given by the Shareholders at a General Meeting, properly convened and held.

13.11 **Power to Obtain Finances and Giving of Securities**

(a) For the purposes of the Company only, the Board may obtain finance or borrow moneys from third party financiers, including (without limitation) banks, development financial institutions, other financial institutions and / or the Shareholders and secure payment of such sum or sums of money in such manner and upon such terms and conditions as it may think fit and in particular by the creation of mortgages and / or charges on the property, assets (movable and immovable) and / or on book debts / receivables of the Company and by the issue of bonds, perpetual or redeemable Debentures or Redeemable Capital, or by mortgage or charge or other security on the whole or any part of the property, assets and rights of the Company (both present and future), and the undertaking of the Company, provided however, that the above power of the Board shall not entitle the Company to carry on the business of banking/finance/investment company;

(b) Any bonds, Debentures, Redeemable Capital or other securities issued or to be issued by the Company shall be under the control of the Board which may issue them on such terms and conditions and in such manner and for such consideration as shall be considered by the Board to be for the benefit of the Company.

13.12 **Minute Books**

(a) The Board shall cause minutes to be made in English language in the books provided for the purposes:

(i) of the names of Directors (including Alternate Directors) present in person, at each meeting of the Board;

(ii) of all resolutions and proceedings at all meetings of the Company and the Board; and

(iii) of appointment of officers made by the Directors.

(b) Any such minutes of any meeting of the Board or of the Company, if signed by the Chairman of such meeting or of the next succeeding meeting and approved by the Board or the Shareholders (as the case may be), shall be receivable as evidence of the matters stated in such minutes.

(c) Every Director (including an Alternate Director) present in person at any meeting of the Directors shall sign his name in a book to be kept for that purpose and a list of the Directors present in person shall be listed as such in that book by the Chairman of the meeting

14. PROCEEDING OF DIRECTORS

14.1 Meeting of Directors

(a) The Directors of the Company may meet together for the dispatch of business, adjourn, and otherwise regulate meetings of the Board as they think fit.

(b) The Board shall at a minimum meet at least four (4) times annually at the registered office of the Company or at such other location as may be approved by the Board from time to time.

(c) Two (2) Directors may, by written request to the Chairman, request for a meeting of the Board, which meeting shall be convened by the Chairman within thirty (30) days of such request. In respect of any meeting of the Board, at least fourteen (14) days' notice will be given to all Directors.

(d) Any notice shall include an agenda identifying in reasonable detail the matters to be discussed at the meeting and such notice shall be sent by registered air mail or faxed or emailed to any Director residing outside Pakistan.

(e) A Director's attendance at a meeting shall constitute a waiver of notice of that meeting except when the Director attends a meeting for the express purpose of objecting, at the beginning of the meeting, to the transaction of any business because the meeting is not properly called or convened.

(f) The meeting of the Board may take place in person or by telephone conference call or video conference, if and to the extent permitted or not expressly prohibited under the applicable law. Subject to the Ordinance and any provision in that respect made by the Commission, all business transacted by the Directors by telephone conference or video conference for the purposes of the Articles shall be deemed to be validly and effectively transacted at a meeting of the Directors.

14.2 Quorum of Directors' Meeting

(a) A meeting of the Board, at which quorum is present, shall be competent to exercise all or any of the authorities, powers and discretion by or under these Articles or by or under any law vested in or exercisable by the Board generally. For the purposes of any Board meeting, the quorum shall be no less than four (4) Directors, which Directors shall include at least two (2) Directors nominated by Thal SPV and two (2) Directors nominated by Nova SPV.

(b) If a quorum is not present within thirty (30) minutes from the time when the meeting should have begun or if during the meeting there is no longer a quorum, the meeting shall be adjourned to the same day and time in the following week and at that adjourned meeting, the presence of four (4) Directors, including at least two (2) Directors appointed by each of Thal SPV and Nova SPV shall be a quorum. A Director shall be regarded as present for the purposes of quorum under this Article 14.2 (*Quorum of Directors' Meeting*) if represented by an alternate Director in accordance with Article 15 (*Alternate Directors*).

14.3 **Approval of Actions by Directors**

The approval of a resolution by vote of the Directors present at a meeting of the Board at which quorum is present, in person or by telephone conference call or by video device, shall be sufficient for constituting such action as the decision of the Board. It is clarified that for purposes of deciding the matters specified in Section 196(2) of the Ordinance a duly convened physical meeting of the Board at which quorum is present will be required. For sake of clarity, participation of Directors through means of audio/video conferencing at such meeting shall be counted towards formation of quorum at such meeting.

14.4 **When acts of Meetings of the Board Valid – Defective Appointment**

All acts done by any meeting of the Board, or by any person acting as Director or alternate Director shall, notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such Directors or persons acting as aforesaid, or that they or any of them were disqualified, be as valid as if every such Director or person had been duly appointed and was qualified to act, provided that as soon as any such defect has come to notice, the Director or other person concerned shall not exercise the right of his office till the defect has been rectified.

14.5 **Resolution by Circulation**

Except for resolutions relating to matters contained in Section 196(2) of the Ordinance, a resolution which is circulated together with the necessary papers, if any, to all Directors and approved by all the Directors entitled to vote thereon shall be as valid and effectual as if it has been passed at a meeting of the Directors duly convened and held. Transmission of documents and signature of resolutions by facsimile or other electronic transmission shall be effective for the purpose of circulating and executing documents and resolution. A resolution may consist of several documents in the like form each signed by one or more Directors. A resolution signed by an Alternate Director need not be signed by his appointer and, if it is signed by a Director who has appointed an Alternate Director, it need not be signed by the Alternate Director in that capacity.

15. ALTERNATE DIRECTORS

Subject to the approval by the Board, any Director not permanently resident in Pakistan or any Director so resident but intending to be absent from Pakistan for a period of not less than three (3) months may appoint any person acceptable to the Board to be an alternate Director of the Company to act for him. Every such appointment shall be made by notice to the Board in writing under the hand of the Director making the appointment (with a copy to the Shareholders). An alternate Director so appointed shall not be entitled to appoint another Director, but shall otherwise be subject to the provisions of the Articles with regard to the Directors. An alternate Director shall be entitled to receive notice of all meetings of the Board, and to attend and vote as a Director at any such meeting at which the Director appointing him is not personally present, and generally to perform all the functions of his appointer as a Director in the absence of such appointer, including approving and signing Board resolutions by circulation under Article 14.5 (*Resolution by Circulation*). An alternate Director shall *ipso facto* cease to be an alternate Director if his appointer for any reason ceases to be a Director or if and when his appointer returns to Pakistan or if the appointee is removed from office by notice in writing under the hand of the appointer.

16. CHIEF EXECUTIVE

16.1 **Appointment of Chief Executive**

(a) Subject to the Ordinance, the Board shall at all times, appoint a professional (other than the directors elected by the Shareholders) to the office of the Chief Executive for such remuneration as is determined in accordance with Article 16.1(c), and his appointment shall subject to determination *ipso facto* cease in accordance with Article 16.2 (*Removal of Chief Executive*).

(b) The Chief Executive shall, if he is not already a Director be deemed to be a Director of the Company.

(c) The remuneration of a Chief Executive shall be determined from time to time by the Board.

16.2 **Removal of Chief Executive**

The Board may, by resolution passed (subject to quorum being met) or the Company may by approval of the Shareholders in a General Meeting, in each case as required by section 202 of the Ordinance, remove a Chief Executive before the expiration of his term of office notwithstanding anything contained in these Articles or in any agreement between the Company and the Chief Executive.

16.3 **Filling Vacancy in Position of Chief Executive**

In case of a vacancy in the office of the Chief Executive, the Board shall appoint another Chief Executive in accordance with these Articles.

16.4 **Power of the Chief Executive**

Except for matters stated in Section 196(2) of the Ordinance, the Board may delegate to the Chief Executive such of its powers, authorities and discretion as are necessary for and consistent with the effective management of the Company, and as are not required to be exercised by the Directors at their meetings, upon such terms and conditions and with such restrictions as they may think fit, and either collaterally with or to the exclusion of their own powers, and, may from time to time, render, withdraw, alter or vary any such powers.

17. **DISQUALIFICATION OF DIRECTORS**

17.1 **Automatic Vacation of Office of Directors**

The office of a Director shall *ipso facto* be vacated if:

(a) he becomes ineligible to be appointed a Director on any one or more of the grounds enumerated as follows, that is to say, he:

(i) is a minor;

(ii) is of unsound mind;

(iii) has applied to be adjudicated as an insolvent and his application is pending;

(iv) is an undercharged insolvent;

(v) has been convicted by a Court of Law for an offence involving moral turpitude;

(vi) has been debarred from holding such office under any provision of the Ordinance;

(vii) has betrayed lack of fiduciary behavior and declaration to this effect has been made by the court under Section 217 of the Ordinance at any time during the preceding five (5) years;

(viii) is not a Shareholder, provided that this Article 17.1(a)(viii) shall not apply in case of:

(A) a person representing the Government of Pakistan or an institution or authority which is a Shareholder;

(B) a whole time Director who is an employee of the Company;

(C) the Chief Executive;

(D) a person representing a creditor.

(ix) he absents himself from three consecutive meetings of the Directors or from all the meetings of the Directors for a continuous period of three (3) months, whichever is longer, without leave of absence from the Directors The appointment of an alternate Director will constitute leave of absence from the Board of Directors for whom such alternate is appointed during such Director's absence;

(x) 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 Directors or the Company in General Meeting accepts or holds any office of profit under the Company other than that of chief executive or a legal or technical advisor or a banker; or

(xi) accepts a loan or guarantee from the Company in contravention of Section 195 of the Ordinance (if applicable in terms of this Section).

(b) he resigns his office by notice in writing to the Company.

(c) being a Director nominated by Thal SPV on the Board, his nomination is withdrawn by Thal SPV;

(d) being an employee or Director of Thal SPV or of an Affiliate of Thal SPV, he ceases to be the employee or Director of Thal SPV, or its Affiliate;

(e) being a Director nominated by Nova SPV on the Board, his nomination is withdrawn by Nova SPV; and

(f) being an employee or Director of Nova SPV or an Affiliate of Nova APV, he ceases to be the employee or Director of Nova SPV or of its Affiliate.

17.2 **Interest of Directors**

Subject to the provisions of Section 196(2)(g), Section 214, Section 216 and Section 219 of the Ordinance, the Directors shall not be disqualified from contracting with the Company as vendor, purchaser or otherwise, but in respect of 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 shall be a director or shareholder or otherwise interested, the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined, if the interest then exists, or in any other case at the first meeting of the Directors after the acquisition of the interest. No Director shall take part in the discussion on or vote as a Director in respect of any contract or arrangement in which he is so interested as aforesaid, and if he does so vote, his vote shall not be counted but he shall be entitled to be present at the meeting during the transaction of the business in relation to which he is precluded from voting, although he shall not be reckoned for the purpose of ascertaining whether there is a quorum of Directors present. These provisions shall not apply to any contract by or on behalf of the Company to give to Directors or any one of them any security for advances or by way of indemnity against any loss which they or any of them may suffer by reason of becoming or being sureties for the Company to the extent permissible by law. A general notice that any Director is a shareholder of any specified company or is a partner of any specified firm and is to be regarded as interested in any subsequent transaction with such firm or company shall be given for purposes of disclosure under this Article, and any such general notice shall expire at the end of the financial year in which it was given but it may be renewed for a further period of one financial year by giving fresh notice in the last month of the financial year in which it would otherwise expire. A register shall be kept by the Directors in which shall be entered particulars of all contracts or arrangements to which this Article 17.2 (*Interest of Directors*) applies.

18. CONFLICT OF INTEREST

18.1 Each Shareholder hereby agrees that where it becomes aware that its interests (or those of a related party of such Shareholder) in relation to any matter conflict, or are reasonably likely to conflict, with the interests of the Company in any material respect, each such Shareholder shall immediately give notice to the Company, each Director and the other Shareholder(s) of such conflict or potential conflict.

18.2 If a Shareholder (an "**Interested Shareholder**") or its Affiliates or related parties is a party or proposed party to any agreement or proposed agreement to be entered into by the Company, other than those non-material transactions carried out in the ordinary course of business and on an arm's-length basis, all matters relating to such transaction, including the exercise of rights and / or compliance with its obligations by the Company, shall be dealt with by the other Shareholder(s) (or, if the other Shareholder(s) so direct, the

Company) and, accordingly, the Interested Shareholder (and/or any nominee Director of such Shareholder) shall in relation to such matters, be bound by and subject to the following conflict restriction principles which are to apply only to the specific circumstances and matters and to the relevant Shareholder (and/or nominee Directors of such Shareholder), unless the other Shareholder(s) otherwise agrees in writing:

(a) exclusion from all decisions directly relating to such circumstance or matter;

(b) complete disentitlement and disenfranchisement from exercising any consent or any votes on any resolutions proposed directly in connection with such circumstance or matter; and

(c) disentitlement and disenfranchisement from attending and speaking at any Board meeting or any part thereof at which such circumstance or matter is to be considered (and, to such extent, the requirements as to quorum as specified in these Articles shall be amended so that a quorum may be present notwithstanding the relevant Director may not be in attendance or notified thereof).

19. OFFICIAL SEAL

The Board shall provide a Seal for the purposes of the Company and shall provide for the safe custody of the Seal with the Chairman of the Board. The Seal shall never be used except by the authority of the Board, and at least two (2) Directors (one being a nominee of Thal SPV and one being a nominee of Nova SPV) shall sign every instrument to which the Seal is affixed, provided, nevertheless, that any instrument bearing the Seal of the Company and issued for valuable consideration shall be binding on the Company notwithstanding any irregularity.

20. DIVIDENDS AND RESERVES

20.1 Declaration of Dividends and Restrictions on Amount Thereof

The Company in General Meetings may declare dividends, but no dividend shall exceed the amount recommended by the Board.

20.2 Interim Dividends

The Board may from time to time pay to the Shareholders such interim dividends as appear to be justified by the profits of the Company.

20.3 Distribution of Dividends

No dividends shall be paid otherwise than out of the profits of the Company for the year or any other undistributed profits.

20.4 Form of Payment

Any payment may be made by cheque sent through the post to the registered address of the Shareholder or person entitled thereto, or to such person and at such address as the Shareholder or the person entitled may direct. Every such cheque shall be made payable to the order of the person to whom it is sent, or to the order of such other person as the Shareholder or person entitled may direct.

In case of payment of dividend to any non-resident Shareholder, such dividend shall be remitted from the account of the Company to the designated account of such non-resident Shareholder in accordance with applicable law.

20.5 Power of Board to create Reserve

The Board, before recommending any dividend, may set aside out of the profits of the Company such sum as it thinks proper as a reserve or reserves, which shall, at the discretion of the Board, be applicable for meeting debt obligations or contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may properly be applied, and pending such application may, in the like discretion, either be employed in the business of the Company or be invested in such investments (other than the Shares of the Company), as the Board may from time to time think fit.

20.6 No interest on Dividends

No dividend shall bear interest or mark-up against the Company. The dividend shall be paid within the period laid down in the Ordinance.

20.7 **Carrying forward of Profits**

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

20.8 **Unclaimed Dividends**

Unclaimed dividends may be invested or otherwise used by the Board for the benefit of the Company until claimed.

21. CAPITALIZATION

The Shareholders at a General Meeting may, upon recommendation of the Board, resolve that any undistributed profits of the Company (including profits carried forward and standing to the credit of any reserves or other special accounts or representing premiums received on the issue of Shares and standing to the credit of the share premium account and capital reserves arising from realized or unrealized appreciation of the assets or goodwill of the Company or from any acquisition / sale of interests in other undertakings) be capitalized. Such capitalized undistributed profits and reserves, except unrealized appreciation of the assets or goodwill of the company, shall be distributed amongst such of the Shareholders as would be entitled to receive the same if distributed by way of dividend, and in the same proportions, on the footing that they become entitled thereto as capital. All or any part of such capitalized fund, except unrealized appreciation of the assets or goodwill of the company, may be applied on behalf of such Shareholders for payment in full or in part either at par or at such premium as the resolution may provide, for any unissued Shares or debentures of the Company which shall be distributed accordingly and such distributions or payment shall be accepted by such Shareholders in full satisfaction of their interest in the said capitalized sum.

22. ACCOUNTS

22.1 **Books of Accounts to be Kept**

The Board shall cause to be kept proper books of accounts and to be maintained detailed, complete, accurate and itemized accounts of the Company in accordance with the generally accepted accounting principles in Pakistan and, to the extent possible, in accordance with the International Financial Reporting Standards and the procedures of the International Accounting Standards Board.

22.2 **Where to be Kept**

The books of accounts shall be kept at the Registered Office, principal office or at such other place as the Board thinks fit and shall be open to inspection by the Directors during business hours.

22.3 **Inspection by Shareholders**

Each Shareholder will have the right, exercisable by providing at least seven (7) days prior written notice to the Company, at all reasonable times during the Company's normal business hours and at the sole expense of that Shareholder and with the assistance of the Shareholder's employees, consultants and / or agents, to examine all or any portion of the Company's books of accounts.

22.4 **Profit and Loss Account and Balance Sheet**

Once at least in every year, the Directors shall cause to be prepared and laid before the Company in a General Meeting a Balance Sheet and Profit and Loss Account, both made up in accordance with the Ordinance and to a date not more than four (4) months before the date of the General Meeting. Every such balance sheet shall be accompanied by an Auditor's Certificate and the Directors report in accordance with the provisions of the Ordinance in that respect.

22.5 Copies of Directors' Report and Balance Sheet to be sent to Shareholders

A copy of the report of the Directors and of the Balance Sheet (including a report of the Auditors and every document required by law to be annexed thereto), and of the Profit and Loss Account shall be sent to all Shareholders along with the notice convening the General Meeting before which the same are required to be laid at least twenty one (21) days preceding the General Meeting.

22.6 Compliance with Ordinance

The Directors shall in all respects comply with the provisions of Section 230 to Section 247 of the Ordinance, as applicable, in relation to the accounts of the Company.

23. AUDIT

23.1 Appointment of Auditors and their Duties

Auditors shall be appointed and their duties regulated in accordance with Section 252 and Section 260 of the Ordinance. The auditors shall have access to all books of accounts, records, invoices, cheques, vouchers, papers and documents relating to the business of the Company.

It is clarified that the Auditors of the Company shall only be appointed from amongst the following: PricewaterhouseCoopers, Deloitte Touch Tohmatsu, Ernst & Young or KPMG (or their affiliate firms in Pakistan).

23.2 Bank Account and Use of Funds

The Company shall keep its funds in one or more bank accounts, in the sole name of the Company, with banks or other financial institutions approved by the Board. The opening of any account is required to have written approval by the Chief Executive and a Director or the chief financial officer and a Director of the Company, and has to be signed jointly by the Chief Executive and a Director or the chief financial officer and a Director of the Company. Such funds shall be used in connection with the business of the Company or as may be otherwise provided in the Memorandum and any authorization of specific use of such funds shall be subject to specific policies and procedures to be established by the Board. Each payment of funds must apply for the payment approval process approved by the Board.

24. NOTICES

24.1 How Notices to be Served

A notice may be given by the Company to any Shareholder or Director either personally or by sending it to them by mail, prepaid postage, electronic message or by facsimile, at their registered postal or email address, or if they have no such registered address in Pakistan, to the address supplied to the Company for the giving of notices to them. Notwithstanding the foregoing, notices to Shareholders and Directors that are located outside Pakistan shall be sent by facsimile or electronic message at the facsimile number or email address outside Pakistan provided by the Shareholder or Director in question.

24.2 Personal Delivery of Notice

Where a notice is delivered personally, the recipient shall sign a receipt in such form as the Board shall determine.

24.3 Service by Post

Where a notice is sent by post, service of the notice shall be deemed to be made by properly addressing pre-paying and posting a letter containing the notice and unless the contrary is proved, to have been effected at the time at which the letter would be delivered in the ordinary course of post.

24.4 Notice of General Meetings

Subject to the requirements of these Articles, notice of every General Meeting shall be given in the same manner herein authorized to every Shareholder.

25. SECRECY

25.1 Secrecy

Every Director, Chairman, Chief Executive, Auditor, Trustee, Shareholder, officer, servant, agent, accountant or other person employed in the business of the Company shall, if so required by the Board before entering upon his duties, sign a declaration in the form approved by the Board pledging himself to observe strict secrecy concerning the business and affairs of the Company and all transactions of the Company with the customers and state of the accounts with individuals and in matters relating thereto, and shall by declaration pledge himself not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required so to do by the Board, or by any General Meeting, or by a court of law or by competent authority, and except so far as may be necessary in order to comply with any provisions in these Articles.

25.2 Restriction on Inspection of Books of Account of Company or on entering into the property of the Company

No person other than the Shareholders or Directors, or any person authorized by a Shareholder or Director, or the person authorized by the Company, shall be entitled to enter the property of the Company, or inspect any account or books of accounts or document of the Company or properties of the Company, without permission of the Board and to require disclosure of any information relating to the Company's trading, or any matter which is or may be in the nature of a trade secret, mystery of trade, or secret to the conduct of the business of the Company and which in the opinion of the Board will be expedient in the interest of the Company not to communicate.

26. DISTRIBUTION OF ASSETS ON WINDING UP

26.1 If the Company shall be wound up (whether voluntarily or otherwise), the Liquidator may, with the approval of the Shareholders present in a General Meeting (in person or proxy) and any other sanction required by the Ordinance, divide amongst the Shareholders in specie or kind, the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

26.2 For the purpose of aforesaid, the Liquidator may set such value as it may deem fair (with the approval of the Shareholders in a General Meeting) upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the Shareholders or different classes of Shareholders.

26.3 The Liquidator may, within the like sanction, vest the whole or any part of such assets in trustees upon such trust for the benefit of the contributors as the Liquidator, with the like sanction, thinks fit, but so that no Shareholder shall be compelled to accept any shares for securities whereupon there is any liability.

27. DISPUTE CLAUSE

27.1 In the event that a dispute, claim or controversy arises between the Company, its management or its shareholders, or between the shareholders inter-se, or the directors inter-se, all steps shall be taken to settle the dispute and resolve the issue through mediation by an accredited mediator before taking recourse to formal dispute resolution such as arbitration or litigation.

Company Registration Office Karachi

We, the several persons whose names and addresses are hereto subscribed, are desirous of being formed into a Company in pursuance of these Article of Association, and we respectively agree to take the number of Ordinary Shares in the capital of the Company set opposite our respective names.

Sr No	Name and Surname (Present, Former) in full (In Block Letters)	Computerized National Identity Card No.	Father's Name in Full	Nationality	Occupation	Residential Address	No. of Shares taken by each Subscriber	Signature
1	Thal Power (Pvt) Limited Represented By Mr. Ali Suleman Habib And Mr. Muhammad Salman Burney	CUIN 8[illegible]085 42201-0580664-9 42301-0193986-7	 Suleman Habib Ashfaq Azim Burney	 Pakistani Pakistani	 Business Man Business Executive	4th Floor, House of Habib, 3-Jinnah Cooperative Housing Society, Block-7/8, Karachi House No. B-58, KDA Scheme No. 1 Karachi House No. 41, Khayaban-e-Bharia, Phase 5, D.H.A. Karachi	500 (five hundred) ordinary shares of Rs.10/- each	
1(a)	Mr. Ali Suleman Habib	42201-0580664-9	Suleman Habib	Pakistani	Business Man	House No. B-58, KDA Scheme No. 1, Karachi	1 (One) ordinary share of Rs.10/- each	
1(b)	Mr. Muhammad Salman Burney	42301-0193986-7	Ashfaq Azim Burney	Pakistani	Business Executive	House No. 41, Khayaban-e-Bharia, Phase 5, D.H.A. Karachi	1 (One) ordinary share of Rs.10/- each	
1(c)	Syed Firdous Shamim Naqvi	42201-0822599-9	Syed Shamim ul Hasan Naqvi	Pakistani	Business Executive	House No. C-141, KDA Scheme A-1, Karsaz Road, Karachi	1 (One) ordinary share of Rs.10/- each	
2	Nova Thar Powergen (Pvt) Limited Represented By Mr. Rizwan Diwan	CUIN 98522 42201-6388792-9	 Abdul Razak Diwan	 Pakistani	 Industrialist	Room No. 50, 2nd Floor Ahmed Complex, Jinnah Road, Quetta House No. 27-B, Street No. 3, Gizri, Phase IV, DHA, Karachi	500 (five hundred) ordinary shares of Rs.10/- each	
2(a)	Mr. Shabbir Diwan	42201-3578127-3	Pir Muhammad	Pakistani	Industrialist	House No. 43/6-D, Block-6, P.E.C.H.S. Karachi	1 (One) ordinary share of Rs.10/- each	

2(b)	Mr Rizwan Diwan	42201-6388792-9	Abdul Razak Dewan	Pakistani	Industrialist	House No 27-B, Street No 3, Gizri,Phase IV, DHA, Karachi	1 (One) ordinary share of Rs 10/- each	
2(c)	Mr Saqib Haroon Bilwani	42301-1042615-5	Haroon Bilwani	Pakistani	Industrialist	House # 32/1 27 Gizri Street No 5, Phase IV, DHA, Karachi	1 (One) ordinary share of Rs 10/- each	
					Total Shares Taken		1006 (one thousand six)	

Dated: 07th day of April, 2016.

WITNESS TO THE ABOVE SIGNATURES:

NIFT (PVT) LIMITED
5th Floor, AWT Tower
I. I. Chundrigar Road,
Karachi

Fsaud 28/6/16

18/4/16

Fsaud 10/3/16

Registrar ... Karachi

3(5)(h) FEASIBILITY STUDY

330 MW Lignite Fired Power Plant

Feasibility Study Report

June 2016

Prepared For
ThalNova Power Thar (Private) Limited

Élan Partners (Pvt.) Ltd
4th Floor, Rizwan Plaza,
9 West, Blue Area,
Sector F-6, Islamabad,
Pakistan
Tel.: +92 (51) 227 2582-85
Fax: +92 (51) 227 2580
Email: mail@elan.com.pk
Website: www.elan.com.pk

Report Disclaimer
Élan Partners has prepared this document in accordance with the instructions of **ThalNova Power Thar (Private) Limited**for its sole and specific use. Any other persons, companies, or institutions that use any information contained herein do so at their own risk.

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1. EXECUTIVE SUMMARY

The Government of Sindh (GoS) has taken an initiative to construct coal-fired power plants based on indigenous Thar Lignitemitigate the power shortage in Pakistan generally and especially those of the Province of Sindh. The GoS, through the Thar Coal & Energy Board (TCEB) has taken the initiative to develop Thar Coal as a major source of power generation for Energy & Economic Security of the country and as a Hub of Petro Chemical Industry to generate 5,000 MW by 2020 to achieve affordable and reliable energy security

The objective was to provide a Feasibility Study for the application of Generation License while a comprehensive Bankable Feasibility Study is under process and a corresponding RFP for the development of power plants as a reliable basis for decision making and further development of the Thar Block -II coal and power generation project.

The Feasibility study summary is provided to obtain Generation License from NEPRA for the development of mine-mouth lignite fired power plant of 330 MW and to verify the profitable use of the circulating fluidized bed boiler process and pulverized fuel boiler process for the given lignite analysis results of lignite of Thar Block- II.

The present study is based on design concepts which were elaborated for a CFB plant technology which consists of power train of the 330 MW class and a Pulverized Fuel power train of the 330 MW class. The given net electrical output figure of 300 MW is standing as median of the related power plant performance classes which are clustering several plant performance types within a limited range.

The designated area for the energy park sited 5km away from the lignite open cast mine is large enough for the construction and operation of 1x 330MW CFB. The soil condition permits construction of the power plant without any constraints.

The site of power plant ideally be located at mine-mouth. The site of Thar Block- II is close to the mine in the radius of 5 Km.

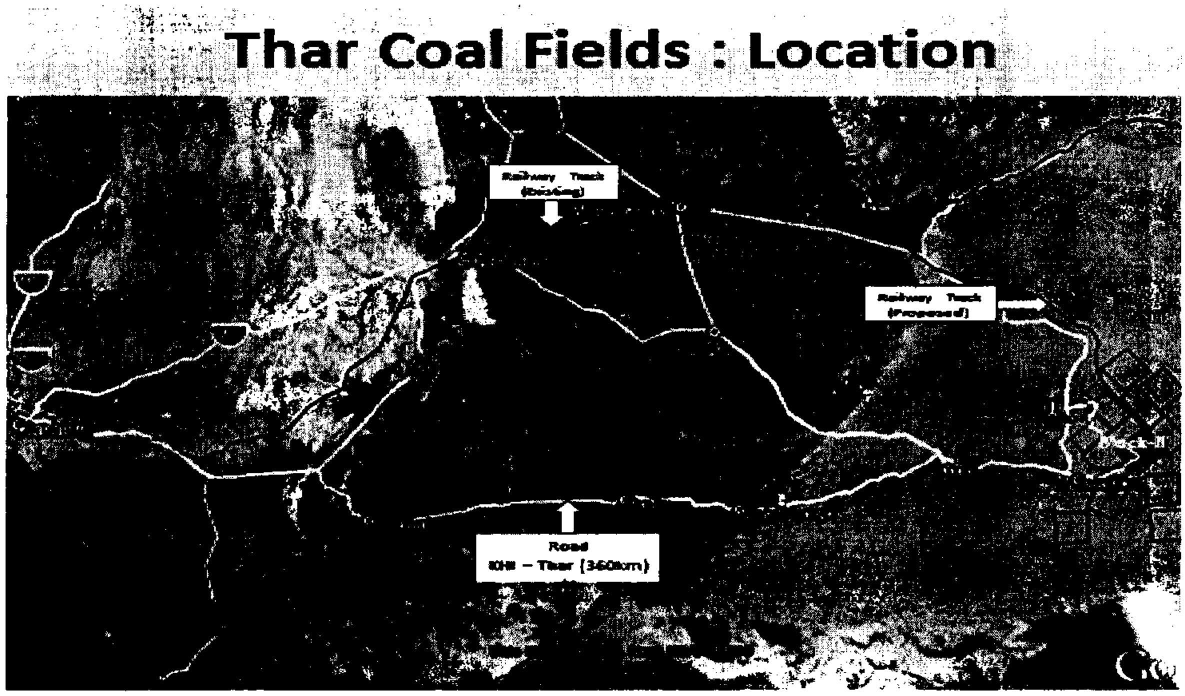
The site is located near Islamkot in the Energy Park Block- II at approximately 24° 49' 16.49" N and 70° 23' 37.61"E

- The Road having load carrying capacity of 70 tonnes is available up to Project site. The following two main transportation routes from Karachi to Project site were considered:

  (1) National Highway

  (2) Super Highway which is going to be upgraded in motorway

The Route (1) is recommended through National Highway via Badin – Sujawal



- The railway track exists from Karachi to Mirpurkhas and onward. A railway track is proposed to be built from Mirpurkhas up to the Energy Park in future
- Thar Airport Runway work is in progress.

The Thar Desert lies at the north-western corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi

The anticipated power plant normal demand for water is between 1200 to 1400 m^3/h.

In general the soil is suitable to bear foundation loads. No "problematic layers" like soils with high organic content, very loose sand or unconsolidated clay were amongst the findings.[1]

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.

The ESIA was conducted to comply with the national environmental regulations and best industry practice. The potential adverse environmental and social impacts of the proposed Project are likely to be within the acceptable limits.

The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits. The annual PM_{10} concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. The 24-hour $PM_{2.5}$

[1]Thar Coal and Energy Board

concentration complies with both SEQS and IFC EHS limits. The annual concentration complies with SEQS but exceeds IFC EHS limits.

The desert background is very quiet and approximately 10 dBA below SEQS for both day and night time.

The supply of fuel for the power plant is guaranteed from the adjacent mine which has sufficient volumes of coal to supply the fuel requirements over the power plant operating life. CFB technology is resilient to fuel quality fluctuations. Additional fuel procurement strategy includes importing Indonesian coal during the initial years of the power plant operations.

The power plant will be fed with lignite from the adjacent mine being operated by SECMC. The mine will initially cater for 3.8 mt/a to EPTL 2x330 MW plant and later on 1.9 Mt/a for TNPTL..

The mining for 3.8mt/a currently is being conducted using shovel excavators of 6.5 m^3 and trucks with a capacity of 60 tons. Overburdenand lignite for the additional 1.9mt/a will be mined by shovel excavators with a capacity of $12m^3$. Mining trucks with a capacity of 100 tons each carry the overburden to the dump and the lignite to the mouth of the mine.

The power plant complex should be build-up modular as lignite fired plant and should consist mainly (amongst others) out of the following modularized units:

Power Island

- Once-through forced flow boiler with reheat cycle
- Multi-casing steam turbine
- Live steam, cold and hot intermediate superheating systems
- Multi-stage preheating systems
- Condensate- and feed water systems
- Condensate polishing system
- Main cooling system
- Closed intermediate cooling system
- Conditioning and sampling systems
- Piping
- Auxiliary boiler system
- Generator
- Generator shunt
- IC&E Systems
- Switching Units

- Process control system
- Communication systems

The following aqueous discharges can be expected at the power station;

a) Water treatment plant (pre-treatment and boiler make up water).
b) Condensate polishing plant.
c) Plant drainage system and oily water drains.
d) Air heater and boiler wash/chemical cleaning
e) Sanitary drainage system.
f) FGD plant.
g) Cooling tower blow down.

It is proposed to develop a 330 MW power plant utilizing circulating fluidized bed (CFB) boiler technology and sub-critical steam parameters. The major systems of the proposed plant include:

- Coal handling and processing system
- CFB boiler
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Ash handling system
- Utilities and waste management system.

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), primarily in order to meet product quality requirements of saleable gypsum as well as to meet the stack emission limits for particulates.

A profitable Thar power plant Stage-I with an attractive US Dollar based Internal Rate of Return (IRR) of 20% is feasible under acceptable financial risks.

High sensitivities on the profitability exist for a deviation of Capex, of technical availability of the plant and of construction schedule. A deviation of start of mine operation i.e. the use of an alternative coal supply or a change of Thar coal price scheme will have no influence on the probability as these risks are expected to be covered by a pass through mechanism within the Power Purchase Agreement (PPA).

A significant risk reduction for the power plant project will be achieved by an attractive power purchase agreement (PPA) with NTDC. The conditions of the up-front tariff contract must protect the pioneer entrepreneurship of the project.

The study determines the technical and economic feasibility for utilization of the fuel stock and its use in the power plant in order to produce electricity under the framework of a competitive environment

2. INTRODUCTION

2.1 Project Background

The country is currently facing an acute shortage of electricity for a number of reasons demonstrated by the high level of load shedding experienced throughout the year, peaking at up to 12 hours per day in some areas of the country. The most visible illustration of the effect of load shedding is the disruption to the everyday life of the general public but more importantly is the severe impact on the provision of civic amenities, commercial activities, agricultural and industrial output.

Presently the shortfall in the country is up to 5,000MW. Pakistan's peak electricity demand is projected to rise by 4–5 % over the next 10 years and it is therefore clear that strategies must be developed to improve the capacity within the country to meet the expected demand over the next decade. To make electricity more affordable in the short to medium term and to improve the energy security within Pakistan, it is essential to improve the fuel mix for electricity generation throughout the country.

Due to the fact that high cost of electricity in Pakistan and the availability indigenous of fuel for power generation. **Figure 2-1** shows Thar Coal Bases Power Projects. The Government of Sindh (GoS) has taken the initiative to construct coal-fired power plants to help meet Pakistan's power needs generally and especially those of the Province of Sindh. The GoS, through the Thar Coal & Energy Board (TCEB) has taken the initiative to develop Thar Coal as a major source of power generation for Energy & Economic Security of the country and as a Hub of Petro Chemical Industry to generate 5,000 MW by 2020 to achieve affordable and reliable energy security

Figure 2-1: Thar Coal Bases Power Projects

Thar Coal based Power Projects

Block	Investment Firm	Total coal Potential of Block Bn Tons	Power Projects Initiated/Planned MW	Expected COD
Block-I	SSRL (China-Pak)	3.657	4X330	2018-19
Block-II	SECMC Pakistan	1.584	Phase-I 2X330	2017-18
			Phase-II 2X330	2019
			Phase-III 4X660	2021
Block-III	Asia Power UK	2.007	2X660	2019-20
Block-IV	Harbin Electric China	2.572	2X660	2019-20
Block-V	UCG Project	1.394	2X50 Phase I: 8-10 MW	2016-17
Block-VI	Oracle Coalfields (UK)	1.423	2X330	2018-19

In order to cater to rising electricity demand of the country and increase reliance on indigenous sources of energy Government of Pakistan is focused on development of Thar coal block area for power generation. The coal block area has massive power generation potential with more than 175 Billion tons of lignite deposits making it the biggest national fossil energy resource of the country. The Thar Block-II has achieved the Financial close of the country's first open pit mine and the mine will be able to support an energy park with a capacity of 6 x 600 MW. The mine will be developed gradually in a phase wise manner and the current phase in development has an annual capacity of 3.8 mtpa which will support 2x330 MW plants.

The study done was based on design concepts which were elaborated for a CFB plant technology which consists ofpulverized coal power train of the 330 MW class. The net electrical output, after accounting for auxiliary power,is 300 MW which is similar to that of other power plants with different performance types. The results are found in a small range and that of CFB plant can be found midway of that range.

As there is already a power plant of 2x330 MW being setup by EPTL, a subsequent step for the Energy Park realization will be the construction and operation of another 1x 330 MW Circulating Fluidized Bed (CFB) Power Plant. Because of the need for simultaneous project developments of the open pit mine and the power plant there lies a risk that both projects will not be operate able by same date.

To address the risk of mine not achieving the full hauling capacity and power plant has achieved construction completion, alternate resource has been planned to provide temporary fuel arrangement to the power plant, for that purpose Indonesian Lignite is selected as an alternate source of fuel. The Indonesian lignite and Thar differ in characteristics and hence the combustion system design should be able to handle the quality differences. The CFB boiler has such built in flexibility handle different quality fuels without capacity losses along with downside of lower system efficiency against PC boiler systems.

It makes economic sense to have power plant located near the open pit mine, as the cost of transportation is very high and coal water content also being high. Hence the distance between power plant and mine is 5KM where the overburden /coal ratio is very poor so that this area will not be in the focus of mine hauling activities for measurable future. Moreover, the combustion residues will be dumped beside the mine in the overburden dump area or in mine dead zone later on in future.

2.2 Objectives

The objective was to provide a Feasibility Study for the application of Generation License while a comprehensive Bankable Feasibility Study is under process and a corresponding RFP for the development of power plants as a reliable basis for decision making and further development of the Thar Block-II coal and power generation project.

Main task of the power plant study is to determine the technical and economic feasibility for utilization of the fuel stock and its use in the power plants in order to produce electricity under the framework of a competitive environment

3. SITE CHARACTERISTICS

3.1 Site Selection

The investigation was based on general observations of the topography of site, land usage, location to rail, road and water sources and any perceived risks to the construction, sustainability and viability of the project.

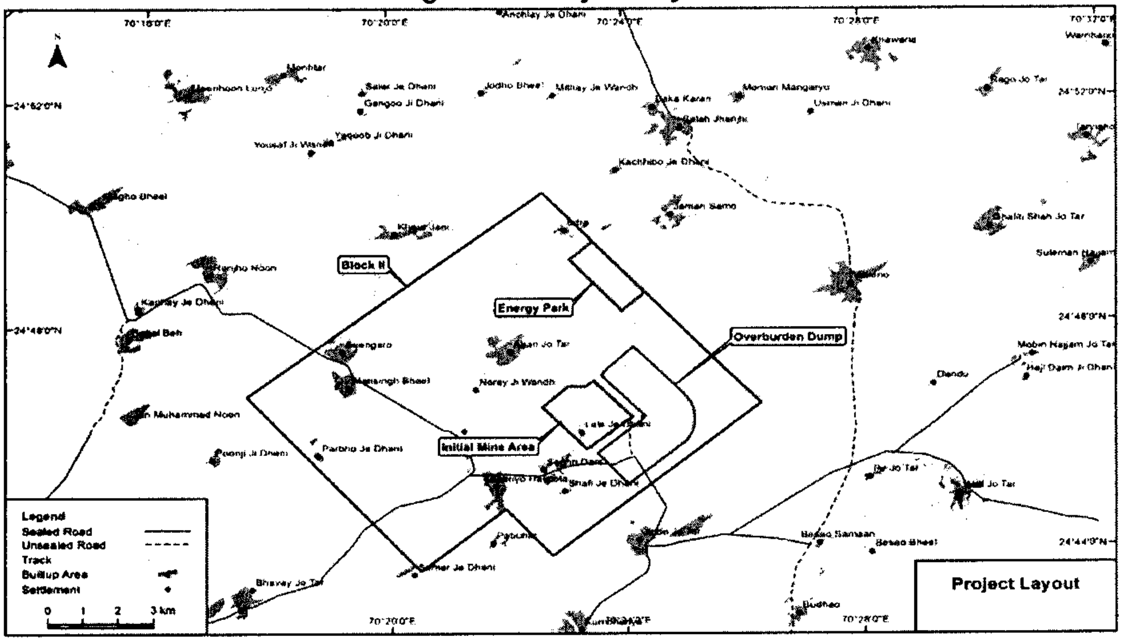
The soil condition at the power park area is favourable for building a power plant because of favourable topography and there will be a moderate need of clearing and levelling works required for construction. Water table is 60 meters below the surface. The climatic conditions are favourable as well since it is a desert area and there is one heavy rain period a year which can potentially cause flooding. To cater to this need adequate drainage provisions should be taken in construction phase. Moreover, there is ample land to construct more units and extend the scope of project.

3.2 Site Location

The site of power plant ideally be located at mine-mouth. The site of Thar Block- II is close to the mine in the radius of 5 Km. Lignite is most economically transported by a dedicated infrastructure to the nearby power plant. The moisture or water present in the fuel represents a significant dead weightduring transport and therefore international best practice dictates to the construction of the power plants close to the related fuel supply mine area.

The site is located near Islamkot in the Energy ParkBlock- II at approximately 24° 49' 16.49" N and 70° 23' 37.61"E. The land allocated for the proposed coal plant will be around 115 acres or more in order to cater for future expansions**Figure 3-1** shows a general layout of project

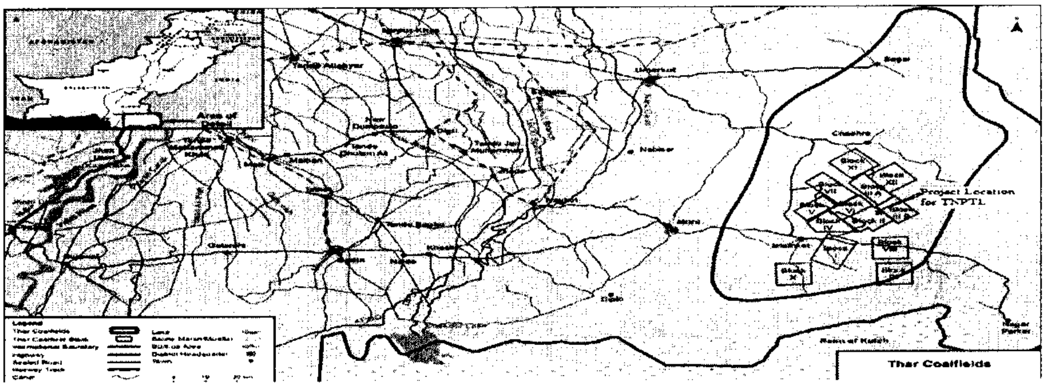
Figure 3-1:Project Layout



The lignite mine will only be economically viable if the buyer is located nearby since cost of transport is the biggest element of the overall cost hence it cannot cater to power plants located in far flung areas. Globally as well lignite mines are constructed along with power plants as both the consumer and producer co-exist in a captive market. The power plant is located 5 KM away from the mine which is under the economic limit for fuel transportation and the proximity ensures profitability of operations for the power plant. More synergies can be achieved as combustion residues like ash can be transported back to the mine in filling dead zones.

Figure 3-2: shows Project Location of TNPTL with Thar Coal Field

Figure 3-2: Project Location of TNPTL with Thar Coal Field



The advantage of locating a power plant nearby mine is two folds as not only the process is economical and profitable but also the mine drainage water can be used by the power plant for the cooling process. Although there is GoS scheme of Left Bank Outfall Drainage (LBOD) to supply water to power plants in the power park area but the mine drainage water can be used as a potential backup. There will be significant advantages of having this backup water option in case LBOD water supply is suspended.

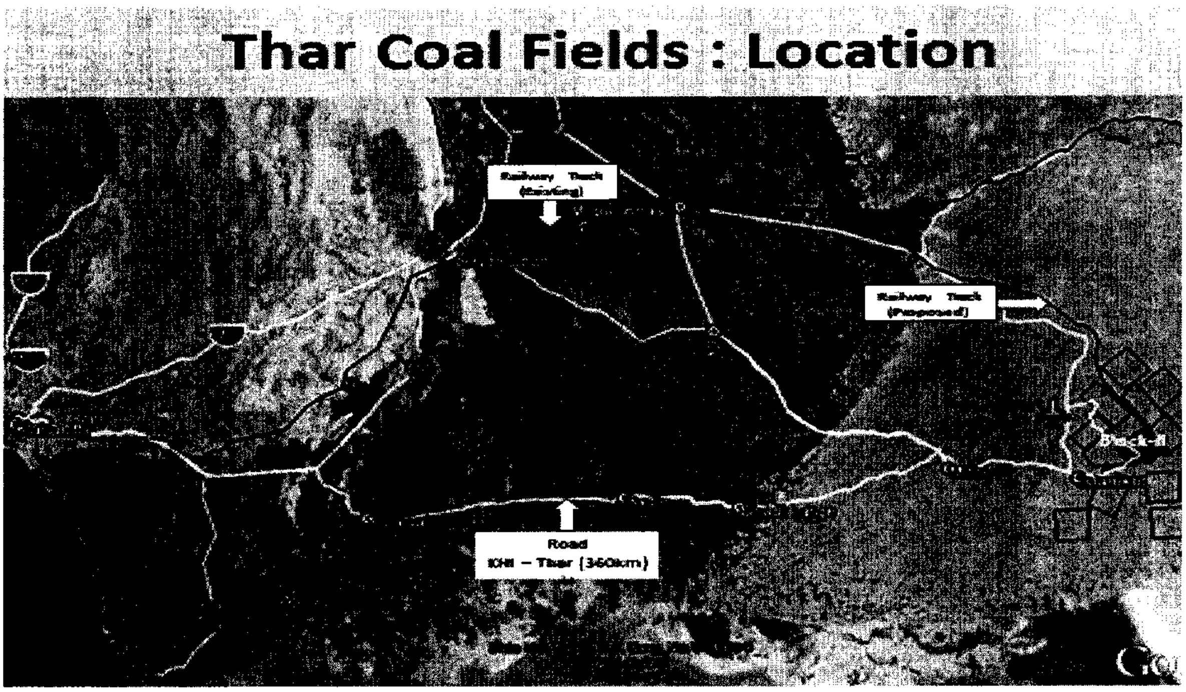
3.3 Access to the Site

The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District in Sindh. The original transport route is only 5 KM from the open pit mine to the power plant.However, the alternate fuel from Indonesia will be imported through sea route to Karachi Port and subsequent selected transport route from Karachi to the Project site is shown in **Figure 3-3.**The route, is 360 km long which passes through the towns as shown in **Table 3-1**

Table 3-1: Route passing though Towns

Karachi- Thatta	Thatta- Badin	Badin-Mithi	Mithi-Islamkot	Islamkot-Energy Park
National Highway N-5 74 km Two lane 7.3 m wide	Provincial Highway 103 km Two lane 6.1-6.7 m wide	Provincial Road 112 km Two/One lane 4-6 m wide	Provincial Road 43 km Two/One lane 4-6 m wide	Provincial Road 28 km Two/One lane 4-6 m wide

Figure 3-3: Project Location & Route



3.3.1Modes of Transport

Road: The Road having load carrying capacity of 70 tonnes is available up to Project site. The two main transportation routes from Karachi to Project site were considered:

(1)National Highway

(2)Super Highway which is going to be upgraded in motorway

The Route (1) is recommended through National Highway via Badin – Sujawal

Railway: The railway track is available from Karachi to Mirpurkhas. A railway track is proposed to be built from Mirpurkhas up to the Energy Park

By air: Islamkot Airport construction work is in progress

In view of the above, it is recommended that the transport of equipment from the port area to the project site is by road.

3.4 Climatic and Seismic Conditions

3.4.1 Climatic Conditions

The climate characterizes the prevailing weather conditions in the Study Area. 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). The station's World Meteorological Organization (WMO) ID is 41786. Weather data from this station was used to develop the baseline.

A summary of the climate in the Study Area based on the data from the Mithi weather station are presented in

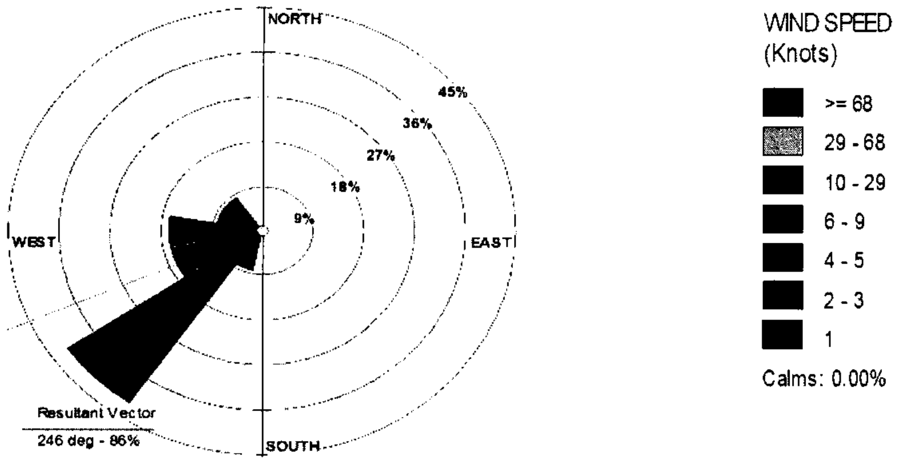
Table 3-2and **Table 3-3** shows site conditions.A wind rose is provided in **Figure 3-4.**

Table 3-2:Summary of Weather Data for Study Area

Month	*Temperature (°C)*		*Relative Humidity at 1200*	*Rainfall*	*Cloud Cover*
	Max	*Min*	*% at 1200 UTC*	*mm*	*oktas at 1200 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
September	36	24	50	129	4

October	38	20	27	14	1
November	34	13	25	3	1
December	29	7	24	1	1

Figure 3-4:Wind Rose



Mithi

Table 3-3 Site conditions

Parameter	Site average	Design reference
Dry bulb temperature (°C)	25.2	30.0
Ambient pressure (mbar a)	998.6	996.0
Relative humidity (%)	55	60
Wet bulb temperature (°C	18.8	23.8

3.4.2Seismic Conditions

The Thar Desert lies at the north-western corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi

Based on the Global Seismic Hazard Map Project (GSHAP), Seismic zones of Pakistan are shown in **Figure 3-5**, the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 m/s2

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 (MW) 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.

Uniform Building Code (UBC) of 1997 classifies the region in which Thar Block II is located under zone '2B' which means a "moderate" influence of seismic impacts.

It must be absolutely emphasized that the civil design according to UBC does not aim at any availability targets but shall only assure the personnel's safety in the case of a design-earthquake. Neither the design of non-Civil components of the plant nor the stability of any power-generation process fall under the regulations of the UBC.

A (non-nuclear) power-plant would be not classified as a building of major importance in the case of an earthquake, which results in a low "importance-factor" and by this way to minor design requirements compared e.g. to a hospital. Thus a power-plant designed according to the

UBC under civil aspects will probably shut down even when affected by minor earthquakes or might even be severely damaged.

The decision whether the availability of power generation shall be maintained during seismic events must be made in front of the background of the local.

Figure 3-5: Seismic Zone areas of Pakistan

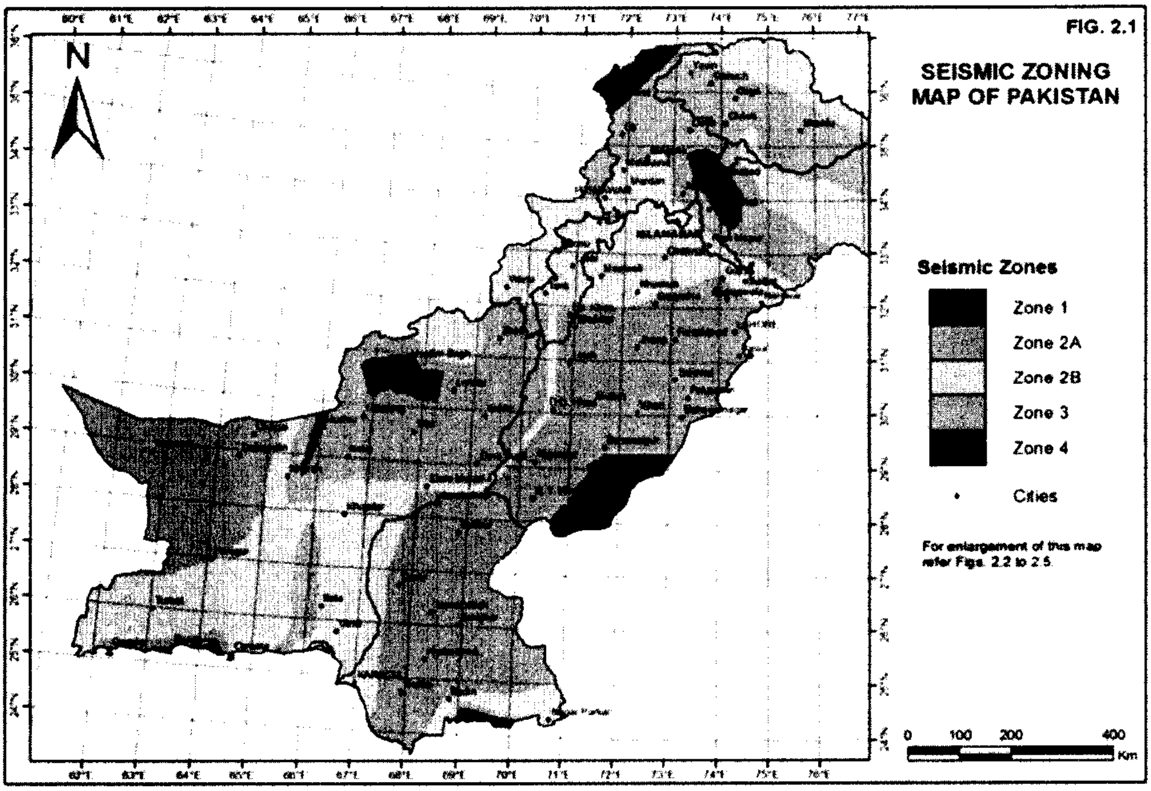


FIG. 2.1
SEISMIC ZONING MAP OF PAKISTAN

3.5 Water Availability

The accomplished geotechnical investigation encountered no subterranean water down to depths of 60m below surface level. Nevertheless, no data from long term measurements on the groundwater table are available. Therefore, the impact of seasonal variations and especially the effects of singular extreme heavy monsoon events on the groundwater level are unknown.

With the given information about the local groundwater conditions no dewatering has to be foreseen for open pits during the construction period. If the construction timetable comprises earthworks and / or the realisation of basements during the monsoon season there might be the need to pump rainwater out of the pits that does not soak away into the sandy-silty soil quickly enough

To protect basements from surface and seepage water during and after heavy rainfalls the outer walls shall be realised using "watertight" concrete including the engineered sealing of construction joints and the limitation of crack widths by the choice of appropriate rebar and concrete mixtures.

The anticipated power plant normal demand for water is between 1200 to 1400 m3/h. Of the required makeup water approximately 40% goes towards evaporation losses and 40% goes towards discharge of pre desalting water station.

The water supply of the power station can be realized by two types of raw water:

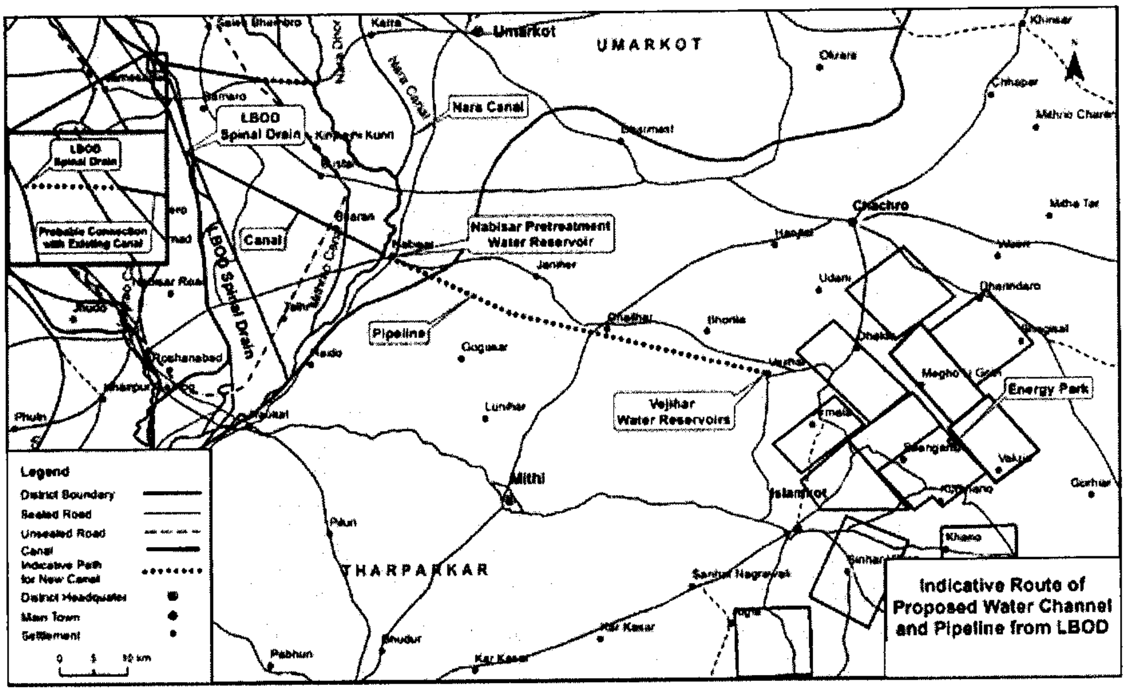
Option 1: LBOD (Government of Sindh's water supply scheme called *Left bank outfall Drainage*) as pre-treated raw water with a TDS up to 500 ppm. **Figure 3-6** shows Indicative Route of the Proposed Water Channel from LBOD to Vajihar. Vajihar is outside the coal blocks and to make the water available to the mine-mouth power plant, it is proposed to set up a Pumping Station at Vajihar and a Pipeline from Vajihar to Energy Park Block-II.

The raw water should be provided for the production of process water which is mainly required for the following systems:

- Process Water and Service Water — Main Cooling Water System
- Auxiliary Cooling Water System — Fire Fighting Water
- Deionized / Demineralized Water — Potable Water

All of the above process waters require pre-treatment by means of a suitable water treatment facility to ensure the production of water of adequate quantity and quality as needed for operation of the entire plant. Each stage of the project is required to operate independently; therefore, the facilities described herein do not consider later plant extensions.

Figure 3-6: Indicative Route of the Proposed Water Channel from LBOD to Block II



Option 2: Ground water (aquifers), pumped out of the mining area with a TDS up to 7000 ppm.

The expected demand of ground water for 1x330 Mw Coal project has been estimated to be approximately 11.7 to 13.7 cusecs.

To minimize the Reverse Osmosis water treatment plant effluent, the brine from R02 system is always used as raw water for ROI system. The R02 brine quality is similar or even better than the Ground water. This set-up has no significant impact on the power demand.

The quality of RO1 brine is below the Ground water and the costs to make up this water are comparatively high. The only target to use the RO1 brine as feed water for R03 is to minimize the amount of high TDS waste water from 700m^3/h down to 350m^3/h. The outgoing waste water of about 350m^3/h mainly consists of RO3 concentrate. The TDS is app. 28.000 mg/l.

3.6 Ground Conditions

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.

Detailed and definitive information on the prevailing ground conditions within the project site wasnot available at the time of preparing the Feasibility Study Report. However, initial investigations would lead us to anticipate that the near surface geology will comprise of :

in such circumstances it would be prudent to allow for the use of piled foundations, particularly to the more heavily loaded structures. There are seven main groups of soils found in the Thar given as below:

- 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

The soil investigations were done and documented for the lignite power plant Thar Block II site, on behalf of the owner in 2003 which reveal that the underground of the site consists of almost entirely fine sand only. There is a varying content of silt with a very small range of grain size distribution according to the hydrometer analysis results along with the conducted sieve. Moreover the density of sand increases steadily from medium dense to highly dense at a depth of 10m according to the SPT-results.

According to the reports, soil has the ability to bear foundation loads and there are no problematic layers i.e. soils with high organic content, very loose sand or unconsolidated clay. The studies done are sufficient for tendering process and preliminary considerations about applicable foundation systems. For detail design there needs to be a study on denser grid of soil investigations and additional testing.

The site of the Lignite Power Plant Thar Block II is characterised by a rather flat to slightly inclined landscape with an elevation of approx. 84m to 87m above sea level (asp. From this level dunes rise in several places with heights between 20m and 30m (dune top 108amsl to 119amsl). The surface is loosely covered by desert vegetation. To achieve a power plant property with a surface (flood protection) slightly above the surrounding countryside the area of future buildings and other sensitive power plant installations will be backfilled to an appropriate level.

It is good engineering practice to define a "power plant zero level" which can be referred to, all through the design and construction process. Typically the height of the ground floor in the buildings is defined as 0,00m. A reasonable choice for this zero level is a value that coincides with the outside ground-level plus approx. 50cm to protect the building's inside from flooding and sand / dust entry. In the following +87.50amsl is preliminarily defined as 0,00m for the Lignite Power Plant Thar Block II project.

Initial observations would suggest that there are no insurmountable issues or impediments likely to prevent the construction of an industrial plant such as a power station on this particular site However, mitigation works will be necessary to overcome the potential for site flooding and to cater for any poor ground conditions encountered. Preparation of the site will be required prior to the commencement of the main construction work and to a greater or lesser degree may involve amongst other things, site levelling, installation of flood protection measures, piling, preparations for large foundations and subterraneous structures, etc.

3.7 Environmental Requirements and Standards

3.7.1 Introduction

The environmental requirements and standards applicable to the proposed Project will be dependent upon the source of lending.It is thereforeunderstood that, at the current time, only national and provincial environmental regulations are applicable. However, other international environmental regulations and guidelines (such as those of the World Bank, International Finance Corporation and the Asian Development Bank) may also be applicable in the event that the proposed Project applies for lending from these or any other international agency.

Therefore, within this Section, national and provincial environmental requirements and standards are presented alongside international environmental requirements and standards.

3.7.2Topography

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 **Figure 3-7.**The dunes in the Study Area are at an average elevation of 101 m above mean sea level (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

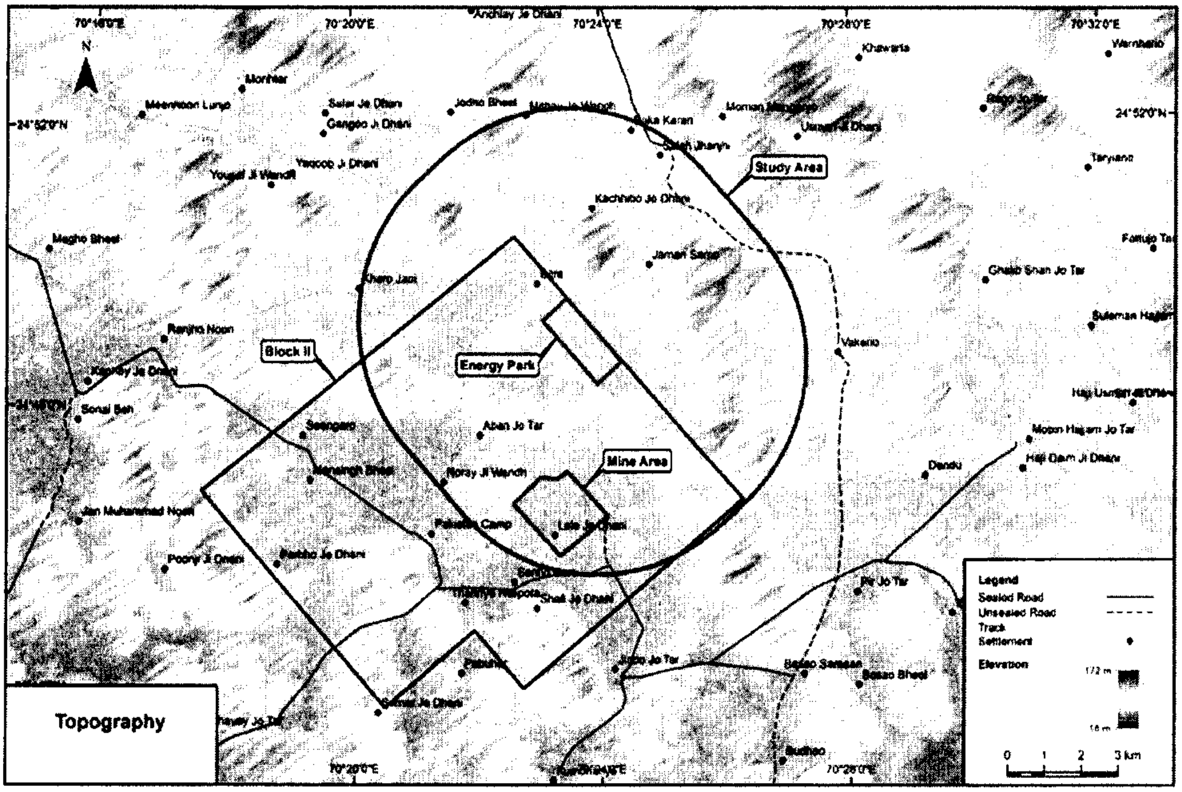


Figure 3-7 Topography

3.7.3Air Quality

The air quality baseline specifically assesses the concentration of pollutants in the ambient air without the Project. The Project is assumed to become operational in 3 to 4 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 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

The measured air quality baseline was developed using both primary and secondary data on ambient air quality in the Project area. **Table 3-4** shows the Combined Baseline results

Table 3-4: Combined Baseline Results (µg/m^3)

Pollutant	***Averaging Period***	***Measured Baseline***	***Modeled Baseline***	***Combined Baseline***	***SEQS***	***IFC EHS limits***
SO_2	24-hour (98th percentile)	7	22	30	120	125
	Annual (Max)		6	6	80	-
NO_2	24-hour (98th percentile)	3	15	18	80	-
	Annual (Max)		4	7	40	40
PM_{10}	24-hour (98th percentile)	140	307	[redacted]	150	150
	Annual (Max)		56		120	70
$PM_{2.5}$	24-hour (98th percentile)	30	30	60	75	75
	Annual (Max)		8	[redacted]	40	35

The following conclusions were drawn:

- The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits.
- The 24-hour PM_{10} concentrations exceed both SEQS and IFC EHS at 28% of the area (195 km^2 out of total area of 700 km^2).
- The annual PM_{10} concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average.

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 24-hour $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits. The annual concentration complies with SEQS but exceeds IFC EHS limits. The modelled 24-hour and annual concentrations complies with the standards. When added to the modelled baseline elevated $PM_{2.5}$ levels exceed the annual IFC EHS limits as shaded in
- Table **3-4**

3.7.4Sound Levels

The desert background is very quiet and approximately 10 dBA below SEQS for both day and night time. 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 night time SEQS.

Measurement Results and Analysis

A summary of the results and SEQS for noise are provided in Error! Reference source not found.**3-5**. Reported results include:

- L_{90} isthe 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.

Table 3-5: Summary of Sound Levels during the Survey and from Literature

Point	*Description*	*24 hour (dBA)*			*Daytime Averages (dBA)*	*Nighttime Averages (dBA)*
		L_{90}	L_{10}	L_{eq}	L_{eq}	L_{eq}
Current Study						
N1	Village (Bitra)	31.8	52.4	51	51.8	[redacted]
N2	Background, no human presence	35.8	46.8	45	46.2	43.0
N3	Background, no human presence	29.0	41.1	40	41.9	34.2
N4	Road + Village	36.0	50.2	50	49.8	[redacted]
Literature						
TCON1	Village	31.6	44.2	46.8	48.6	41.1
TCON2	Village	25.8	44.5	43.9	45.5	38.6
TCON4	Village + Road	34.0	55.5	52.4	53.7	[redacted]
SEQS					**55.0**	**45.0**

3.8 Fuels

3.8.1 Fuel Supply

CFB technology as already discussed being flexible in terms of fuel quality, the power plant can rely on adjacent mine for backup fuel since there are vast coal reserves in the Thar coal field. Moreover, Indonesian coal can also be used as a backup option for the plant operations in the initial years of operations when other parts of the mine are not developed. Adequate fuel for operation of the mobile plant and site vehicles will need to be procured in large quantities through long term fuel procurement contracts.

Definition of the fuels

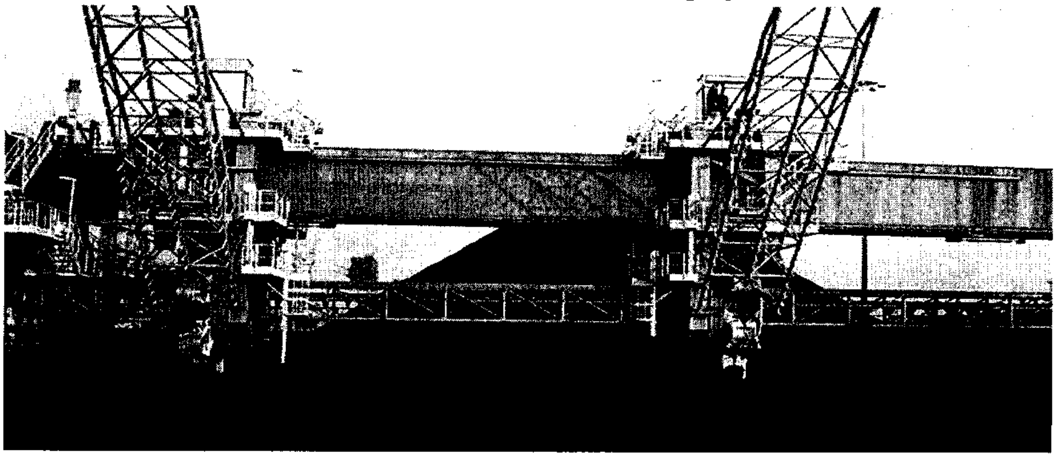
Main fuel:	Lignite from Thar II field
Fuel Option:	Lignite from Indonesia
Ignition Fuel / Start-up fuel:	Light Fuel Oil

3.8.2 Fuel Handling System

The fuel handling system to be used will be trucks which carry lignite from mine to power plant for a distance of 5KM approx. since it is the most feasible and economical option. The trucks will unload lignite at the unloading station which has a capacity of about 1000 t/h which is sufficient for the 330MW unit and balancing out the inconsistency of road delivery. There is also an option of conveyor belt from mine to plant site but that can be used later in regular operations and truck transport will then be a backup option. There will be a need for an enclosed stockyard with a stacker lift and lowerable boom and bridge type scraper reclaimer.

It guaranteed a continuous fuel supply and the best blending quality. **Figure 3-8** shows Fuel Handling System

Figure 3-8: Fuel Handling System



3.8.3 Alternative Coal Fuel

Preliminary assessment carried out to identify key issues associated with reliable supply of suitable lignite for the power plant as follows:

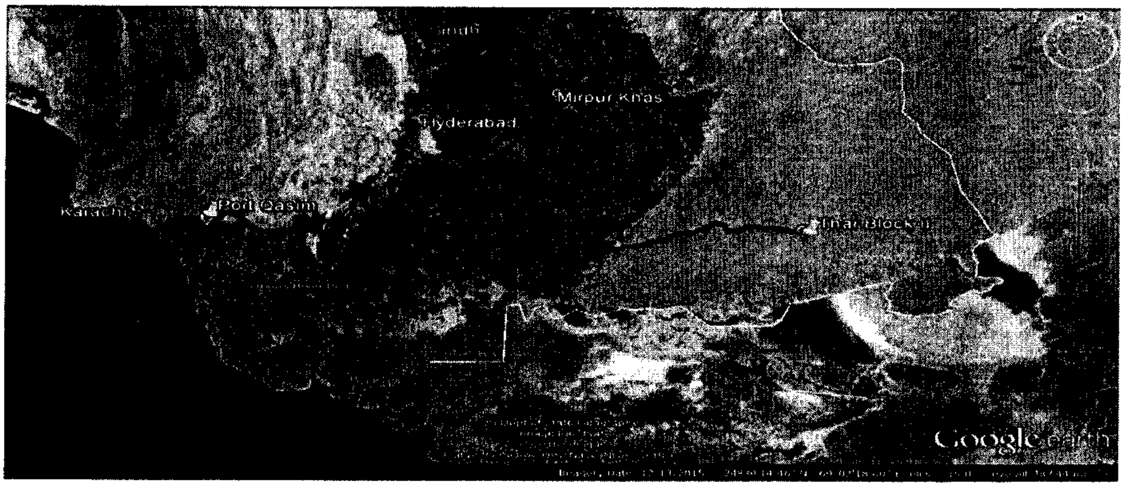
- Available worldwide reserves of lignite with a calorific value in the range of 2600 to 3000 Kcal/Kg,
- Identification of sources of suitable coal,
- Supply agreements from different countries,
- International long term coal supply agreement terms and conditions and pricing mechanisms,
- Analysis of pricing against calorific value, sulphur content, ash content and other parameters,
- Shipping contracts.

Indonesia and other few countries were considered as the most likely lignite exporting countries to Pakistan, keeping in view the overall fuel cost. The report concludes therefore that the most likely source of imported fuel would be from Indonesia.

Being in a captive market the size of power plant must match with the output of the mine in order to use the coal as early and efficiently as possible and minimize the initial development cost. Indonesian coal has been identified as a potential backup for thar coal due to its lower calorific value in case the mine development schedule is delayed.

The distance from Port Qasim to Thar Block II is about 336 Km via Badin - Sujawal Route. **Figure 3-9** shows the direction & distance from Port Qasim to Thar Block II

Figure 3-9: Distance from Port Qasim to Thar Block II via Badin – Sujawal Route



The alternate coal has different specifications and for that the plant has to be flexible enough to handle the different types of fuel. On average the lump size of coal will be from zero to 300 mm for transport and preparation inside the power station. The alternate fuel will be transported using trucks with a loading capacity in the range of 25-35 tons. Moreover, the truck unloading devices and road transport must also have capacity of 500 t/h for full load consumption of 1x 330 MW plant.

3.8.4Process flow

The power plant will be fed with lignite from the adjacent mine being operated by SECMC. The mine initial capacity of 3.8 mt/a will serve EPTL 2x330 MW plant. The mine capacity will be enhanced by 1.9 Mt/a to supply coal to TNPTL.

Overburden and lignite for initial capacity of 3.8mt/a mine will be mined by shovel excavators with a capacity of 6.5m^3 andmining trucks with a capacity of 60 tons each will carry the overburden to the dump and the lignite to the mouth of the mine. The incremental capacity of 1.9mt/a will be mined by shovel excavators with a capacity of 12 m^3 and mining trucks with a capacity of 100 tons. The mine has also planned to build a stockyard to fill using mine trucks and have a capacity of around 120,000 tons of lignite.

The mine has placed semi-mobile crushers to break the coal into smaller pieces of less than 300 mm but the fines should be as low as possible. The capacity of these crushers is 1000 tons/ hour and a belt conveyor leads from each conveyor to the coal stockyard. This stockyard is subdivided into stock areas with 5,000 square meters of area and 28,000 tons of capacity. Moreover, to keep the blending and quality of the coal uniform, the stacker fills every stock area by Windrow method. The stockyard will initially be located near the power station and later on it will follow the mining progress. The stockyard will be connected with power station using belt conveyors or mining trucks however conveyors are a more efficient solution.

4. POWER STATION CONCEPT

4.1 Design and Operating Philosophy

4.1.1General

The generating plant to be installed at Thar Block-II will represent approximately 1.5% of the current generation capability in Pakistan. As the power station is to run on Thar lignite it is less flexible from an operational perspective than other technologies such as OCGT and CCGT power stations. It is therefore intended for the plant to operate at base load with a minimum availability of 85%.

It is therefore recommended that the Technical Specification or Request for Proposal is written on the basis that the plant is designed to operate at base load.

The following requirements should be included as part of a Technical Specification or RFP such that any plant offered has a high degree of flexibility, reliability and availability without adversely affecting the mechanical integrity or life of any component within the plant.

4.1.2Operating Regime

Coal fired plants are only capable of operating down to loads of 40% beyond which they would have flame stability issues. To maximise operational flexibility the unit turn down range should be 100% down to 40% TMCR. In addition the plant should be capable of house load and base load operation to meet the requirements of the PPA which will require the unit to operate purely on DFO for periods of up to 7 days per annum. In order to correctly design the plant, the number of starts should be defined.

The operating regime for the plant should be established and the respective details incorporated into the specification before placing the EPC Contract

When considering that the plant will need to be designed for base load operation with occasional the following start up times should be achieved as a minimum;

Type of start	Time to full load (minutes)
Cold	480
Warm	300
Hot	120 and more

4.1.3Other Salient Design Features

Concept of Design

The final target is to build a standard power generation system which is reliable and proven on lignite combustion as well as state of the art in relation to availability, efficiency and environment-friendliness.

It is very important to meet the given fast track realization criteria. The plant should be designed and manufactured on basis of market proven components from brand manufacturers with long-term experiences and revisable references.

The power plant must meet the availability criteria of > 7500 h/a.

Main features of the power plant

- Power plant efficiency should be greater than or equal to 37%
- Power plant cooling system should be using LBOD water or mine waste water
- Emissions must be under the SEQS and NEQS specified limits.
- Fuel will be Thar lignite with Indonesian coal as a backup option
- Commercial operations date planned to be December 2019,
- Plant availability should be greater than 85%
- National grid to provide 500kV back start ability
- Operation control system for aging and length of life control
- Type of contract should be EPC turnkey
- Plant should be suited to desert conditions
- Plant should be suited to given cooling media conditions
- Plant must have necessary flexibilities and redundancies for future expansion and fluent operations
- Computerized documentation and maintenance system

4.1.4Plant Design Life

As per Owner requirements and in keeping with a project of this nature the plant should be designed for a life of at least 30 years. All calculations have assumed this design life as part of the feasibility study.

4.1.5Site related auxiliary systems outside power plant batterylimit

The power plant needs to build up sufficient redundancies to keep the guaranteed availability of plant in case of failure of system or tripping leading to a partial or complete shutdown. The redundancies need to be built in three major areas:

- General
- Fuel Supply Handling
- Lignite Supply

The plant needs guaranteed fuel supply for continuous operations. The trucks will be responsible for fuel supply from mine to power plant while the fuel takeover of each truck load will be at the weighing bridge of the power plant after the monitoring and registration of each truck load with the subsequent dumping of the lignite in the truck receiving hopper. The mine storage area has a capacity of around three weeks of coal while additionally there can be a storage at the power plant of around 3-4 days. For environmental purposes and keeping emissions under control the power plant has to be in a closed building and also reducing the amount of water spraying.

In the plant arrangements of the 1x 330 MW CFB and the sub-sequent following 1 x 330 MW PC plant two separately operate able power plant lignite storage areas are foreseen. The modules of the material handling systems should give the chance to be compatible to each other to achieve highest synergies in O&M and a possible redundancy effect. The monitoring of hot spots from possible lignite self-ignition processes and the adequate extinguishment is one of the important fire fighting aspects. An adequate explosion proof concept with the related primarily measures in all areas of the material handling zone where lignite dust can occur has to be considered intensively. In the unlikely case that imported lignite from Indonesia has to be procured the material handling system within its interface points has to guarantee full function ability with that fuel as well. The different delivery volumes through natural oscillation of fuel parameters as well as part and peak load situations have to be considered in the design.

4.1.6 Material Handling 1x 330 MW CFB Plant / 1 x 330 MW PC Plant

The scope of concept covers all necessary processing, conveying and storage steps from mine lignite takeover to the head of conveyor point at the lignite service bunkers.

4.1.7 Boiler

The boiler is the most important component which must be designed in a way that the calculable oscillation in lignite fuel quality over 30 years lifetime will be considered.

No availability decrease should occur through abnormal fouling, slagging, corrosion, dusting, wear etc. All related investigations in fuel analysis for the long-term suitability in the related boiler and combustion process to achieve the guaranteed performance parameters has to be carried out and verified by the boiler vendor. Especially for all constituents/elements that will have a negative impact to the boiler process and its performance or availability. All necessary technical mitigations to control the calculable fuel quality oscillation and its impacts to the boiler operation have to be implemented in the boiler design. The co-firing of biomass or other lignite fuel substitutes is not foreseen, yet. In case of CFB technology the design has to consider the qualities of the long-term procure able sand and limestone qualities from the local market and be reconfirmed to the client. All related sand and limestone quality assessments for further use has to be carried out by the vendor.

The boiler will work in base load operation mainly the related flexibility is given in the functional specification. The auxiliary steam production should be sufficient for the start-up of a second same sized boiler.

The boiler should be covered in a way that the high availability criteria can be fulfilled under the given desert conditions including extreme weather situations like sand & thunder storms and monsoon rain.

4.1.8 Auxiliary Boiler

The auxiliary boiler has to be designed for the given auxiliary fuel. The boiler has to be designed in a way that enough auxiliary steam will be produced for the start-up of one CFB boiler.

4.1.9 Ash / Residue removal Systems

1 x 330 MW PC Wet Ash Handling System (separate)

1 x 330 MW PC Fly Ash (see Flue Gas Cleaning) (separate)

1 x 330 MW PC Fly Ash / Wet Ash / Gypsum Handling mutual system together with unsalable gypsum stakes.

4.1.10 Flue Gas Cleaning

Flue gas cleaning requirements will be based on the Pakistani emission laws and regulations for lignite power plants or given comparable power plant laws and regulations. The flue gas system consists in minimum out of the sub-sequent mentioned units. The flue gas cleaning units should be have ability to incorporate future capacity additions or upgrades with regards to space and/or process interfaces of the power plant process. Moreover, flue gas cleaning will produce sell able materials which could be used in civil construction (PF bottom ash) or lightweight building boards (gypsum) or for cement industry (Fly Ash). The recycling processes are well known and the local standard qualities for further use of the materials have to be achievable.

4.1.11 Electrical Systems

The electrical engineering of the plant encompasses:

4.1.12 Generator

The generator system includes amongst others:

- Generator incl. exciting facility
- Auxiliary facilities for generator cooling

- Steering-, control-, operation-, monitoring- and protection systems including all related indicators, sensors, data transformers and -amplifiers including all adequate cablings
- Signalizing- and remote control facilities
- Synchronization facilities
- Generator specific auxiliary power supply
- H_2-/CO_2 exhaust stack
- Generator-power switch
- Emergency Power System
- Earthing and Lightning Protection Systems
- Decentralized electrical sub-distribution
- Auxiliary Power Supply System
- Energy Evacuation System from Generator to Grid Portal
- Switch Yard Control System
- Start- and Shut down programs:

4.1.13 Civil Engineering

The vendor is responsible for all the structural and construction services of the power island while other structures and buildings of plant necessary for final architectural design have to be listed, offered optional and will be beyond its scope. The plant must be able to be operated, maintained or repaired under all calculable weather conditions. The complete seismic design to meet the relevant Pakistani laws and regulations of the determined seismic zone is under responsibility of the contractor.

Guidelines for industrial power plant buildings, relevant laws along with Health & Safety and environmental requirements must be met by all buildings and structures. The following civil engineering items to achieve a complete and under all calculable conditions operatable power plant and where the staff can work in a safe and long term healthy way have to be encompassed in vendor's responsibility:

- Ground / Subsoil
- Foundations
- Building sub-/superstructure / supporting formworks
- Outer walls /Claddings
- Roofs/Shelters/Wind & Creeping sand barriers
- Storm water & Flooding Protection

- Coating / Coloring / Signage
- HVAC
- All facilities for plant safety & protection (e.g. Gates / Fences / Firefighting / Air traffic warning lights etc.)
- All facilities for the staff care (e.g. ambulance/rest rooms /canteens etc.)
- All road traffic and infrastructural facilities
- All workshop and storage facilities
- Architectural finish of the plant including Planting and Gardening

4.1.14 Standards

The Standards that are applicable to the project for the design, manufacture, testing, commissioning and manufacture of the works as per Owner instruction are to be Internationally accepted Standards such as, National or other design standards or codes of practice that are acceptable to the Owner. International standards are defined as those standards such as BS, IEC, ISO, ANSI/ASME, API, NFPA, JIS, TRD, DIN and EN which are in common use throughout the world for this type of application.

4.2 Control and operating philosophy

4.2.1 Introduction

The power plant control system should be capable of automatically regulating the unit's electrical output according to a pre-determined load set-point and responding to external demands to any change in load without the need for intervention by the operator.

4.2.2 Fixed/constant and variable pressure operation

Fixed/constant pressure operation

Fixed/constant pressure (throttling) control involves the simultaneous operation of all turbine main steam control valves. This mode of operation is sometimes known as full arc admission with some turbine designs as steam is admitted to all portions of the control stage. In this mode of operation, the main steam pressure is typically held constant at rated conditions and the main steam control valves are opened by the same amount. As the valves are opened the steam turbine output gradually increases and full turbine load is achieved when the valves are wide open.

Fixed pressure control minimises the mechanical loading on the steam turbine control stage as a function of reduced pressure to the stage and the equal loading on all stage sections.

At part load conditions fixed pressure control is the least efficient of all control modes as the throttling process reduces the useful energy available in the steam expansion process.

Variable pressure operation

Variable pressure operation is where the steam flow to the turbine is regulated by allowing the steam generator (boiler) pressure to vary along a pre-determined curve whilst the main turbine steam control valves are maintained in a fixed position, typically at or near the 100% MCR valve position.

The steam flow to the steam turbine is controlled by the pressure of the steam from the steam generator by controlling the firing rate.

The main advantage of variable pressure control is that the steam turbine first stage temperature remains fairly constant over the load range resulting in shortened start up times and increased steam turbine rotor life.

The main disadvantage of variable pressure operation is that it has poorer thermodynamic performance and limited load response capability. The main steam pressure in this mode of operation has the result of more energy being available than if operating in the fixed pressure mode. The response time however, is limited by the steam generator firing rate which in turn, controls the main steam pressure. In the fixed pressure mode of operation, the steam turbine load can be regulated more rapidly by modulating the main steam control valves and utilising the pressure and thermal energy stored in the steam generator.

A further modification to the control philosophy which should be considered, is the adoption of Co-ordinated Control Mode. This incorporates, within the control loop, a modified version of the steam turbine generator MW set-point to directly adjust the boiler firing (i.e. a feed-forward control term) in parallel with regulation of the steam turbine generator output. The result is to improve the response of the overall steam cycle to variations in load.

Operating philosophy

If the selected power station technology were to be sub critical, during normal operation, the plant would be capable of constant pressure operation to enable fast response to load changes and would need to be compliant with the Pakistan Grid Code with the capability of responding togrid frequency deviations.

The Unit should also be capable of sliding pressure or modified sliding pressure operation which would help to minimise efficiency and throttling losses. This is only relevant at part load operation which may not be how the units are initially intended to operate, however the ability to operating in sliding pressure mode would be beneficial if the normal operational mode changes from base load in the future.

If the selected power station technology is super critical the main mode of operation would be sliding pressure operation as during normal supercritical operation the control of the plant will be maintained by continuous and accurate balancing of feed water and main stream flow via the boiler feed pumps and by adjusting the firing rate of the boiler.

Regardless of the technology selected, a fully automatic control system should be provided, designed to ensure the safe and efficient control and monitoring of the plant at all times and with the requirement for minimum intervention by the operator under all conditions. The resulting control loops should be responsive to the varying demands of the transmission system to which it is connected in accordance with the Pakistan Grid Code requirements. All facilities should be incorporated in the control system design to allow remote operation and supervision of the plant from a central point (the Central Control Room or CCR). This is considered a prerequisite for all normal operations of the plant due to the complexity and need for the operators to have access to all relevant measurements and alarm data, enabling them to properly coordinate their decisions and actions. The CCR should be continuously manned on a 24-hour basis.

The CCR is the focal point for management and supervision of actions arising from emergencies and incidents requiring first aid and/or fire control response and therefore houses the security control console.

It is considered that only operations that are expected to be performed locally to the plant relate to post maintenance normalisation, such as de-isolation of pumps and the filling and venting of systems and the testing and charging of chemical dosing tanks.

It is anticipated that in addition to the CCR,there would also be a requirement to provide limited local control and/or monitoring facilities for specific plant areas typically;

a) HV substation/switchyard – Control and monitoring will be from the CCR. Local control and monitoring would not be required although a local metering room, situated close to the switchyard, would be provided.

b) Coal Handling Plant - A Separate Local Control Room shall be provided in the coal unloading and storage area to allow operator control and monitoring of the unloading procedure and to supplement the monitoring facilities at the CCR. Local control panels for each stacker/reclaimed and the unloading station shall also be provided.

c) Water treatment plant – A small control room would be provided local to the WTP to allow commissioning and testing of the plant etc. Monitoring of the WTP would be from the CCR with the local control room normally unmanned.

d) Emergency diesel generator – A local control panel would be provided to operate and test the operation of the EDG. Normal operation and monitoring would be from the CCR however.

e) CW pump house – A local control panel would be provided to allow testing of the plant.

f) Compressed air plant – It is usual for compressors, dryers etc. to be supplied with the manufacturer's standard control and monitoring package. Local monitoring and control would be available at the local panel provided with remote monitoring of a limited number of parameters and alarms at the CCR.

Local control room facilities can provide a mode of operation under special circumstances in order to sustain plant operations. Where provided, close supervision and a "permit-to-operate" system, together with safety interlocks, would be required to prevent spurious or unsafe operation of the plant occurring.

4.3 Selection of emissions control

4.3.1 Aqueous emissions

All aqueous discharges are to comply with the requirements of NEQS as detailed in Section 3.7.

The following aqueous discharges can be expected at the power station;

h) Water treatment plant (pre-treatment and boiler make up water).
i) Condensate polishing plant.
j) Plant drainage system and oily water drains.
k) Air heater and boiler wash/chemical cleaning
l) Sanitary drainage system.
m) FGD plant.
n) Cooling tower blow down.

5. PLANT CONFIGURATION

5.1 Major Systems

It is proposed to develop a 330 MW power plant utilizing circulating fluidized bed (CFB) boiler technology and sub-critical steam parameters. The major systems of the proposed plant include:

- Coal handling and processing system
- CFB boiler
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Ash handling system
- Utilities and waste management system.

330 MW gross power unit will be installed at the Thar Block II, basic design parameters for which are listed below:

Capacity:	1 × 330 MW gross
Power technology:	Sub Critical Circulating Fluidized bed Boiler
Steam conditions:	Main steam 175 bar at 541 °C Single reheat steam 36 bar at 541 °C
Plant efficiency LHV:	37%
Fuel:	Lignite from Thar Block II
Circulating water cooling:	Mechanical / Natural draft cooling tower
Emission control:	ESP efficiency > 99.9% De-SOx efficiency > 90 %

5.2 Power Generation Technology

Circulating fluidized bed (CFB) technology uses a gas/solids fluidized bed operating with an actual gas velocity, which, in combination with the particle size distribution of the solids, generates an expanded phase fluidized bed regime in the major portions of the Furnace. The solids concentration in the furnace decreases continuously from the bottom to top rather than having a sudden change in density as is typical for a dense phase bed. The solids are continuously entrained with the flue-gas from the top of the furnace and the major portion of these solids is separated from the gas by the cyclone separator. The separated solids are recycled to the furnace via return ducts and a pressure seal. The CFB boiler therefore at least consists of the furnace, the separator, the return pipes and the pressure seal. The CFB reactor is used for homogeneous and/or heterogeneous, physical and/or chemical reactions all of which may be endothermic or exothermic. This allows the extraction of surplus heat by cooling surfaces, which form part of the furnace envelope and/or are located in the furnace and/or in a boiler bank.

5.3 Steam Turbine and Auxiliaries

The main steam turbine will be a single reheat condensing, tandem-compound, 3,000 rpm, for operation with inlet main steam conditions of 167 bar, 538 oC. It will have eight stages for feed water heating: four low pressure, a deaerating, and three high pressure feed water heaters.

The steam turbine will be nominally rated at 330 MW gross output at 6.9 kPa back pressure (at design condition) with major design parameters as following:

A turbine bypass steam path, with spray water and pressure reducing valves, will be provided to dump steam into the condenser in case of an emergency turbine trip. Additional major steam turbine auxiliary systems will include a lubrication oil system, gland seal system, rotor turning gear, control and protective valve system, and supervisory and control instrumentation.

5.4 Condenser and Condensate System

The surface condenser will receive exhaust steam from the low pressure turbines and condense it into liquid for reuse in the cycle. Water-cooled surface condenser is the dominant technology used in modern large central power stations. The surface condenser will be maintained at a back pressure of around 6.9 kPa and will serve the following functions:

- Provide low back pressure at the turbine exhaust to maximize the unit's thermal efficiency.
- Conserve the high purity water (condensate) for reuse in the boiler-turbine cycle to minimize water treatment costs for makeup water.
- Receive and condense the exhaust steam from the boiler feed pump turbine drives.
- Serve as a collection point for all condensate drains, steam vents and dumps.
- Serve as a heat sink for the turbine by-pass steam during startup, shutdown and emergency unit trip.

5.5 Generator and Electrical System

The electric generator will be a totally enclosed, three-phase, 3,000 rpm, synchronous machine with hydrogen-cooled rotor. The cooling medium for the conductor-cooled stator windings will be either hydrogen or water. The main characteristics of the electric generator will be:

Rated output:	330 MW, 375 MVA
Power factor:	0.8
Terminal bushings:	Neutral connect
Short circuit ratio:	0.55
Winding insulation:	Class F
Efficiency:	99% or higher.

The generator will be suitable for operation in parallel with other electric generating equipment. The housing will be fabricated to withstand the pressure generated by an explosion of a mixture of hydrogen and air within the housing. All leads, including power, control and instrumentation will be brought out of the casing through gastight seals.

5.6 Emissions Control

5.6.1Flue Gas Treatment System

Electrostatic Precipitators

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), primarily in order to meet product quality requirements of saleable gypsum as well as to meet the stack emission limits for particulates.

The ESP may be rigid electrode or rigid frame design. . 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 ppm at all loads when burning design coal.

The ESP will have multiple, independently powered electrical sections. The electrical sections will be arranged in at least two 50% independent load groups, such that a loss of power supply to one load group will not affect the performance capability of the electrical section served by the other load group.

The ESP will be a self-supporting structure designed for outdoor installation. It will be able to withstand all external forces simultaneously with all internal forces created due to pressure, dust loading, operating temperatures and the dynamic loading imposed by vibrators and rappers. Airtight expansion joints will be provided to accommodate the thermal expansion of the breaching and casing. The roof will be designed to support maintenance personnel and tools in addition to all other external loads. The roof will be pitched for drainage and provided with suitable gutter and roof drain piping terminating at grade level. The casing wall will have a minimum thickness of 6 mm. The ESPs will be designed with 10% extra plate collection area. All metal parts of the collector subject to abrasion and wear will have a 3 mm corrosion allowance, except for discharge and collecting electrodes.

A rapping system will be provided for cleaning electrodes and collecting plates. It will be capable of 50g acceleration normal to the most remote section of the plates.Rapping frequency and intensity will be adjustable to provide for variation in steam generator operating conditions. The rapping system will operate automatically, and will be such that flue gas puffs and fluctuations in the electrical load are minimized. Rapper controls will bereadily adjustable for intensity and frequency, and will be independently adjustable for each electrical field. All electrical parts will be outside of the gas stream.

Collecting plates will be at least 1.2 mm in thickness. Collecting electrode design will be such that the electrodes remain straight and free from warping after extended periods of operation. The entire precipitator will be insulated and lagged. Insulation will be asbestos free.

Sulfur Dioxide Control

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%.

Nitroge Oxide Control

NOX control will be provided by using low NOX burners.

5.7 Disposal of Ashes/Combustion & FGD Residues

The CFB Boiler process will produce a combustion residue mixture of sand / bottom ash /fly ash /dry gypsum / free limestone etc. In case of future emission aggravation wet gypsum from a spray absorption unit could occur as well.

A possible disposal process will start with the mixture and wetting (by RO brine water) of the residue fractions. The wetted residues will be transported by truck to the overburden dump yard of the mine for further disposal. In future the residues could be dumped in the dead zones of the mine as well.

All related parts of the ash disposal system within the power plant boundary has to be installed and managed in a way that it will meet all given legal regulations. The vendor has to verify that within all residue preparation processes where water is getting in contact with the residues no curing processes occur in a way that the operate ability of the related or sub-sequent related equipment is not reduced or blocked.

5.7.1 Other options for residues utilisation

Fly and bottom ash, being a coal combustion residue, shows a wide variation in its physical, chemical and mineralogical properties depending on the nature of the parent coal, conditions of combustion, type of emission control devices, storage and handling methods. Fly ash in particular has a low bulk density with high surface area and light texture which requires large areas for its storage unless it is collected and disposed of immediately from the site. Whilst it is proposed that space is allocated at the site for storage of this by-product, the preference is for off-site disposal. For this to be effective, the aim should be to establish a commercial arrangement for the usage of the by-product

Furnace waste from hard coal fired boilers may be widely used in a number of industries, including, but not limited to the following:

a) Use as active additive to cement,
b) Production of concrete and other construction materials,
c) Production of lightweight aggregates,
d) Non cement based adhesives,
e) Road construction,
f) Farming and gardening,
g) Production of self-hardening backfill for mining industry,
h) Other.

Historically, because of the small number of coal-fired power stations in Pakistan, a commercial industry for the use of the ash by-products has been very small. However, with the current plan being promoted by the Government of Pakistan to increase the number of coal-fired power plants throughout the country, the production of fly ash is expected to increase significantly. Unless avenues of fly ash consumption are established, it will become difficult to manage the storage of these large amounts potentially leading to them becoming a hazard to the environment. It is anticipated therefore that the availability and usage of fly ash and other by-products to produce saleable commodities such as cement etc. will increase and become commercially attractive industries. Consequently, it is recommended that various areas of usage are investigated in order to minimise the associated costs of loading, transport, off-loading and disposal of the materials in question.

Whilst some or all of the industries listed above should be investigated, it is expected that the cement manufacturing industry is likely to be the most important sector in the utilization of fly ash owing to its pozzolanic properties as a replacement for some of the Portland cement contents of concrete. The following **Table 5-1** provides information about the installed production capacity of cement in Pakistan up until August 2015.

Table 5-1: installed production capacity of cement in Pakistan up until August 2015

	Name Of Unit	Operational Capacity (tonnes/annum)	
		Clinker	Cement
1	Askari Cement Limited - Wah	1,050,000	1,102,500
2	Al-Abbas Cement Limited - Nooriabad, Dadu	900,000	945,000
3	Askari Cement - Nizampur	1,500,000	1,575,000
4	Attock Cement Pakistan - Hub Chowki, Lasbela	1,710,000	1,795,500
5	Bestway Cement Limited - Hattar	1,170,000	1,228,500
6	Bestway Cement Limited - Chakwal	3,428,571	3,600,000
7	Bestway - Mustehkum Cement Limited - Hattar	1,035,000	1,086,750
8	Cherat Cement Company Limited-Nowshera	1,050,000	1,102,500
9	Dandot Cement Limited - Jehlum	480,000	504,000
10	Dewan Hattar Cement Limited - Hattar	1,080,000	1,134,000
11	Dewan Hattar Cement Limited - Dhabeji	1,680,000	1,764,000
12	D.G.Khan Cement Limited - D.G.Khan	2,010,000	2,110,500
13	D.G.Khan Cement Limited - Chakwal	2,010,000	2,110,500
14	Fauji Cement Company Limited - Fateh Jang	3,270,000	3,433,500
15	Fecto Cement Limited - Sangjani	780,000	819,000
16	Flying Cement Limited - Lilla	1,140,000	1,197,000
17	GharibWal Cement Limited - Jehlum	2,010,000	2,110,500
18	Kohat Cement Company Limited - Kohat	2,550,000	2,677,500
19	Lafarge Pakistan Cement Company Limited - Chakwal	1,950,000	2,047,500
20	Lucky Cement Limited - Pezu	3,605,714	3,786,000
21	Lucky Cement Limited - Indus Highway, Karachi	3,428,571	3,600,000
22	Maple Leaf Cement Factory Limited - Daudkhel	3,210,000	3,370,500
23	Pioneer Cement Limited - Khushab	1,933,571	2,030,250
24	Thatta Cement Limited - Thatta	465,000	488,250
Total		**43,446,428**	**45,618,750**

Some of the cement producing units listed in the table were contacted to establish whether they were presently using fly ash in the production of cement in their units. It was found that, with the exception of the Bestway Group, none of the other organisations were making use of fly ash and they were using only 2% fly ash in production of cement in their plants. The fly ash is presently being produced in Joharabad and Khushab areas by some chemical plants and the output is used entirely by the Bestway Group. As the substitution of fly ash in the production of cement can be increased to 7%, the group has substantial capacity to consume more fly ash if available at competitive price. At present, the price of fly ash in international markets ranges from 30 to 60 US$ per tonne [2] depending on its quality. It can therefore be concluded that the entire quantity of fly ash likely to be produced by the power plant could be utilised by the Bestway Group and other potential users.

In addition, gypsum is commonly used to manufacture plasterboard, plasterwork etc. The commercial market for the use of this material is less developed than that

[2] KAPCO Feasibility.

for fly ash although if it became more readily available and at a reasonable cost, the speed and size of the development of the market could be significant.

It is recommended that further investigation and research is undertaken to more fully understand the commercial drivers for the usage of both ash and gypsum products. Meanwhile, technical solutions have been identified within this report to enable the reception of furnace waste by external parties in the future, to be utilised as required once the waste utilisation market is more established/mature.

5.8 Electrical

5.8.1Interconnection Study

The proposed plant is going to be connected to the nearest grid facility of NTDC which is Matiari 500 KV Converter Station.

Taking the location of Noval Power Plant in consideration, the most feasible Interconnection scheme would be looping in-out one 500 KV circuit between Engro Coal Fired Power Plant and Matiari Converter Station. The two breaker bays of 500kV at Thal Nova CFPP to connect with the 500kV circuits each from Engro CFPP and Matiari-CS respectively will be required

In view of planned COD of the Thal Nova Power Plant in the Last quarter of 2019, the base case of studies have been assumed as of January 2020 because maximum power flow occurs on southern grid of NTDC due to concentration of thermal power plants in the South. Therefore the above proposed interconnection have been tested for steady state conditions through detailed load flow studies for both peak and off-peak low water conditions of January 2020. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code

Steady state analysis by load flow for peak and off-peak load of January 2020 reveals that proposed scheme is adequate to evacuate the maximum power of 330 MW of the Plant under normal as well as contingency conditions

Currently a high voltage 500kV/1200 MW double circuit long distance (235 KM) transmission line is being setup for the 2x330 MW power for Engro Power. Since the line can bear excess load, he plant once operation will be fully dependent on the same double circuit transmission line. The fulfilment of grid stability criteria and usability for commissioning of the new transmission line has to be verified in detail through various simulations. The long transmission line with the huge generation units at its end might pose a considerable challenge for grid stability.

5.8.2Plant electrical system

The following design data will be considered:

- Unit power output is 330MWgross / 300MWnet
- Unit power consumption is estimated to 30MWel/37.5MVA

- The redundancy for the electrical auxiliary power supply follows the n-1 criteria. Main reason for the n-1 criteria is; single fault of equipment shall not cause a trip of the whole power plant. Certain redundancy (e.g. 2 x 100% / 3 x 50% / 4 x 33% / etc.) will be specified in later design stage to fulfill the n-1 criteria as well as to secure the functionality of critical/essential systems.

The power train includes all components and their auxiliary systems that are necessary to generate electrical power and feed it into the local grid connection point. Also included are all systems that are necessary to feed the electrical consumption of the balance of plant.

As a rule, the construction of electrical equipment must be conform to the regulations of the relevant construction standards (e.g. IEC, EN (consultant recommendation)), or equivalent). For the plant and its equipment a risk assessment has to be performed and the results have to be fixed in a HAZOP study and SIL classification in the detailed design phase. In addition the "THE GRID CODE" (by The National Transmission and Dispatch Company Ltd.) shall be fulfilled by the units. The commissioning of the 1x 330 MW unit in combination with the commissioning of the new built high voltage transmission line needs to be planned and prepared very carefully in advance.

5.9 Controls and instrumentation

5.9.1 General concepts

The proposed control, instrumentation, data and voice communications systems, site security, surveillance and access systems are described in the following sections and cover the complete plant.

The main objectives of the control and instrumentation (C&I) systems are:

a) Allow the safe and efficient monitoring and control of the plant at all times and under all conditions,
b) Provide a high level of integrated protection to ensure the plant does not enter a condition or state of operation which is unsafe or could create a hazard to personnel, the plant or the environment,
c) Incorporate autonomous operation in order to minimise operator manning levels and reduce the need for operator intervention in the running of the plant,
d) Incorporate a high level of system availability and reliability,
e) Provide a high degree of system integration across the plant and allow operator monitoring and control from a centralised location on the site,
f) Allow interconnection with external systems for load despatch activities, management monitoring and reporting, plant and systems maintenance,
g) Short, medium and long term historical data storage for plant management,

h) Integrate data and voice communications across the site with external areas of the TNPTL business as well as national and international organisations where required,

i) Provide security for the site by the implementation of systems to control and record personnel access in and out of the site, detect unauthorised attempts to breach the site boundaries and provide visual and audible monitoring of the overall site from a centralised location.

5.9.2Distributed Control System (DCS)

The control system for a large, fossil-fuelled power plant is normally based on the provision of a system of functionally and geographically distributed microprocessor-based controllers. These are interconnected through a serial data network to allow data acquisition and the exchange of data and commands between network nodes or control points. The monitoring and control functions for the individual plant areas are executed in software resident in the distributed controllers and through control strategies located at supervisory computers or servers higher up within a hierarchical structure – commonly referred to as a Distributed Control System (DCS).

The DCS concept has been developed over many years and has been used successfully in many power plants of different types world-wide. Whilst the concept was conceived during the 1970s, it's use is currently still valid as the most suitable concept for this application and its implementation has been continuously improved and updated through the development of improved technology including more powerful microprocessors, increased availability of data storage, improved materials, display technologies and data communications. Further developments in technology which are increasingly being applied to DCS include the use of wireless communications, mobile interfaces and the use of web-based systems and servers.

It is proposed that in order to meet the above objectives, a DCS-based system is implemented as the most appropriate for a project of this magnitude which is likely to require the management of in excess of 60,000 plant signals (I/O). The modern DCS has a number of distinct features particularly its flexibility of operation and its availability to communicate directly with programmable logic controllers (PLCs) used for the coal handling plant, water treatment plant etc. and third party, specialist systems such as the steam turbine controller, furnace protection system etc. Increasingly the most up to date generation of DCS incorporate networking of various PLCs, stand-alone systems and servers through standardised data networking specifications and protocols and web-based options.

Functional software resident in the DCS controllers and servers will be programmed with algorithms designed for the integrated operation of the plant including automatic sequencing of the process, closed and open loop control, alarm and event handling etc. The exchange of control and monitoring data will take place over the DCS communications network and will be supplemented by a separate, integrated protection system to ensure an unsafe condition cannot occur due to instability in the process or incorrect operation of the plant.

The plant-wide data communications network will be designed for maximum availability and reliability by the use of built-in redundancy of components. All communications links will be duplicated and operate in hot-standby mode such that an alternative route would automatically be implemented in the case of a fault. Fibre optic cables would be implemented where appropriate to minimise interference in areas where high electrical fields may be present whilst ensuring adequate transmission speeds are achieved for potentially high data volumes. Internationally accepted data transmission protocols, error detection and correction techniques should be applied to avoid corruption of data.

The use of high quality, industrial grade components and the provision of redundancy for control processors, data communications network and power supplies, ensures a high level of availability and reliability can be achieved with a DCS. The general concept applied should be that a single component failure of the control and monitoring system shall not result in a tripping of the plant or a reduction in its output.

The data available in the DCS will be further utilised in separate and interconnected hardware using special software for historical data storage, plant performance monitoring, condition monitoring of dynamic plant, predictive maintenance systems etc.

5.9.3Operator's Facilities and Central Control Room (CCR)

Power plant status monitoring, starting and stopping of individual items of plant or plant groups, adjustment of set points and load etc. will be available to the operator at a Centralised Control Room (CCR) equipped with all necessary display, reporting and control devices available at any time. Operator workstations (OWS) supplemented by wall-mounted displays, printers, long term storage devices, Engineer's Workstations (EWS) etc. will be provided for use by the operating and maintenance staff for this purpose.

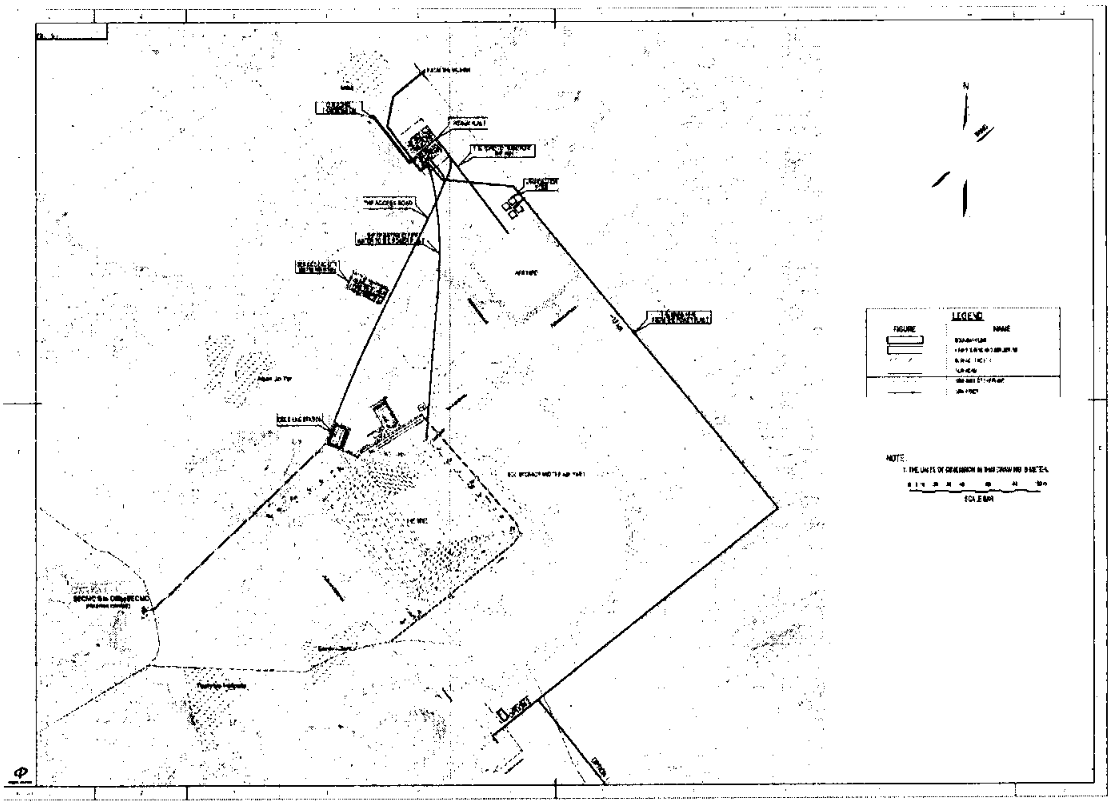
The CCR layout will be developed in accordance with the requirements of the plant operator but is likely to include separate areas for the unit control desk, electrical system workstation, supervisor's workstation etc. The equipment provided will utilise the latest technology for the intended function and, combined with suitable lighting, heating, air conditioning and furnishings etc. will ensure easy and efficient use by the staff in order to minimise operator fatigue and incorrect or inadvertent operator actions as a result.

5.9.4Boiler Control and Monitoring

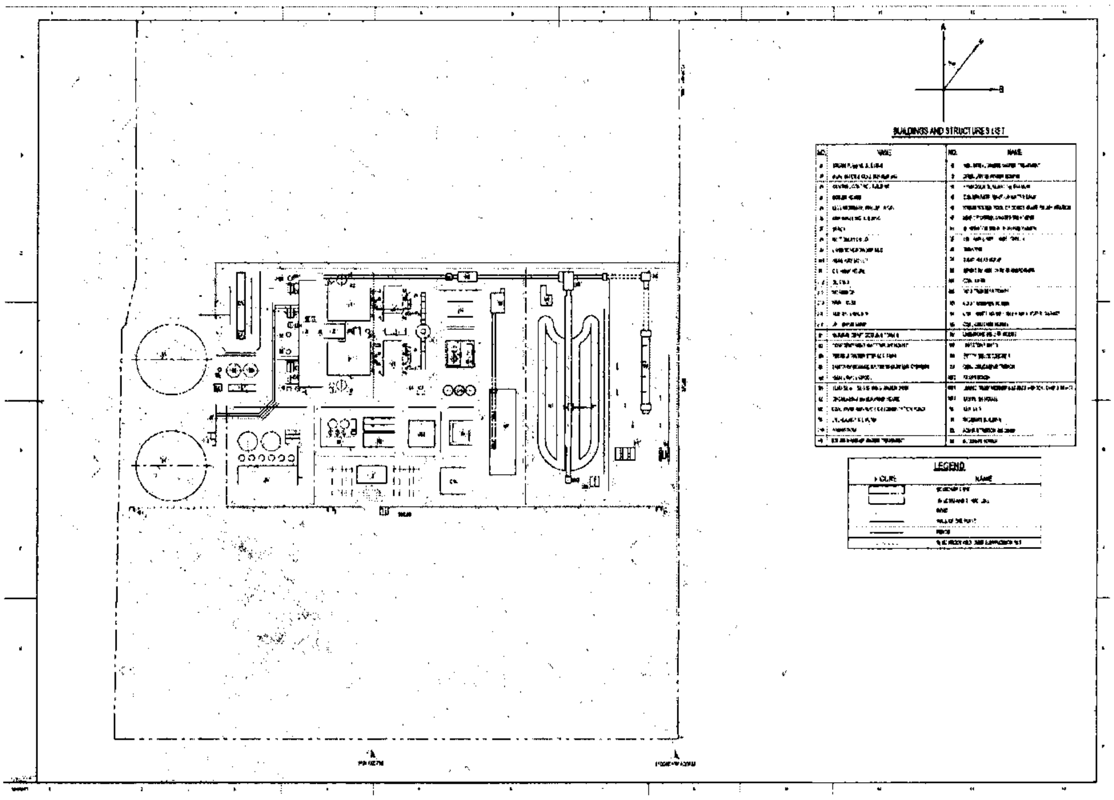
Monitoring and control of the boiler plant and its auxiliaries will be performed substantially by the DCS in accordance with the manufacturer's specified control strategy, sequences and parameters. The exceptions to this will be the furnace flame safety system (FFSS),a stand-alone control and protection package designed to operate in accordance with statutory requirements and guides (e.g. NFPA or similar). Similarly, boiler steam pressure and temperature control may be implemented within the boiler manufacturer's standard hardware controller package due to the criticality of these control loops and sequence control. In all cases full interfacing with the DCS should be provided to ensure integrated operation of the complete plant and allow centralised access and monitoring by the operator from the CCR.

6. PLANT LAYOUTS

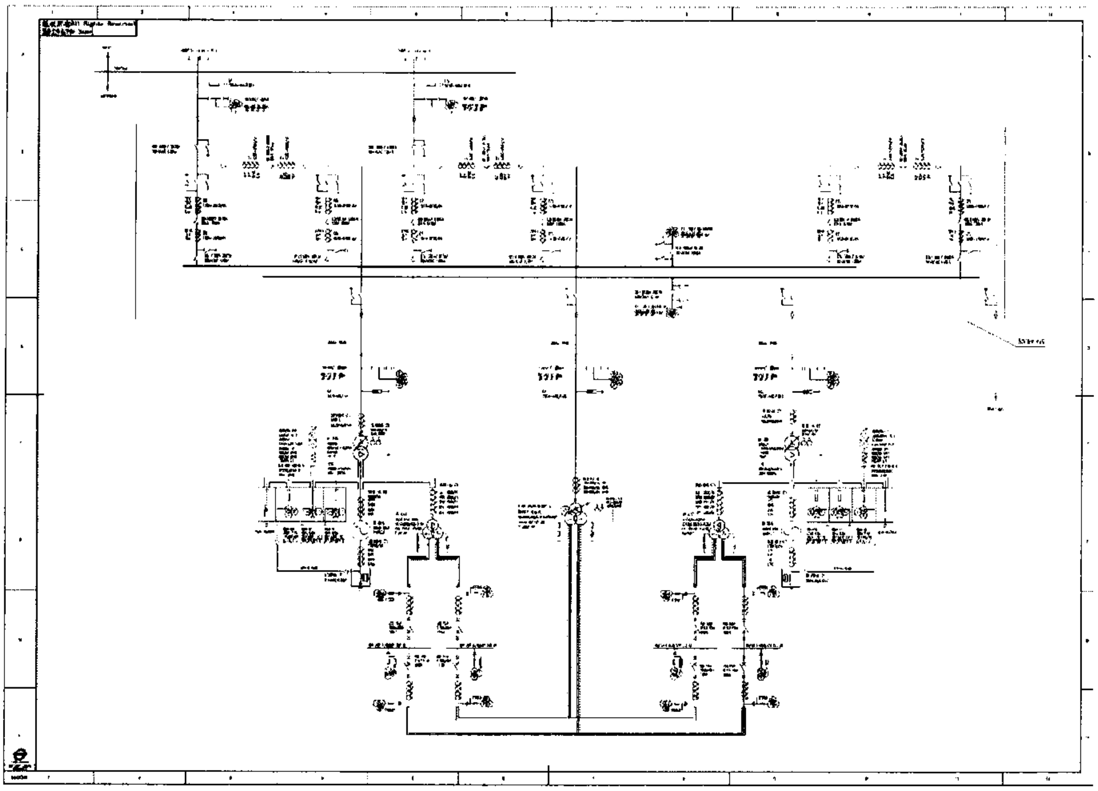
Master Layout



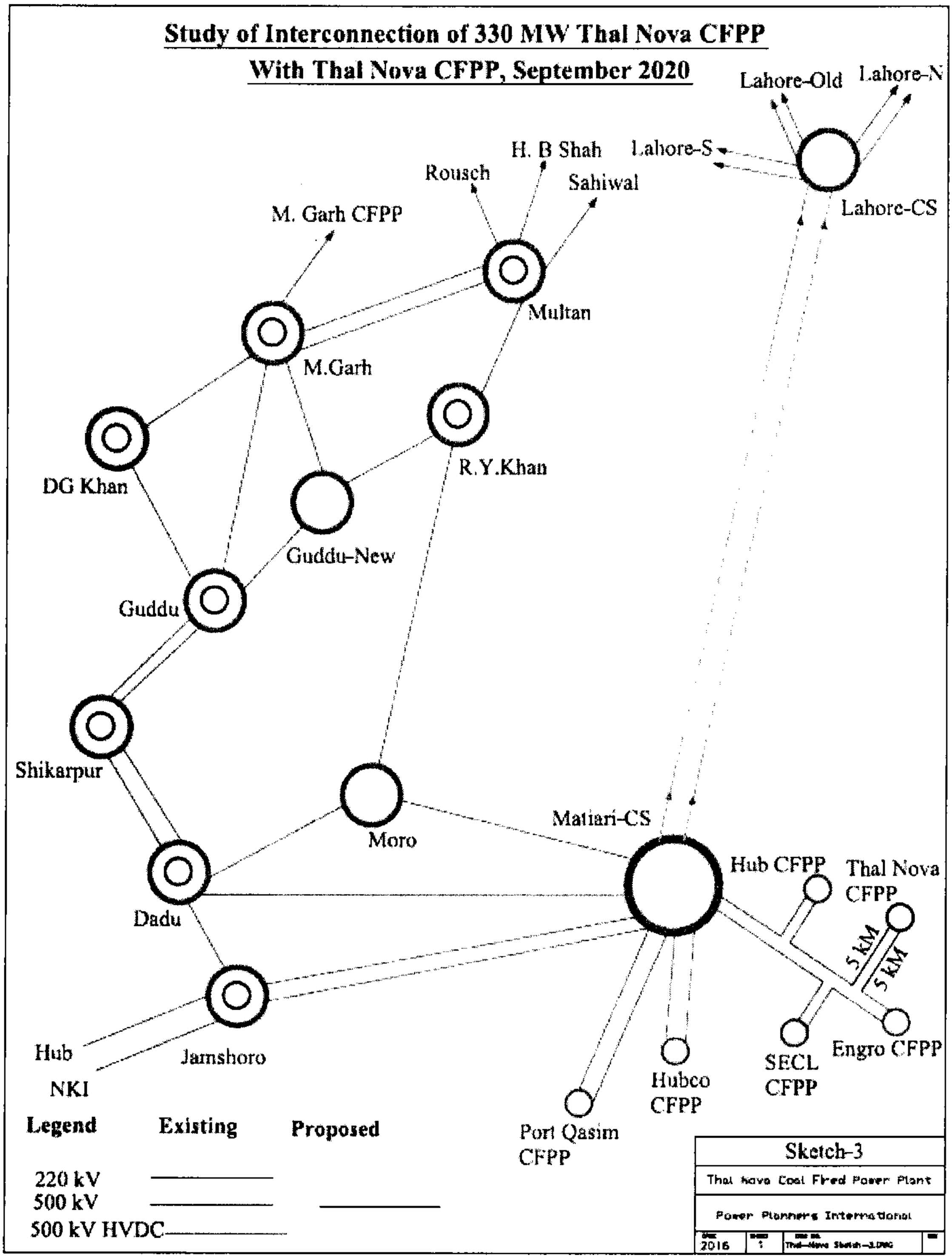
General Layout of Power Plant



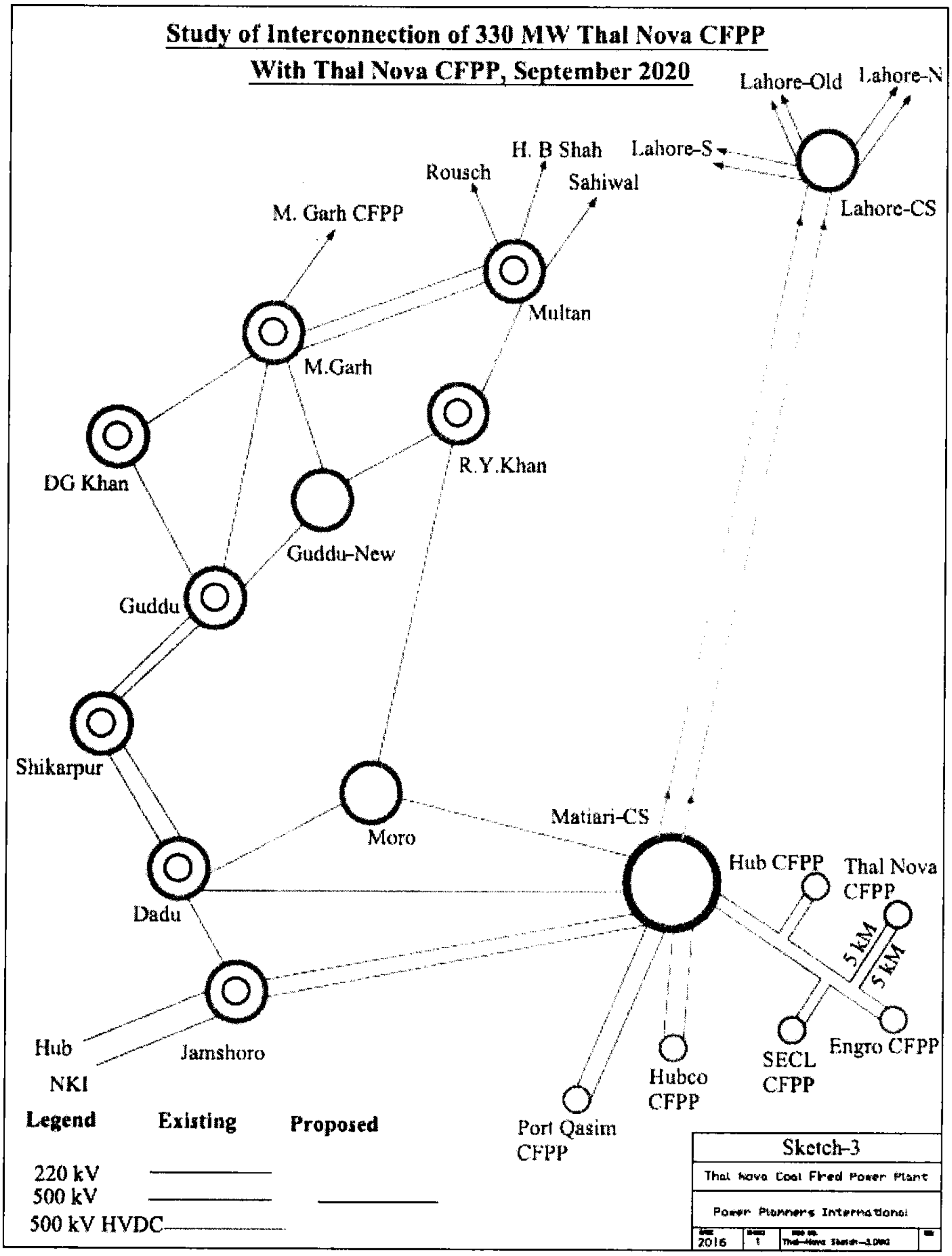
ELECTRICAL SINGLE LINE DIAGRAM

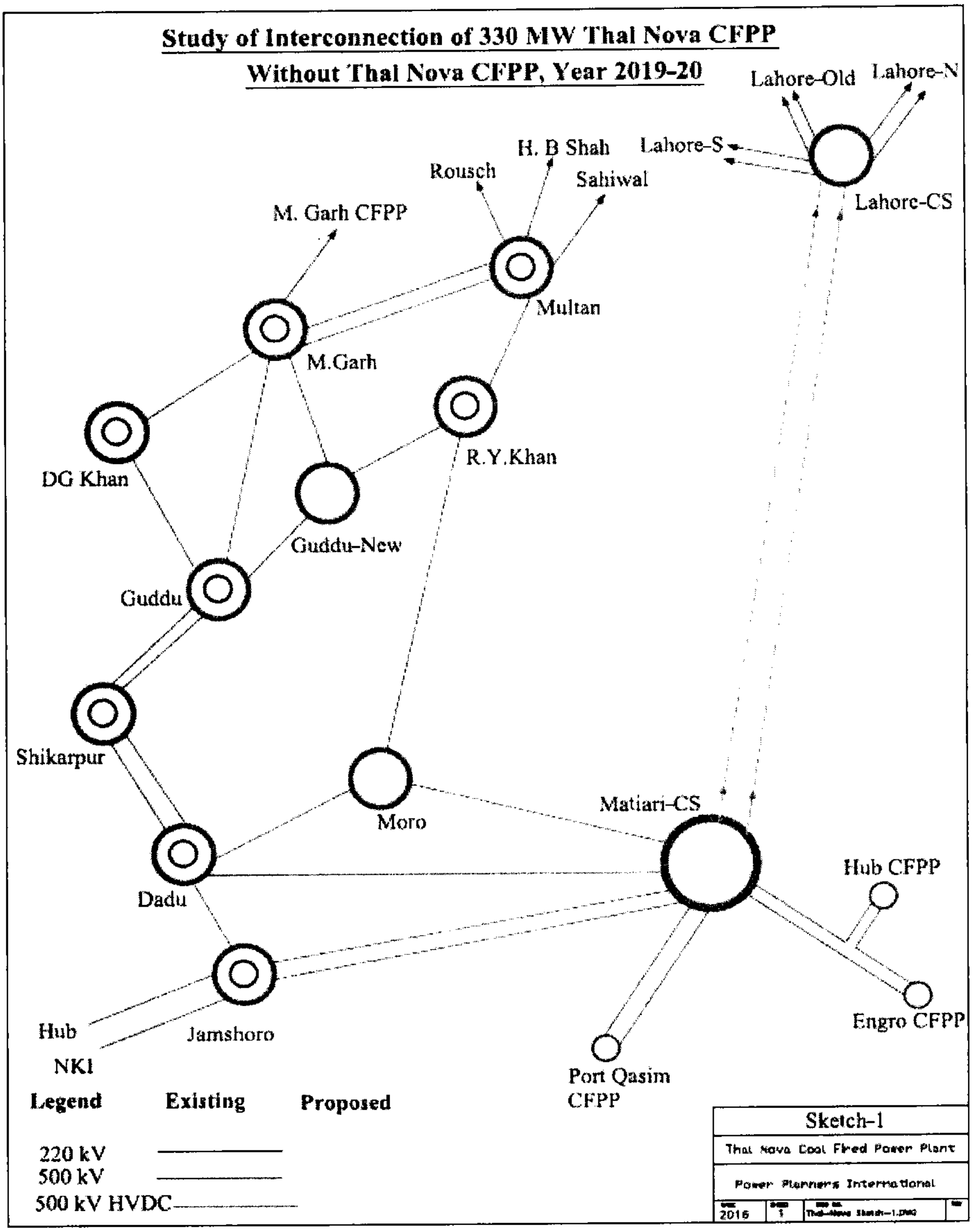


Interconnection Study of 330MW Thal Nova CFPP with Thal Nova CFPP

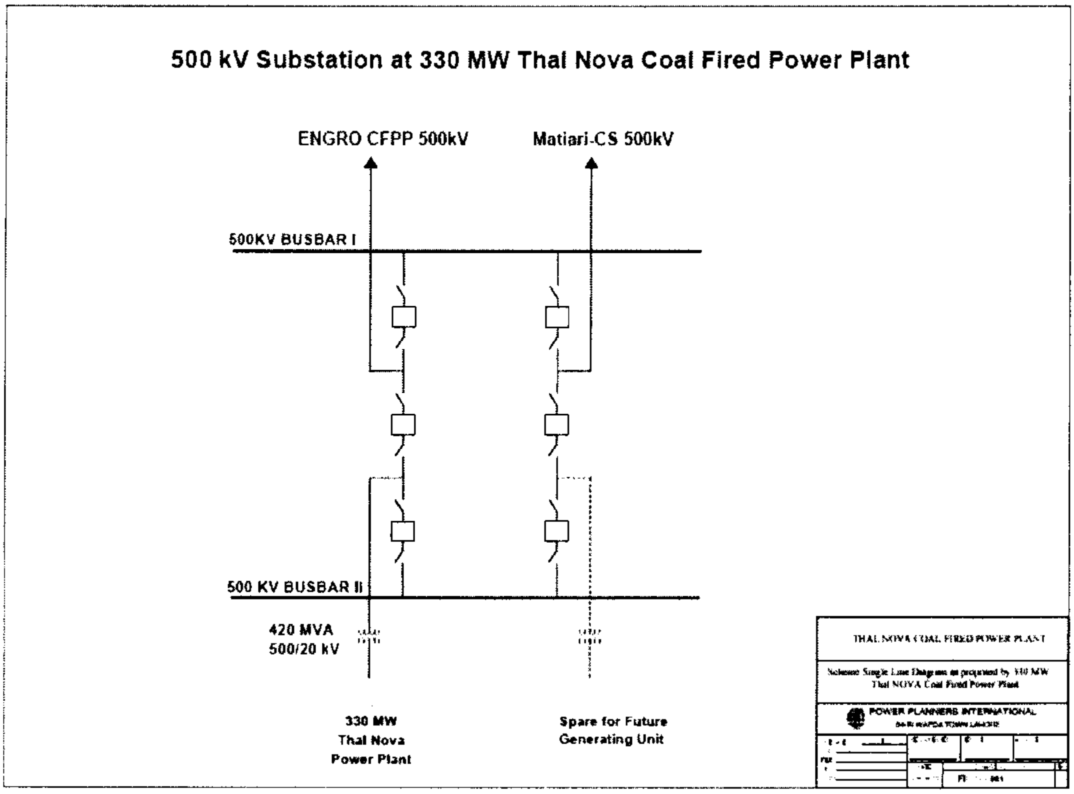


Interconnection Study of 330MW Thal Nova CFPP without Thal Nova CFPP




Study of Interconnection of 330 MW Thal Nova CFPP
Without Thal Nova CFPP, Year 2019-20
Lahore-Old
Lahore-N
Lahore-S
Lahore-CS
H. B Shah
Rousch
Sahiwal
M. Garh CFPP
Multan
M.Garh
R.Y.Khan
DG Khan
Guddu-New
Guddu
Shikarpur
Moro
Matiari-CS
Hub CFPP
Dadu
Engro CFPP
Jamshoro
Hub
NKI
Port Qasim CFPP
Legend
Existing
Proposed
220 kV
500 kV
500 kV HVDC
Sketch-1
Thal Nova Coal Fired Power Plant
Power Planners International
2016

Single Line Diagram as proposed by 330 MW Thal Nova Coal Fired Power Plant



7. FINANCIAL ANALYSIS

7.1 Financial Report

The financial report will be part of the Bankable Feasibility Study (BFS) for the development of a mine mouth power plant consisting of one unit with 330 MW Circulated Fluidized Bed (CFB) boiler technology (Stage-I) operating at Block—II of Thar Coal Fields, Pakistan. The financial model must be in a format that is acceptable to international lenders and banks. The project has a guaranteed Internal Rate of Return (IRR) of 20% in dollar terms which makes it profitable and attractive for investors given the risks of the project. The project will be built and operated under the Power Generation Policy 2015 which operates on a Build Own Operate Transfer (BOOT) principle and provides Government of Pakistan guaranteed attractive IRR along with tax concession and exemptions.

The

High sensitivities on the profitability exist for a deviation of Capex, of technical availability of the plant and of construction schedule. A deviation of start of mine operation i.e. the use of an alternative coal supply or a change of Thar coal price scheme will have no influence on the probability as these risks are expected to be covered by a pass through mechanism within the Power Purchase Agreement (PPA).

With regard to a high portion of fixed costs (78%) split into fixed and variable portion within the PPA is mandatory. To reduce the risk of underestimating it is important to select appropriate cost indices for main cost items to cover the price escalation from real to nominal tariff.

The feed-in tariff considers debt and the equity requirements of the investor. A breakdown of the tariff is given for variable and fixed cost portions i.e. an Energy Purchase Price (EPP) and a Capacity Purchase Price (CPP). Beside this calculation a tariff reference based on a NEPRA concept is provided for benchmark purposes. Finally, a sensitivity analysis for the IRR on Equity with a change of main economic parameters is prepared.

7.2 Risk Analysis

7.2.1Risk Assessment Report-

The risk assessment of TNPTL is done by using standard methodology for thermal power plants which identifies the major risks, the cause of those risks, what can be the potential impact of those risks and how can these risks be addressed.

Major Risks:

The project risks identification includes all types of risks from risks affecting project success which must be addressed i.e. prevented or mitigated.

A recommendation for mitigation measures is also given along with every listed risk.

1 -**Coal price risk:** Pass through for power producer subject to security package

2 -**Economic outline data change:** Pass through for power purchaser via indexation mechanism

3 -**Bankruptcy of contractors (construction phase):** Develop risk based contracting strategy, proper credit risk tracking and demand bank guarantees; EPC contract: Capex with robust contingency mark-up.

4 - **Bankruptcy of contractors & delay of payments by purchaser (operation phase):** Develop risk based contracting strategy; ensure guarantees for compensation of delay of payment by purchaser; employ capable / reputable O&M operator; employ strong owner's resident organization.

5 - **Wrong partner selection:** Proper partner selection with defined evaluation criteria; upfront equity bank guarantees from equity partners at Financial Close.

6 - **Greenfield risks and missing infrastructure:** Early study for logistic concept, monitoring. Adjust split of responsibility between comprehensive planer and PP project; execute intensive monitoring and scheduling; secure of redundancies in construction phase.

7 - **Low price approach for power plant equipment:** Provide quality management and execution plan incl. milestones; engage experienced consultant; provide quality assurance at place of manufacturing

i.e. ex works; prepare concept for reworks incl. consider location; ensure quality concept as part of EPC contract; plan adequate design & take of allowance and contingency within construction budget.

8 - **No sufficient defined construction standards and performance data :** Early definition of minimum standards and performance for technical scope with high Capex and O&M relevance; implement standards & performance in EPC contract upfront signing contract; introduce adequate design allowance and contingency.

9 - **High interdependence of complex projects:** Provide superior study and analyze interdependence of all projects (infrastructure, mine, PP) and risk analysis of their interaction; secure central superior steering of all interacting projects sponsored by province Sindh or GoP.

10 - **Impact of extreme weather on lay out and during construction:** Study of climate & weather impacts on construction phase; implement buffer time for delay due to climate & weather impacts; adjusted seasonal working time and erection plan and adequate H&Smeasures.

11 - **Lack of qualified staff:** Provide study for recruiting concept and execute early start of recruiting; secure infrastructure management.

12 - **Lack of decision making:** Stakeholder management plan.

13 - **Complex interfaces:** Detailed interface engineering.

14 - Change of policy and unforeseen political decisions: Stakeholder management plan; Communication plan; any event materially affecting the project can be declared as change in law force majeure event under PPA/IA.

15 - Outstanding permits: Early contact to authorities; communication plan

16 - Self ignition and contamination of coal: Indoor coal storage area for power plant, covered logistic system and specific coal operation & firefighting concept ("hot spot" detection); install wet coal system by sprinkler spraying system for power plant and mine coal storage.

17 - Dependency from local coal mine: Select proven CFB boiler technology to ensure high flexible use of fuel quality; proven schedule and technology for open cast mine; contractual secondary back up fuel and logistics inclusive harbor facility and transportation (trucks, street); implement sensitivity analysis in financial analysis for timely use of Indonesian coal for first two years **of** operation

18 - Cooling water assumptions: Detailed water demand analysis with proven prediction model; analysis of water availability and effect on the environment; presume of LBOD delay and adequate mine water treatment facility and plan mine water resource; introduce design allowance in Capex and Opex estimate for additional cooling expenses.

19 - Grid connection: Initiate early study for grid connection for Thar PP; use external expertise & second opinion of experienced operator; set realistic Capex and Opex for grid facility, introduce adequate design allowance & contingency for grid project (PP external)

20 - Electricity supply during erection phase: Study on layout for sufficient power supply; set up adequate redundancy for power supply with diesel aggregates during construction phase; introduce back up & redundancy equipment in construction budget (Capex & Opex in advance).

21 - Effect of medias and hazards on plant & environment: Detailed analysis of the medias and their effects on the plant and environment and consideration in plant layout.

22 - Change of coal quality: Define band of coal quality (Base, Min, Max) for relevant parameter (e.g. heating value, ash, alkali, ferric) within Fuel Purchase Agreement; implement measures for fuel quality management including blending and control; consider contractual counteractions within Fuel Purchase Agreement.

23 - Impact of extreme weather on plant operation: Specific analysis of effects in the Thar desert by analyzing comparable industrial/power plant installations.

24 - No sufficient soil investigation: Early and detailed analysis of soil with definition of requirements e.g. foundation for civil construction; introduce adequate design allowance and contingency.

Overall, the riskiness of the project has been significantly mitigated with the Financial Close of Engro 2x330 MW power plant at Thar Block II and all the standard documents like Power Purchase Agreement, Coal Supply Agreement, Implementation Agreement, Land Lease Agreement, Security documents, etc. are already in place.

8. PROJECT EXECUTION PLANNING

8.1 Project Execution Plan

Project Execution Plan is a comprehensive plan which includes the roles and responsibilities of the whole project execution team. The plan will enlist all the targets of the individuals and ways to achieve those targets. The document is updated on a regular basis by the Project Manager (PM) or whoever is leading the project. The PM will take into account all the factors like project background, HSE principles, risks and risk mitigation methods, Project economics principles, changes in master milestone plan etc. The Project execution plan includes the following key functional areas along with others:

- Engineering
- Procurement
- HSE
- Construction
- Commissioning
- QA/QC
- Cost control
- Document Control
- Project Management

8.2 Milestones

As shown in the attached chart.

3(5)(i) PROSPECTUS

a. Brief Introduction of applicant:

Thal Limited is a diversified national conglomerate engaged in the manufacture of Engineering products (Karachi), Jute products (Muzaffargarh), Laminate sheets (Hub) and Paper sacks (Hub & Gadoon). Apart from these key operational areas, Thal Limited's subsidiaries include renowned entities like Makro-Habib Pakistan Limited, Pakistan Industrial Aids (Private) Ltd, Noble Computer Services (Pvt) Limited and Thal Boshoku Pakistan (Pvt.) Ltd.

Novatex was established in 1994 and since then it is the only PET Resin Bottle Grade manufacturer in Pakistan, with the brand name of Gatronova. Novatex currently boasts a capacity of 350,000 MT/Year which is around 2% of total global production. The company also has a wholly owned subsidiary in North America for distribution and sales.

Descon is an integrated group with interests in Engineering, Power Solutions and Chemicals. The group's major company, Descon Engineering Limited is an integrated engineering services and manufacturing company operating in Pakistan and the Middle East, delivering client-specific solutions for projects related to Energy, Infrastructure and Process industry. Descon provides solutions as EPCC (Engineering, Procurement, Construction and Commissioning) services provider to a host of international clients.

ThalNova Power Thar (Private) Ltd. (TNPTL) plans to establish a 330 megawatt (MW) Thar Lignite Coal-based Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh. The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines, however, currently the exploration and development work is being carried out in less than half of the blocks. An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of the about 2 km^2 500 acres and is expected to contain six power plants, with a combined power generation capacity of about 4,000 MW.

b. Salient Features of the facility:

TNPTL has planned to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters. The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District in Sindh.

c. Proposed Investment:

The total cost of the project as per NEPRA Tariff determination rules dated January 20th, 2015, for a 330MW power plant is USD 408.245 million which is subject to specific indexation mechanisms. The project would be financed in a debt to equity ratio of 75:25. As shown in the attached Expression of Interest as per regulation 3(5)(d)(ii) (in divider # 10) ICBC and HBL intend to arrange debt financing from international and local banks respectively. The repayment period of the loan is 10 years, which is in line with the requirements of NEPRA. The debt repayment will commence from the COD. Equity would be raised by sponsors with their own funds.

d. Social & Environmental Impact of the proposed facility:

Social Impact:
The Project is likely to have following social impacts during and after its completion.

Employment:
A large number of job opportunities will be created thus giving a fair chance of employment to the locals during construction and at operational stage

Living Standard / Quality of life:
The increased employment opportunity provided by the proposed project will definitely have a positive effect on the daily life of the local population in terms of improved living standard and quality of life.

Education:
New and better primary and secondary education institutions/facilities will be available to the local population though CSR activities of the proposed project.

Health Facilities:
Basic health facility will be available to the local population though the CSR activities of the Project

Communication/infra-structure:
The energy park planned by the government along with the development activity in Thar region being conducted will facilitate the development of a better communication network and overall infra-structure.

Environmental
The proposed project is likely to have following environmental impacts:

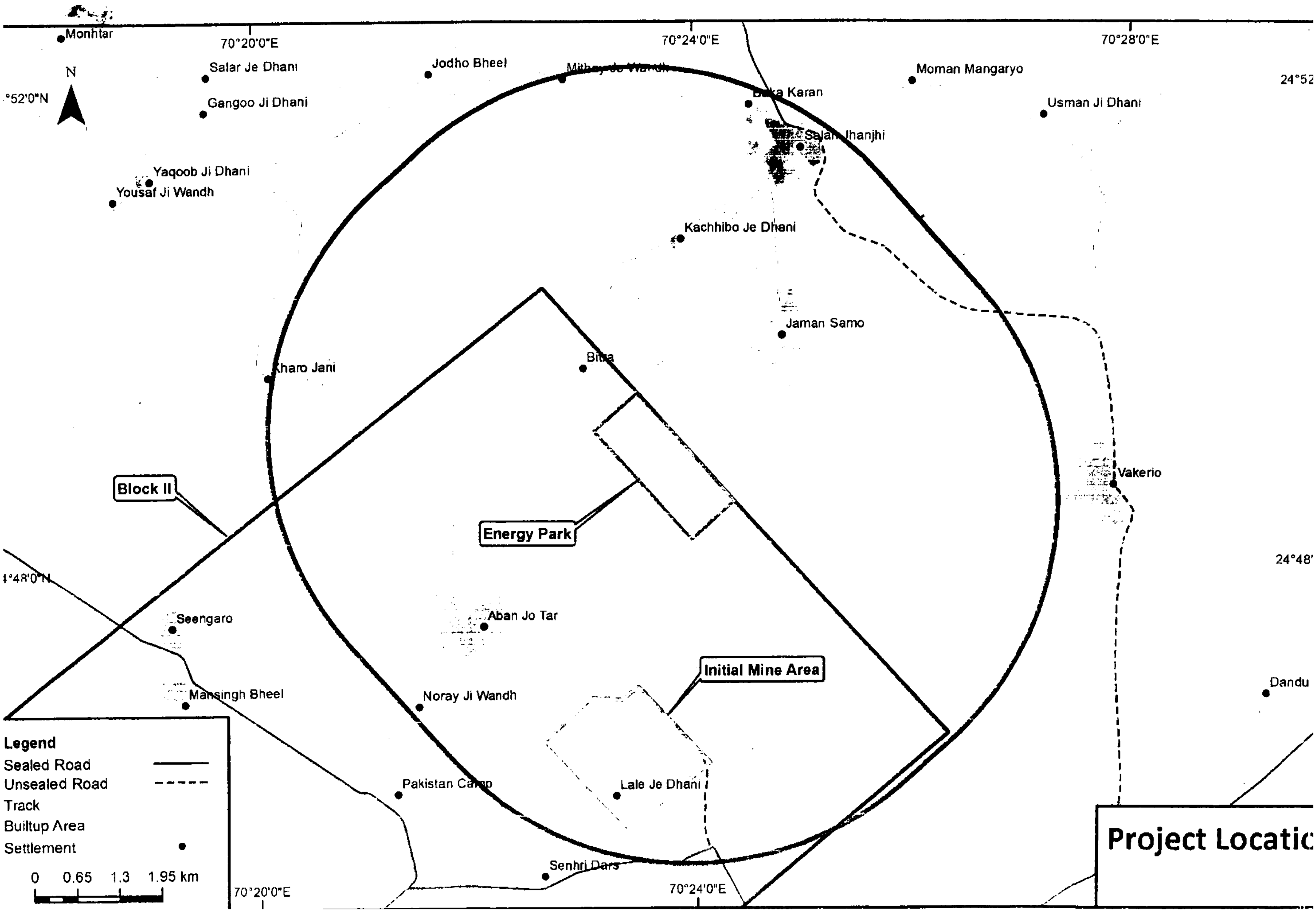
- Combustion takes place at relatively low temperatures when compared with pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these temperatures results in an effective suppression of NOx-formation.
- SO2 control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). The efficiency of the system will be more than 90%.
- 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 ppm at all loads when burning design coal.

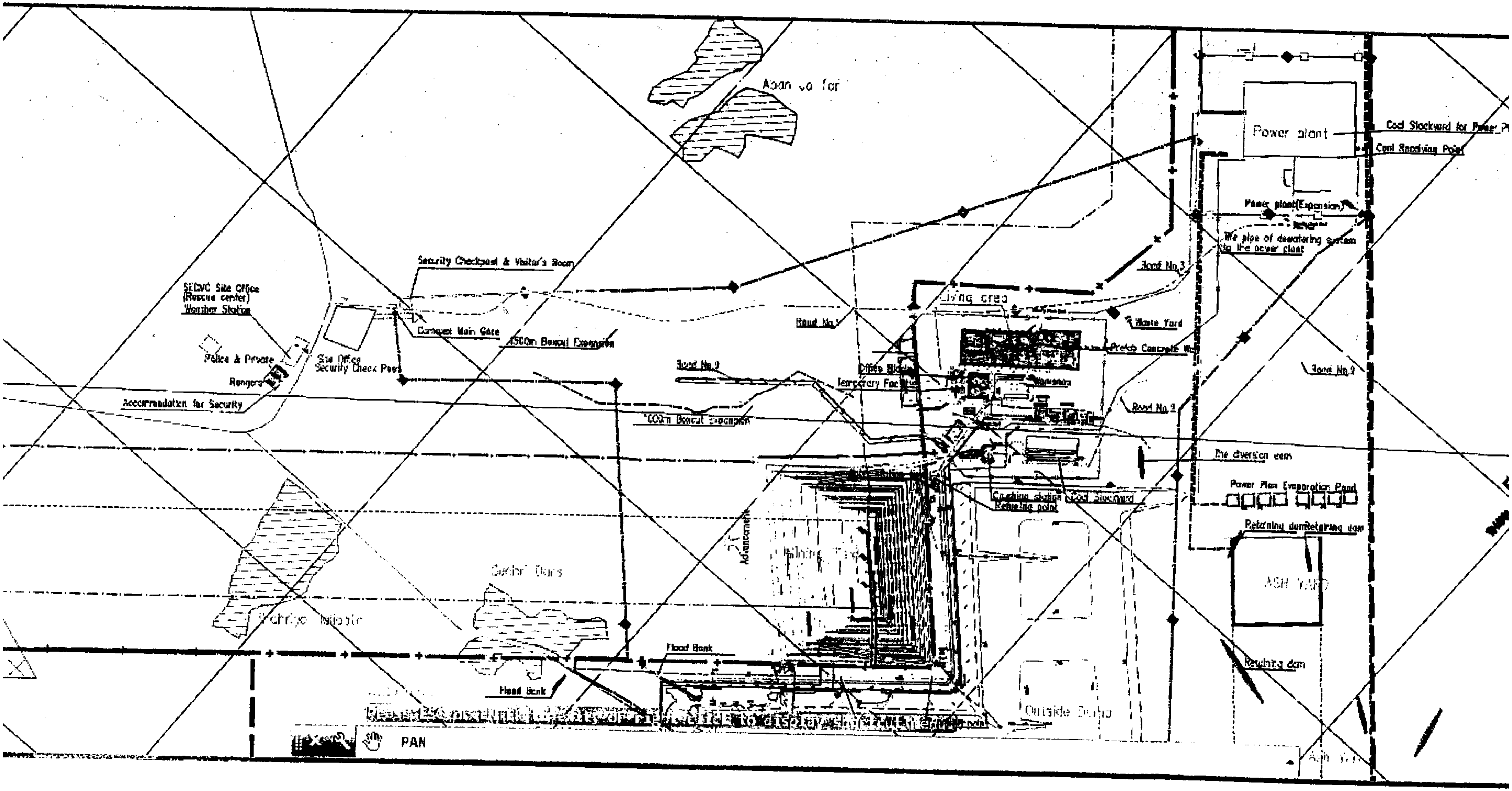
SCHEDULE-III

1. LOCATION MAPS, SITE MAPS, LAND


Kunri
Jhuddo
Mithi
Islamkot
Engro Coal Mines Thar Block II
US Dept of State Geographer
© 2015 Google
Image Landsat
Google earth



Monhtar
70°20'0"E
70°24'0"E
70°28'0"E
N
Salar Je Dhani
Jodho Bheel
Mithay Je Wandh
Moman Mangaryo
°52'0"N
Gangoo Ji Dhani
Buka Karan
Usman Ji Dhani
Salam Jhanjhi
Yaqoob Ji Dhani
Yousaf Ji Wandh
Kachhibo Je Dhani
Jaman Samo
Bitta
Kharo Jani
Vakerio
Block II
Energy Park
24°48'
°48'0"N
Seengaro
Aban Jo Tar
Initial Mine Area
Dandu
Mansingh Bheel
Noray Ji Wandh
Legend
Sealed Road
Unsealed Road
Track
Builtup Area
Settlement
Pakistan Camp
Lale Je Dhani
Project Locatic
0 0.65 1.3 1.95 km
Senhri Dars
70°20'0"E
70°24'0"E



Power plant
Coal Stockyard for Power Pl
Coal Receiving Point
Power plant(Expansion)
The pipe of dewatering system to the power plant
Road No.3
Living area
Waste Yard
Precast Concrete Wo
Road No.2
Road No.9
Security Checkpost & Visitor's Room
SECWC Site Office (Rescue center) Weather Station
Compound Main Gate
1500m Bowout Expansion
Police & Private
Site Office Security Check Post
Rangers
Accommodation for Security
Road No.9
Office Block
Temporary Facilities
Workshop
Road No.2
The diversion dam
Power Plan Evaporation Pond
Crushing station
Retaining point
Coal Stockyard
Retaining dam
Retaining dam
ASH YARD
Retaining dam
Flood Bank
Head Bank
Outside Dump
Mining Pit
Advancement
PAN

Land Details:

Land will be acquired in the designated power park area of Thar Block-II. The power plant will be based next to the existing EPTL power plant which has already achieved Financial Close and is in construction phase. The land will be leased from SECMC for a period of at least 30 years. The land size will be at least 115 acres or more in order to cater to future expansions as per the feasibility study.

2. TECHNOLOGY, SIZE OF PLANT, NUMBER OF UNITS

General Information			
i.	Name of Company	ThalNova Thar Power (Pvt.) Limited.	
ii.	Registered Business Office	Ground Floor G&T Tower, No. 18, Beaumont Road, Civil lines-10 Karachi	
iii.	Plant Location	The project site is located at Block-II of Thar coalfields. Thar Parker District, and eastern part of Sindh Province, Pakistan. Thar block II has total lignite reserves of 2 billion tons. It is 20 KM from City of Islamkot, near villages of Singharo-Bitra. The power project is located at 5 Km from Thar Block-II Open cast mine, near the village of Bitra.	
iv.	Type of Generation Facility	Mine mouth lignite fired power generation	

Plant Configuration			
i.	Plant size installed capacity	1x330 MW	
ii.	Type of technology	Subcritical parameters	
iii.	Number of Units/Size (MW)	1	330
iv.	Units Make/Model/Type & Year of Manufacture etc.	Boiler	Circulating Fluidized Bed (CFB) Boiler, with subcritical steam parameters
		Steam Turbine	Sub Critical ,Two Cylinder, Tandem compound , double exhaust ,one reheat , condensing turbine
		Generator	330 MW, an inner-cooled generator with rotor and stator core cooled by hydrogen, and stator winding cooled by water, horizontal shaft, cylindrical rotor, 20 KV,

			50Hz, 3-phase
v.	Commissioning/ Commercial operation date of the generation facility	Planned to be August, 2020	
vi.	Expected Useful Life of the Generation Facility from Commercial Operation/ Commissioning Date	30 Years	

3. FUEL: TYPE, IMPORTED/INDIGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Fuel/ Raw Material Details

i.	Primary Fuel	Thar Block II Lignite		
ii.	Alternative Fuel	Imported Indonesian coal		
iii.	Start-Up Fuel	HSD		
iv.	Fuel Source for each of the above (i.e. Imported/Indigenous)	The main fuel source is indigenous, produced from Thar Block II lignite mine, owned & operated by Sindh Engro Coal Mining company (SECMC)		
v.	Fuel Supplier for each of the above	Primary Fuel	Alternative Fuel	Start-Up Fuel
		SECMC / Thar Block II lignite mine	Imported from Indonesian Coal mines	PSO
vi.	Supply Arrangement for each of the above	Primary Fuel	Alternative Fuel	Start-Up Fuel
		SECMC / Thar Block II lignite mine	Imported from Indonesian Coal mines	PSO
vii.	No of Storage Bunkers/Tanks/Open Yard	Primary Fuel	Alternative Fuel	Start-Up Fuel
		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
viii.	Storage Capacity of each Bunkers/Tanks/ Open Yard	Primary Fuel	Alternative Fuel	Start-Up Fuel
		Approx. 195,000t	Approx. 195,000t	2x500m^3
ix.	Gross Storage	Primary Fuel	Alternative Fuel	Start-Up Fuel
		Approx. 360,000t	Approx. 360,000t	2x500m^3

4. EMISSION VALUES

Emission Values				
i.	SOx (mg/Nm^3)	<850	<850	<850
ii.	NOx (mg/Nm^3)	<510	<510	<510

As provided by Environmental and Social Impact Assessment Study done by HaglerBailly.

5. **COOLING WATER SOURCE: TUBE WELLS, SEA/RIVER/CANAL, DISTANCE FROM SOURCE, ETC.**

Cooling System		
i.	Cooling water Source	LBOD Water from GoS Scheme (primary source)
ii.	Secondary Source	Well water from mine (backup source)
iii.	Cycle	Close Cycle cooling system

9. PROJECT COMMENCEMENT AND COMPLETION SCHEDULE WITH MILESTONES

The construction of the Project will start in July-'17 and will be commissioned by the end of August '20. Detailed implementation schedule is given below.

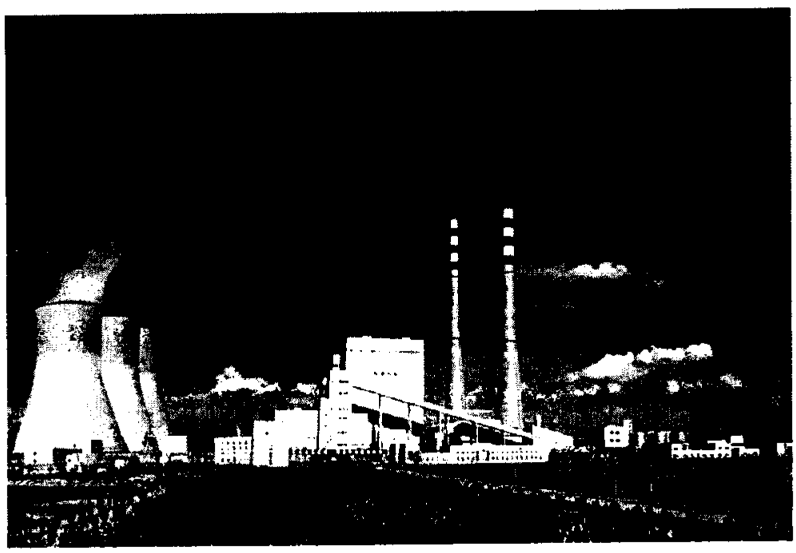
[illegible]

	Target Date
Proposal Submission	March-16
Formation of Project Company (JVC)	19-Apr-16
Notice to Proceed	13-May-16
Posting of LOI PG	27-May-16
Issuance of LOI by PPIB	2-Aug-16
Application of Generation License	10-Aug-16
Finalization of Power EPC	30-Sep-16
Application for Upfront Tariff Determination	11-Aug-16
Upfront Tariff by NEPRA	11-Oct-16
Posting of LOS PG	5-Nov-16
LOS	11-Nov-16
IA / PPA	15-Feb-17
Financial Close (9 months from LOS)	11-Aug-17
COD (36 months from FC)	11-Aug-20
Note: Sanctity of our project's timelines especially for the Financial Close and COD heavily dependent upon timely performance of GOP/GOS entities as well as Regulatory Authorities.	

Report No. PPI-195.1-Draft/16

INTERCONNECTION STUDY

For
330 MW Thal Nova Coal Fired Power Plant at Thar, Sindh



Draft Report
(June 2016)

POWER PLANNERS INTERNATIONAL

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax:+44-(0)208-9223219

Pakistan Office:
64-F/1, Wapda Town,
Lahore, Pakistan
Phone: +92-42-35968118;
Fax: + 92-42-35183166

Email: info@powerplannersint.com
www.powerplannersint.com

Executive Summary

- The Draft Report of interconnection of the 330 MW Thal Nova Coal Fired Power Plant with NTDC grid system is submitted herewith. The installed capacity of the plant would comprise of one coal fired unit of 330 MW which would deliver maximum net power of 300 MW to the grid.
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated. The network of Thal Nova Power Plant has been modeled at 500 kV.
- The system data of NTDC has been used as per permission granted by NTDC vide their letter no. ________________________ attached in Appendix-A.
- The nearest grid facility is Matiari 500 kV Convertor Station as shown in Sketch-1 in Appendix-B.
- Taking the location of Thal Nova Power Plant in consideration, the most feasible Interconnection scheme would be looping in-out one 500 kV circuit between Engro Coal Fired Power Plant and Matiari Convertor Station. The up-coming chapters discuss in detail the location and interconnection of the proposed Power Plant. A few approximate sketches are shown in Appendix-B.
- The two breaker bays of 500 kV at Thal Nova CFPP to connect with the 500 kV circuits each from Engro CFPP and Matiari-CS respectively will be required.
- In view of planned COD of the Thal Nova Power Plant in the Last quarter of 2019, the base case of studies have been assumed as of January 2020 because maximum power flow occurs on Southern grid of NTDC due to concentration of thermal power plants in the South. Therefore the above proposed interconnection have been tested for steady state conditions through detailed load flow studies for both peak and off-peak low water conditions of January 2020. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- In addition, peak high water condition of September 2020 has also been studied.
- Steady state analysis by load flow for peak and off-peak load of January 2020 September 2020 reveals that the proposed scheme is adequate to evacuate the maximum net power of 300 MW of the Plant under normal as well as contingency conditions.

- The short circuit analysis has been carried out to calculate maximum fault levels at Thal Nova Power Plant and the substations of 500 kV and 220 kV in its vicinity for the year 2020. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Thal Nova Power Plant.
- The short circuit level of the Thal Nova Power Plant 500 kV is 13.26 kA and 13.70 kA for 3-phase and 1-phase faults respectively for the year 2020. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 500 kV switchyard of Thal Nova Power Plant taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfill the NEPRA Grid Code requirements specified for 500 kV switchgear.
- The dynamic stability analysis of proposed interconnection has been carried out for the peak load case of Januray 2020. The stability check for the worst case of three phase fault right on the 500 kV bus bar of Thal Nova Power Plant followed by the final trip of one 500 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) as understood to be the normal fault clearing time of 500 kV protection system, and for fault clearing of 9 cycles (180 ms) in case of stuck breaker as specified in the Grid Code. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase occurring at Engro CFPP 500 kV bus bar and Matiari CFPP bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

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Appendices

Appendix –A:

- **NTDC Generation Program**
- **Transmission Expansion Plan**
- **NTDC Load Forecast**

Appendix –B: Sketches for Chapter-4

Appendix –C: Plotted Results of Load Flow for Chapter – 5

Appendix –D: Results of Short Circuit Analysis for Chapter – 6

Appendix –E: Plotted Results of Stability Analysis for Chapter – 7

Appendix –F: Generator Data Used for Stability Analysis

1. Introduction

1.1 Background

Thal Nova Power Plant is a coal fired power project which is located in Thar, Distance of about 5 km from the proposed location of Engro CFPP 500 kV Power Station of NTDC.

The electricity generated from this project would be supplied to the grid system of NTDC through 500 kV grid available in the vicinity of this project. The nearest grid facility is Matiari 500 kV Converter Station as shown in Sketch-1 in Appendix-B

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Thal Nova Power Plant and NTDC network, for stable and reliable evacuation of the electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives of this report are:

1. To develop scheme of interconnections at 500 kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.
3. To check if the contribution of fault current from this new plant increases the fault levels at the adjoining substations at 500 kV voltage levels to be within the rating of equipment of these substations, and also determine the short circuit ratings of the proposed equipment of the substation at Thal Nova Power Plant.
4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	± 5 %, Normal Operating Condition (+ 8 % is permitted for 500 kV only) ± 10 %, Contingency Conditions
Frequency	50 Hz Nominal 49.8 Hz to 50.2 Hz variation in steady state 49.4 - 50.5 Hz, Min/Max Contingency Freq. Band
Power Factor	0.8 to 0.85 Lagging; 0.9 to o.95 Leading

Short Circuit:

Substation Equipment Rating for 500 kV should be 40 kA or 50 kA (if desired)

Dynamic/Transient:

The system should revert back to normal condition after dying out of transients without loosing synchronism with good damping after permanent three-phase fault on any primary transmission element; including: transmission circuit, substation bus section, transformer, or circuit breaker. It is assumed that such a fault shall be cleared by the associated circuit breaker action in 5 cycles.

In case of failure of primary protection (stuck breaker case), the total fault clearing time from the instant of initiation of fault current to the complete interruption of current to isolate the faulted element, including the primary protection plus the backup protection to operate and isolate the fault, is equal to 180 ms (9 cycles).

2. Assumptions of Data

The number of generating units at Thal Nova Power Plant is one. Data of the Thal Nova Power Plant is provided by client and is attached in Appendix – F.

2.1 Thal Nova Power Plant data

Generator data:

Installed capacity of power plant = 330 MW

Net Generation to be Delivered to the Grid = 300 MW

Power factor = 0.8 lagging, 0.95 leading

Lump sum MVA capacity = 412.5 MVA

Combined Inertia Constant, H (Generator + Turbine) = 2.8564 MW-sec/MVA

Generating Voltage = 20 kV

Generator Step Up Transformer = 420 MVA

2.2 Network data

The 500 kV network in the area near Thal Nova Power Plant is as shown in Sketches in Appendix-A. The system data of NTDC has been used as attached in Appendix-A as per permission granted by NTDC vide their letter no. ______________________.

3. Study Approach and Methodology

3.1 Understanding of the Problem

Thal Nova Power Plant is a coal fired power project which is located in Thar, Distance of about 5 km from the proposed location of Engro CFPP 500 kV Power Station of NTDC.

Due to the location of Thal Nova Power Plant, the following scheme is proposed for the interconnection of the said plant with the 500 kV network of NTDC.

- Thal Nova Power Plant to be Looped In out of Engro CFPP to Matiari-CS 500 kV circuit using 500 kV Greeley Conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be about 5 km.

The adequacy of NTDC network of 500 kV in and around the proposed site of Thal Nova Power Plant has been investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for January 2020 after the commissioning of Thal Nova Power Plant by the last quarter of 2019, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year.
- Month of January 2020 has been selected for the study because it represents the maximum thermal dispatch conditions after the COD of Thal Nova Power Plant. Thus the loading on the lines in the vicinity of Thal Nova Power Plant will be maximum allowing us to judge the maximum impact of the plant on the transmission system in its vicinity.
- The proposed interconnection scheme has also been tested for the off-peak load conditions of January 2020.
- In addition to Peak and off-peak conditions of January 2020, system conditions have also been tested in High water condition of September 2020.

- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Perform technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme will be subjected to standard analysis such as load flow, short circuit, and transient stability study to check the adequacy of transmission network and strength of the machines for the proposed interconnection scheme under normal and disturbed conditions.
- Determine the relevant equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

4. Development of Scheme of Interconnection

4.1 The Existing and Ongoing Network

The existing 500 kV network available around Thal Nova Power Plant is shown in Sketch-1 in Appendix-B. Many thermal Power Plants are being installed in the Southern part of the country. The plants which will be in the system by September 2020 are:

- Port Qasim CFPP
- Engro CFPP
- Hub CFPP
- Shanghai Electric CFPP
- HUBCO CFPP

Power from all these power plants will be collected at Matiari-CS and will be transmitted to Lahore-CS via ± 600 kV Bi-pole HVDC Transmission Lines.

4.2 The Scheme of Interconnection of Thal Nova Power Plant

Keeping in view of the above mentioned 500 kV network available in the vicinity of the site of the Thal Nova Power Plant, two alternatives have been proposed for the interconnection of the said plant with the 500 kV network of NTDC. Both alternatives have been shown in Appendix B.

Due to the location of Thal Nova Power Plant, the following scheme is proposed for the interconnection of the said plant with the 500 kV network of NTDC.

- Thal Nova Power Plant to be Looped In out of Engro CFPP to Matiari-CS 500 kV circuit using 500 kV Greeley Conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be about 5 km.

5. Detailed Load Flow Studies

5.1 Base Case Load Flow January Peak 2020, Without Thal Nova Power Plant

A base case has been developed for the peak load of January 2020 using the network data of NTDC, after updating with latest load forecast and expansion plan of NTDC. Demand forecast obtained from NTDC have been incorporated into the base case.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises of 500 kV network around the proposed power plant including 500 kV Grid Stations of Matiari-CS, Lahore-CS, Jamshoro, Guddu-New, Moro, Dadu, Muzaffargarh and Multan etc.

The load flow results show that the power flows on all the circuits are within their normal rating. The voltage profile of these surrounding substations is also within normal limits.

For N-1 contingency conditions we have performed the simulation cases with results plotted as follows:

Exhibit 0.1	Engro CFPP to HUB CFPP 500 kV Single Circuit Out
Exhibit 0.2	Engro CFPP to Matiari-CS 500 kV Single Circuit Out
Exhibit 0.3	HUB CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 0.4	Port Qasim CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 0.5	Jamshoro to Matiari-CS 500kV Single Circuit Out
Exhibit 0.6	Matiari-CS to Lahore South-CS HVDC Single Circuit Out
Exhibit 0.7	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit 0.8	Matiari-CS to Dadu 500kV Single Circuit Out
Exhibit 0.9	Matiari-CS to Moro 500kV Single Circuit Out

We see that in all the cases the power flows on all circuits remain within their rated limits. Also the bus voltages are within the acceptable operating range.

5.2 Load Flow Peak January 2020 with Thal Nova Power Plant

Load flow studies have been carried out for January 2020 because it represents the maximum thermal dispatch conditions in the grid after the COD of Thal Nova Power Plant in the last quarter of 2020. Thus the loading on the lines in the vicinity of Thal

Nova Power Plant will be maximum, allowing us to judge the maximum impact of the plant on the transmission system in its vicinity. The results of Normal case of Peak January 2020 are plotted in Exhibit 1.0 shown in Appendix-C. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 1.1	Thal Nova CFPP to HUB CFPP 500 kV Single Circuit Out
Exhibit 1.2	Thal Nova CFPP to Engro CFPP 500 kV Single Circuit Out
Exhibit 1.3	Engro CFPP to Matiari-CS 500 kV Single Circuit Out
Exhibit 1.4	HUB CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 1.5	Port Qasim CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 1.6	Jamshoro to Matiari-CS 500kV Single Circuit Out
Exhibit 1.7	Matiari-CS to Lahore South-CS HVDC Single Circuit Out
Exhibit 1.8	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit 1.9	Matiari-CS to Dadu 500kV Single Circuit Out
Exhibit 1.10	Matiari-CS to Moro 500kV Single Circuit Out

5.3 Load Flow Off-Peak January 2020 with Thal Nova Power Plant

The results of Normal case of Off Peak January 2020 are plotted in Exhibit 2.0. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 2.1	Thal Nova CFPP to HUB CFPP 500 kV Single Circuit Out
Exhibit 2.2	Thal Nova CFPP to Engro CFPP 500 kV Single Circuit Out
Exhibit 2.3	Engro CFPP to Matiari-CS 500 kV Single Circuit Out
Exhibit 2.4	HUB CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 2.5	Port Qasim CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 2.6	Jamshoro to Matiari-CS 500kV Single Circuit Out
Exhibit 2.7	Matiari-CS to Lahore South-CS HVDC Single Circuit Out
Exhibit 2.8	Jamshoro to Dadu 500kV Single Circuit Out
Exhibit 2.9	Matiari-CS to Dadu 500kV Single Circuit Out
Exhibit 2.10	Matiari-CS to Moro 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.4 Load Flow Peak September 2020 with Thal Nova Power Plant

The results of Normal case of Peak September 2020 are plotted in Exhibit 3.0 for alternative-I. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

Exhibit 3.1	Thal Nova CFPP to HUB CFPP 500 kV Single Circuit Out
Exhibit 3.2	Thal Nova CFPP to Engro CFPP 500 kV Single Circuit Out
Exhibit 3.3	Engro CFPP to SECL CFPP 500 kV Single Circuit Out
Exhibit 3.4	SECL CFPP to Matiari-CS 500 kV Single Circuit Out
Exhibit 3.5	HUB CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 3.6	Port Qasim CFPP to Matiari-CS 500kV Single Circuit Out
Exhibit 3.7	Jamshoro to Matiari-CS 500kV Single Circuit Out

Exhibit 3.8 Matiari-CS to Lahore South-CS HVDC Single Circuit Out

Exhibit 3.9 Jamshoro to Dadu 500kV Single Circuit Out

Exhibit 3.10 Matiari-CS to Dadu 500kV Single Circuit Out

Exhibit 3.11 Matiari-CS to Moro 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.5 Conclusion of Load Flow Analysis

The proposed scheme for the interconnection of Thal Nova Power Plant has been tested under normal and contingency conditions for peak load and off-peak load conditions of January 2020. In all the normal and contingency cases, we find that the loading on the circuits remain within the rated capacity. Also the bus bar voltages are well within the permissible limits in all the normal and contingency events.

The proposed scheme has been further tested for High Water conditions of September, 2020 It is found that the loading on the circuits remain within the rated capacity and the bus bar voltages are well within the permissible limits in all the normal and contingency events.

The proposed scheme fulfils all the required criteria under normal and contingency conditions and recommended to be adopted.

6. Short Circuit Analysis

6.1 Methodology and Assumptions

The methodology of IEC 909 has been applied in all short circuit analyses in this report for which provision is available in the PSS/E software used for these studies.

The maximum fault currents have been calculated with the following assumptions under IEC 909:

- Set tap ratios to unity
- Set line charging to zero
- Set shunts to zero in positive sequence
- Desired voltage magnitude at bus bars set equal to 1.10 P.U. i.e. 10 % higher than nominal, which is the maximum permissible voltage under contingency condition.

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2019-20 i.e. all the generating units have been assumed on-bar in fault calculation's simulations.

The assumptions about the generator and the transformers data are the same as mentioned in Ch.2 of this report.

6.2 Fault Current Calculations without Thal Nova Power Plant

In order to assess the short circuit strength of the network of 500 kV without Thal Nova Power Plant, fault currents have been calculated for balanced three-phase and unbalanced single-phase short circuit conditions.. These levels will give us the idea of the fault levels without Thal Nova Power Plant and later on how much the contribution of fault current from Thal Nova Power Plant may add to the existing levels,.

The results are attached in Appendix – D.

The short circuit levels have been calculated and plotted on the bus bars of 500 kV of substations lying in the electrical vicinity of our area of interest i.e. Matiari-CS, Lahore-CS, Jamshoro, Guddu, Dadu, Moro, Guddu-New, Muzaffargarh, Multan and surrounding bus bars and are shown plotted in the Exhibit 4.0 attached in Appendix-

D. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

Table-6.1
Maximum Short Circuit Levels without Thal Nova Power Plant

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Engro-CFPP 500 kV	11.98	12.04
Hub-CFPP 500 kV	11.82	11.63
Matiari-CS 500 kV	27.06	22.37
Port Qasim-CFPP 500 kV	14.38	14.77
Lahore South-CS 500 kV	32.85	27.24
Jamshoro 500 kV	28.72	28.22
Dadu 500 kV	19.53	11.34
Moro 500 kV	15.34	7.31
Shikarpur 500 kV	18.84	12.61
R.Y Khan 500 kV	14.20	7.98
Guddu 500 kV	25.44	22.58
Guddu-New 500 kV	24.98	22.20
D.G.Khan 500 kV	14.65	9.43
M.Garh 500 kV	30.73	24.47
Multan 500 kV	32.32	23.84

The tabular output of the short circuit calculations is also attached in Appendix-D for the 500 kV bus bars of our interest i.e. the substations connecting in the 500 kV circuits lying close to Matiari-CS. The total maximum fault currents for 3-phase and 1-phase short circuit at these substations are summarized in Table 6.1. We see that the maximum fault currents do not exceed the short circuit ratings of the equipment at these 500 kV substations which normally are 40 kA for older substations and 50 kA for new substations.

6.3 Fault Current Calculations January 2020 with Thal Nova Power Plant interconnected

Fault currents have been calculated for the electrical interconnection proposed for base case of January 2020. Fault types applied are three phase and single-phase at 500 kV bus bars of Thal Nova Power Plant itself and other bus bars of the 500 kV substations in the electrical vicinity of Matiari-CS. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 5.0. Both 3-phase and 1-phase fault currents are indicated in the Exhibit which are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault currents are shown below the bus bar.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 500 kV bus bars of the network in the electrical vicinity of Thal Nova Power Plant are placed in Appendix-D. Brief summary of fault currents at significant bus bars of our interest are tabulated in Table 6.2.

Table-6.2

Maximum Short Circuit Levels with Thal Nova Power Plant – January 2020

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Thal Nova CFPP 500 kV	13.26	13.70
Engro-CFPP 500 kV	13.29	13.72
Hub-CFPP 500 kV	12.97	12.93
Matiari-CS 500 kV	27.73	22.75
Port Qasim-CFPP 500 kV	14.47	14.83
Lahore South-CS 500 kV	32.85	27.24
Jamshoro 500 kV	29.23	28.59
Dadu 500 kV	19.64	11.37
Moro 500 kV	15.43	7.32
Shikarpur 500 kV	18.88	12.62
R.Y Khan 500 kV	14.21	7.98
Guddu 500 kV	25.46	22.59
Guddu-New 500 kV	25.01	22.22
D.G.Khan 500 kV	14.66	9.43

M.Garh 500 kV	**30.74**	**24.47**
Multan 500 kV	**32.32**	**23.84**

Comparison of Tables 6.1 and 6.2 show slight increases in short circuit levels for three-phase and single- phase faults due to connection of Thal Nova Power Plant on the 500 kV bus bars in its vicinity. We find that even after some increase, these fault levels are below the rated short circuit values of the equipment installed on these substations.

6.4 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Thal Nova Power Plant there is no problem of violations of short circuit ratings of the already installed equipment on the 500 kV equipment of substations in the vicinity of Thal Nova Power Plant due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The maximum short circuit level of Thal Nova Power Plant 500 kV is 13.26 kA and 13.70 kA for 3-phase and 1-phase faults respectively. It would be advisable to go for standard size switchgear of short circuit rating of 40 kA. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

7. Dynamic Stability Analysis

7.1 Assumptions & Methodology

7.1.1 Dynamic Models

The assumptions about the generator and its parameters are the same as mentioned in Ch.2 of this report.

We have employed the generic dynamic models available in the PSS/E model library for dynamic modeling of the generator, exciter and the governor as follows;

Generator	GENROU
Excitation System	EXST1
Speed Governing System	TGOV1
Inertia Constant (Supplied by Client),	H = 2.8564 MW-sec/MVA

Also the dynamic model of Power System Stabilizer is used in the simulation to help the system stability. As the Thal Nova is connected on a radial end via a long Transmission line (250 km) with Matiari-CS. Therefore, to improve the damping after clearance of fault, stabilizer has been proposed.

7.1.2 System Conditions

The proposed scheme of looping In-out Thal Nova Power Plant to Matiari-CS and Engro-CFPP 500 kV S/C has been modeled in the dynamic simulation.

All the power plants of WAPDA/GENCOs and IPPs from Tarbela to Hub have been dynamically represented in the simulation model.

7.1.3 Presentation of Results

The plotted results of the simulations runs are placed in Appendix-E. Each simulation is run for its first one second for the steady state conditions of the system prior to fault or disturbance. This is to establish the pre fault/disturbance conditions of the network under study were smooth and steady. Post fault recovery has been monitored for nineteen seconds. Usually all the transients due to non-linearity die out within 2-3 seconds after disturbance is cleared in the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbance in the system. We have considered 3-phase fault in the closest vicinity of Thal Nova Power Plant i.e. right at the 500 kV bus bar of Thal Nova Power Plant substation, cleared in 5 cycles, as normal clearing time for 500 kV i.e. 100 ms, followed by a permanent trip of single 500 kV circuit emanating from the substation.

7.2 Dynamic Stability Simulations' Results January 2020 with Thal Nova Power Plant

7.2.1 Fault at 500 kV Near Thal Nova Power Plant

We applied three-phase fault on Thal Nova Power Plant 500 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 500 kV single circuit between Thal Nova Power Plant and HUB CFPP 500 kV substation. We monitored different quantities for one second pre-fault and nineteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 1.1 Bus Voltages

The bus voltages of 500 kV bus bars of Thal Nova Power Plant, Engro-CFPP, Hub CFPP, Port Qasim-CFPP, Matiari-CS and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see the system frequency recovers back to normal within a few seconds after fault clearance.

Fig. 1.3 MW/MVAR Output of Generator of Thal Nova Power Plant

The pre-fault output of Thal Nova Power Plant is 300 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 1.4 Speed and Mechanical Power of Generators at Thal Nova Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 1.5 MW Flow on Thal Nova Power Plant to Engro-CFPP 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Thal Nova Power Plant to Hub-CFPP causes the entire output of Thal Nova Power Plant to flow on the intact 500 kV circuit between Thal Nova Power Plant to Engro-CFPP. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 1.6 Rotor Angles

The rotor angles of the generators of Thal Nova Power Plant 500 kV, Hub-CFPP, Engro-CFPP, Port Qasim-CFPP and Jamshoro 500 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angle of Thal Nova Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.2 Fault at 500 kV Near Thal Nova Power Plant(Stuck Breaker)

We applied three-phase fault on Thal Nova Power Plant 500 kV bus bar, cleared fault in 9 cycles (100 ms) followed by trip of a 500 kV single circuit between Thal Nova Power Plant and HUB CFPP 500 kV substation. We monitored different quantities for one second pre-fault and nineteen seconds after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 2.1 Bus Voltages

The bus voltages of 500 kV bus bars of Thal Nova Power Plant, Engro-CFPP, Hub CFPP, Port Qasim-CFPP, Matiari-CS and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see the system frequency recovers back to normal within a few seconds after fault clearance.

Fig. 2.3 MW/MVAR Output of Generator of Thal Nova Power Plant

The pre-fault output of Thal Nova Power Plant is 300 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 2.4 Speed and Mechanical Power of Generators at Thal Nova Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 2.5 MW Flow on Thal Nova Power Plant to Engro-CFPP 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Thal Nova Power Plant to Hub-CFPP causes the entire output of Thal Nova Power Plant to flow on the intact 500 kV circuit between Thal Nova Power Plant to Engro-CFPP. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 2.6 Rotor Angles

The rotor angles of the generators of Thal Nova Power Plant 500 kV, Hub-CFPP, Engro-CFPP, Port Qasim-CFPP and Jamshoro 500 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angle of Thal Nova Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.3 Fault at 500 kV Engro-CFPP (Far-End Fault)

We applied three-phase fault on 500 kV bus bar of Engro-CFPP to study the impact of disturbance in the adjacent Power Plant on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 500 kV systems, followed by trip of 500 kV single circuit between Engro-CFPP to Matiari-CS. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 3.1 Bus Voltages

The bus voltages of 500 kV bus bars of Thal Nova Power Plant, Engro-CFPP, Hub CFPP, Port Qasim-CFPP, Matiari-CS and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see the system frequency recovers back to normal within a few seconds after fault clearance.

Fig. 3.3 MW/MVAR Output of Generator of Thal Nova Power Plant

The pre-fault output of Thal Nova Power Plant is 300 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 3.4 Speed and Mechanical Power of Generators at Thal Nova Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 3.5 MW Flow on Thal Nova Power Plant to Engro-CFPP 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Thal Nova Power Plant to Hub-CFPP causes the entire output of Thal Nova Power Plant to flow on the intact 500 kV circuit between Thal Nova Power Plant to Engro-CFPP. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 3.6 Rotor Angles

The rotor angles of the generators of Thal Nova Power Plant 500 kV, Hub-CFPP, Engro-CFPP, Port Qasim-CFPP and Jamshoro 500 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angle of Thal Nova Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.2.4 Fault at 500 kV Matiari-CS (Far-End Fault)

We applied three-phase fault on 500 kV bus bar of Matiari-CS to study the impact of disturbance in the adjacent Power Plant on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 500 kV systems, followed by trip of 500 kV single circuit between Engro-CFPP to Matiari-CS. We monitored different quantities for one second pre-fault and nine cycles after clearance of fault (post-fault) conditions and plotted the results attached in Appendix – E and discussed as follows;

Fig. 4.1 Bus Voltages

The bus voltages of 500 kV bus bars of Thal Nova Power Plant, Engro-CFPP, Hub CFPP, Port Qasim-CFPP, Matiari-CS and Jamshoro are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see the system frequency recovers back to normal within a few seconds after fault clearance.

Fig. 4.3 MW/MVAR Output of Generator of Thal Nova Power Plant

The pre-fault output of Thal Nova Power Plant is 300 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

Fig. 4.4 Speed and Mechanical Power of Generators at Thal Nova Power Plant

The speed deviation of the generator, after clearing fault, damps down quickly returning to normal speed as of before fault. The transients in mechanical power also damp quickly and settle to a new equilibrium.

Fig. 4.5 MW Flow on Thal Nova Power Plant to Engro-CFPP 500 kV circuit

Followed by clearing of fault, the trip of a 500 kV single circuit from Thal Nova Power Plant to Hub-CFPP causes the entire output of Thal Nova Power Plant to flow on the intact 500 kV circuit between Thal Nova Power Plant to Engro-CFPP. We plotted the flows of MW and MVAR on this intact circuit and see that the power flows on this circuit attains to steady state level with power swings damping down fast.

Fig. 4.6 Rotor Angles

The rotor angles of the generators of Thal Nova Power Plant 500 kV, Hub-CFPP, Engro-CFPP, Port Qasim-CFPP and Jamshoro 500 kV are plotted relative to machines at Guddu-New 500 kV. The results show that the rotor angle of Thal Nova Power Plant gets back after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is strongly stable and very strong in damping the post fault oscillations.

7.3 Conclusion of Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed scheme for the severest possible faults of 500 kV systems near to and far of Thal Nova Power Plant. Therefore there is no problem of dynamic stability for interconnection of Thal Nova Power Plant; it fulfills all the criteria of dynamic stability.

8. Conclusions

- The proposed plant is going to be connected to the nearest grid facility of NTDC which is Matiari 500 kV Converter Station.
- Taking the location of Thal Nova Power Plant in consideration, the most feasible Interconnection scheme would be looping in-out one 500 kV circuit between Engro Coal Fired Power Plant and Matiari Convertor Station. The up-coming chapters discuss in detail the location and interconnection of the proposed Power Plant. A few approximate sketches are shown in Appendix-B.
- The two breaker bays of 500 kV at Thal Nova CFPP to connect with the 500 kV circuits each from Engro CFPP and Matiari-CS respectively will be required.
- In view of planned COD of the Thal Nova Power Plant in the Last quarter of 2019, the base case of studies have been assumed as of January 2020 because maximum power flow occurs on Southern grid of NTDC due to concentration of thermal power plants in the South. Therefore the above proposed interconnection have been tested for steady state conditions through detailed load flow studies for both peak and off-peak low water conditions of January 2020. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- In addition, peak high water condition of September 2020 has also been studied.
- Steady state analysis by load flow for peak and off-peak load of January 2020 September 2020 reveals that the proposed scheme is adequate to evacuate the maximum net power of 300 MW of the Plant under normal as well as contingency conditions.
- The short circuit analysis has been carried out to calculate maximum fault levels at Thal Nova Power Plant and the substations of 500 kV and 220 kV in its vicinity for the year 2020. We find that the fault currents for the proposed scheme are within the rated short circuit capacities of switchgear installed at these substations. There are no violations of exceeding the rating of the equipment due to contribution of fault current from Thal Nova Power Plant.
- The short circuit level of the Thal Nova Power Plant 500 kV is 13.26 kA and 13.70 kA for 3-phase and 1-phase faults respectively for the year 2020. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to

be installed at 500 kV switchyard of Thal Nova Power Plant taking care of any future generation additions and system reinforcements in its electrical vicinity and also fulfill the NEPRA Grid Code requirements specified for 500 kV switchgear.

- The dynamic stability analysis of proposed interconnection has been carried out for the peak load case of Januray 2020. The stability check for the worst case of three phase fault right on the 500 kV bus bar of Thal Nova Power Plant followed by the final trip of one 500 kV circuit emanating from this substation, has been performed for fault clearing of 5 (100 ms) as understood to be the normal fault clearing time of 500 kV protection system, and for fault clearing of 9 cycles (180 ms) in case of stuck breaker as specified in the Grid Code. The system is found strong enough to stay stable and recovered with fast damping. The stability of system for far end faults of 3-phase occurring at Engro CFPP 500 kV bus bar and Matiari CFPP bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults for the most stringent cases.
- The proposed scheme of interconnection has no technical constraints or problems, it fulfills all the criteria of reliability and stability under steady state load flow, contingency load flows, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

Hagler Bailly Pakistan

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

Environmental and Social Impact Assessment

Final Report

HBP Ref.: R6V02HOH

July 13, 2016

ThalNova Power Thar (Private) Limited.

Karachi

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Executive Summary

ThalNova Power Thar (Private) Ltd. (TNPTL) plans to establish a 330 megawatt (MW) Thar Lignite Coal-based Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh.

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (**Exhibit I**), however, currently the exploration and development work is being carried out in less than half of the blocks.

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of the about 2 km^2 (500 acres) and is expected to contain six power plants, with a combined power generation capacity of about 4,000 MW.

The Proposed Project

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District in Sindh, as shown in **Exhibit II.**

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

- 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.
- 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%.
- 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 ppm at all loads when burning design coal.

Exhibit I: Project Location within the Thar Coalfields

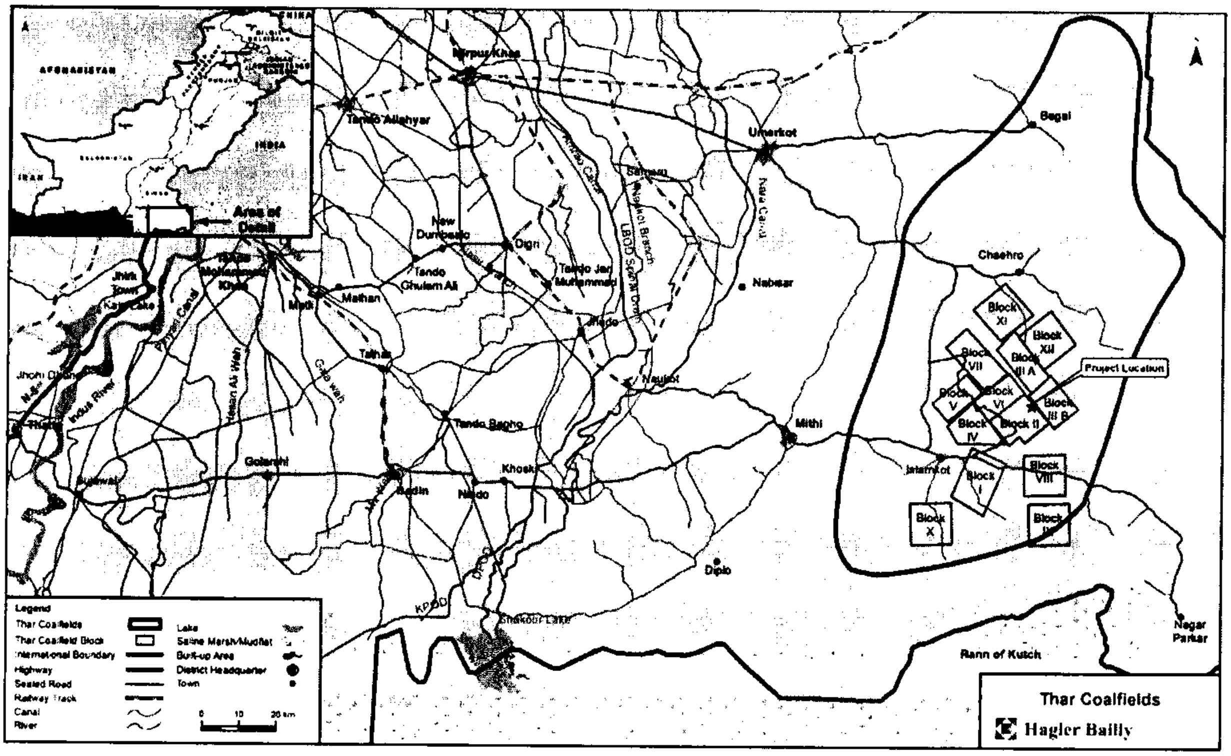
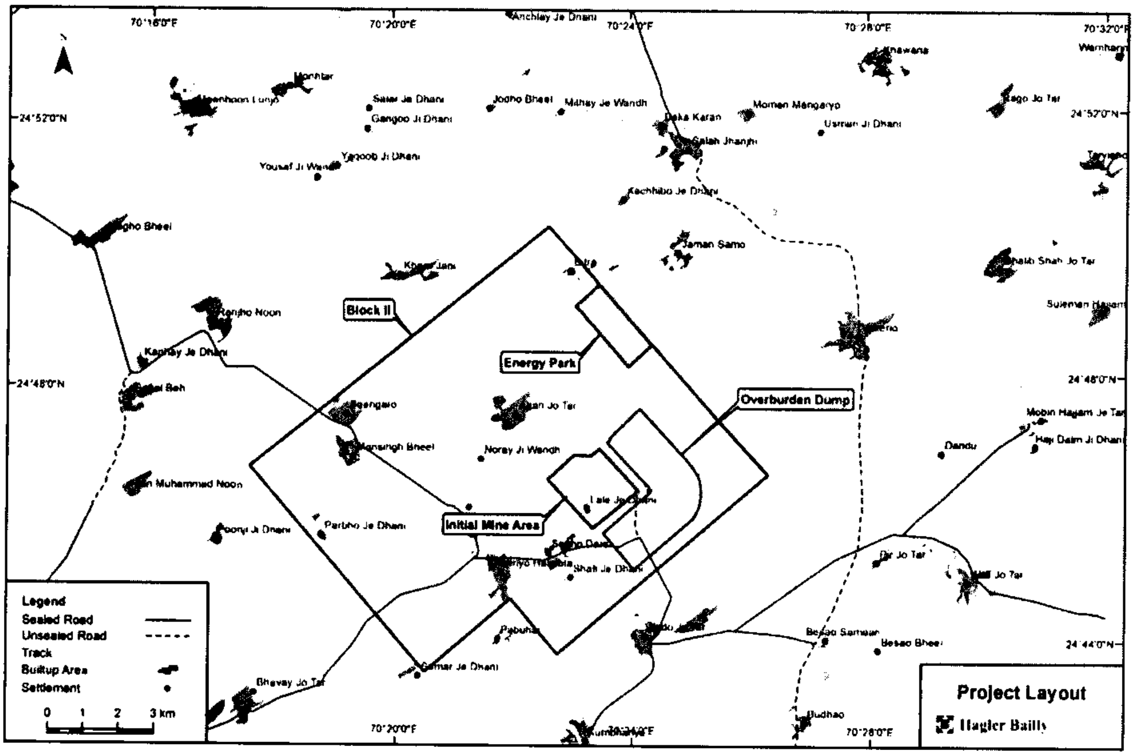


Exhibit II: Project Layout



Coal Consumption

The main fuel for the power plant will be Thar Coal from Block II mine. Based on the net calorific value and plant capacity, approximately 250 tons per hour will be required, for a total of 1.9 million tons per year.

Water Consumption

The anticipated power plant normal demand for water is between 1,200 to 1400 m^3/h. Of the required makeup water approximately 40% goes towards evaporation losses and 40% goes towards discharge of pre desalting water station.

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD) [1] towards the Thar Coalfields. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts not evaluated as part of this ESIA.

Waste Disposal

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

Ash will be stored temporarily on the power plant site until it is transported to the mine area (see **Exhibit II**) for final disposal. 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.

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. 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 drainage and waste water effluent channel being prepared by the Government of Pakistan (GoP).

Main gaseous emissions of concern from the coal power Project include sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) along with particulate matter emissions (PM_{10} and $PM_{2.5}$, which refers to particulate matter less than 10 and 2.5 microns respectively are

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[1] 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).

pollutants of health concern). The release and dispersion of these pollutants is discussed in detail in later sections.

Description of the Environment

The Study Area selected for the EIA includes sensitive receptors that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it

A detailed description of the existing environment, including the physical, ecological and socioeconomic baseline conditions, is described in the report. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic.

Topography, Geology and Seismic Hazards

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. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (amsl). The entire surface of the Study Area is covered by aeolian sands of the Quaternary. The Thar Desert lies at the north-western corner of the Indian Plate.

The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi. Based on the Global Seismic Hazard Assessment Program (GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 m/s^2.

Climate

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.

Air Quality

Ambient air quality is established using both primary and secondary data. **Exhibit III** presents the current pollutant levels of the Study Area that are established based on measured data. Expected activities near the Study Area, that may influence the air quality baseline of the Project are shown in **Exhibit IV** The influence of these developments were modelled and the expected baseline ambient air quality conditions present at the time of operation of the proposed Project are shown in and **Exhibit V**. Contour maps that show the spatial distribution of the expected baseline of the Project are provided in the report.

Exhibit III: Baseline Ambient Air Quality in the Study Area ($\mu g/m^3$)

	NO_2	SO_2	PM_{10}	$PM_{2.5}$
Baseline Levels	*3 ± 3*	*7 ± 6*	*140 ± 170*[2]	*30 ± 40*
SEQS (annual)	40	80	120	40
SEQS (24-hour)	80	120	150	75
IFC EHS (annual)	40	-	70[a]	35[a]
IFC EHS (24-hour)	-	125	150	75

Exhibit IV: Approved Developments

Block No.	*Coal Mine*	*Power Plant*	*Source*
Block II	6.5 mpta	660 MW	ESIA of Block II Mining Project[3] ESIA of Block II Power Plant Project[4]
Block VI	2.5 mpta	-	ESIA of Block VI Mining Project[5]

2 The standard deviation is 93 μg/m³ when the reading of 780 μg/m³ is removed. The reading of 780 μg/m³ is 5 times the median value and is likely a low occurring outlier.

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

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

5 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 V: Simulated Baseline Results (μg/m³)

Pollutant	Averaging Period	Measured Baseline	Modeled Increment	Simulated Baseline	SEQS	IFC EHS limits
SO_2	24-hour Max	7.4	22.4	29.4	120	125
	Annual Average		6.4	13.4	80	-
NO_2	24-hour Max	3.3	14.6	17.6	80	-
	Annual Average		4.2	7.2	40	40
PM_{10}	24-hour Max	140	133.534	273.534	150	150
	Annual Average		8.417	148.417	120	70
$PM_{2.5}$	24-hour Max	30	12.498	42.498	75	75
	Annual Average		1.185	31.185	40	35

The following conclusions can be drawn:

- The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits.
- The 24-hour PM_{10} concentrations exceed both SEQS and IFC EHS at 28% of the area (195 km² out of total area of 700 km²).
- The annual PM_{10} concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average.
- The 24-hour and annual concentrations of $PM_{2.5}$ complies with both SEQS and IFC EHS limits.

Sound Levels

Baseline sound levels were established using primary data collected for this Study and data available from secondary sources. The resulting baseline sound levels are shown in **Exhibit VI.** The sound levels are generally low and comply with limits.

Exhibit VI: 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

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[6]. 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
- deep aquifer (Deep Aquifer or Bottom Aquifer) of marine sands belonging to the bottom part of the Bara Formation.

Ecological Baseline

The ecological baseline includes nearby protected areas, habitat types and ecological resources. The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief varies between near sea level to more than 150 meters. The topography is defined by sand dunes which are mostly longitudinal, forming a NE-SW trend. They are stabilized by shrubs and grass. Alluvial soil brought down by rain water, is deposited in depressions within the inter-dunal valleys. The vegetation is desertic and semi-desertic.

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.[7]

Detailed descriptions of the flora and fauna of the Study Area are presented in the report. Based on the information collected key aspects for each ecological resource are provided below:

- Vegetation – there are no plant species of conservation importance in the Study Area, based on the IUCN Red List or under the Pakistan legislation. The only plant species included in the CITES Species List is Leafless Milk Hedge (Thor) *Euphorbia caducifolia* that is included in Appendix II.[8] It is a major species in

6 Bender, 1995, Geology of Pakistan

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

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

rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[9].

- Mammals – there are no mammal species are of conservation importance in the Study Area based on the IUCN Red List of Threatened Species. Some of the mammal species found in the Study Area are on Pakistan's Mammals National Red List. However, their distribution is widespread and not limited to the Study Area.
- Birds – the main concern is with respect to vulture species including the Oriental White-backed Vulture listed as Critically Endangered and the Egyptian Vulture listed as Endangered according to the IUCN Red List. Another bird species of conservation importance is the Laggar Falcon listed as Near Threatened according to the IUCN Red List.
- Herpetofauna – there is discrepancy in the references for endemism, however, there is at least one endemic reptile species, the Cholistan Desert Lacerta, and possibly two more endemic species, including the Red-throated Ground Agama and the Sindhi Krait. However, their distribution 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.

Socioeconomic Baseline

There are ten villages in the Study Area. The population of the area is estimated to be a little over 6,000 individuals. These villages and their relative populations are shown in **Exhibit VII**.

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.

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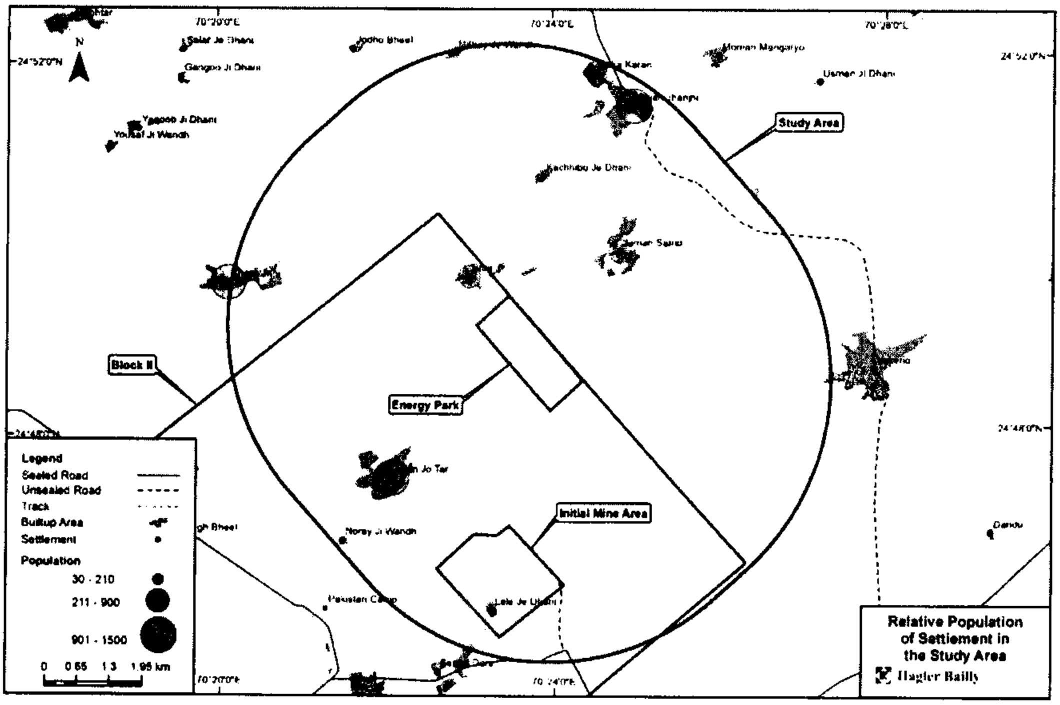
9 LLifle, Encyclopedias of living forms, The Encyclopedia of Succulents, *Euphorbia caducifolia*, <http://www.llifle.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/28041/Euphorbia_caducifolia>, accessed December 18, 2015

Exhibit VII: Population Distribution in the Study Area [10]



[10] 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 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.

Ethnology and Religion

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes.

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

Governance

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.

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.

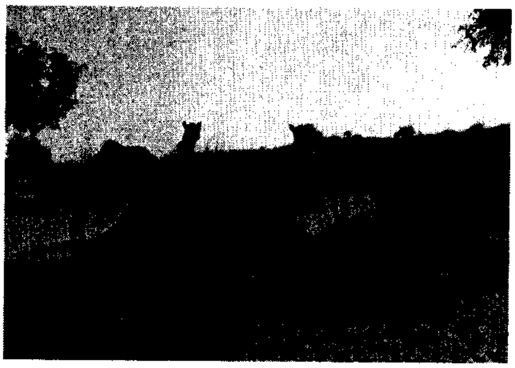
Livelihoods and the Local Economy

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. Images of livestock are shown in **Exhibit VIII**. 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.

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.

Exhibit VIII: Typical images of Livestock



Camels

Livestock use roads to access grazing areas.

Physical Infrastructure

The area has a weak infrastructure when compared to other districts provincially and nationally

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.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 census reported that only 6.75% of the housing units were using electricity in Tharparkar.

Social Infrastructure

Literacy[11] 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.

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.

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

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11 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."

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.

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. The Thakurs, first cremate their dead and the ashes are buried.

Public Consultation and Disclosure

Community consultations were conducted with the community members for all 10 settlements within the Study Area. Separate consultation sessions were arranged for the community women. Institutions identified as important stakeholders were also consulted. A combined list of stakeholders which were consulted for the Project is given in **Exhibit IX**. Key concerns raised by the stakeholders and complete logs of the consultations are presented in the report.

Exhibit IX: List of Consulted Stakeholders

No	*Stakeholder Group*	*Stakeholders*	*Date of Consultation*
1.	Villages within the Study Area	Baka Karan, Salah Jhanjhi,Kachhibo Je Dhani, Jaman Samo, Bitra, Mithay Je Wandh, Kharo Jani, Aban Jo Tar, Noray Ji Wandh and Lale Ji Dhani	May 12, to May 25, 2016
2.	NGOs	Participatory Village Development Programme, Baanhn Beli, Sukar Foundation, Social Welfare, National Commission For Human Development	May 24, to May 25, 2016
3.	Government	Assistant Commissioner Islamkot	May 24, 2016
4.	Civil Society	Press Club, Thar Coal Action Board	May 24, to May 25, 2016
5.	Other Developers in the Area	The Hub Power Company Limited	May 23, 2016

Project Impacts and Mitigation Measures

Impacts for the construction and operation of the Projects are discussed in detail in the report. This is followed by a cumulative impact assessment of the expected coal mines and power plants in the area.

Impacts to Air Quality

Impacts to air quality can be assessed by comparing impacts to standards for stack emissions and to standards for ambient air quality.

Stack Emissions

The Project will be compliant with both SEQS and IFC guidelines for coal power plant emissions as shown in **Exhibit X**. The relevant IFC air quality guidelines are in bold.

Exhibit X: Compliance with SEQS and IFC Emission Standards for Coal Fired Power Plants

Parameter	*SEQS*	*IFC Guidelines*	*Project Emissions*	*Status*
Sulfur Dioxide	100 - 500 Tons per day	**For NDA: 900-1500 mg/Nm^3** For DA: 400 mg/Nm^3	17 tons per day or 584 mg/Nm^3	Compliant
Oxides of nitrogen	For lignite fossil coal: 260 ng/J of heat input	**For NDA: 510 mg/Nm^3** For DA: 200 mg/Nm^3	168 ng/J of heat input 381 mg/m^3	Compliant
Particulate matter	500 mg/Nm^3	For NDA: 50 mg/Nm^3 **For DA: 30 mg/Nm^3**	23 mg/Nm^3	Compliant

Ambient Air Quality

As there are a number of existing, planned, 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 XI** and the results provided in **Exhibit XII**.

Exhibit XI: Gaseous Emission Sources and their Assessment

Additional Sources	*Approach*	*Section*
Existing Natural Biomass Burning Traffic	Measured Baseline Measured	**Section 4.3.6**
Planned Projects 2x330 MW Plant, Block II Block II Coal Mine Block VI Coal Mine	Simulated Baseline Modelled + Measured	**Section 4.3.6**
Proposed 330 MW Plant 1x330 MW Plant, Block II	Impact of Proposed Plant Incremental Impact of Proposed Plant + Simulated Baseline	**Section 6.3.2**
Second 330 MW Plant being developed Simultaneously 1x330 MW Plant, Block II	Impact of Second Plant Incremental Impact of Second Plant + Impact of Proposed Plant	**Section 6.3.2**
Future Developments 2640 MW Plants, Block II 1320 MW Plants, Block III 330 MW Plant, Block VI Block III Coal Mine	Cumulative Impact Incremental Impact of Future Developments + Impact of Second Plant	**Section 6.4.1**

Dispersion modelling was used to quantify the impact of air pollutants on nearby sensitive receptors. The United States Environmental Protection Agency approved regulatory air quality model AERMOD was used to model dispersion of the total pollutant loads. Details of the assumptions and model inputs are given in the report.

Exhibit XII: Predicted Results (µg/m^3)

Pollutant	*Averaging Period*	*Simulated Combined Baseline*	*Impact of Proposed 1x330 MW Plant*		*Impact of Additional 1x330 MW Plant*		*SEQS*	*IFC EHS limits*
			Increment	Ambient	Increment	Ambient		
SO_2	24-hour Max	29.4	8.4	37.8	17.7	47.1	120	125
	Annual Avg.	13.4	2.9	16.3	5.6	18.9	80	-
NO_2	24-hour Max	17.6	5.5	23.1	11.5	29.1	80	-
	Annual Avg.	7.2	1.9	9.1	3.6	10.8	40	40
PM_{10}	24-hour Max	273.534	0.006	273.540	0.013	273.546	150	150
	Annual Avg.	148.417	0.011	148.429	0.023	148.441	120	70
$PM_{2.5}$	24-hour Max	42.498	0.004	42.502	0.003	42.506	75	75
	Annual Avg.	31.185	0.005	31.189	0.009	31.194	40	35

The following conclusions can be drawn:

Incremental Impact of SO_2 and NO_2 Emission

The 24-hour and annual concentrations of SO_2 and NO_2 will increase due to the proposed Plant (**Exhibit XII**). However, the increase will be less than 10 µg/m^3 in all cases (SO_2 and NO_2, annual and 24-hour). The impact of the second plant will be similar.

SO_2 and NO_2 Concentration after the Proposed Plant

The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits. This is true for the proposed Plant as well the second Plant.

Incremental impact on PM_{10} and $PM_{2.5}$ Concentrations

There is no significant impact of proposed plant on PM_{10} and $PM_{2.5}$ concentrations. The reason is as the plant is using electrostatic precipitators with 99.9% efficiency that captures almost particulate matter of each size and leaves a minute amount of particulate matter in flue gas. As can be seen from **Exhibit XII**, the net increase even after both plant are operational will be less than 1 µg/m^3.

PM_{10} and $PM_{2.5}$ Concentration after the Proposed Plant

The ambient 24-hour and annual PM_{10} concentrations exceed both the SEQS in a large area. The 24-hour $PM_{2.5}$ concentration complies with both SEQS limits but is relatively high. This is primarily due to the natural causes.

The air quality management of an area is the responsibility of SEPA under the Sindh Act. It is proposed that SEPA, working with the developers in Thar Coalfields, develop an ambient air quality management plan to mitigate the high concentration of natural dust in the area.

Impacts to Socioeconomic Environment

Impacts to the socioeconomic environment are summarized below and described in detail along with the proposed mitigation measures in the report:

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.

Increased Power Generation

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.

In-Migration

The increased job opportunities offered by the Project and by service providers to the Project will lead to an influx of job seekers in the Study Area. The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing facilities. The migrants can also effect the culture of the Study Area. This can possibly generate conflict between locals and the in-migrants. Mitigation measures to avoid this are detailed in the report.

Impacts to Ecology

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.

The vulture population in the Indian subcontinent is declining due to existing threats to it. A major cause is presumably poisoning by the veterinary drug Diclofenac, probably combined with other causes (Bird Life International 2010)[12]. 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 vicinity of the Energy Park 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.

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[12] BirdLife International 2010. Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 27/6/2010.

Environmental Management Plan

The Environmental Management Plan (EMP) is the fundamental tool that ensures that all mitigation measures to reduce the impacts of the Project discussed in **Chapter 6** 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.

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.

Analysis of Alternatives

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

Conclusion

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.

1. Introduction

ThalNova Power Thar (Private) Ltd. (TNPTL) plans to establish a 330 megawatt (MW) Thar Lignite Coal-based Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh.

This document identifies basic settings and design of the proposed project, prevalent national and international laws, regulations, physical, ecological and socioeconomic baseline conditions and assesses the environmental impact of the proposed Project. In accordance with the environmental regulations of Sindh, the results are presented as an Environmental Impact Assessment (EIA) for submission to the Sindh Environmental Protection Agency (SEPA) for review and grant of environmental approval.

TNPTL acquired the services of Hagler Bailly Pakistan (Pvt.) Ltd. (HBP) to undertake the EIA study.

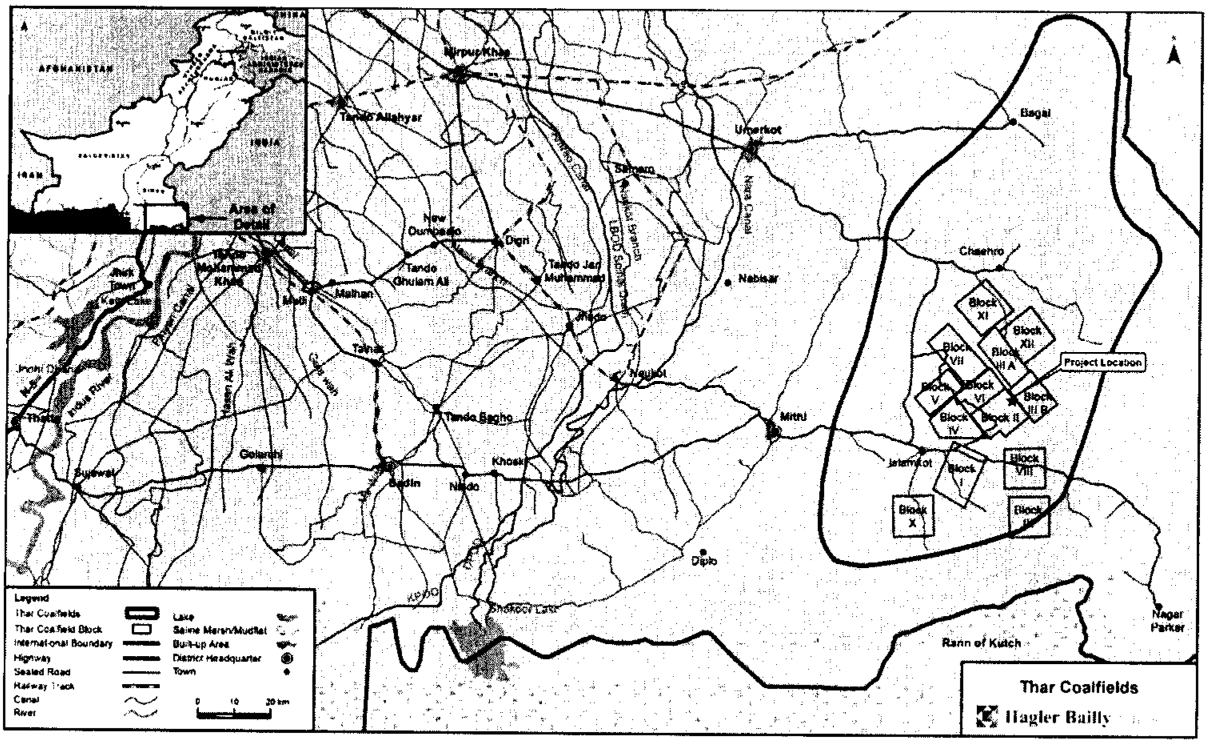
1.1 Project Setting

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (**Exhibit 1.1**), however, currently the exploration and development work is being carried out in less than half of the blocks.

Sindh Coal Authority (SCA) has awarded a 95.5 square kilometer (km^2) area of the coalfield, known as Thar Block II ('Block II'), to Sindh Engro Coal Mining Company (SECMC), which is jointly owned by the GoS and the Engro PowerGen Limited.

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of the about 2 km^2 (500 acres) and is expected to contain six power plants, with a combined power generation capacity of about 4,000 MW.

Exhibit 1.1: Project Location within the Thar Coalfields



1.2 Introduction to the EIA Study

This EIA 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 needed, reference is also made to the International Finance Corporation's (IFC) Performance Standards (PS)[13] and Environmental, Health, and Safety Guidelines.[14] The guidelines provided by these documents are considered as the best industry practice in environment.

1.2.1 Objectives of the EIA

The objectives of EIA are to:

- Assess the existing environmental 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.
- 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.
- Assess the proposed Project activities and determine whether they comply with the relevant environmental regulations of Pakistan.

The findings of the EIA have been documented in the form of this report which is to be submitted to the SEPA as per regulatory requirements.

1.2.2 Scope of the EIA

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

- Construction activities 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 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.

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

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

1.3 Exclusion from Scope of the EIA

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

- The mining of coal and all associated activities: This is covered in the ESIA of Block II which is already approved;
- Sourcing and transport of water to the Plant: This is in the scope of the GoS and is subject of a separate environmental assessment;
- Ultimate disposal of wastewater and ash from the power plant: This is in the scope of the GoS and is subject of a separate environmental assessment;
- Evacuation of power: This is in the scope of the National Transmission and Despatch Company and is subject of a separate environmental assessment; and
- Acquisition of land or resettlement for the power plant site: This is covered in the ESIA of Block II which is already approved.

1.4 Organization of this Report

The EIA report is organized in the following sections:

Section 1 (*Introduction*) provides an overview of the project, introducing the project proponent, and outlines the scope of this study.

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

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

Section 4 (*Description of the Environment*) documents in detail the existing physical, ecological and socioeconomic conditions around the Project site.

Section 5 (*Public Consultation and Disclosure*) presents the objectives and outcomes of the public stakeholder consultations that were conducted during the EIA.

Section 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.

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

Section 8 (*Analysis of Alternatives*) discusses alternatives to the proposed Project that were considered.

Section 9 (*Conclusion*) summarizes the findings and recommendations of this EIA study and concludes the report

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.[15] 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.

[15] 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[16] 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 EIA.

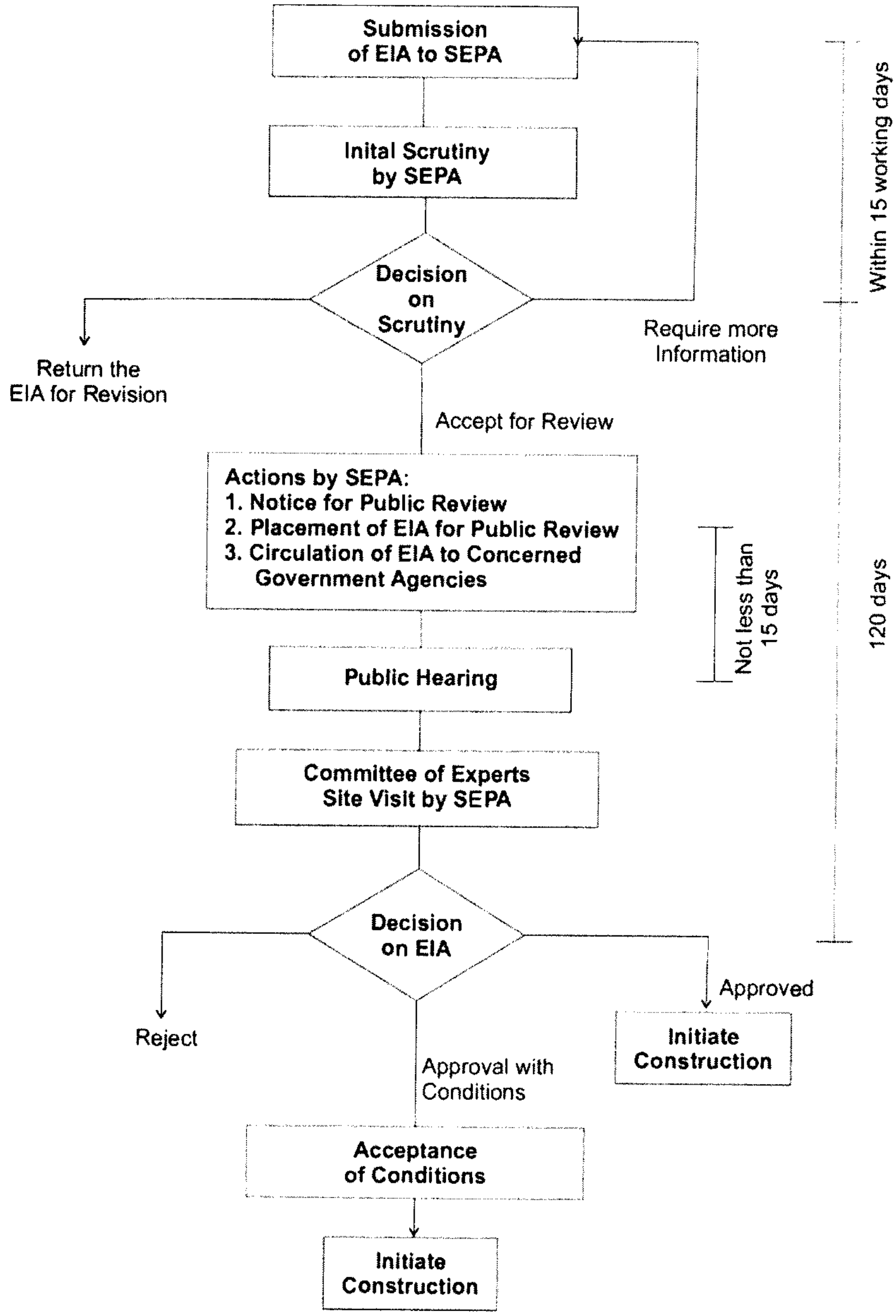
Regulation 9 of the IEE-EIA Regulations 2014 requires that '(1) Ten paper copies and two electronic copies of an IEE or EIA shall be filed with the Federal Agency; (2) Every IEE and EIA shall be accompanied by (a) an application, in the form set out in Schedule V; (b) copy of receipt showing payment 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.

[16] 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

2.5.1 World Bank/IFC Environmental, Health and Safety Guidelines for Thermal Power Plants 2008

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

2.6.1 Sindh Government Institutions

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, and SEQS for ambient air quality. The environmental standards applicable in Sindh are NEQS as developed by Pakistan Environmental Protection Agency prior to 18th Amendment. The only exception is the ambient air quality standards which Sindh Environmental Protection Agency has notified separately. In **Exhibit 2.3** and **Exhibit 2.4**, comparisons of SEQS and IFC Guidelines for key parameters of emission and ambient air quality are provided. **Exhibit 2.5** provides a comparison of SEQS and IFC Guideline limits for effluents. **Exhibit 2.6** provide SEQS guideline values 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 Limits for Emission of Key Pollutants from Coal Fired Power Plant

Parameter	*Source of Emission*	*National Standards*	*IFC Guidelines*
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	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			
Sulfur Dioxide	Power plant operating on oil and coal	100 - 500 Tons per day	For NDA: 900-1500 mg/Nm^3 For DA: 400 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.

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

Pollutants	*Time-weighted Average*	*Sindh Standards (µg/m³)*	*IFC Guidelines (µg/m³) (For Reference)*
Sulfur Dioxide (SO_2)	Annual Average	80	–
	24 hours	120	125
Oxide of Nitrogen as (NO)	Annual Average	40	–
	24 hours	40	–
Oxide of Nitrogen as (NO_2)	Annual Average	40	40
	24 hours	80	–
Ozone (O_3)	1 hour	130	–
Suspended Particulate Matter (SPM)	Annual Average	360	–
	24 hours	500	–

Pollutants	*Time-weighted Average*	*Sindh Standards ($\mu g/m^3$)*	*IFC Guidelines ($\mu g/m^3$) (For Reference)*
Respirable particulate Matter. PM_{10}	Annual Average	120	70
	24 hours	150	150
Respirable Particulate Matter. $PM_{2.5}$	24 hours	75	75
	Annual Average	40	35
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 Limits 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

Parameter	*SEQS (Into Inland Waters)*	*IFC Guidelines (For Reference)*
Chromium (trivalent and hexavalent)	1	0.5
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: Sindh Environmental Quality Standards for Noise

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

Note:

1. Day time hours: 6 .00 am to 10.00 pm
2. Night Time 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 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.

2.9 TNPTL Corporate Social Responsibility Policy

The TNPTL Corporate Social Responsibility Policy is as follows:

TNPTL will strive for continuous improvement in environmental performance to achieve sustainable development with operational excellence. The company believes in transparent relations with its stakeholders which includes transparent policies of corporate governance, CSR strategy, environmental protection, workplace and people, marketplace and supply chain and community investment. TNPTL aims to adhere to all applicable national and international laws, directives, regulations and principles of environment, health and safety and corporate social responsibility.

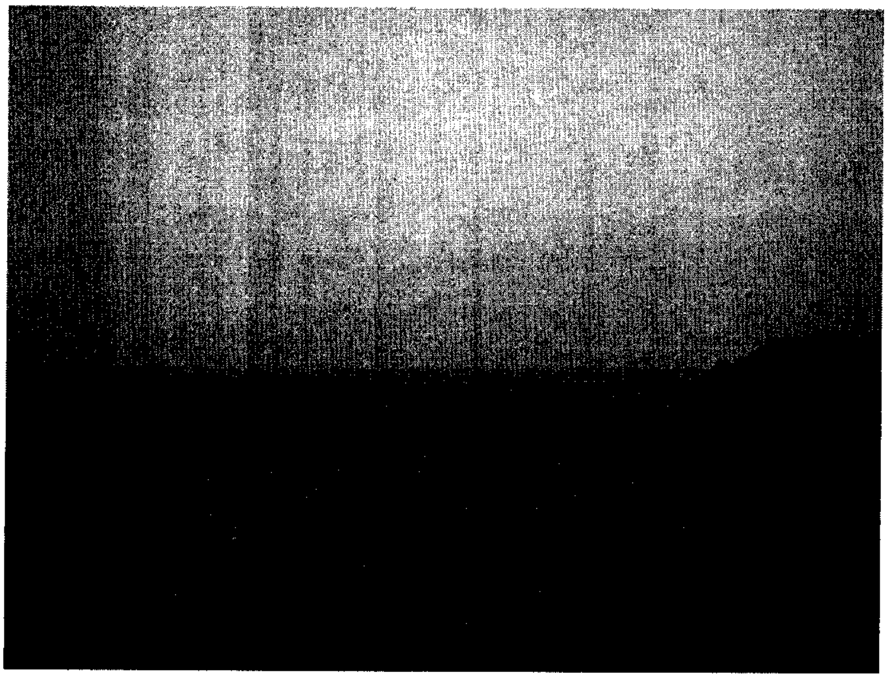
3. The Proposed Project

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

3.1 Project Location and Layout

The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District in Sindh. A photograph of the Project site is shown in **Exhibit 3.1** and a map of the location is given in **Exhibit 3.2.**

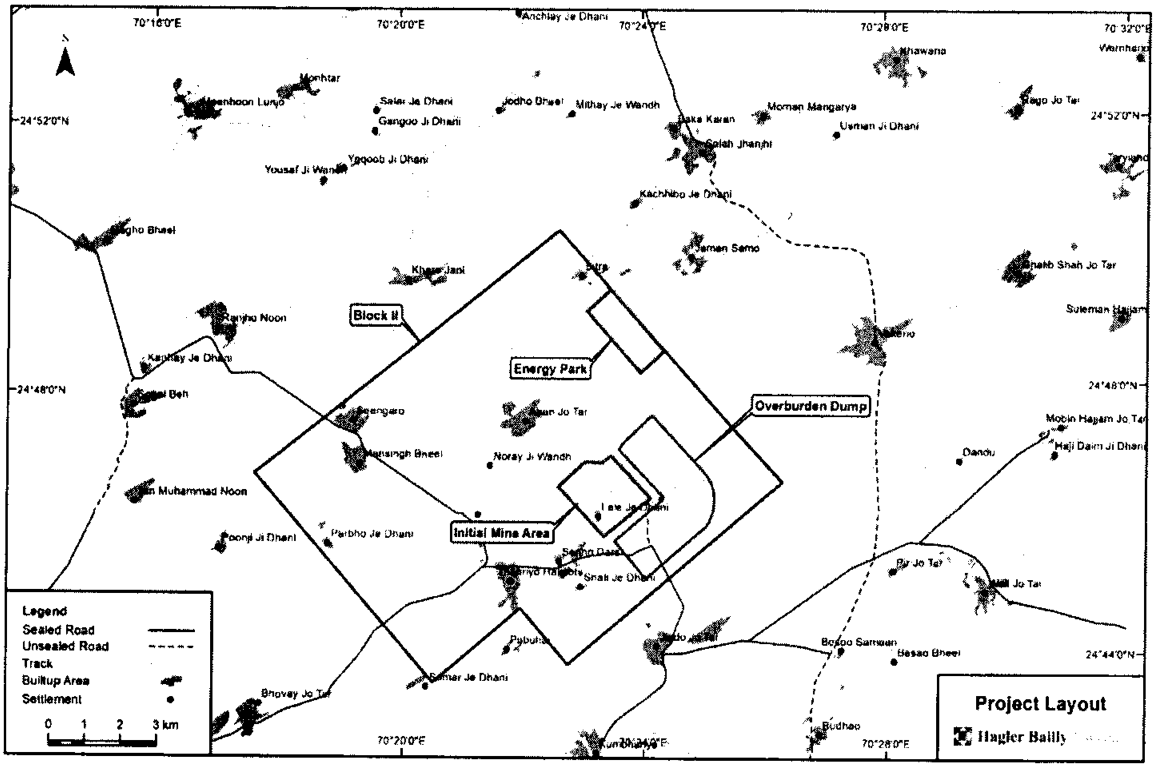
Exhibit 3.1: Project Site as seen from Bitra



The major systems in the proposed plant will include:

- Coal handling and processing system
- CFB boiler and Environmental Control Equipment
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Ash handling system
- Utilities and waste management systems.

Exhibit 3.2: Project Layout



3.2 Project Technology

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters. Plant specifications are summarized in **Exhibit 3.3**. A block diagram of a CFB power plant is shown in **Exhibit 3.4**. The main components are described below.

Exhibit 3.3: Power Plant Specifications

Plant Specifications	*Approx. Value*	*Unit*
Gross Capacity	330	MW
Net Capacity	300	MW
Availability factor	85	%
Efficiency on NCV[17]	37	%
NCV of Coal	2640	kcal/kg
Coal Consumption	250 1.9	tons per hour million tons per year

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 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. The 'bed' is where the coal or fuel spreads for combustion. 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'.

3.2.2 Cyclone

Fine particles of partly burned coal, ash and bed material are carried along with the flue gases to the upper areas of the furnace and then into a 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 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

[17] Net Calorific Value

boiler after passing through condensate polishing system. The rotating steam turbine will operate the power generator, which will generate electricity. The voltage of the electricity will then be stepped-up and exported through the high tension transmission system of 500 kV.

The maximum furnace exit gas temperature will not exceed 950 °C. The flue gas exit temperature from the air heater at all load conditions will not be lower than 10 °C above the sulfuric acid dew point temperature, or 130 °C.

3.2.4 Cooling System

The main components of the circulating water system are cooling towers, circulating water pumps, condenser and its associated valves, and instrumentation and controls.

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. Either mechanical draft or natural draft cooling towers can be used for the coal fired project. 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.

The tower structure is generally constructed of a combination of reinforced concrete, the tower fill PVC or treated wood. The hyperbolic natural draft tower is extremely dependable and predictable in its thermal performance. Air flow through this tower is produced by the density differential that exists between the heated (less dense) air inside the tower and the relatively cool (more dense) ambient air outside. Although hyperbolic towers are more expensive to build than mechanical towers, they are used extensively in the field of electric power generation where long amortization periods allow sufficient time to recover the capital cost of the tower.

3.2.5 Emission Controls

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

NO_X:

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.

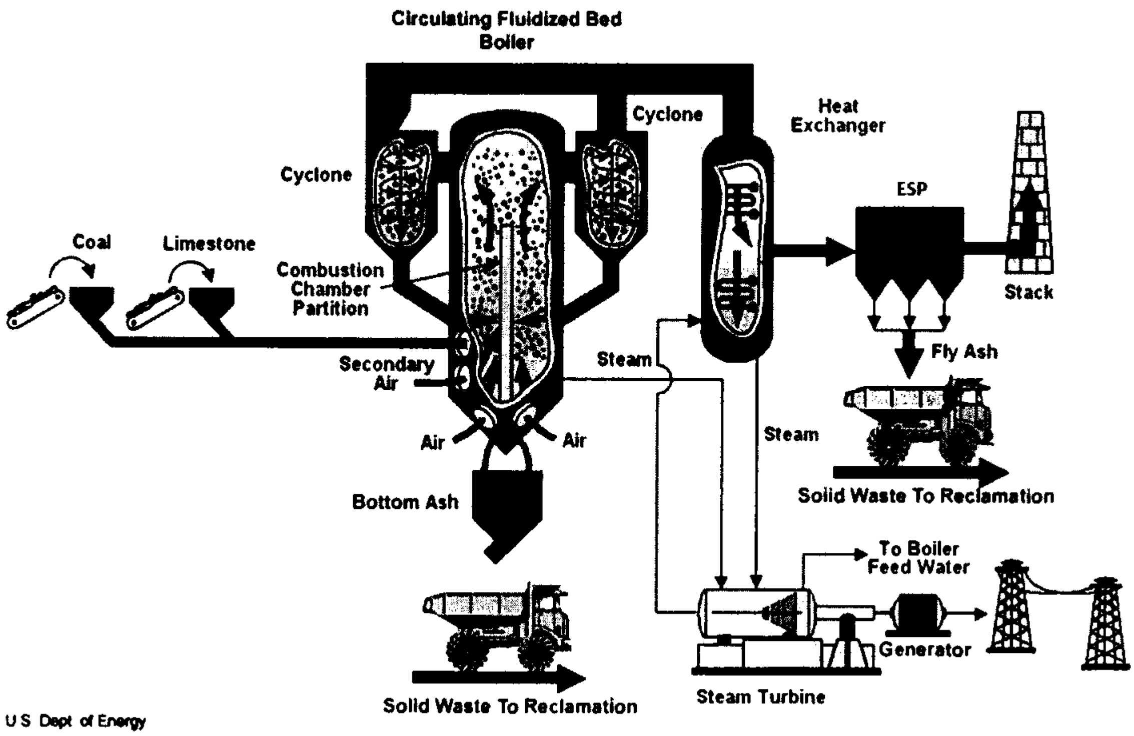
SO_2

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%.

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 ppm at all loads when burning design coal.

Exhibit 3.4: Schematic of CFB Power Plant



U S Dept of Energy

3.3 Raw Material Inputs

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

3.3.1 Coal

The main fuel for the power plant will be Thar Coal from Block II mine. The design specification of the fuel is given in **Exhibit 3.5**. Based on the net calorific value and plant capacity, approximately 250 tons per hour will be required, for a total of 1.9 million tons per year.

Coal will be transported via truck to the Project site after preliminary crushing and storage at the mine stockyard which is at a distance of approximately 5 km from the Power Plant. Coal for the power plant will be received at the coal stockyard at the Project site, which will be built 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 and the stockyard will be equipped with a water sprinkling system for coal dust suppression.

Exhibit 3.5: Design Specification of the Fuel[18]

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
iii	Titanium oxide (as TiO_2)	1.86

[18] 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*
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

3.3.2 Water

The water source and requirements for the proposed coal power Project are discussed in this section.

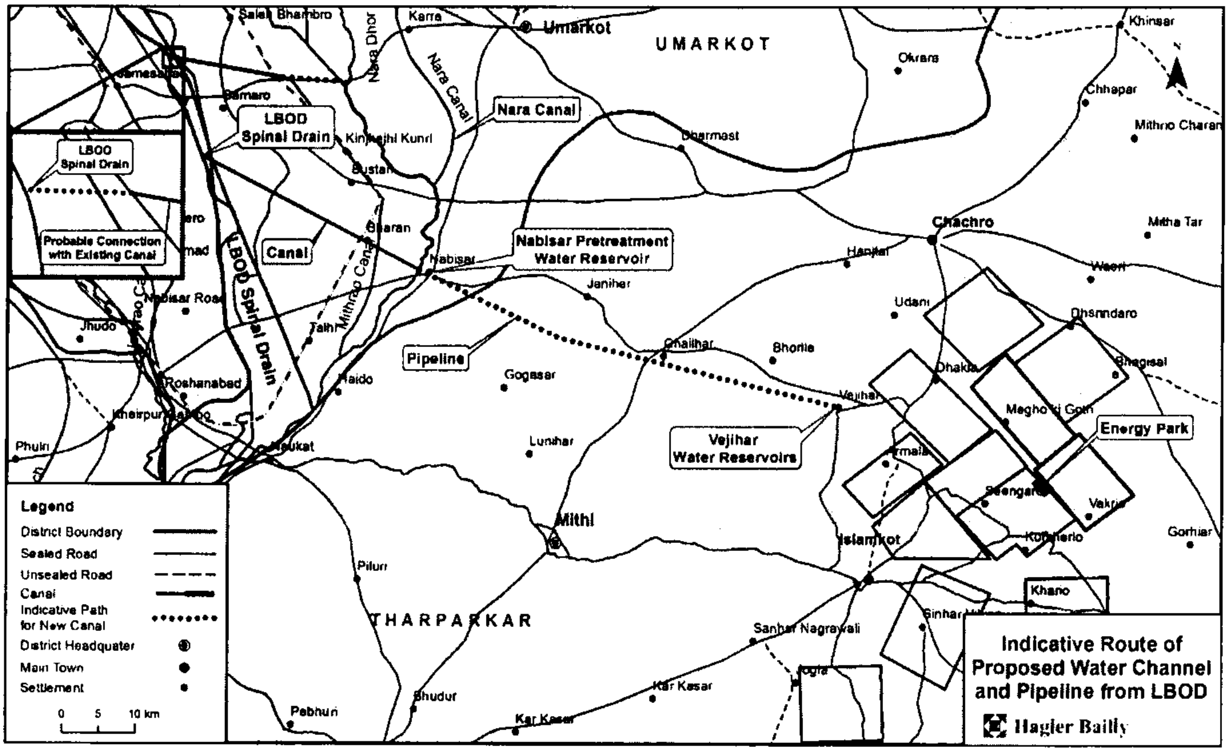
Water Source

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD) [19] towards the Thar Coalfields. An indicative route of the water channel from the LBOD to Thar Coalfield is shown in **Exhibit 3.6**. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts are not evaluated as part of this EIA.

[19] 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 3.6: Indicative Route of the Proposed Water Channel from LBOD to Block II



Water Demand Estimate

The anticipated power plant normal demand for water is between 1,200 to 1400 m^3/h. Of the required makeup water approximately 40% goes towards evaporation losses and 40% goes towards discharge of pre desalting water station.

3.3.3 Limestone

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

3.4 Waste Materials

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

3.4.1 Ash

Bottom ash is what remains after combustion in the furnace and consists of noncombustible 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). The ESP is installed downstream of the furnace (shown as fabric filter in **Exhibit 3.2**). A five chamber ESP house will be installed which is capable of recovering 99.9% of solid carryover.

Ash will be stored temporarily on the power plant site until it is transported to the mine area (see **Exhibit 3.1**) for final disposal. 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.

The mine area is at a distance of around 5 km. The ash transportation will be via truck.

3.4.2 Wastewater

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. 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 drainage and waste water effluent channel being prepared by the Government of Pakistan (GoP). The expected outfall is at the Runn of Kutch (see **Ecological Baseline**), which is a natural depression connected to active sea creek system which is a highly saline water body.[20] Photographs of the construction of the scheme are shown in **Exhibit 3.7**. 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 EIA.

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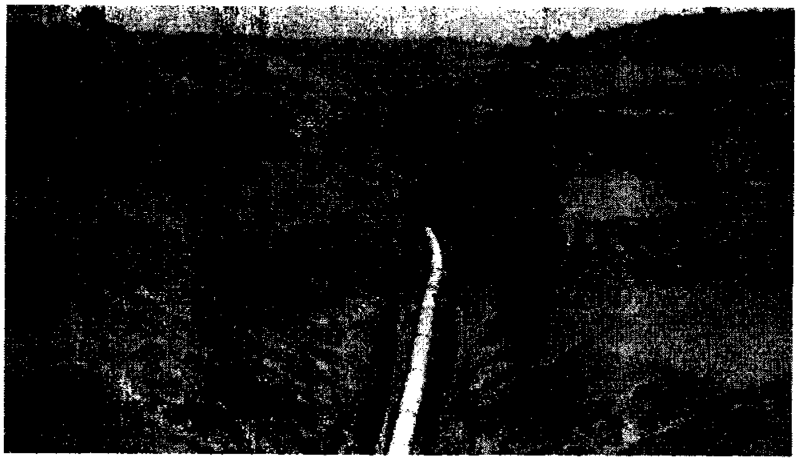
[20] http://sindhcoal.gos.pk/effluent-disposal/

Exhibit 3.7: Wastewater Disposal Scheme



Under construction effluent channel for waste water disposal of Thar coal projects. Dated: May 14, 2016.

3.4.3 Air Emissions

Main gaseous emissions of concern from the coal power Project include sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) along with particulate matter emissions (PM_{10} and $PM_{2.5}$, which refers to particulate matter less than 10 and 2.5 microns respectively are pollutants of health concern). A summary of key parameters related to air emissions, including stack specifications and emission rates, are presented **Exhibit 3.8**. The release and dispersion of these pollutants is discussed in **Chapter 6**.

Exhibit 3.8: Estimated Air Emission Parameters (1 × 330MW)

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	%

4. Description of the Environment

This section describes the existing environment including the physical, ecological and socioeconomic baseline conditions. The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic. The ecological baseline includes nearby protected areas, habitat types and ecological resources. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

4.1 Methodology for Developing the Baseline

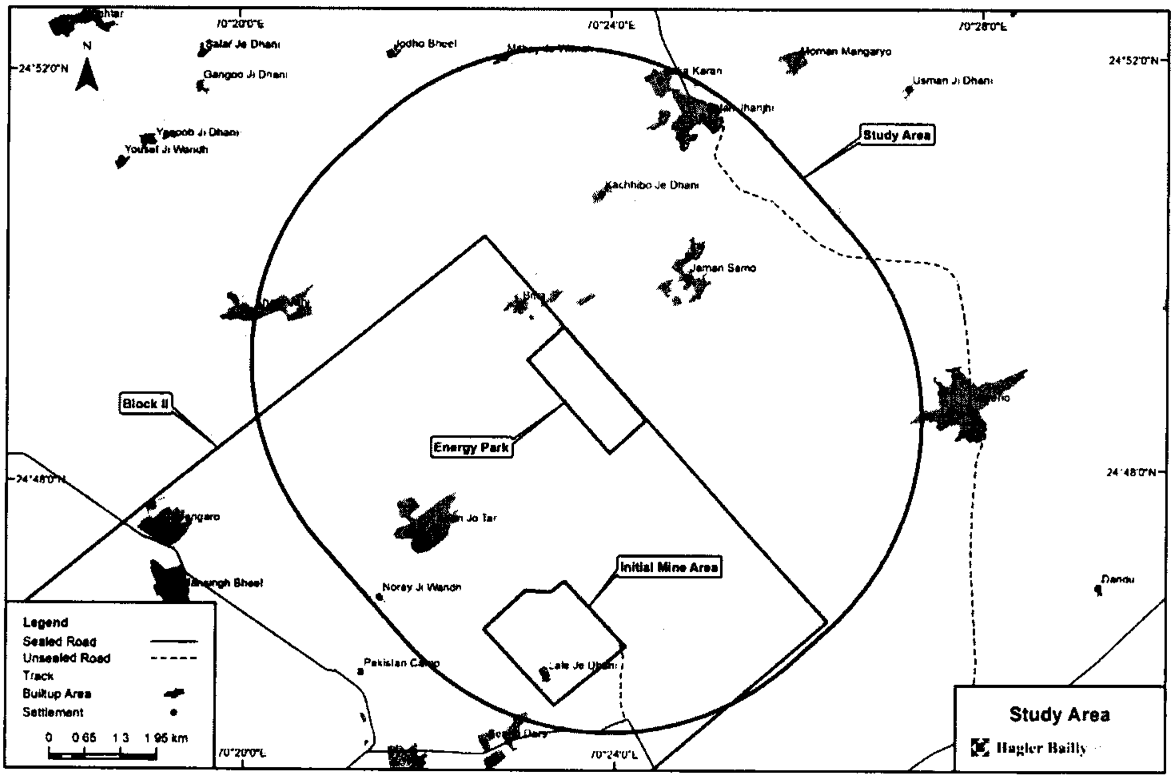
As a number of mining and power projects have been approved in the Thar area, the 'baseline' for the proposed Project takes into account the potential impact of these developments on the environment. This approach is especially used in developing air quality baseline.

4.2 Study Area

The 'Study Area' selected for the EIA includes sensitive receptors[21] that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it and is depicted in **Exhibit 4.1**.

[21] 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



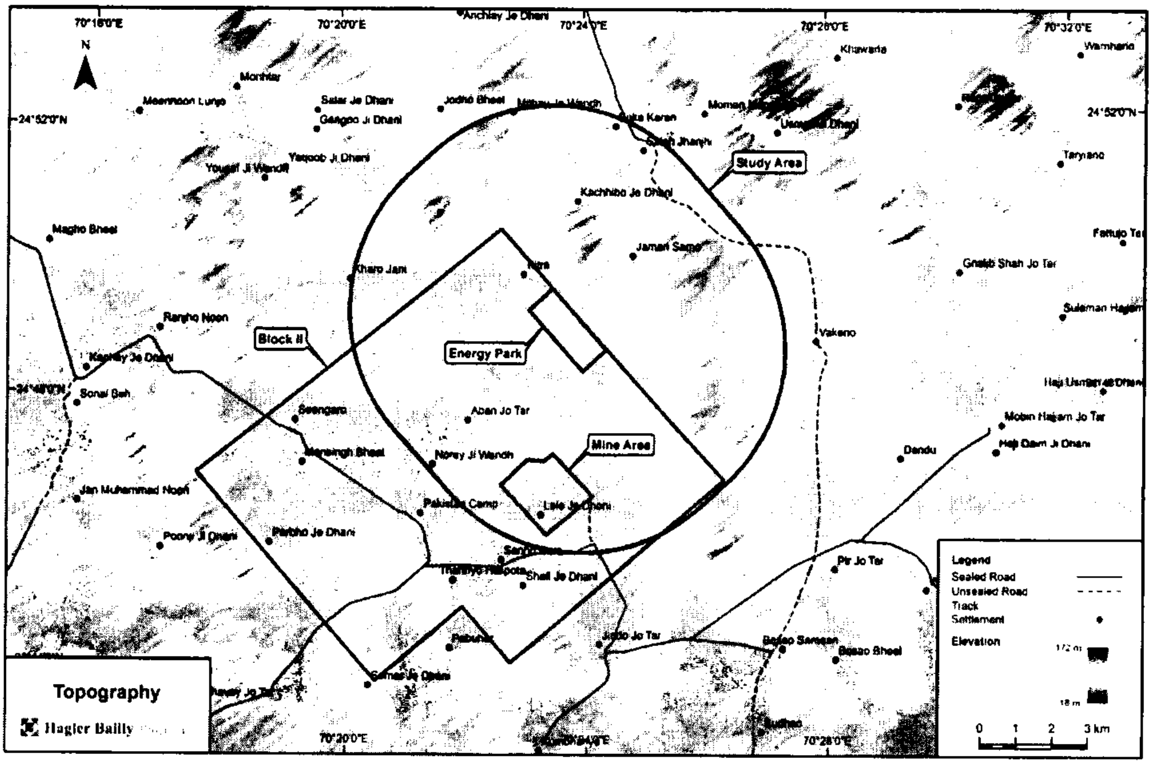
4.3 Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise 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 (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 Visual Character

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

To document the visual baseline, a survey was conducted at the locations listed in **Exhibit 4.3** and shown in **Exhibit 4.4**. The survey was conducted on May 13 and 14, 2016.

Exhibit 4.3: Visual Survey Locations

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 area
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)
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 4.4: Visual Sampling Locations

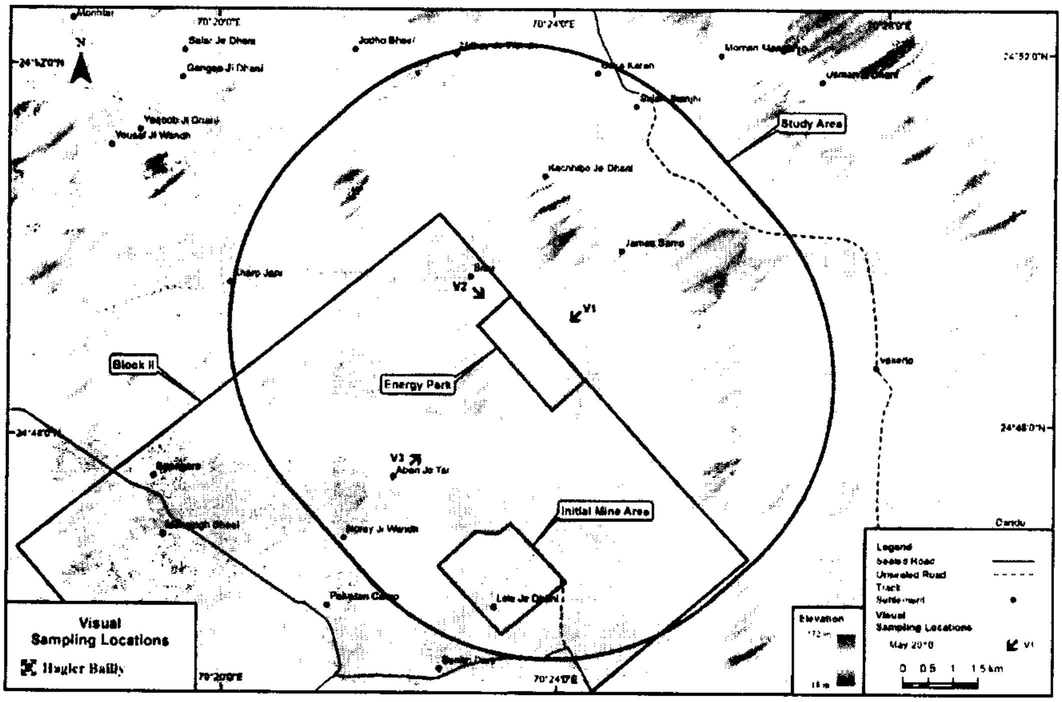
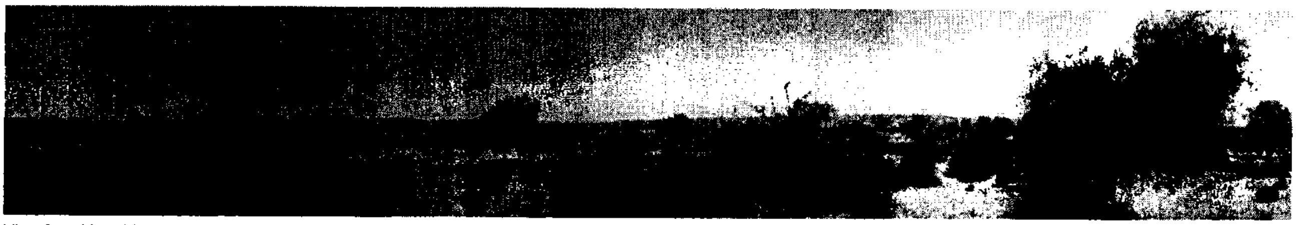
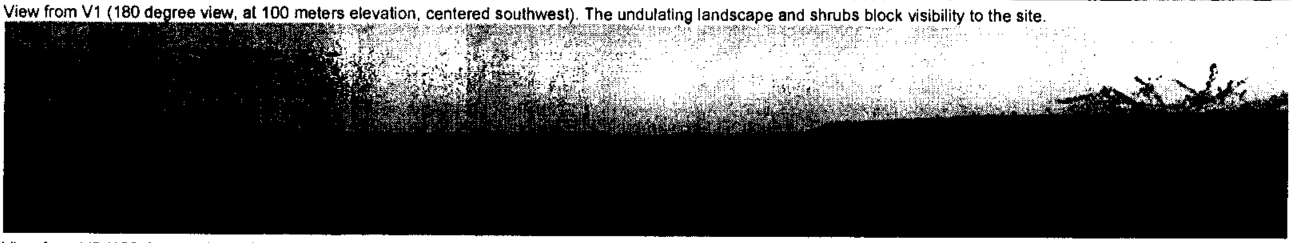


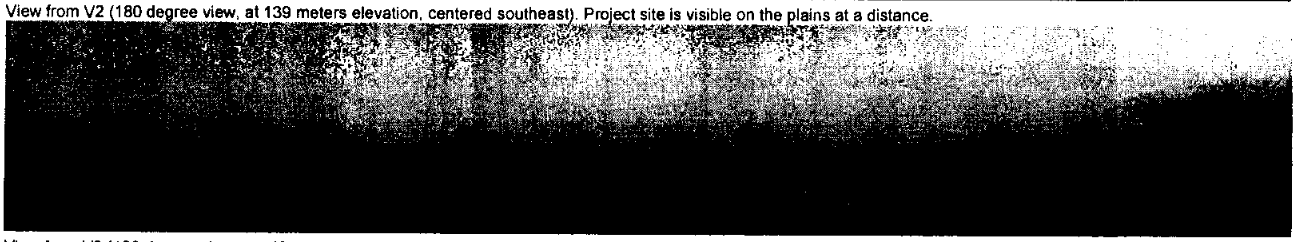
Exhibit 4.5: View of the Project Site from nearby Receptors



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

4.3.3 Geology

Elongate parabolic dunes are dominant within the Study Area, often with small playas within their noses (see **Exhibit 4.6**)[22]. 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[23].

The Thar Desert is covered by parabolic sand dunes and intervening playas[24].A map of the surface geology and the extent of the Thar Coalfields area is shown in **Exhibit 4.7**. The entire surface of the Study Area is covered by aeolian sands of the Quaternary.

Exhibit 4.6: Characteristic Parabolic Sand Dunes in Study Area[25]

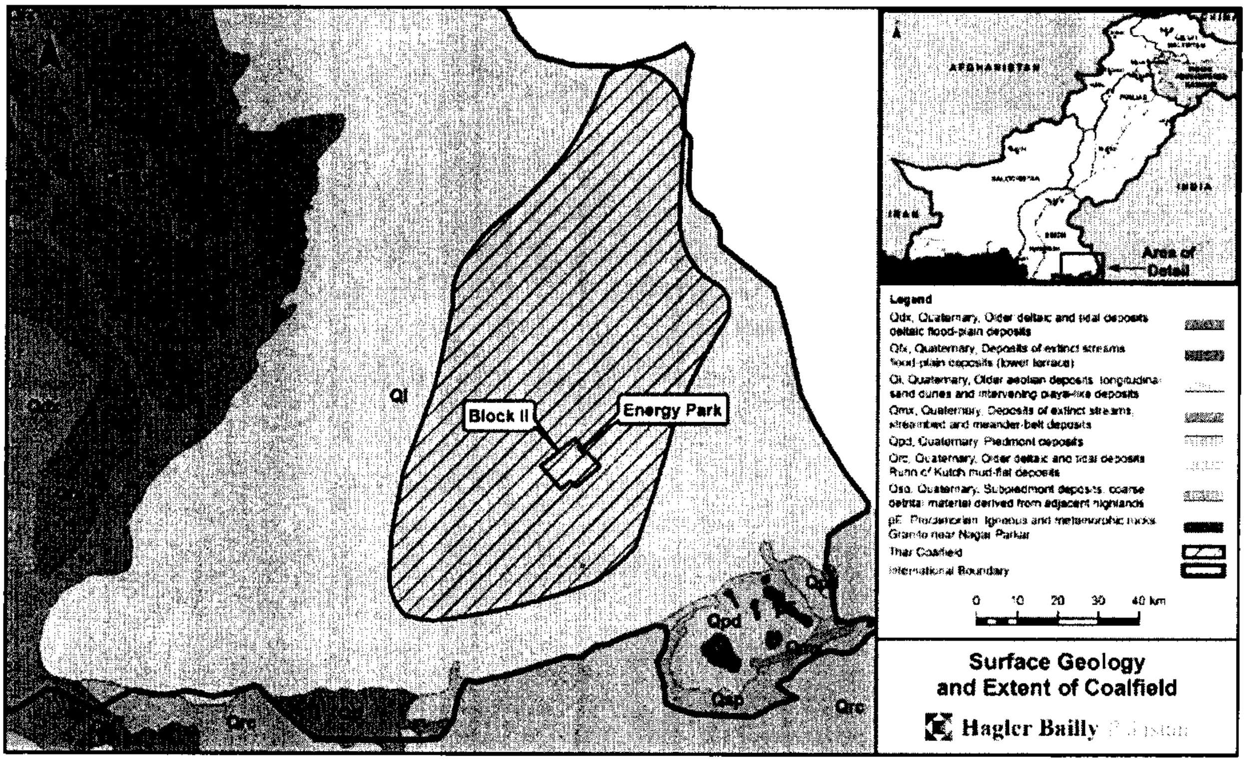
[22] J. Laity, Deserts and Desert Environments (Wiley-Blackwell: 2008)

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

[24] Playa is a typically desert basin with no outlet which fills with water to form a temporary lake after rainfall.

[25] Google Earth Imagery

Exhibit 4.7: Surface Geology and Extent of Thar Coalfields



4.3.4 Tectonics, Earthquakes and Tsunamis

The Thar Desert lies at the north-western corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi (**Exhibit 4.8**).

Based on the Global Seismic Hazard Map Project (GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 0.8 and 1.6 m/s^2 (**Exhibit 4.9**).

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 4.8: Major Tectonics and Earthquakes of Southern Pakistan

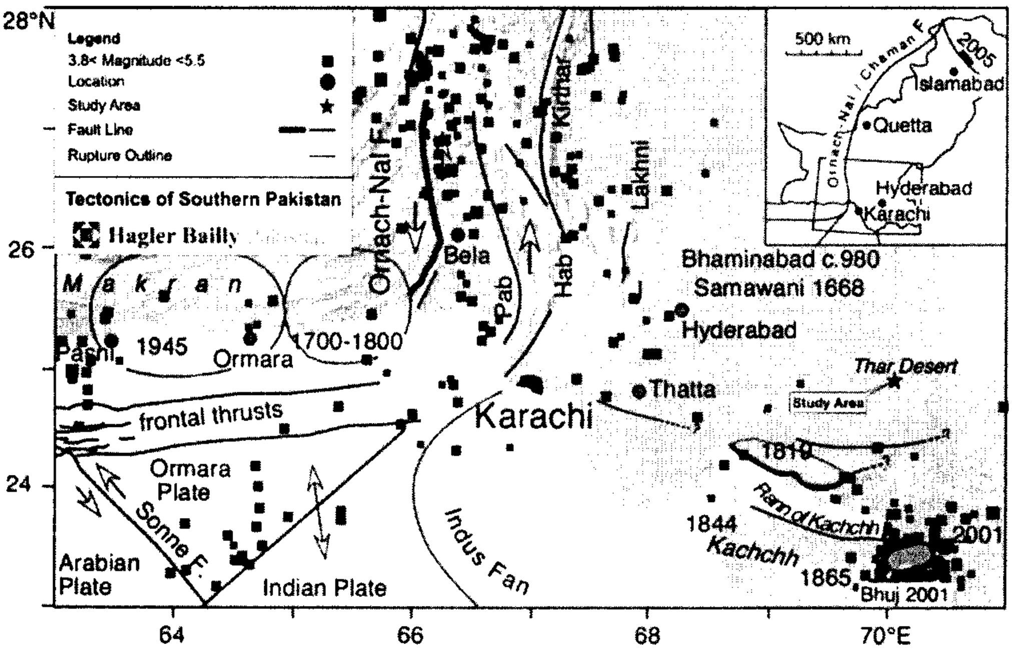
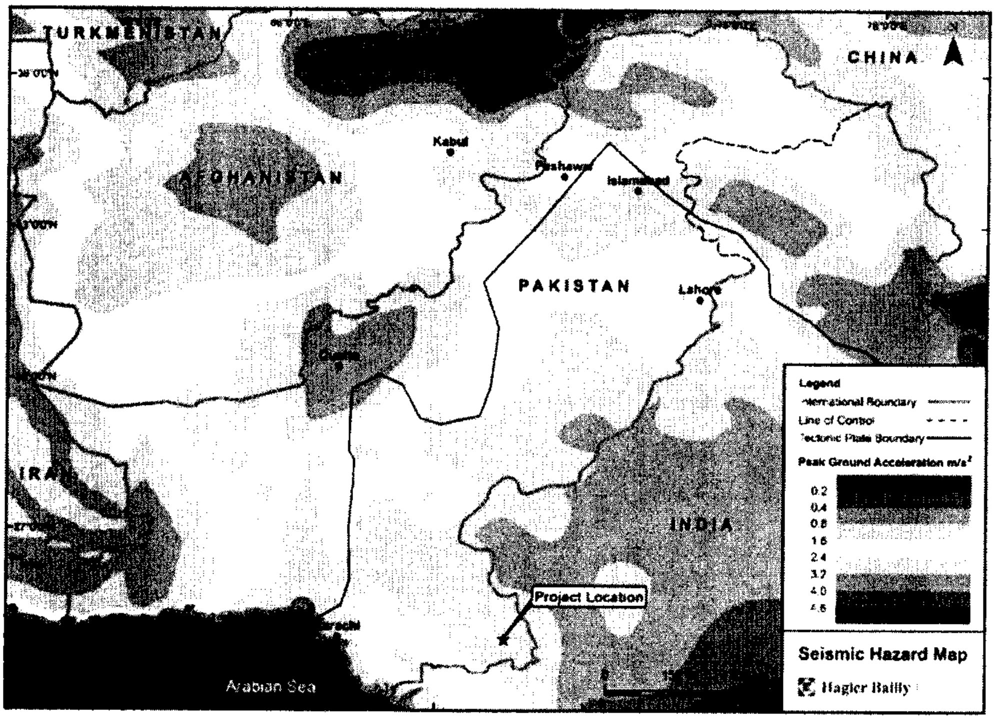


Exhibit 4.9: Seismic Hazard Map of Pakistan[26]



4.3.5 Climate

The climate characterizes the prevailing weather conditions in the Study Area. 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). The station's World Meteorological Organization (WMO) ID is 41786. Weather data from this station was used to develop the baseline.

Seasons

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.

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

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)

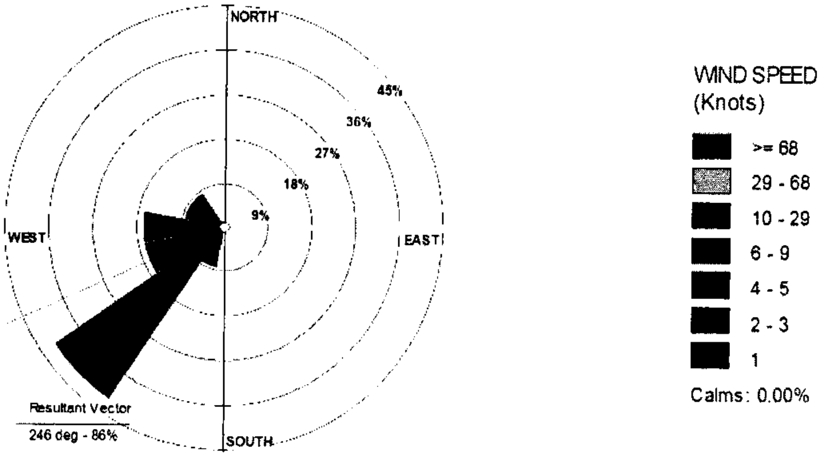
Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

A summary of the climate in the Study Area based on the data from the Mithi weather station are 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 (°C)*		*Relative Humidity at 1200*	*Rainfall*	*Cloud Cover*
	Max	*Min*	*% at 1200 UTC*	*mm*	*oktas at 1200 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
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 objective of the air quality baseline was to collect data on air quality in the airshed, particularly the area likely to be affected by the Project.

The air quality baseline specifically assess the concentration of pollutants in the ambient air without the Project. The Project is assumed to become operational in 3 to 4 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 emission modelling.

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

The measured air quality baseline was developed using both primary and secondary data on ambient air quality in the Project area.

Primary Data

Air quality sampling was carried out at four different locations in the Study Area from May 24th to 31st, 2016. The results from the literature indicate low concentrations of SO_2 and NO_2. This low concentration was expected, as there were no major sources of these pollutants in the area other than cook stoves in villages that use wood as a fuel. However, previous sampling also indicates high concentrations of particulate matter (PM_{10} and $PM_{2.5}$). This was largely due to the desert environment of the area that results in naturally high dust concentrations. Therefore, sampling for this study focused only on sampling ambient particulate matter concentrations.

A description of sampling locations and the rationale of selection is given in **Exhibit 4.12**.

Exhibit 4.12: Air Quality Sampling Locations and Rationale of Selection

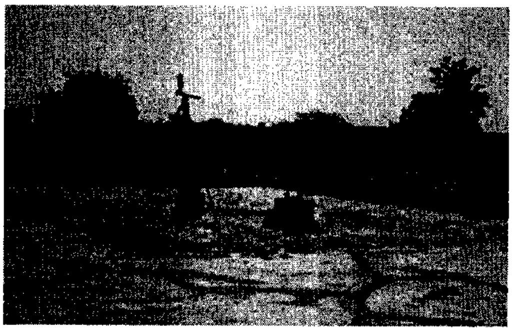
Sample ID	*Coordinates*	*Location*	*Rationale*
A1	24° 45' 55.3" N 70° 23' 08.8" E	Lale Je Dhani	Engro activities influenced zone
A2	24° 48' 42.3" N 70° 28' 00.2" E	Vakerio	Receptor (large village) downwind of site
A3	24° 49' 58.3" N 70° 24' 46.1" E	Jaman Samo	Receptor (village) downwind of site
A4	24° 45' 15.1" N 70° 21' 43.9" E	Thahriyo Halipota	Receptor (village) on transport route

At each location, PM_{10} and $PM_{2.5}$ were sampled using a low volume sampler for 24 hours. Lab analysis was performed at the HBP Laboratory in Islamabad. Photographs of the particulate matter sampling sites are shown in **Exhibit 4.13.**

Exhibit 4.13: Particulate Matter Sampling Site Photographs


Low Volume Samplers at A1


Low Volume Samplers at A2



Low Volume Samplers at A3

Low Volume Samplers at A4

Secondary Data

Additional data on ambient air quality in the Project area, available from previous EIAs conducted near the Study Area, is summarized in **Exhibit 4.14**. The current and previous sampling locations are shown **in Exhibit 4.15.**

Exhibit 4.14: Air Quality Sampling Locations in Literature

Sample ID	*Coordinates*	*Dates of Survey*	*Description*	*Source*
THMA1	24°44' 14.56" N 70°13' 14.32" E	May, June, July 2010	Mehari Bajeer	ESIA of Block II coal mine[27]
THMA2	24°51' 47.63" N 70°24' 54.39" E	May, June, July 2010	Salah Jhanjhi	
THMA3	24°46' 11.39" N 70°21' 23.94" E	May, June, July 2010	Pakistan Camp	
THMA4	24°45' 08.94" N 70°21' 25.76" E	May, June, July 2010	Thario Halepota	
TCOA1	24°49' 12.19" N 70°17' 08.83" E	May, June 2012	Ranjho Noon	ESIA of Block VI coal mine. (Oracle Coalfields Limited)[28]
TCOA2	24°53' 51.32" N 70°19' 04.57" E	May, June 2012	Meghay Jo Tar	
TCOA3	24°51' 21.78" N 70°24' 45.21" E	May, June 2012	Salah Jhanjhi	
SSRA1	24°39' 22.51" N 70°19' 01.10" E	November, 2011	Open Field Tilwai	ESIA of Block I coal mine)[29]

[27] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project. Prepared for Sindh Engro Coal Mining Company

[28] 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].

[29] 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

Sample ID	*Coordinates*	*Dates of Survey*	*Description*	*Source*
SSRA2	24°40' 48.48" N 70°17' 56.62" E	November, 2011	Open Field Varvai	
SSRA3	24°40' 11.39" N 70°22' 01.06" E	November, 2011	Open Field Khario Ghulam Shah	

Results and Analysis

The results of the current sampling along with the results from literature are tabulated in **Exhibit 4.16.** The results were compared against Sindh Environmental Quality Standards (SEQS) and IFC EHS guidelines. Results that exceed SEQS are shaded.

Exhibit 4.15: Air Quality Sampling Locations

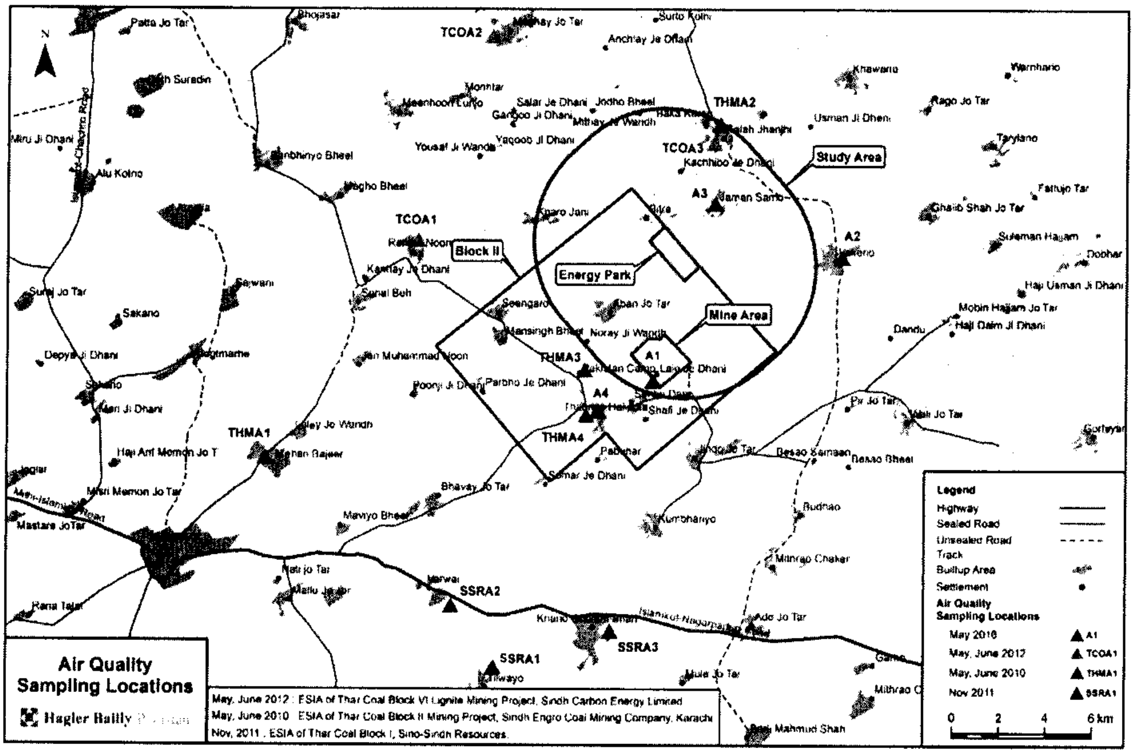


Exhibit 4.16: Results of Current and Previous Sampling (µg/m³)

Sample ID	*Date*	*NO_2*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*
A1	May, 2016	–	–	114.3	63.5
A2	May, 2016	–	–	109.3	68.3
A3	May, 2016	–	–	104.7	52.4
A4	May, 2016	–	–	84.6	36.3
THMA1	May, 2011	6.98	12.40	–	–
THMA2	May, 2011	4.65	9.14	–	–
THMA3	May, 2011	2.39	4.49	–	–
THMA4	May, 2011	3.23	NA	–	–
THMA1	June, 2011	2.95	5.83	138.9	13.9
THMA2	June, 2011	3.36	8.39	180.7	27.8
THMA3	June, 2011	2.81	2.18	166.7	27.8
THMA4	June, 2011	2.22	3.37	222.2	55.6
TCOA1	June, 2012	–	3.2	333	112
TCOA2	July, 2011	–	2.1	776	129
TCOA3	July, 2011	–	9.0	406	98
THMA1	July, 2011	3.31	2.99	83.3	13.9
THMA2	June, 2012	4.56	6.77	97.2	13.9
THMA3	June, 2012	2.66	8.12	97.2	13.9
THMA4	June, 2012	2.88	1.6	111.1	27.8
SSRA1	Nov, 2011	16.1	27.0	140.6	20.8
SSRA2	Nov, 2011	5.8	10.1	228.0	34.2
SSRA3	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 EHS (annual)		40	-	70	35
IFC EHS (24-hour)		-	125	150	75

Note: – means the data was not available

From the measured values the following conclusions can be drawn:

- The median value of SO_2 concentration is 7.4 µg/m³ which complies with SEQS (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded SO_2 in the area is 27.0 µg/m³ which is also well below the SEQS and IFC EHS limits.
- The median value of NO_2 concentration is 3.3 µg/m³ which complies with SEQS (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded SO_2 in the area is 16.1 µg/m³ 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/m³ and 32.5 µg/m³ respectively. The $PM_{2.5}$ concentration complies with SEQS (24 hour

and annual) and is within IFC EHS guideline limits. The median value of PM_{10} concentrations exceeds the annual limit but is within the 24-hour limits of the SEQS and the IFC EHS guideline values. PM_{10} concentrations from previous sampling exceeds the standards at 8 out of 14 locations $PM_{2.5}$ concentrations from previous sampling exceeds the standards at 3 out of 14 locations. PM_{10} and $PM_{2.5}$ concentrations from current sampling complies with the standards. Their 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. In this study the highest PM readings were recorded at A1 (Lale Je Dhani) and A2 (Vakerio).

Based on the above exercise, **Exhibit 4.17** 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 4.17: Baseline Ambient Air Quality in the Study Area ($\mu g/m^3$)

	NO_2	*SO_2*	*PM_{10}*	*$PM_{2.5}$*
Baseline Levels	*3 ± 3*	*7 ± 6*	*140 ± 170*[30]	*30 ± 40*
SEQS (annual)	40	80	120	40
SEQS (24-hour)	80	120	150	75
IFC EHS (annual)	40	-	70[a]	35[a]
IFC EHS (24-hour)	-	125	150	75

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

Expected activities near the Study Area, that may influence the air quality baseline of the Project are summarized in **Exhibit 4.18** and locations shown in **Exhibit 4.19**

Exhibit 4.18: Approved Developments near Study Area

Block No.	*Coal Mine*	*Power Plant*	*Source*
Block II	6.5 mpta	660 MW	ESIA of Block II Mining Project[31] ESIA of Block II Power Plant Project[32]
Block VI	2.5 mpta	-	ESIA of Block VI Mining Project[33]

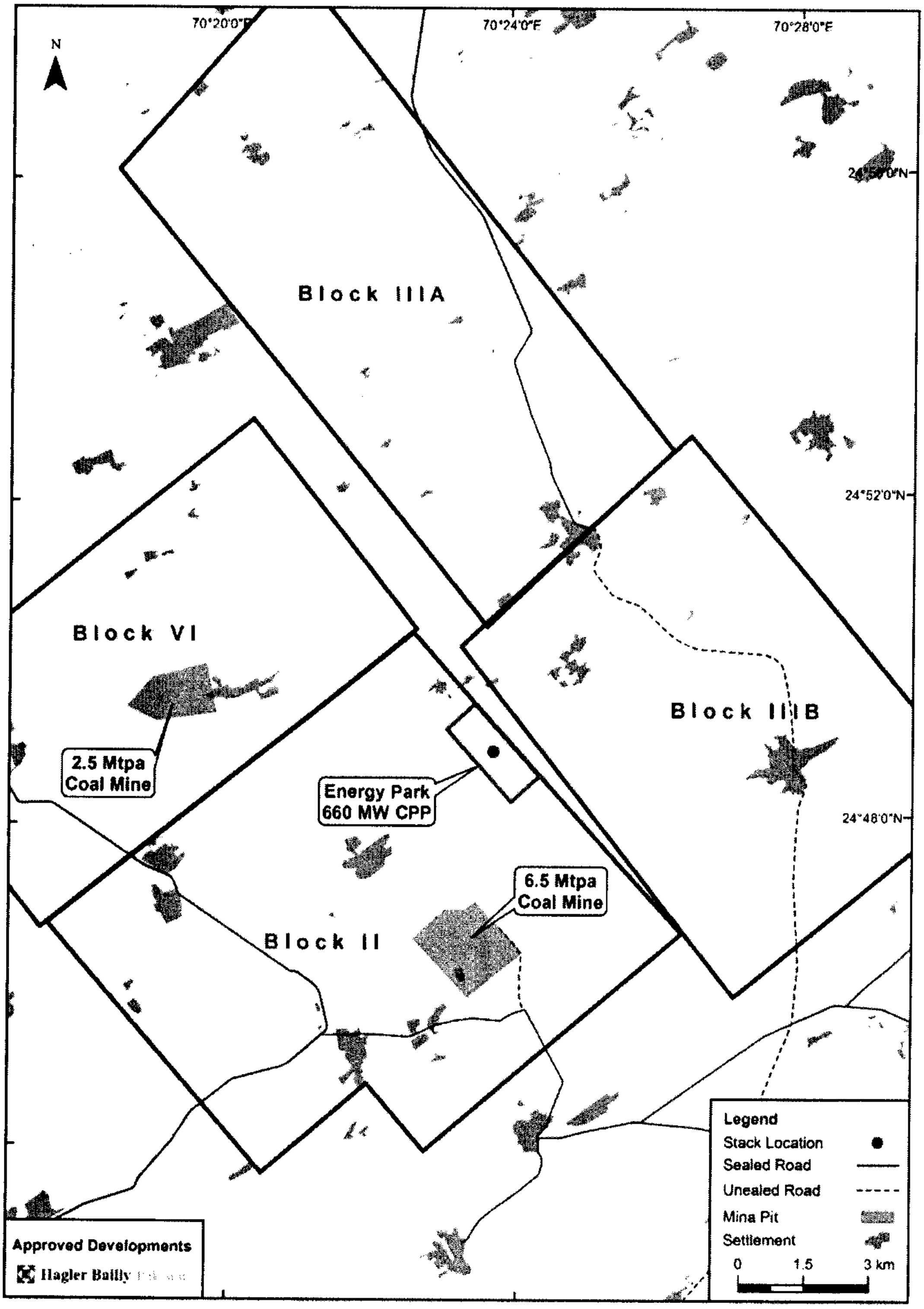
30 The standard deviation is 93 µg/m³ when the reading of 780 µg/m³ is removed. The reading of 780 µg/m³ is 5 times the median value and is likely a low occurring outlier.

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

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

33 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 4.19: 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

It was assumed that the mines are in year 3 and onwards of their development. At this stage the pit opening will be an elongated box cut. A box cut is a term typically applied to strip mining of flat terrain where excavation commences with a trench or "box cut" made through the overburden to expose a portion of the coal seam. After coal removal, a second cut can be made parallel to the first one, and the overburden material from this cut is placed in the void of the first cut. Therefore the initial cut is the dump site and the second cut is the mine pit area.

As the mine will go deeper the activities undergoing in the mine will have insignificant impact on the air quality of the area, therefore no activities from the mine pit are included in this scenario. After third year of the commencement of the mining, either the mine pit will be on surface or the dumpsite, therefore either dumpsite will add dust to the ambient air or the mine pit. Here we assume that dumpsite within the mine pit (first cut) is on the surface.

Furthermore, as no communities will be living within the mine, pollutant concentrations in the mine area can be considered an EHS issue. Therefore pollutant concentration in the mine and within a 500 meter radius which represents an estimated area to which communities will not have access due to ancillary facilities etc. are not reported. However, these concentrations can be seen in the contour diagrams.

CPP stacks were modelled based on the parameters discussed in **Section 3.4.3.**

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 4.20** to **Exhibit 4.27**. Areas that exceed standards have been shaded as hotspots. The measured and modeled results are compiled in **Exhibit 4.28.** The results were compared against SEQS and IFC EHS limits and the values exceeding one of the standards are shaded.

Exhibit 4.20: Baseline SO_2 Concentration (Annual)

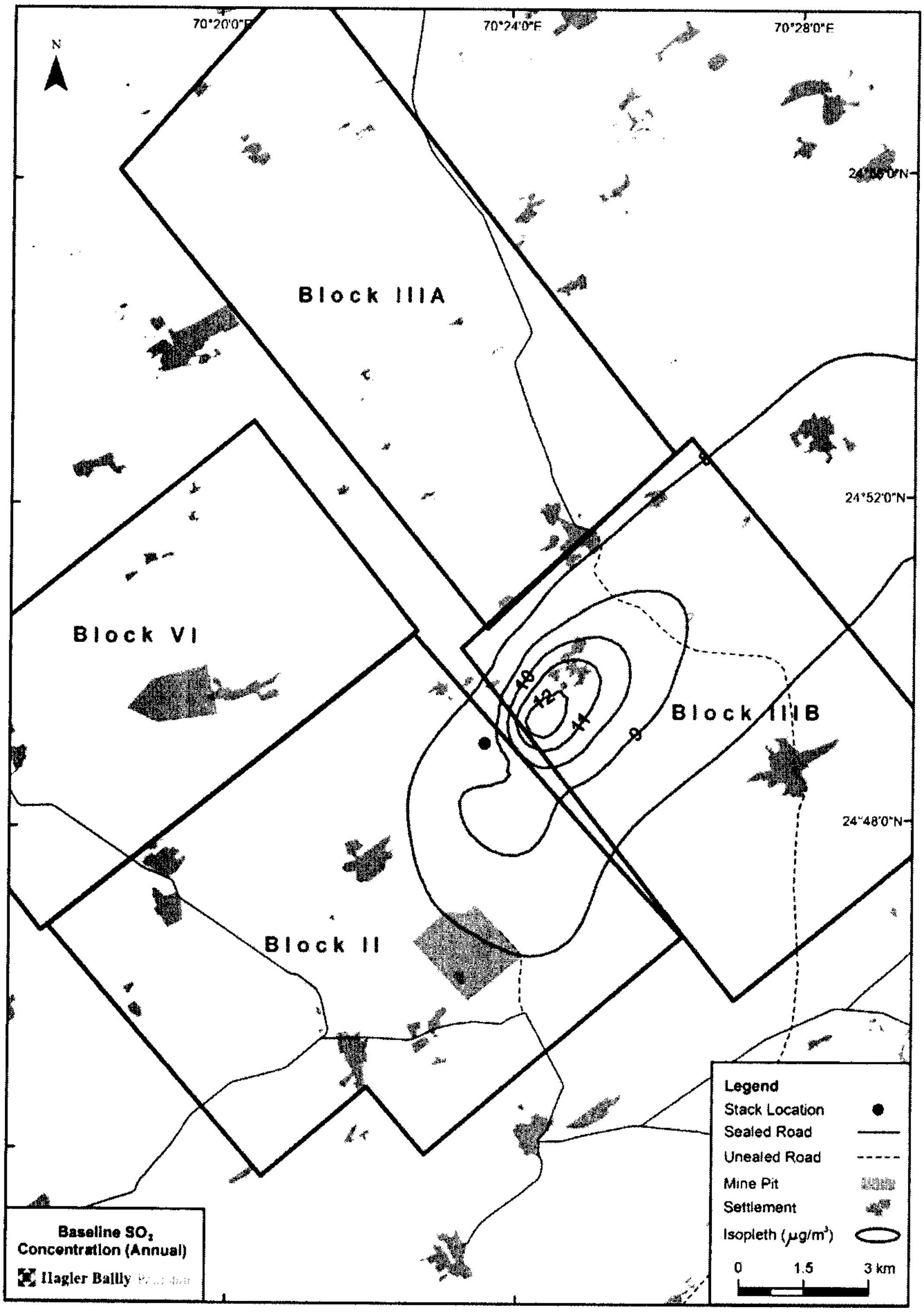


Exhibit 4.21: Baseline SO_2 Concentration (24 hour)

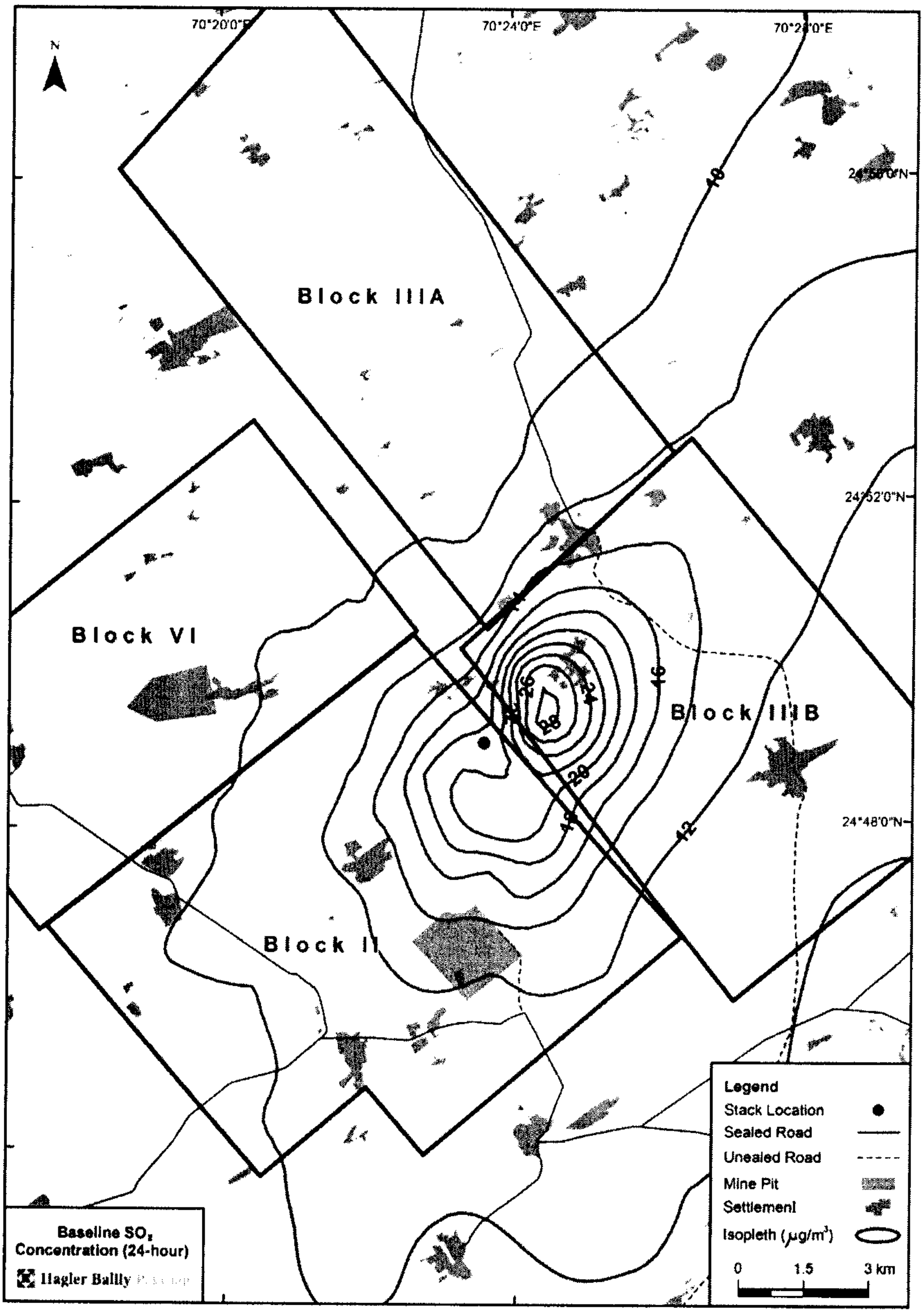


Exhibit 4.22: Baseline NO_2 Concentration (Annual)

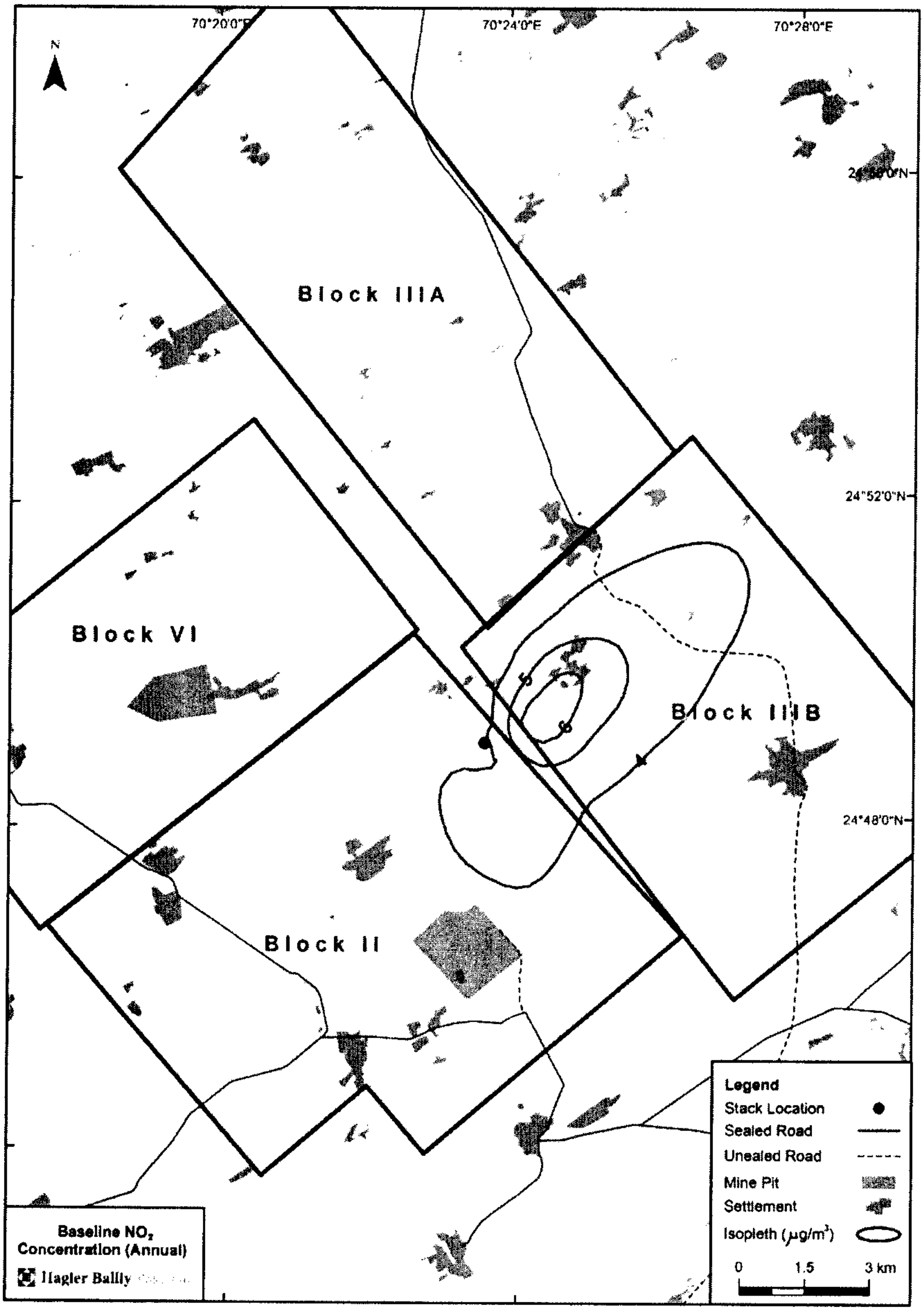


Exhibit 4.23: Baseline NO_2 Concentration (24 hour)

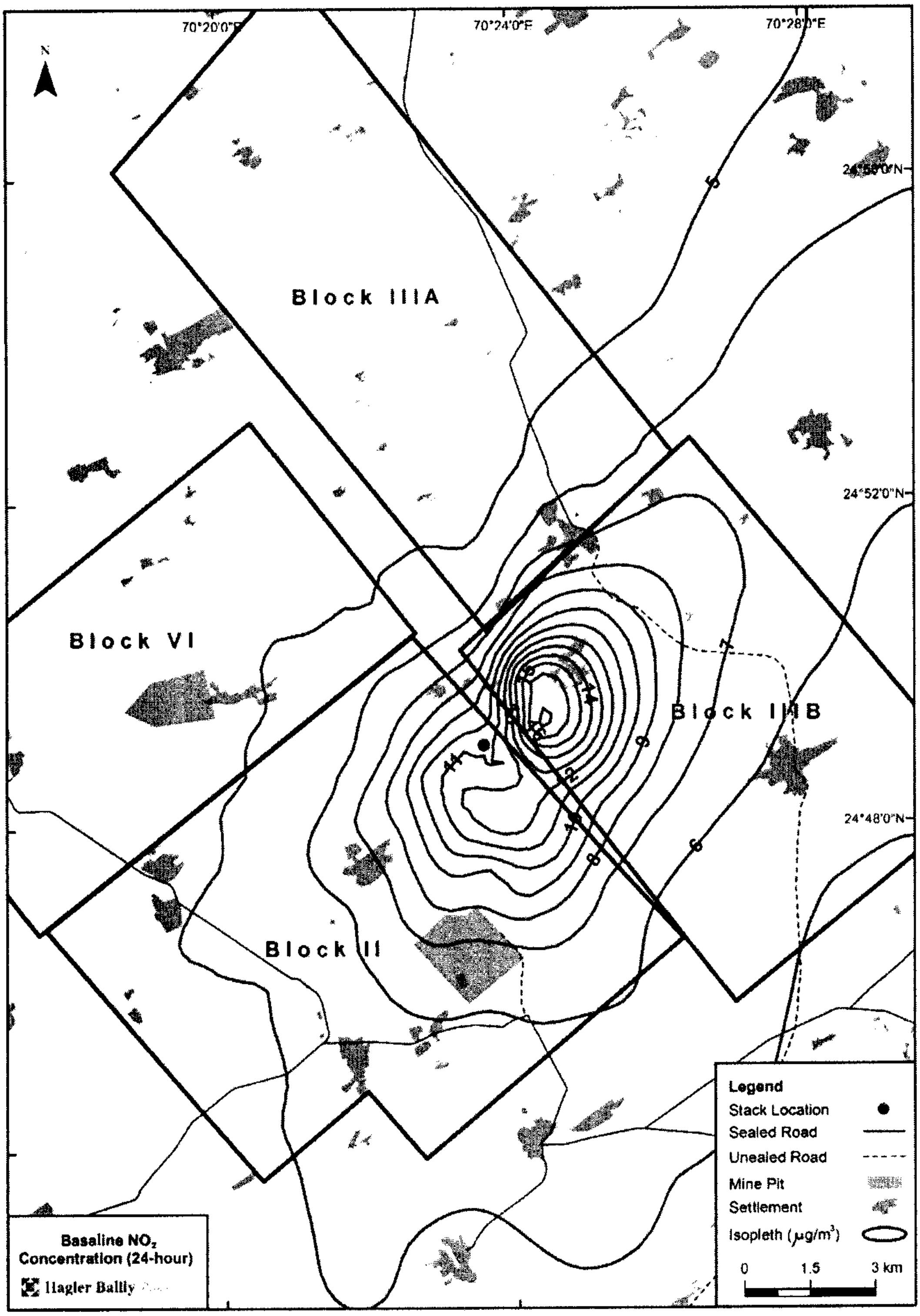


Exhibit 4.24: Baseline PM_{10} Concentration (Annual)

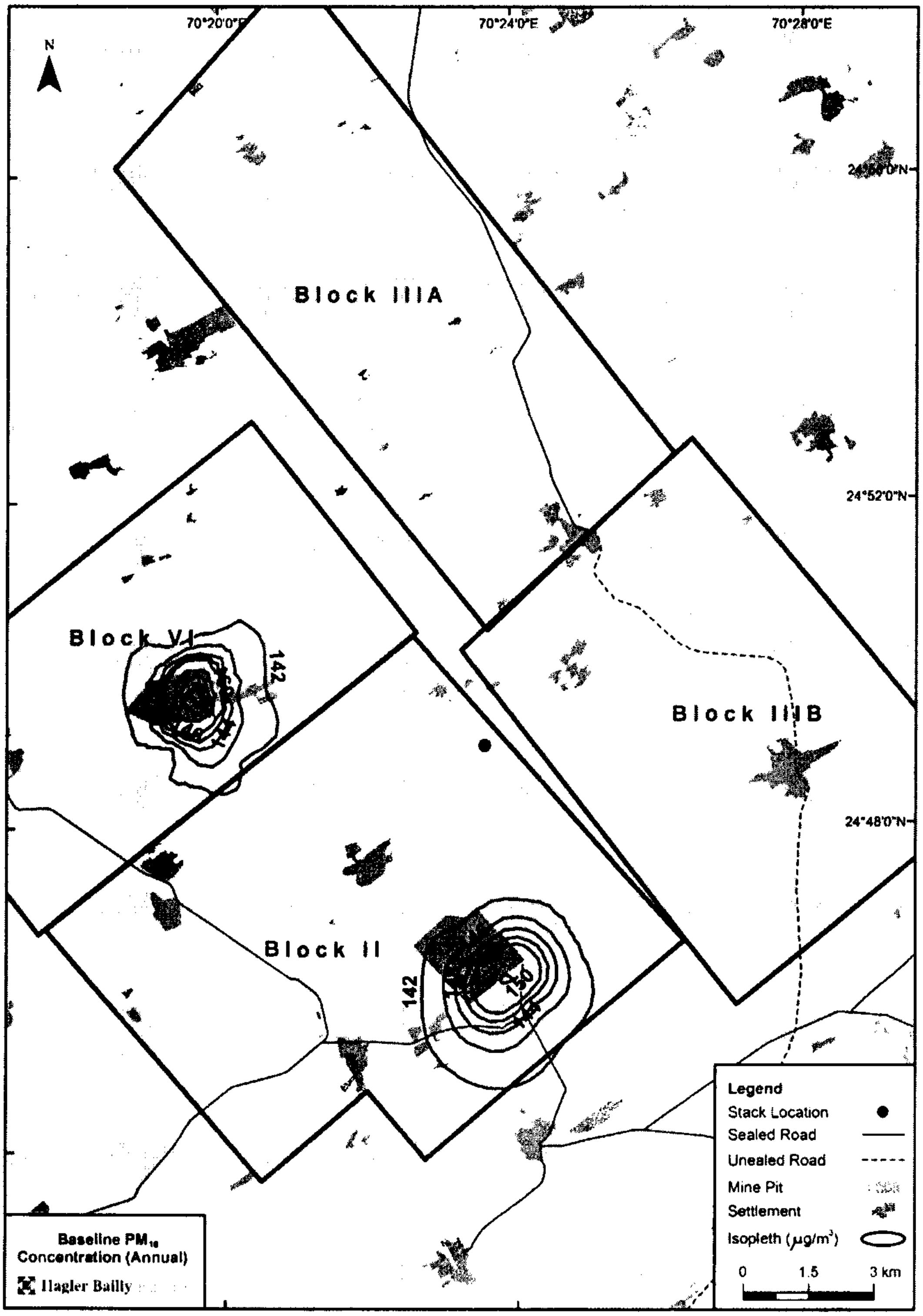


Exhibit 4.25: Baseline PM_{10} Concentration (24-hour)

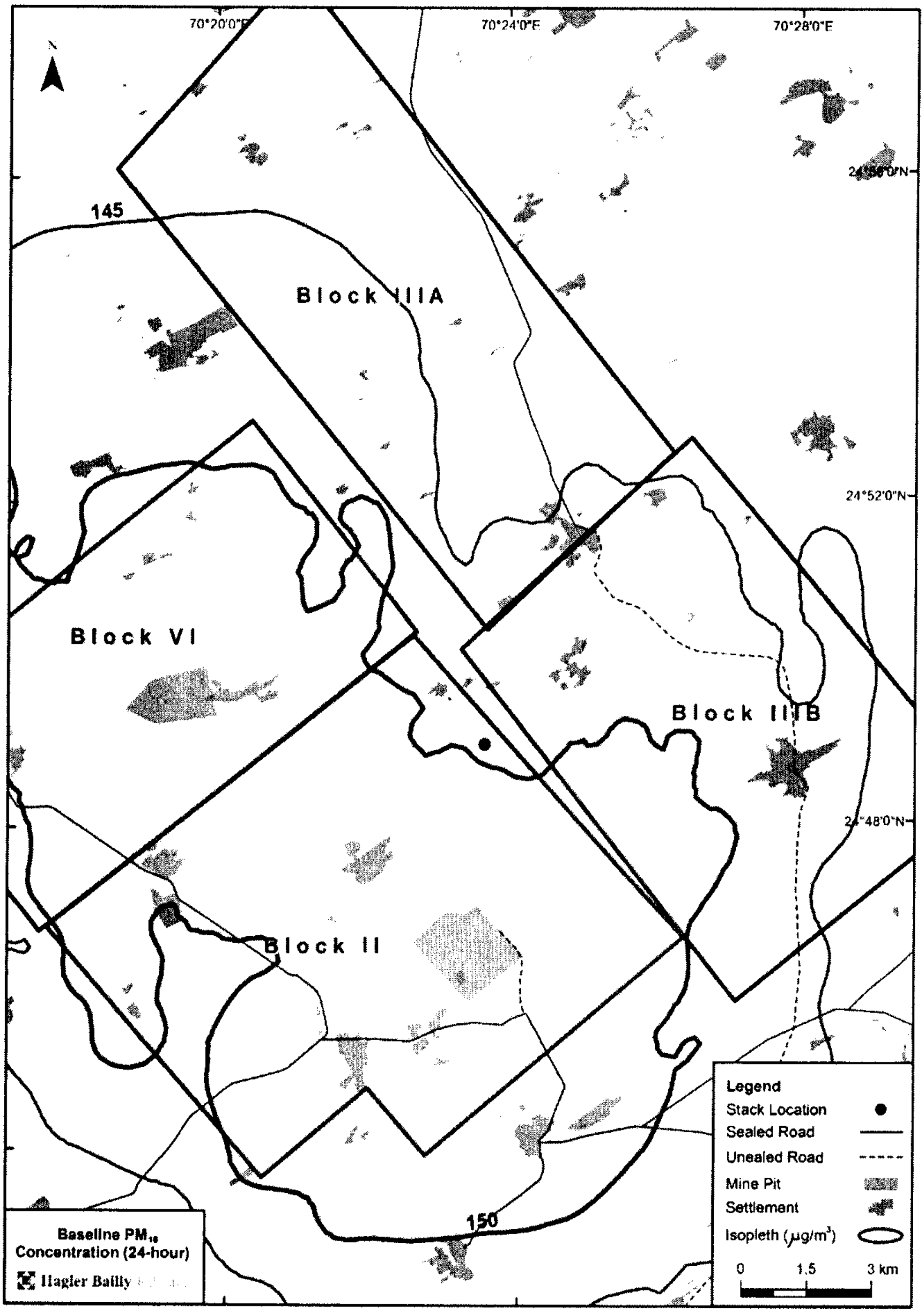


Exhibit 4.26: Baseline $PM_{2.5}$ Concentration (Annual)

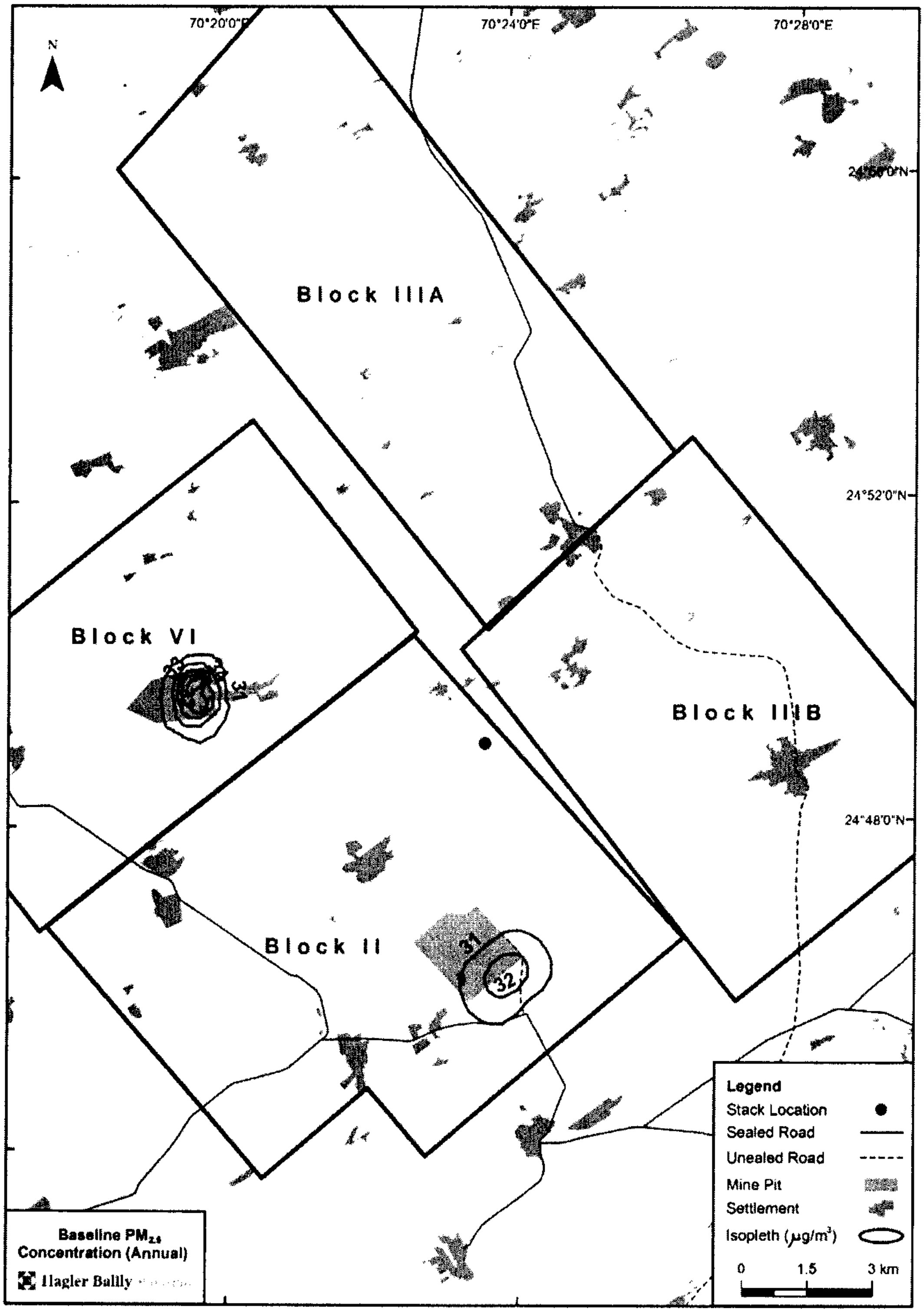


Exhibit 4.27: Baseline $PM_{2.5}$ Concentration (24-hour)

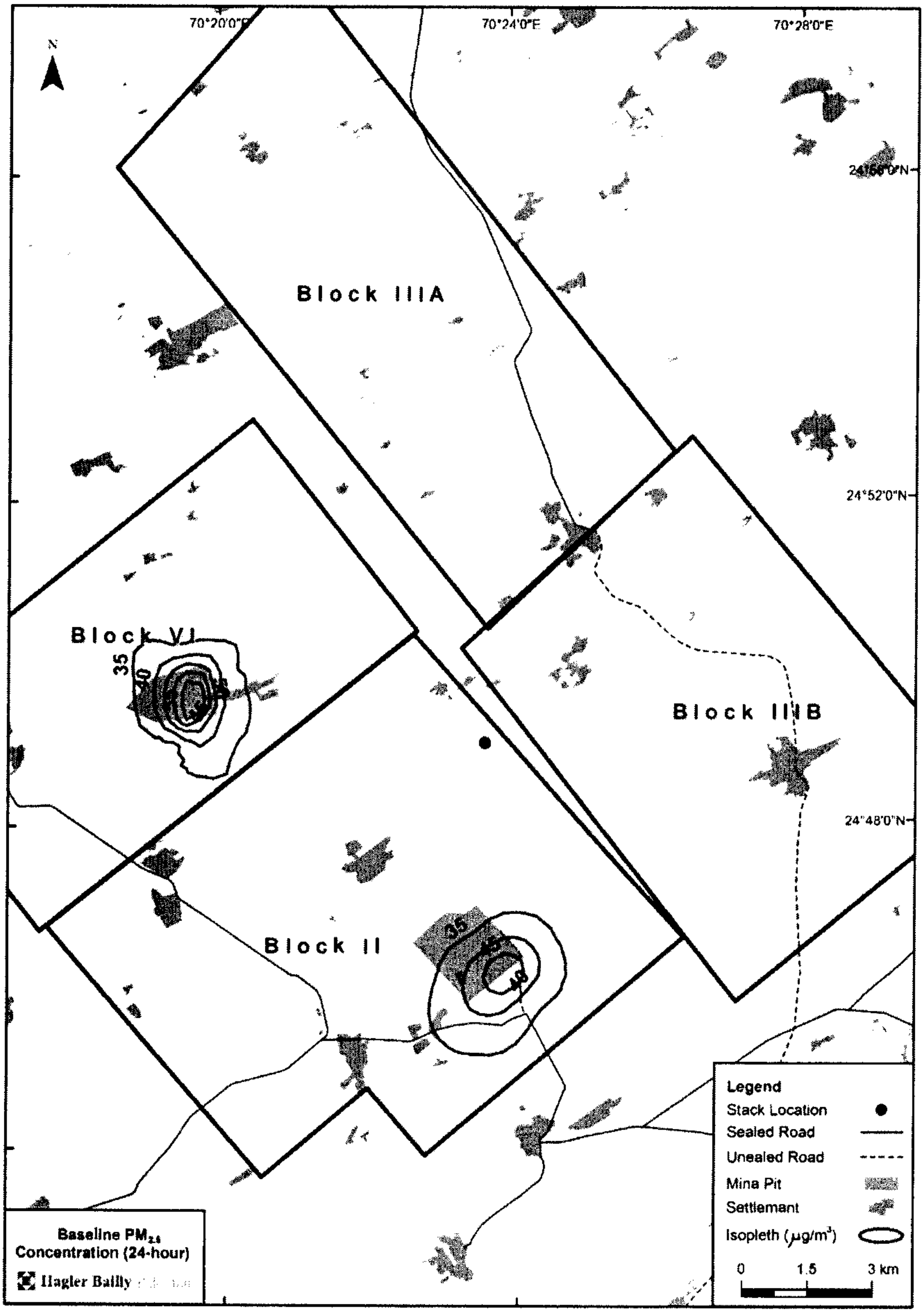


Exhibit 4.28: Combined Baseline Results (µg/m³)

Pollutant	*Averaging Period*	*Measured Baseline*	*Modeled Increment*	*Simulated Baseline*	*SEQS*	*IFC EHS limits*
SO_2	24-hour Max	7	22.4	29.4	120	125
	Annual Average		6.4	13.4	80	-
NO_2	24-hour Max	3	14.6	17.6	80	-
	Annual Average		4.2	7.2	40	40
PM_{10}	24-hour Max	140	133.534	273.534	150	150
	Annual Average		8.417	148.417	120	70
$PM_{2.5}$	24-hour Max	30	12.498	42.498	75	75
	Annual Average		1.185	31.185	40	35

The following conclusions can be drawn:

- The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits.
- The 24-hour PM_{10} concentrations exceed both SEQS and IFC EHS at 28% of the area (195 km² out of total area of 700 km²). The spatial distribution of the area that exceeds the standards is shaded in **Exhibit 4.25**.
- The annual PM_{10} concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average. 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 24-hour $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits. The annual concentrations complies with SEQS but exceeds IFC EHS limits. The modeled 24-hour and annual concentrations complies with the standards. When added to the modeled baseline elevated $PM_{2.5}$ levels exceed the annual IFC EHS limits as shaded in **Exhibit 4.28**.

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.

Primary Data

To determine the baseline noise in the area, sound levels were measured at selected locations considered representative of the nearby receptors of possible noise pollution from the Project. These locations are given in **Exhibit 4.29**. The survey was conducted from the May 11 to 15, 2016. Per second measurements were taken for 24 hours at each location.

Exhibit 4.29: Description of Sampling Sites

ID	*Location*	*Coordinates*	*Dates of Survey*	*Rationale*
N1	Bitra	24° 49' 37.8" N 70° 22' 59.5" E	May 12, 2016	Nearest receptor (village)
N2	Jaman Samo	24° 49' 19.4" N 70° 24' 19.1" E	May 14, 2016	Background levels near the Project site
N3	South of Energy Park	24° 48' 12.2" N 70° 24' 24.8" E	May 15, 2016	Background levels near the Project site
N4	Thahriyo Halipota	24° 45' 15.6" N 70° 21' 38.9" E	May 11, 2016	Road sound levels

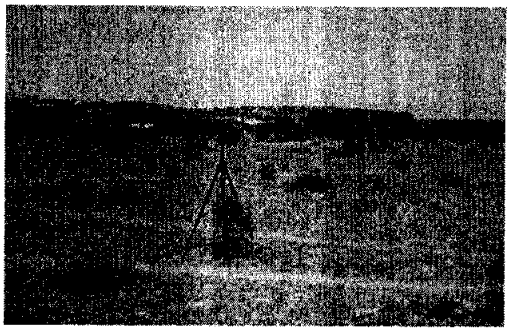
The survey was conducted with Cirrus Research plc.'s sound level meter, Model CR:1720. The instrument meets the International standards IEC 61672-1:2002, IEC 660651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986, and ANSI S1.43-1997 where applicable. The instruments have a resolution of 0.1 dB.

The instrument was mounted on a tripod, to avoid interference from reflecting surfaces within the immediate neighborhood, and a wind shield was used in all measurements. Photographs of the sampling equipment setup are provided in **Exhibit 4.30**. Day time hours are considered to be from 6 am to 10 pm and night time hours are taken to be from 10 pm to 6 am as per SEQS standards for noise.

Exhibit 4.30: Sound Sampling Site Photographs

Sound meter at N1 (Bitra, village)

Sound meter at N2 (background levels)



Sound meter at N3 (background levels)

Sound meter at N4 (Thahriyo Halipota, village near road)

Secondary Data

Additional data on sound levels in the Project area was available from previous ESIA[34]. The previous sampling locations along with the description of each is given in **Exhibit 4.31**.

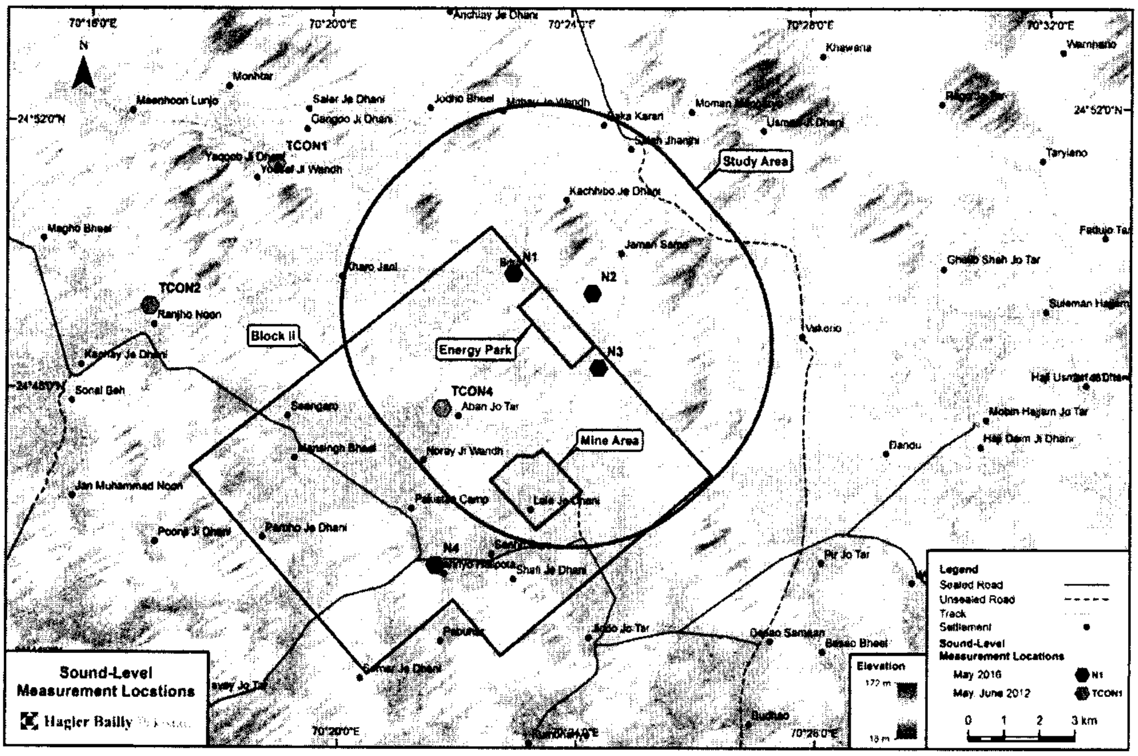
The current and previous sampling locations are shown in **Exhibit 4.32.**

Exhibit 4.31: Sound Level Sampling Locations in Literature

Sample ID	*Coordinates*	*Dates of Survey*	*Description*
TCON1	24° 51' 18.9" N 70° 19' 02.8" E	October 2012	Yaqoob Ji Dhani
TCON2	24° 49' 12.1" N 70° 16' 55.8" E	October 2012	Ranjho Noon
TCON4	24°47' 37.5" N 70° 21' 47.3" E	October 2012	Aban jo Tar

[34] 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 4.32: Sound-Level Measurement Locations



Measurement Results and Analysis

A summary of the results and SEQS for noise are provided in **Exhibit 4.33**. 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 4.33: Summary of Sound Levels during the Survey and from Literature

Point	*Description*	*24 hour (dBA)*			*Daytime Averages (dBA)*	*Nighttime Averages (dBA)*
		L_{90}	L_{10}	L_{eq}	L_{eq}	L_{eq}
Current Study						
N1	Village (Bitra)	31.8	52.4	51	51.8	46.0
N2	Background, no human presence	35.8	46.8	45	46.2	43.0
N3	Background, no human presence	29.0	41.1	40	41.9	34.2
N4	Road + Village	36.0	50.2	50	49.8	50.1
Literature						
TCON1	Village	31.6	44.2	46.8	48.6	41.1
TCON2	Village	25.8	44.5	43.9	45.5	38.6
TCON4	Village + Road	34.0	55.5	52.4	53.7	46.2
SEQS					**55.0**	**45.0**

Conclusion

The sound levels of the primary and secondary data are averaged[35] to obtain the sound level baseline as presented in **Exhibit 4.34** and discussed below.

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

Exhibit 4.34: 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[36]	**55**	**45**

The desert background, is very quiet and approximately 10 dBA below SEQS for both day and night time. 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.

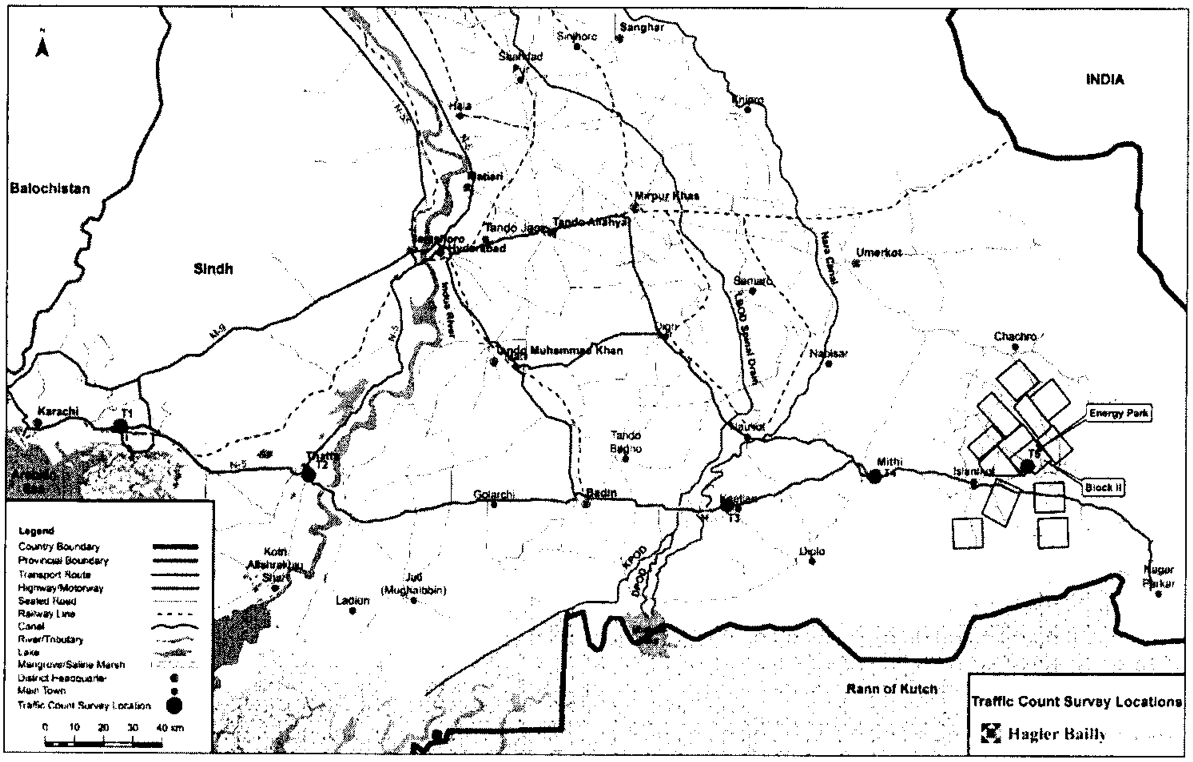
The selected transport route from Karachi to the Project site is shown in **Exhibit 4.35**. The route, is 366 km long and passes through the following towns:

Karachi (PQA) → 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

36 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.

Exhibit 4.35: Transport Route and Traffic Count Survey Locations



Traffic counts are reported at five points as shown in **Exhibit 4.35**. A photograph of the surveyors and site location is given in **Exhibit 4.36**.

The data for four points (T1, T2, T3, and T4) are based on previous surveys[37]. The previous surveys were conducted between 2012 and 2014. To ascertain the present traffic condition, traffic counts from previous surveys were extrapolated using an annual growth rate of 2.58%[38]. The results are shown separately for each direction in **Exhibit 4.37**.

A traffic count for T5 was conducted for this ESIA on May 12, 2016, on the newly constructed road that will provide access to the Project Site.

Exhibit 4.36: Traffic Survey Location

[37] 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.

[38] Pakistan Sustainable Project, "Principle policy guidelines for Sindh urban transport policy", December, 2014.

Exhibit 4.37: 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. [39]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[40]. 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
- 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 in the Study Area for a previous study[41]. The results are summarized below and the locations shown in **Exhibit 4.38**.

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

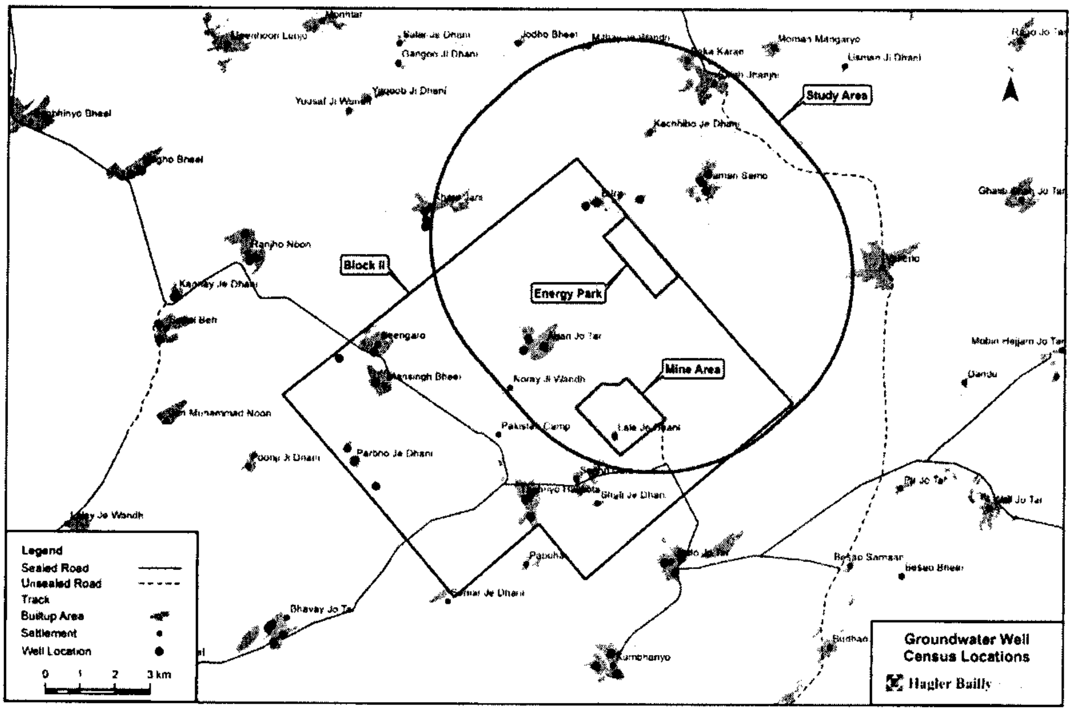
[40] Bender, 1995, Geology of Pakistan

[41] 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 4.39**.

Exhibit 4.38: Groundwater Well Census Locations[42]



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

Exhibit 4.39: Water Quality in the Study Area[43]

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

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

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.

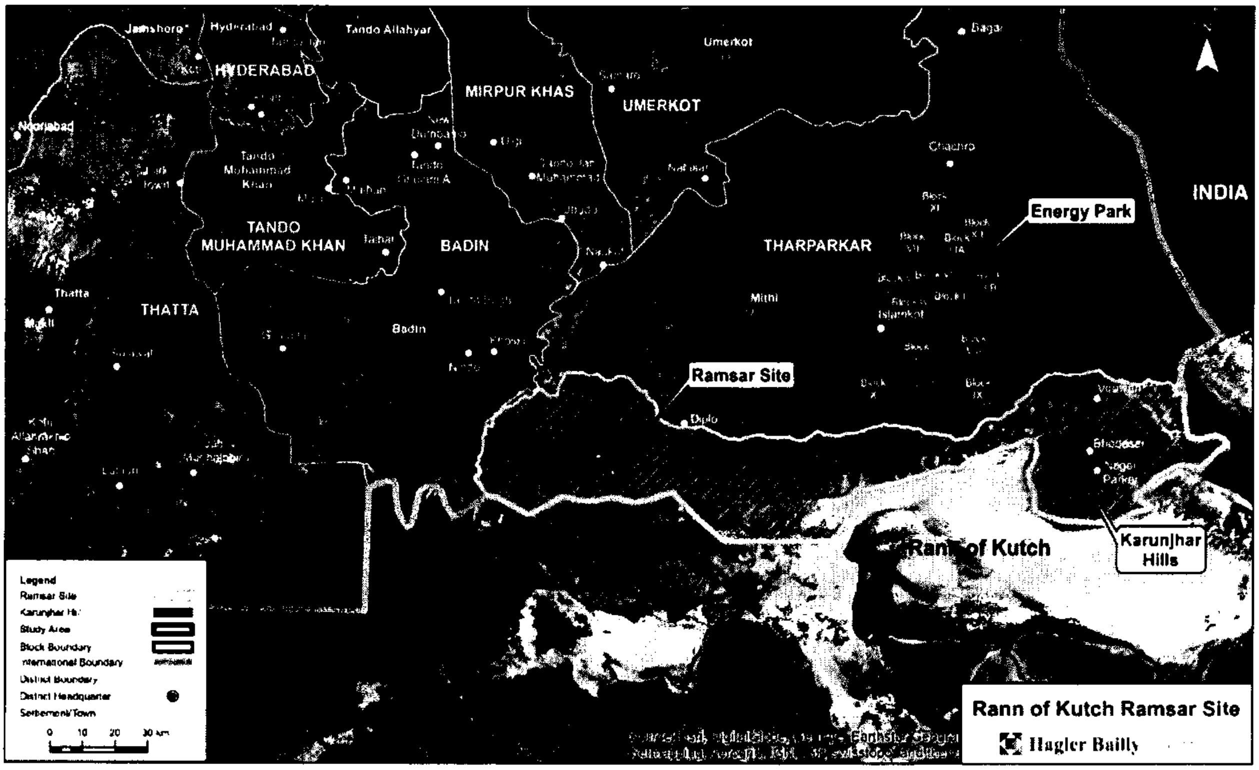
4.4.1 Protected Areas in the Vicinity of the Study Area

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.[44] 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.[45] 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 4.40**.

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

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

Exhibit 4.40: 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 4.41**.

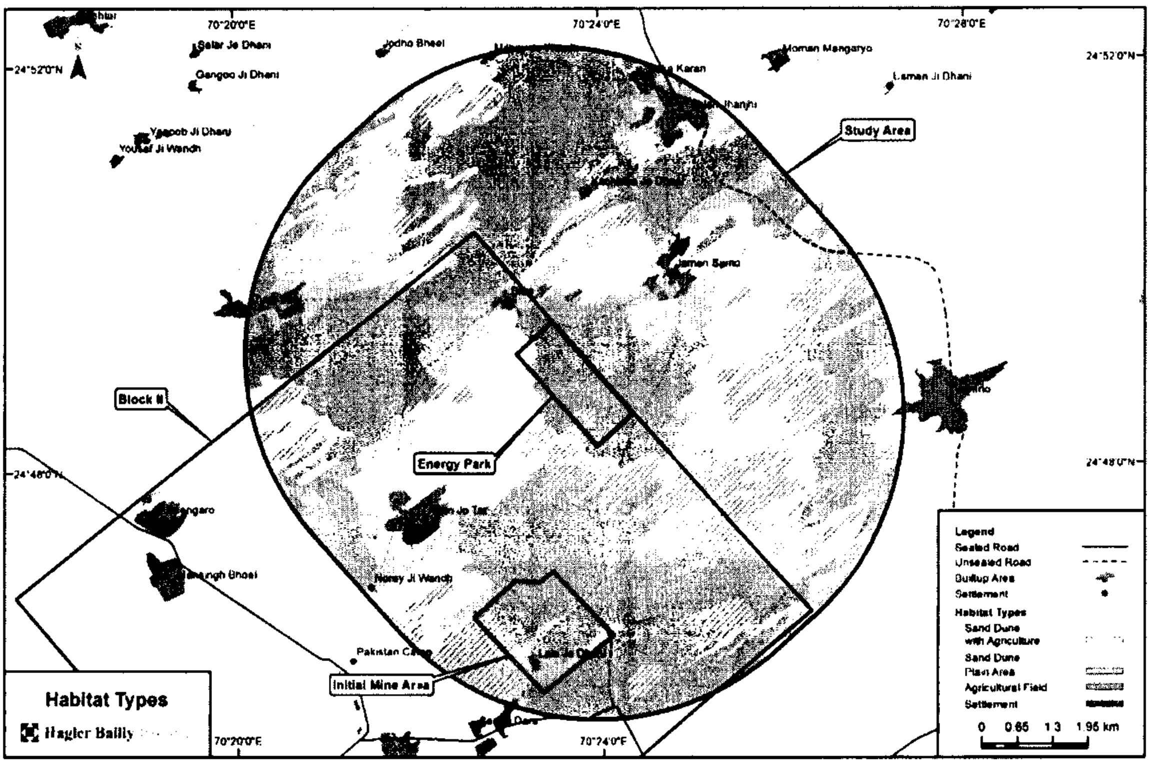
A map showing the distribution of the different habitat types has been shown in **Exhibit 4.42**.

Exhibit 4.41: Table giving Habitat type Percentages

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 4.42: 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.[46] It comprises mainly scattered trees and bushes.[47] These are mainly thorny, drought resistant species and grasses. Following rains, lush green grasses sprout providing a rich source of fodder.[48] The vegetation is typical of arid regions with adaptations to survive the extreme conditions of the desert environment.[49]

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.[50]

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

47 Ibid

48 Ibid

49 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.

50 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.[51] It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[52]

The data for the vegetation survey carried out for the Thar Coal Block II Mining Project[53] has been provided in **Appendix D** 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).[54]

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[55] 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.[56] 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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51 UNEP-WCMC. SPECIES+ CITES database. < http://www.speciesplus.net/species > accessed November 20, 2015

52 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

53 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

54 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)

55 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

56 Ibid

The data for the mammal survey carried out for the Thar Coal Block II Mining Project[57] has been provided in **Appendix D** 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[58] 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[59], 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[60] has been provided in **Appendix D** 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.[61] 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

[57] 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

[58] Ibid

[59] Ibid

[60] Ibid

[61] 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.[62]

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*.[63] None of these amphibian species are of conservation importance based on the IUCN Red List of Threatened Species,[64] however, the Indian Bullfrog is listed in Appendix II of the CITES Species List.[65]

None of the species observed or reported in the area are on the IUCN Red List of Threatened Species. However, according to one reference[66], 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.[67]

The data for the herpetofauna survey carried out for the Thar Coal Block II Mining Project[68] has been provided in **Appendix D** 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.[69] It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.[70]
- 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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62 Ibid

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

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

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

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

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

68 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

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

70 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.

Data Sources

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:

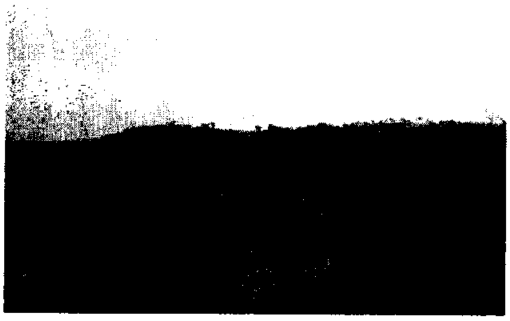
- Information collected from the Thardeep Rural Development Programme offices;
- Development Statistics of Sindh, 2006;
- Pakistan Social and Living Standards Measurement Survey (PSLM) 2006-07;
- District Census Reports, 1998, published by Population Census Organization, Government of Pakistan;

- 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.

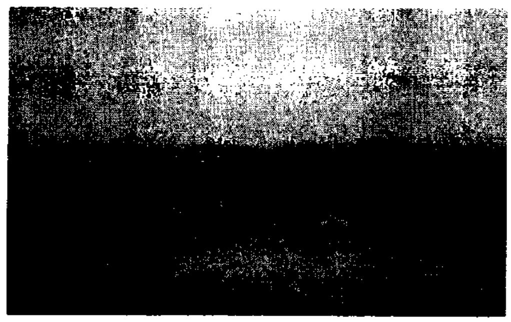
4.5.1 Land Cover and Land Use

The Study Area covers 111 square km of which of sand dunes cover 43 km^2 (38%) and plains cover 69 km^2 (62%)[71]. Major land uses in the Study Area consists of settlements (2%), agricultural fields (61%) and grazing areas (37%). 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 4.43**. The distribution of these uses is given in **Exhibit 4.44** and a land use map is shown in **Exhibit 4.45**.

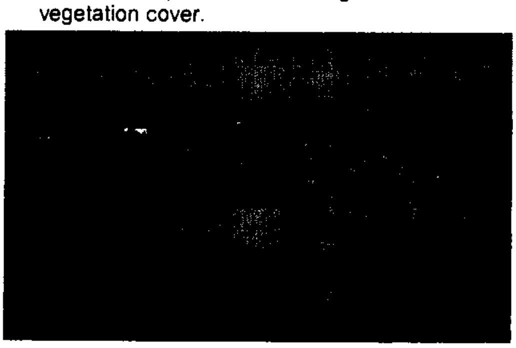
Exhibit 4.43: Photographs of Different Land Uses in the Study Area



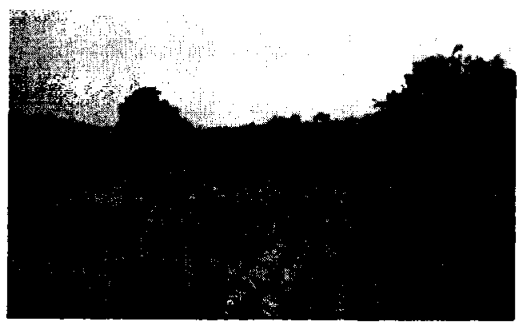
Sand dunes are permanent with significant vegetation cover.



Uncultivated plains are used for grazing livestock.



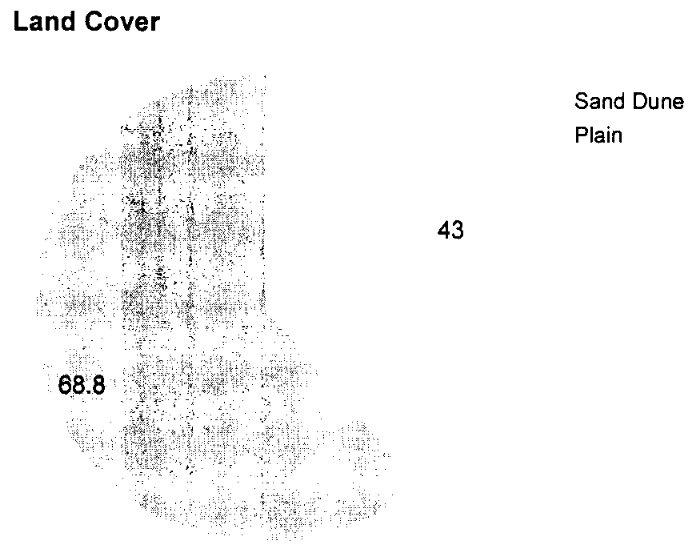
A village on the plain, nestled between dunes.



Agriculture field on the plains.

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

Exhibit 4.44: Land Cover and Land Use Distribution in the Study Area



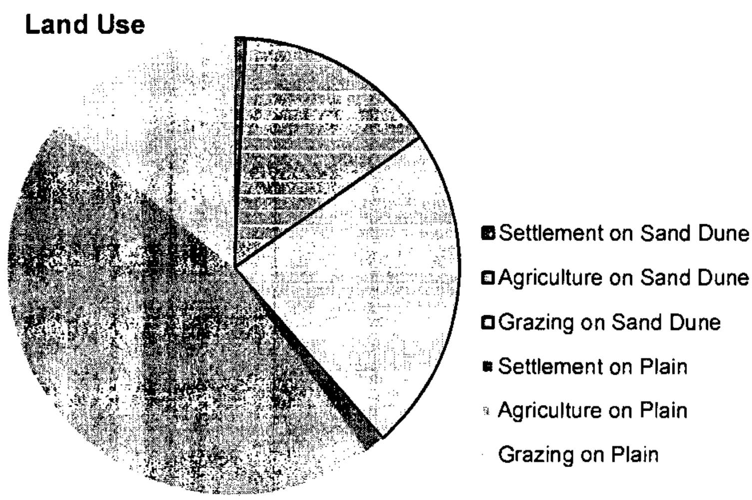
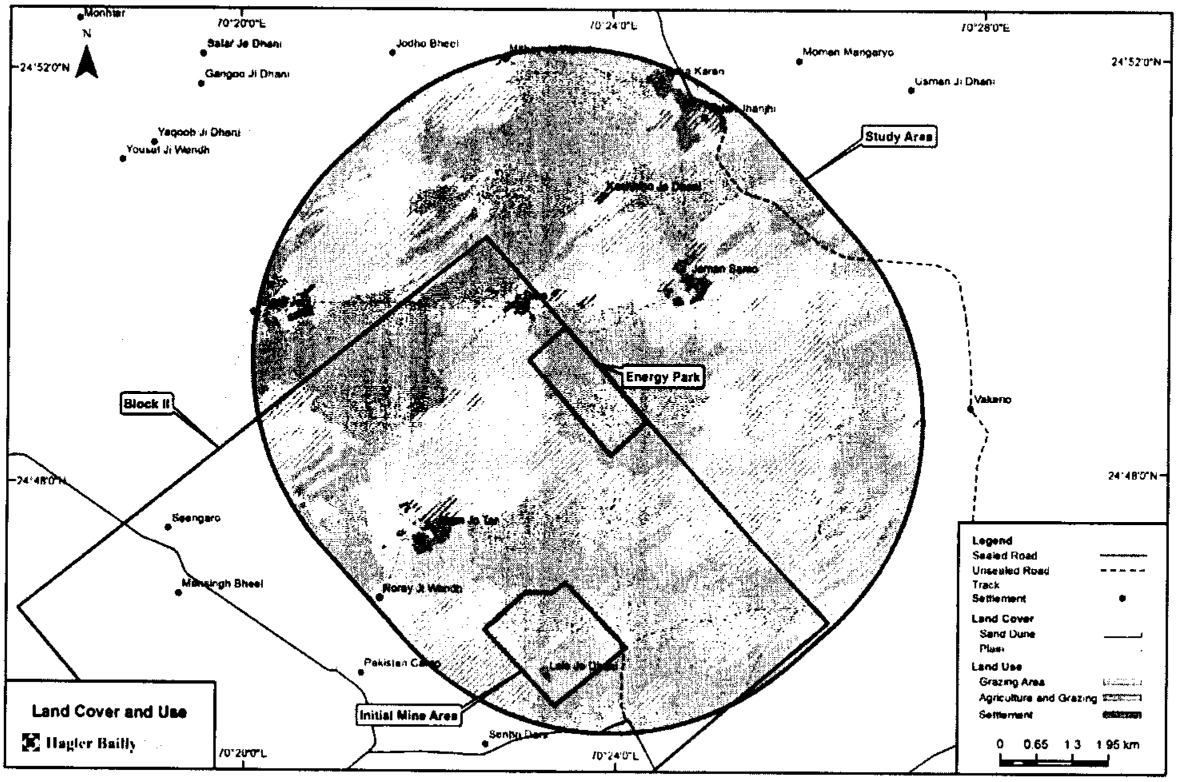


Exhibit 4.45: Land Cover and Land Use



4.5.2 Demography

The estimated population of the Tharparkar District ('District') as compared to Sindh and Pakistan is given in **Exhibit 4.46.** 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 4.46: Population and Growth[72]

	Population, 000'				*Land Area*		*Density (persons per sq. km)*	
	1998	*%*	*2015**	*%*	*sq. km*	*%*	*1998*	*2015**
Study Area	NA	NA	6.2**[73]		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 4.47**.

Exhibit 4.47: Population of Settlements in the Study Area[74]

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

72 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)

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

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

No	*Village*	*Population*
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 4.48** and **Exhibit 4.49** respectively. The population density map in **Exhibit 4.50**, shows the 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 4.48: Average Population per Settlement in Tharparkar and Study Area[75]

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

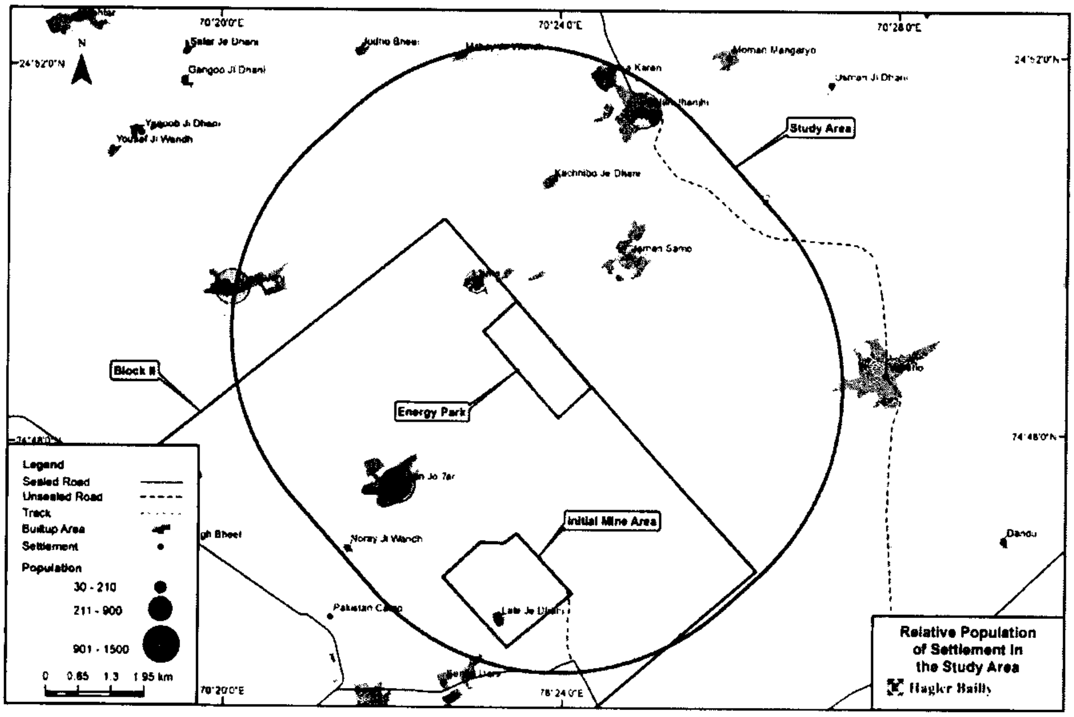
Exhibit 4.49: Average Household Size

	Sample Size	*Average Household Size*
Previous Study[76]	81	6.2
Rural Tharparkar (1998)	156,591	5.6
Save the Children	383	8.3

[75] Ibid

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

Exhibit 4.50: Population Distribution in the Study Area[77]



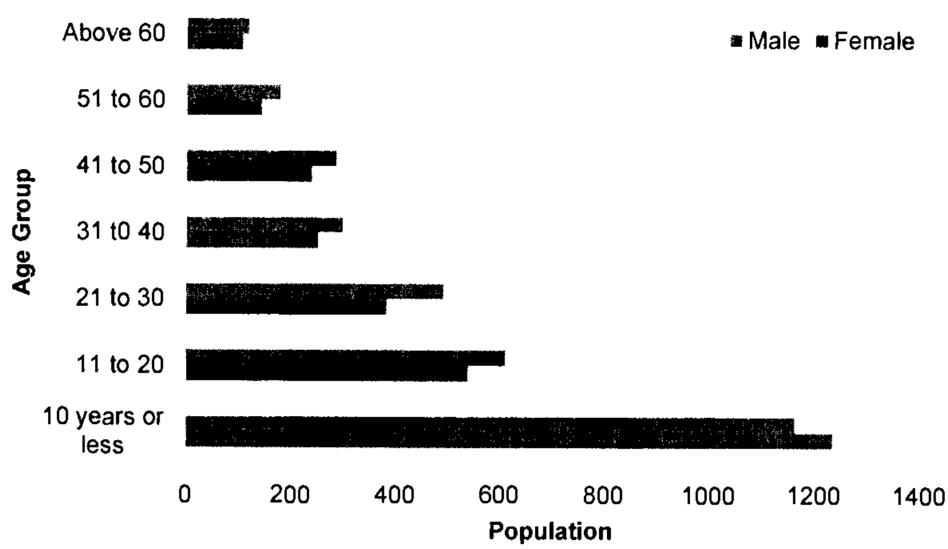
[77] Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

Gender and Age Profile.

The population pyramid of the Study Area is shown in **Exhibit 4.51**. 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 4.51: Age and Sex Composition of Study Area[78]



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 4.52** 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

[78] 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).[79]

Exhibit 4.52: 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

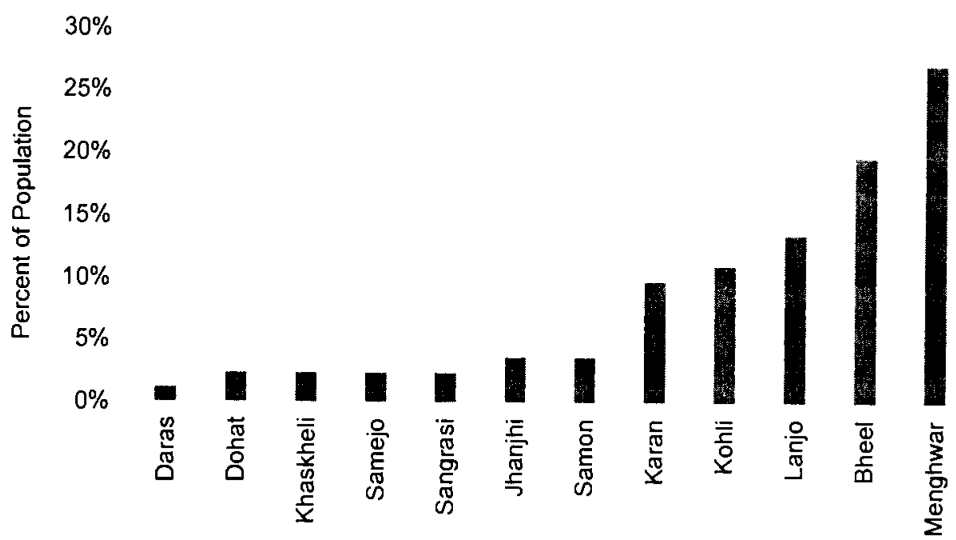
Source: District Census Report of Tharparkar, 1998, Population Census Organization, Statistics Division, Government of Pakistan

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 4.53**.

Exhibit 4.53: Distribution of Population in the Study Area by Castes[80]



[79] 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

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

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. 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 4.54: People of the Study Area

Village elders

Indigenous women

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.

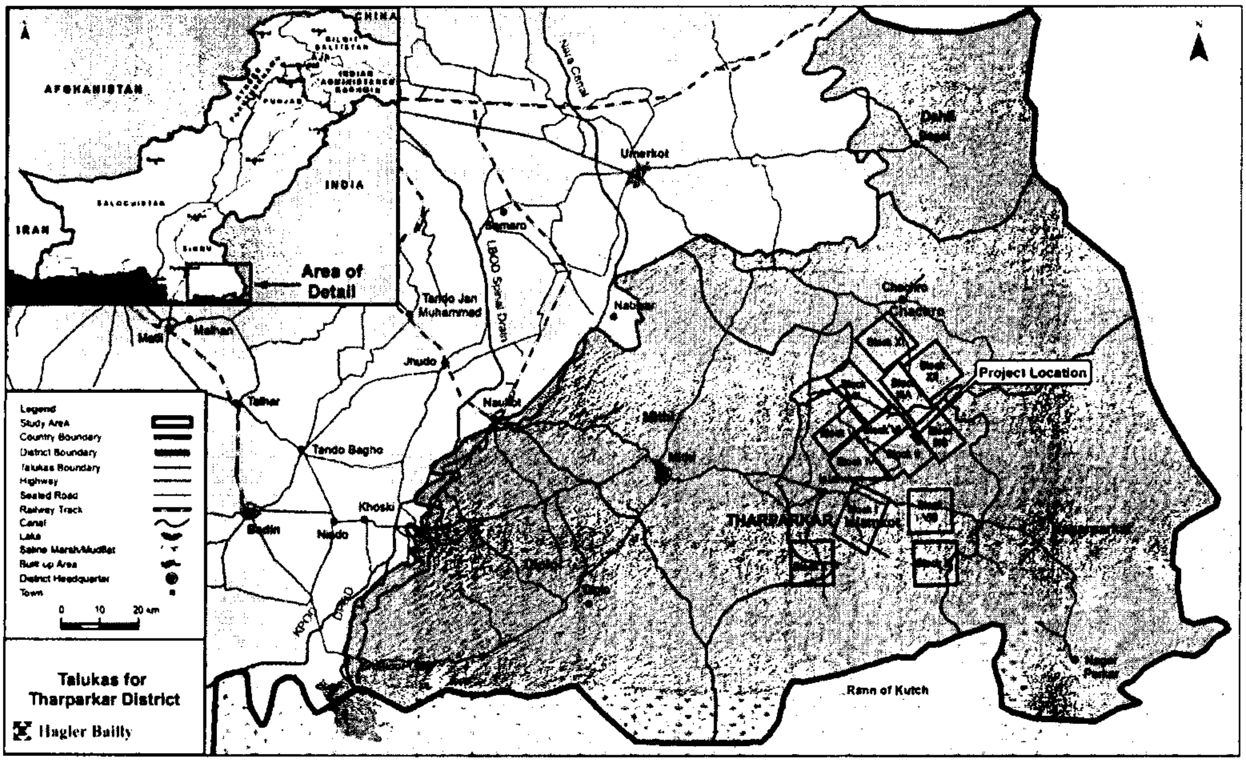
Tharparkar is administratively divided into six *talukas*, namely Mithi, Diplo, Nagarparkar and Chachro, Dhali and Islamkot. The taluka are further sub-divided into Union Councils, town committees and municipal committees. Each Union Council has villages *(dehs)* under its administration, while the municipal and town committees have municipal or town subdivisions called *wards*. The Energy Park falls within the Islamkot *taluka* as shown in **Exhibit 4.55**.

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 4.55: 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.[81]

Exhibit 4.56: Average Annual Yield, Usage and Average Income from Crops Grown[82][83]

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 4.57** 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 4.58** and average livestock held by each household in **Exhibit 4.59**.

81 Development Statistics of Sindh, 2006

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

83 Average income (Rs/kg) taken from Resettlement Study Sample Household Survey

Exhibit 4.57: Typical images of Livestock

Camels

Livestock use roads to access grazing areas.

Exhibit 4.58: Livestock Population in Study Area

Type of Livestock	*Livestock Population in Study Area*[84]	*Livestock Population in Tharparkar (2000)*[85]
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 4.59: Average Livestock Population and Average Price of Livestock[86]

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 4.60**, include shops that are located in larger settlements or on the roadsides.

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

[85] Development Statistics of Sindh, 2006

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

Exhibit 4.60: 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[87]. 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[88]. 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[89] was Rs

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87 Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Center, Karachi

88 Ibid

89 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,[90] 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.[91]

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%[92]. 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 4.61.**

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90 Government of Pakistan, Pakistan Household Integrated Economic Survey 2010-11, Federal Bureau of Statistics, Islamabad.

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

92 Reaching Out from Thar to Other Arid Zones of Sindh, Annual Report 2004-05; Thardeep Rural Development Programme (TRDP)

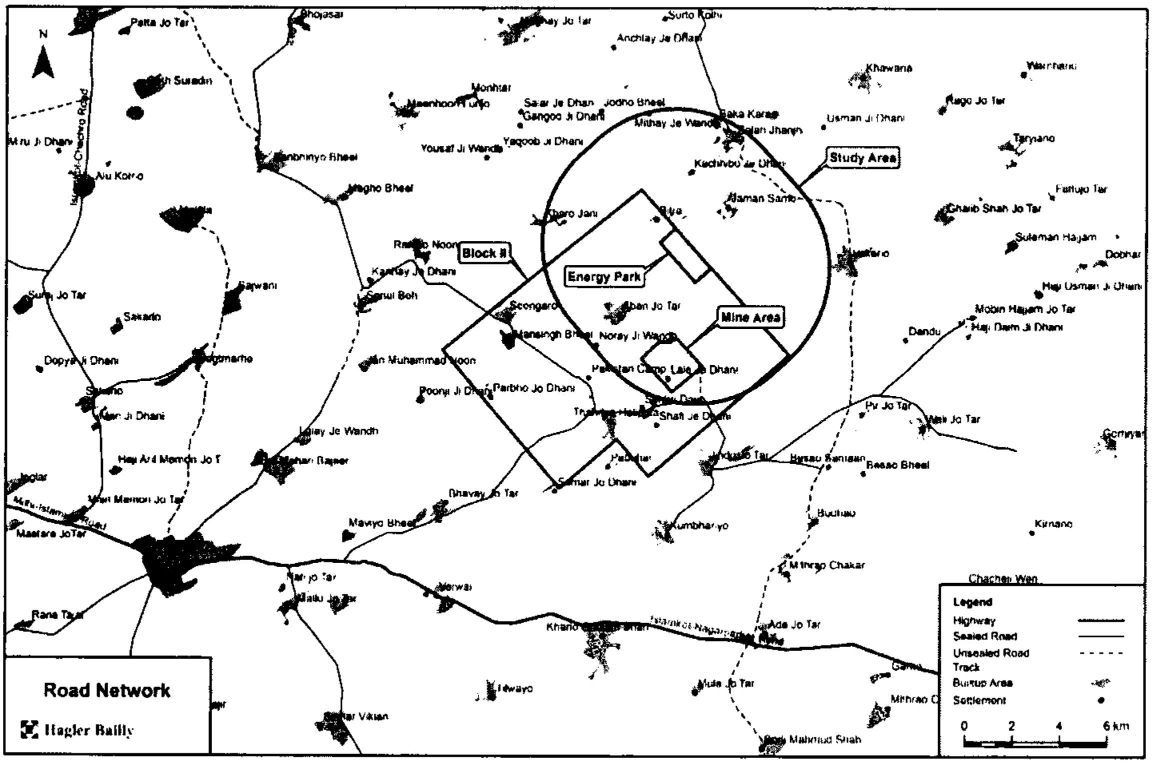
Exhibit 4.61: Satellite Dish Connections[93]

According to a 2006 report the District has a total of 737 km of roads, 529 km of which are of low quality[94]. 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 4.62.**

[93] Source: HBP Library

[94] Development Statistics of Sindh 2006

Exhibit 4.62: Road Network



Community Water Supply and Quality

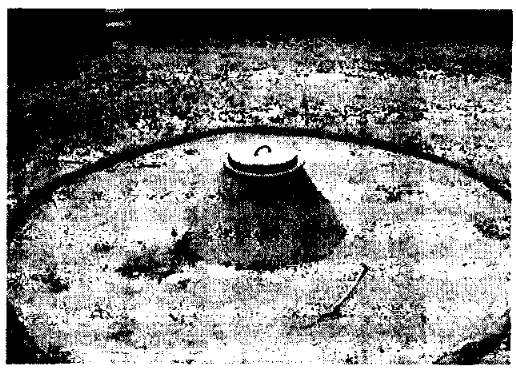
Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais,* and small underground tanks called *tankas.* There are also wells in lower 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 4.63.**

Exhibit 4.63: Water Sources in the Study Area

Tarai[95]



Tanka

Dug Well

Collecting water in a pond for the livestock

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[95] 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.[96]

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 4.64**.

Exhibit 4.64: Housing Structures in the Study Area[97]

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.[98]

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

[97] Source: HBP Library

[98] 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[99].

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[100]. **Exhibit 4.65** shows a comparison of the number of government health facilities present in Tharparkar in 1998 with the number of facilities present in 2005[101]. 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 4.65: 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)[102], 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

[99] 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

[100] Emergency obstetric care (**EmOC**) refers to the care of women and newborns during pregnancy, delivery and the time after delivery

[101] 1998 District Census Report of Tharparkar; Development Statistics of Sindh, 2006.

[102] Thardeep Rural Development Programme (TRDP), 'Socioeconomic and Environmental Aspects of Coal Mining in Tharparkar District' (2003)

facilities. Islamkot has a rural health center (RHC), while Mithi has a district hospital facility.

Education

Literacy[103] 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[104] was recorded at 57% for males and 13% for females in rural Tharparkar in 2011[105].

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 4.66**). The gender disparity in enrollment at the primary level, though present, is less pronounced.

Exhibit 4.66: Net Primary Enrollment Rate in Rural Localities, 2010-2011[106]

	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

[103] 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."

[104] Literacy in population aged 15 years and above

[105] Pakistan Social and Living Standards Measurement Survey 2010-11

[106] Pakistan Social and Living Standards Measurement Survey 2010-11

Mirs (Talpurs), which belongs to the Talpur period (1784 to 1843),[107,108] had a square plan. 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.

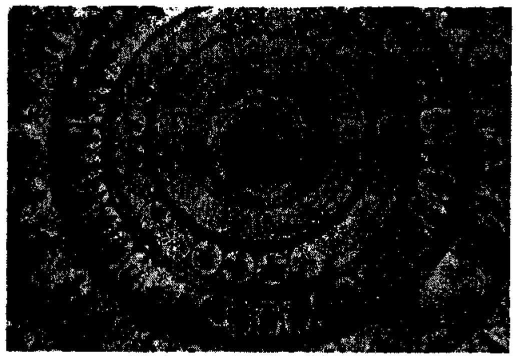
The Gori temple is said to be built around 1376 AD, in the golden era of the Sodhas. Images of the temple are shown in **Exhibit 4.67**. Other important cultural sites that are close to the Study Area are mapped in **Exhibit 4.68**.

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 4.67: Gori Temple[109]

View of the Gorri Temple



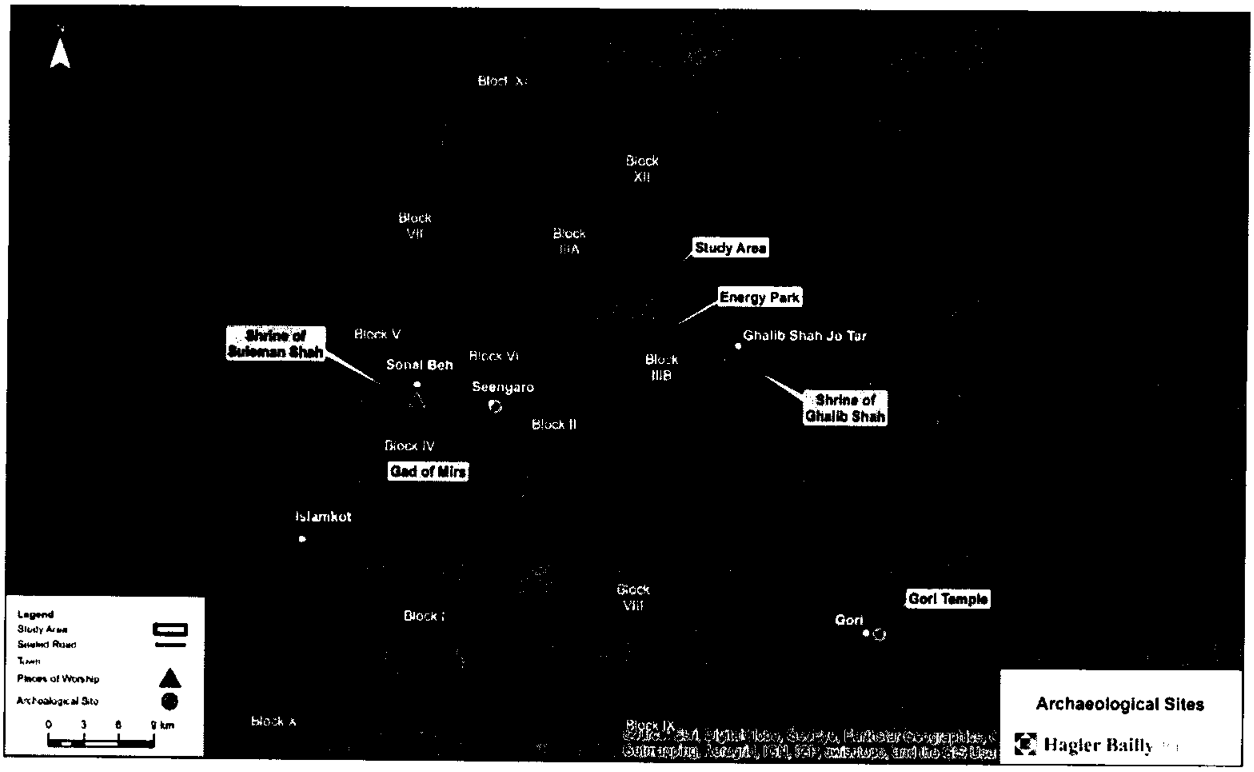
View of roof inscriptions inside the Gorri Temple

[107] Ursani, M.I., *Ser Registan (Travels into desert)* 2nd edition, Jamshoro, Sindhi Adabi Board (1995)

[108] Baloch, N.A., Sindh: Studies Historical, Jamshoro, University of Sindh (2003)

[109] Source: HBP Library

Exhibit 4.68: Archeological Sites and Major Places of Worship



5. Public Consultation and Disclosure

Stakeholders are groups and individuals that are affected by or can affect the outcome of a project. Stakeholder engagement is a broad, inclusive and continuous process between a company and its stakeholders. It encompasses a range of coherent activities and approaches, spanning the entire life cycle of a project. The objective of conducting stakeholder consultations during the EIA process is to inform all the stakeholders about the Project, record and take into account their opinions, suggestions and concerns and establish confidence amongst the Project stakeholders that the Project is developed in a responsible way. This is achieved by informing the stakeholders in a timely manner about the proposed project and its potential consequences on the environment and by encouraging their feedback.

5.1 Consultation Methodology

The methodology adopted for consultations was in line with the legal framework adopted for the Project EIA. It is summarized below.

5.1.1 Consultation Material

The main document for distribution to stakeholders during the consultations was the Background Information Document (BID). The BID contained information on the Project and the EIA process. The BID for the Project is included in **Appendix E**. The consultation material was made available to the stakeholders in English and Sindhi (for communities in the Study Area), to suit their language preference.

5.1.2 Community Consultation Mechanism

The community consultations were conducted with the community members within their settlements to encourage and facilitate their participation. Separate consultation sessions were arranged for the community women. The list of communities consulted along with the dates when the consultations took place are shown in **Exhibit 5.1**. Photographic record of the consultations with the men from the communities are presented in **Exhibit 5.2**, whereas, photographs of consultations with the women of the community are not presented in consideration of local customs and traditions. Communities where stakeholder consultations were conducted are shown on a map in **Exhibit 5.3**. The meetings progressed in the following manner:

- An overview of the Project and EIA process was provided to the community representatives. The main point of the BID was read out to them in Sindhi and Dhatki.
- Members of the communities were given the opportunity to raise queries or concerns regarding the Project. Queries were responded to and concerns were documented.

Exhibit 5.1: List of Communities Consulted

No	*Stakeholder Group*	*Stakeholders*	*Date of Consultation*
1.	Villages within the Study Area	1. Baka Karan,	May 12, 2016
		2. Salah Jhanjhi,	May 12, 2016
		3. Kachhibo Je Dhani,	May 14, 2016
		4. Jaman Samo,	May 12, 2016
		5. Bitra,	May 13, 2016
		6. Mithay Je Wandh,	May 13, 2016
		7. Kharo Jani,	May 13, 2016
		8. Aban Jo Tar,	May 13, 2016
		9. Shafi Je Dhani[110]	May 13, 2016
		10. Noray Ji Wandh	May 14, 2016
		11. Lale Ji Dhani	May 25, 2016

Exhibit 5.2: Photographs of Community Consultations


Male consultation at village Aban jo Tar


Male consultation at village Kachhibo Je Dhani


Male consultation at village Baka Karan


Male consultation at village Jaman Samo

[110] Consulted as representative community on the access route of the Project.

Male consultation at village Noray Ji Wandh

Male consultation at village Mithay Ji Wandh

Male consultation at village Kharo Jani

Male consultation at village Salah Jhanjhi

Male consultation at village Shafi Je Dhani

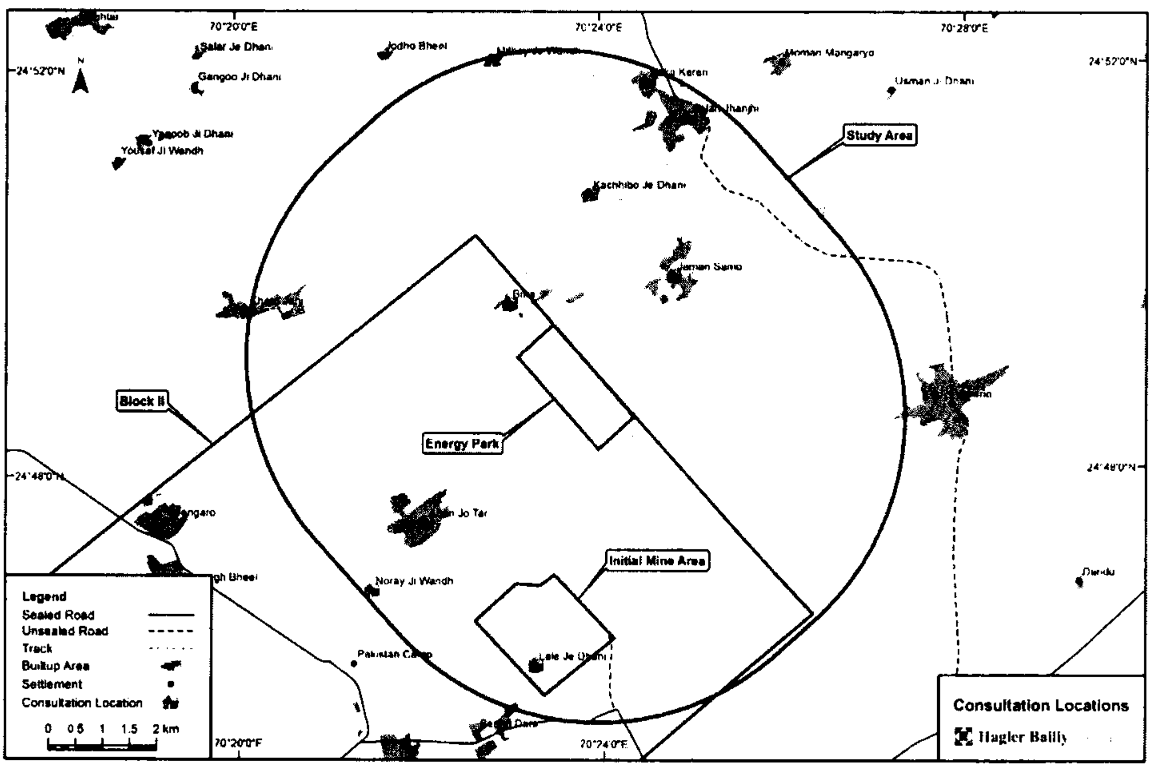
Male consultation at village Bitra

Male consultation at village Lale Je Dhani

Female consultation at village Kachhibo Je Dhani[111]

[111] Photographs of the remaining female consultations were not taken in respect of the local tradition of purdah or veil observance by women.

Exhibit 5.3: Locations of Community Stakeholder Consultations



5.1.3 Institutional Consultation Mechanism

Letters to inform the institutional and industrial stakeholders about the objective of the consultation process and to set up meetings with them were dispatched on May 20, 2016. The BID was enclosed with the letters containing information on the Project for the stakeholders. The list of the institutional stakeholders is provided in **Exhibit 5.4** and photographs of the meetings provided in **Exhibit 5.5**. The meetings progressed in the following manner:

- Stakeholders were provided an overview of the Project description;
- The EIA process that will be undertaken for the Project was briefly described and the structure of the EIA report was presented to facilitate understanding of the process;
- Stakeholders were given the opportunity to raise queries or concerns regarding the Project. Queries were responded to and concerns were documented;

Exhibit 5.4: List of Institutional Stakeholders

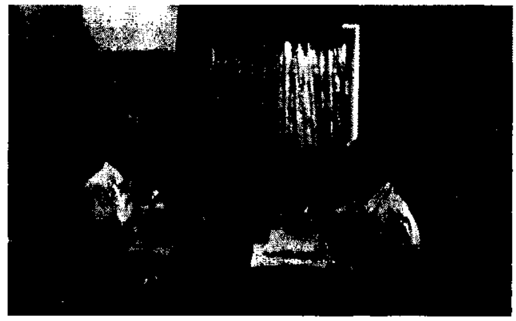
No	*Stakeholder Group*	*Stakeholder*		*Date of Consultation*
1.	NGOs	1.	Participatory Village Development Programme (PVDP)	May 24, 2016
		2.	Baanhn Beli	May 24, 2016
		3.	Sukar Foundation	May 24, 2016
		4.	Social Welfare	May 25, 2016
		5.	National Commission For Human Development (NCHD)	May 25, 2016
2.	Government	6.	Assistant Commissioner, Islamkot	May 24, 2016
3	Civil Society	7.	Press Club, Islamkot	May 25, 2016
		8.	Thar Coal Action Board	May 25, 2016
3.	Other Developers	9.	The Hub Power Company Limited	May 23, 2016

Exhibit 5.5: Photographs of Institutional Consultations

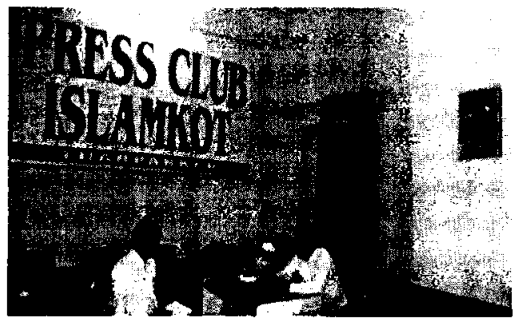

Consultation with PVDP


Consultation with Baanhn Beli


Consultation with Sukar Foundation


Consultation with NCHD


Consultation with Assistant Commissioner, Islamkot



Consultation with Press Club Islamkot


Consultation with Thar Coal Action Board


Consultation with DO Social Welfare

5.2 Summary of Key Concerns Raised by Stakeholders

The main issues and concerns raised by communities and local businesses area summarized in **Exhibit 5.6**. The proposed mitigation is documented alongside each concern. The complete logs of the stakeholder consultations are presented in **Appendix E.**

Exhibit 5.6: Key Community Stakeholder Concerns and Expectations

Issue	*Proposed Mitigation in EIA*
Environmental	
Asthma and skin diseases may increase due to pollution from the project. There is no local access to treat these diseases and the villagers have to travel to Mithi or Islamkot for treatment. Most fail to do so and small instances of disease become very serious health concerns.	The most up to date and efficient equipment will be used to reduce gaseous emissions. Dust suppression techniques will be used. See **Section 7.3** for details.
In June and July there is a fast, hot wind (called *lukh)* and it is already very dusty and hot because of this which causes disease to the livestock and the locals. The impact of coal ash and dust from the power plant will exacerbate the impacts of this hot wind.	Impact assessment, including cumulative impact assessment is presented in **Chapter 6.** Emissions from the Project will comply with SEQS and IFC guidelines for emissions.
The construction of the effluent channel has exposed a large amount of sand previously covered by small trees and bushes. This and other construction activities are exposing sand which will be blown into the air and cause lung disease.	The effluent channel is being constructed by GoS and is beyond the scope of the Project. Mitigation measures to be undertaken during the Project construction are detailed in the Environmental Management Plan (EMP) in **Chapter 7**.
One tree can sustain 2-3 goats. If the trees die then incomes of the community will be effected.	The project does not involve any significant removal of vegetation. All impact of vegetation will be within the Project Site and no tree will be cut outside.
The cumulative impacts of all these developments will greatly impact the environment of the area.	Cumulative impact assessment is presented in **Chapter 6**. A joint strategy should be developed by all developers in the area to address cumulative impacts.
The accidents on the roads will increase as the traffic in the area increases. This includes accidents with pedestrians and livestock that use these roads to travel between villages and to grazing areas.	Techniques to reduce the noise will be employed. Road and traffic route will be planned to avoid disturbance to community.
The soils of the desert are very sensitive and excessive use of machinery or vehicles strips the small fertile layer, reducing their productivity. The locals are heavily dependent on their agricultural land for income.	The construction management plan outlined in **Chapter 7**.

Issue	Proposed Mitigation in EIA
Drinking water is collected in large open rainwater harvesting ponds in many villages and is used for several months of the year. As these are open air ponds the water quality could be affected due to the ash and dust generated by the coal plant which may collect in these ponds and contaminate the fresh water. The dug wells may be impacted due to the mining activity hence, the already scarce water resources in the area will be further compromised.	As shown in the section on impact assessment, the increase in the dust due to the project will be marginal. The impact of depletion of water in dug wells is evaluated in the mining ESIA.
Socioeconomic	
Employment should be given to local persons especially to those from villages within the study area.	Strategies for hire locals, and training and development programs will be developed. These are detailed in the (EMP) in **Chapter 7**.
Hiring for current projects is not being undertaken based on merit, rather land lords and influential people of the area have a say in who gets employed.	
Marginalized communities, such as the Kohli community, own no land and work as labor on the fields. The community will be very happy if provided employment at the project however fear that the hiring process will be prejudiced by those with influence such as local leaders, resulting in their further marginalization. The project should hire locals from this community.	
Poor and marginalized communities do not have access to education or training to have the skills required to work at the project. Training, education and scholarships should be provided to these communities.	
Livestock is scared by the increase in traffic and noise from machinery during Project construction and operation, which may cause stress and disease. The community is dependent on the livestock for income.	Techniques to reduce the noise will be employed. Road and traffic route will be planned to avoid disturbance to community.
Cultural	
The privacy of women will be affected due to the project. Women currently collect fuel wood, tend to livestock etc. and the family is not concerned about their safety. However, with the increase of outsiders this freedom of movement for women will be reduced.	Cultural emersion and sensitization training will be a part of the induction program for new employees.
The increase of outsiders is affecting the culture of the villages. As the area becomes more accessible the family structure is being influenced by the values of the incoming people.	

Issue	*Proposed Mitigation in EIA*
Locals were provided compensation for land that was within Block II. However, many did not have any financial planning, as they were previously poor simple farmers, and some of them have ended up wasting a large amount of this money (such as through the purchase of cars, second weddings etc.) instead of investing it in income generating resources. Locals are concerned once this money ends, which is likely in a few years the locals will have no source of income which will create poverty and conflict within the communities.	

5.3 Future Stakeholder Engagement

TNPTL will continue stakeholder engagement activities throughout the life of the Project. Further details of TNPTL's future stakeholder engagement activities are given in **Chapter 7**. Stakeholder engagement activities will include:

- ongoing reporting on progress on the implementation of environmental and social management measures identified during the EIA process and recording of comments on the effectiveness of these measures;
- updating communities about new project developments and recording comments on these; and,
- ongoing operation of the grievance redress mechanism.

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[112] between the project aspects[113] and receptors.[114] 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 EIA and Project specialists; consideration of issues raised by stakeholders; and findings of baseline investigations as they become available.

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[112] Pathway is the mechanism by which the aspect affects the receptor (such as inhalation of air or drinking of water).

[113] 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).

[114] 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 Energy Park in which the power plant will be located 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[115]	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 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 following types of impact: 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**.

[115] 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 employment opportunities, resulting in increased prosperity and wellbeing due to additional employment for local people.	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.	Households which do not gain directly by employment at the Project or indirectly through increased sales of goods and services will be most affected and will not be able to afford basic goods and services.	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	
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 are achieved expeditiously as a priority as construction related activities are likely to generate concerns and issues among the stakeholders. A Grievance Redress Mechanism to be followed in Project implementation is included in **Chapter 7**.

Project Activity	*Description*	*Impacts*	*Risk*	*Discussion*
Operations Phase				
Emission from Power Plant	Emission of SO_2, NOx, PM_{10}, $PM_{2.5}$ and other pollutants	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	
Effluent discharge from the Power Plant	Discharge from the power plant includes cooling tower blowdown, boiler blowdown, washing effluent, sanitary waste, and some other effluents	Discharge can potentially pollute the 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 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.
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 from 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.

Project Activity	Description	Impacts	Risk	Discussion
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 and 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.
	Increase in local population due to in migration due to increased economic opportunity due to Project activities.	Stress on limited infrastructure 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 natural setting of the area.	Project activities will cause direct loss of habitat due to site clearance and influence a broader zone due to noise air emissions and other activities.	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.[116] 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:

- Incremental increase in the existing traffic on the road will affect the daily commuters.
- Traffic may cause a safety hazards especially for pedestrians and livestock.
- Emission and noise level will affect the air quality and cause nuisance to communities living 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
- Air quality impact from operation of construction machinery and earthwork
- Noise and vibration from machinery and construction work

[116] SECMC director's report, December 31, 2014

- Generation of waste and its disposal
- Off-site impacts such as those related to borrow pits
- Disposal of effluent 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:

- 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.
- Explain the recruitment process to local communities.
- Require contractors to prefer local candidates in the recruitment process provided they have the required skills and qualifications.
- Include an assessment of the contractor's demonstrated commitment to local procurement and local hiring in the tender evaluation process.
- Coordinate recruitment efforts related to non-skilled labor, including for non-skilled labor positions required by contractors.
- 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 is provided will be about 2.5 million tons per year. This estimate has been developed using the IPCC Tier 1 methodology that assumes a 101,000 kg of CO_2 emission per terajoule of heat input from lignite.

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.

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.[117] 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

Air emission impacts were evaluated based on SEQS and IFC emission standards and ambient air quality standards.

Combining the Air Quality Impacts

As there are a number of existing, planned, and foreseeable gaseous emission sources in the area, it is essential to consider their impacts on the ambient air quality in appropriate

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

manner. This inventory of the sources and the scheme under which they are considered are discussed in **Exhibit 6.2**.

Exhibit 6.2: Gaseous Emission Sources and their Assessment

Additional Sources	*Approach*	*Section*
Existing	Measured Baseline	**Section 4.3.6**
Natural Biomass Burning Traffic	Measured	
Planned Projects	Simulated Baseline	**Section 4.3.6**
2x330 MW Plant, Block II Block II Coal Mine Block VI Coal Mine	Modelled + Measured	
Proposed 330 MW Plant	Impact of Proposed Plant	**Section 6.3.2**
1x330 MW Plant, Block II	Incremental Impact of Proposed Plant + Simulated Baseline	
Second 330 MW Plant being developed Simultaneously	Impact of Second Plant	**Section 6.3.2**
1x330 MW Plant, Block II	Incremental Impact of Second Plant + Impact of Proposed Plant	
Future Developments	Cumulative Impact	**Section 6.4.1**
2640 MW Plants, Block II 1320 MW Plants, Block III 330 MW Plant, Block VI Block III Coal Mine	Incremental Impact of Future Developments + Impact of Second Plant	

Emission Standards

The units of the emission rates discussed in **Chapter 3** are converted so that they are comparable to IFC EHS limits and SEQS emission standards and presented in **Exhibit 6.3**. The Study Area is considered a non-degraded air shed (NDA) for SO_2 and NO_x as national guidelines ambient SO_2 and NO_x concentrations are not exceeded, and a degraded airshed (DA) for particulate matter as national guidelines have been exceeded (see **Section 4.3.7**). The Project will be compliant with both SEQS and IFC guidelines for coal power plant emissions.

Exhibit 6.3: Compliance with SEQS and IFC Emission Standards for Coal Fired Power Plants

Parameter	*SEQS*	*IFC EHS limits*	*Project Emissions*	*Status*
Sulfur Dioxide	100 - 500 Tons per day	**For NDA: 900-1500 mg/Nm³** For DA: 400 mg/Nm³	17 tons per day or 584 mg/Nm³	Compliant
Oxides of Nitrogen	For lignite fossil coal: 260 ng/J of heat input	**For NDA: 510 mg/Nm³** For DA: 200 mg/Nm³	168 ng/J of heat input 381 mg/m³	Compliant
Particulate Matter	500 mg/Nm³	For NDA: 50 mg/Nm³ **For DA: 30 mg/Nm³**	23 mg/Nm³	Compliant

Ambient Air Quality Standards

The air quality impact assessment was carried out to predict the impact of proposed Project plus the combined baseline concentration (see **Chapter 4**) on surroundings and compliance with the standards. To evaluate the impacts from proposed plant the modeling was carried out for approved developments and proposed plant as shown in **Exhibit 6.4**.

Modeling Parameters

The modeling was based on the plant parameters, emission control technologies and coal design specifications as discussed in **Chapter 3** and reproduced in **Exhibit 6.5.** Emission rates were calculated based on coal composition and plant coal demand.

Exhibit 6.4: Approved Developments and Proposed Project

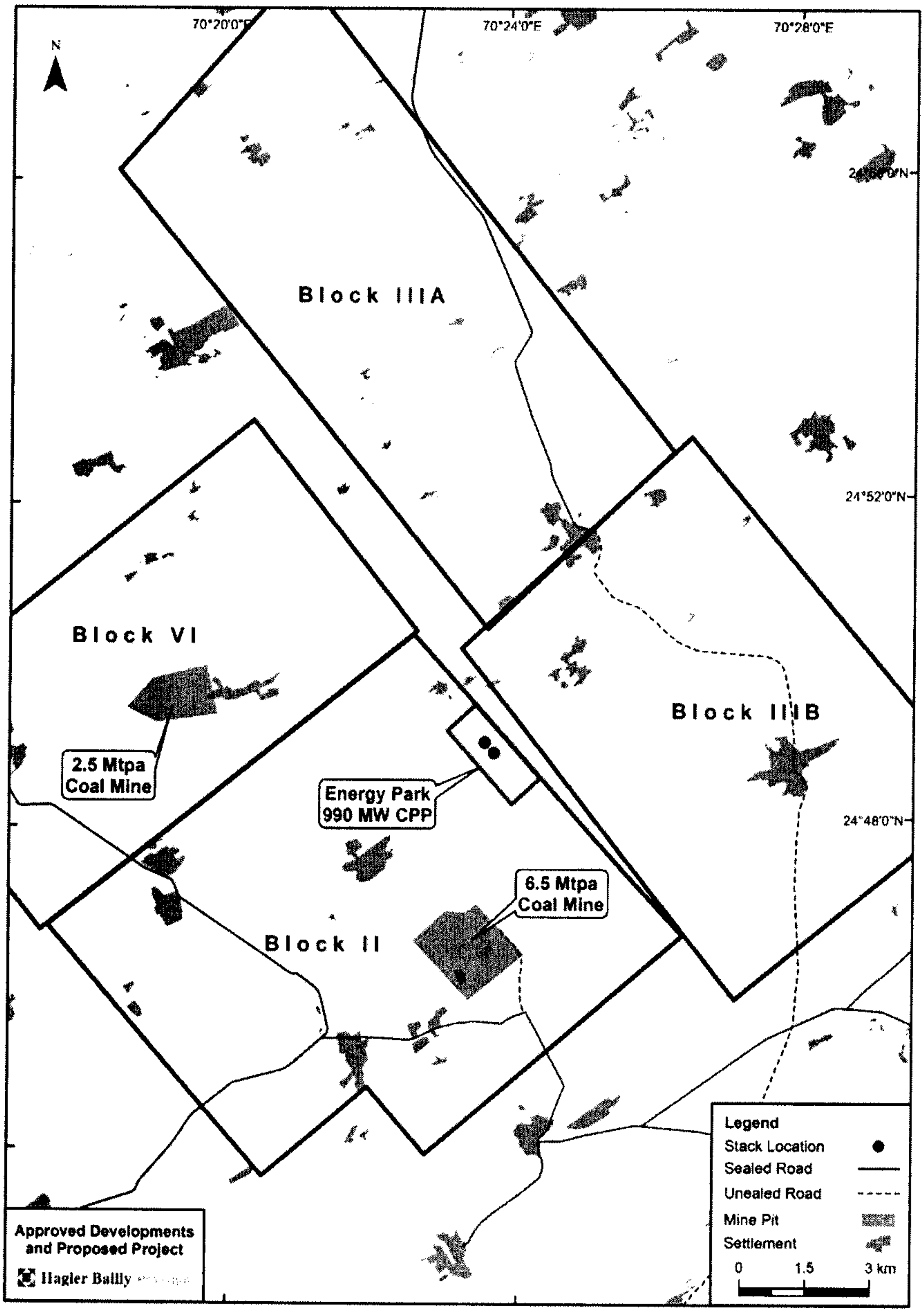


Exhibit 6.5: Modeling Parameters (1 × 330MW)

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 - Flue Gas Desulfurization (FGD)	90.0	%

Modeling 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.

Modeling Results and Discussion

Contour maps for dispersion of each pollutant are presented in **Exhibit 6.6** to **Exhibit 6.13.** Areas that exceed standards have been shaded as hotspots. The measured and modeled results are compiled in **Exhibit 6.14.** The results were compared against SEQS and IFC EHS limits. The pollutant concentrations exceeding one of the standards have been shaded in the table.

Exhibit 6.6: Sum of Baseline and Incremental SO_2 Concentration (Annual)

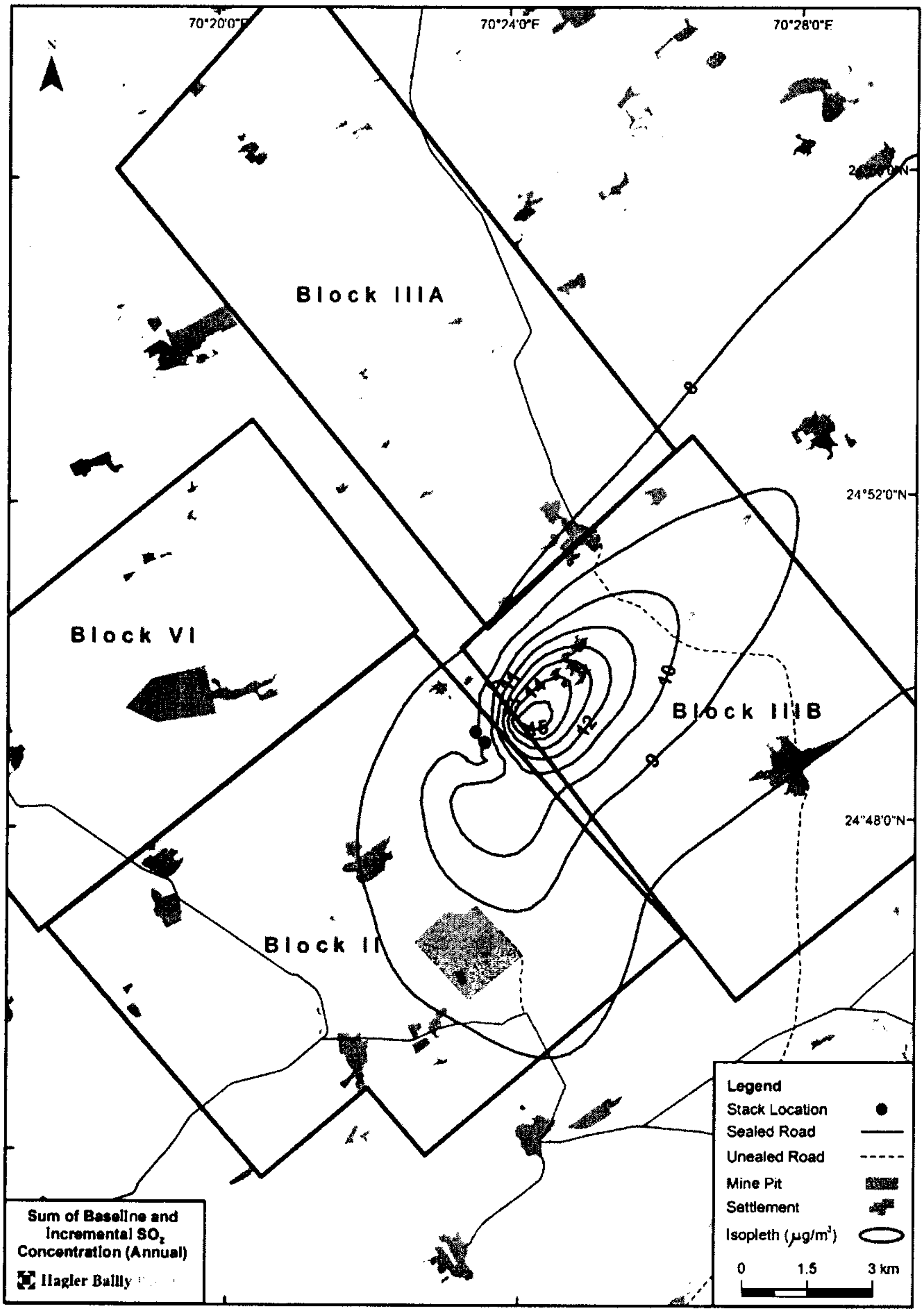


Exhibit 6.7: Sum of Baseline and Incremental SO_2 Concentration (24-hour)

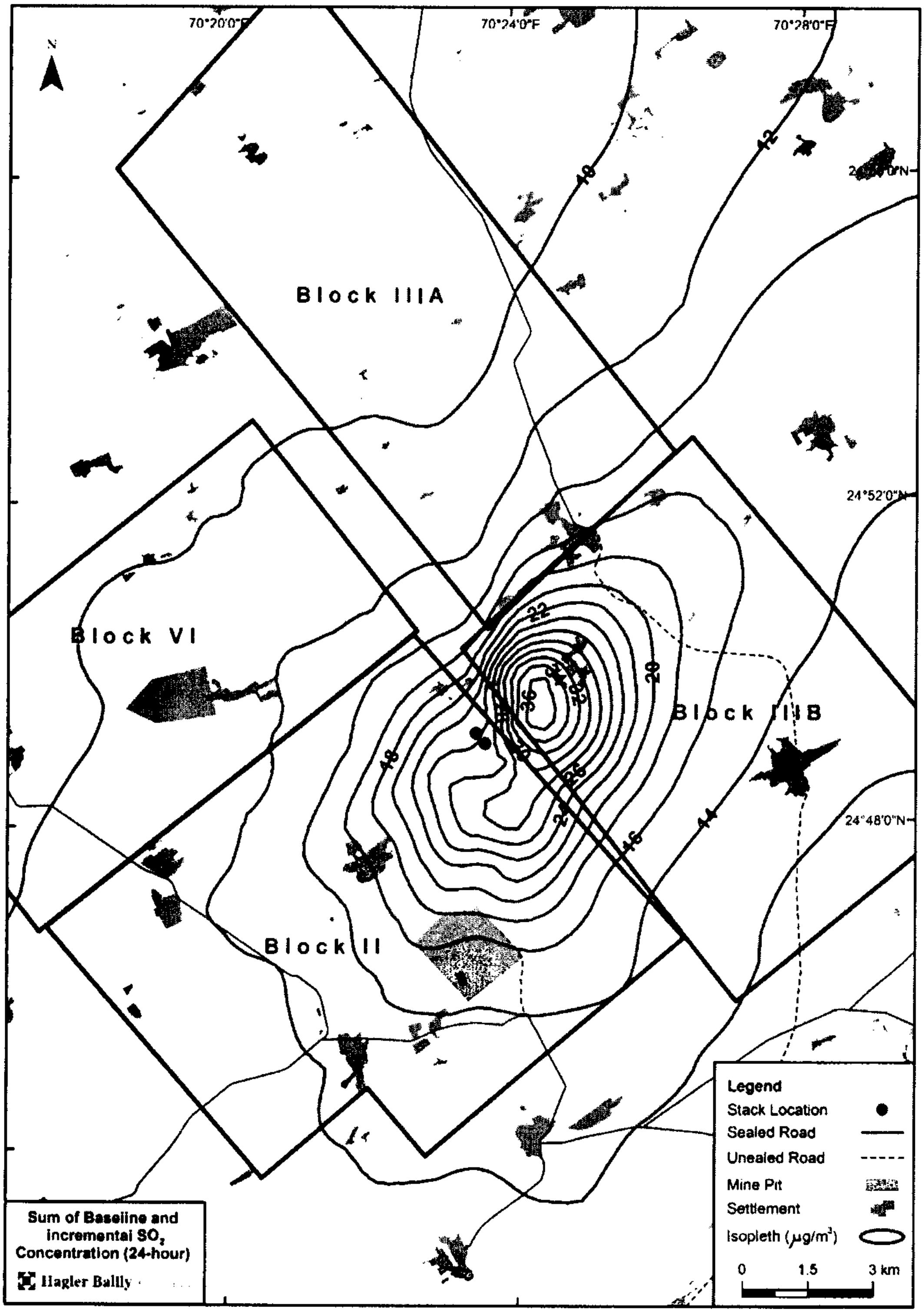


Exhibit 6.8: Sum of Baseline and Incremental NO_2 Concentration (Annual)

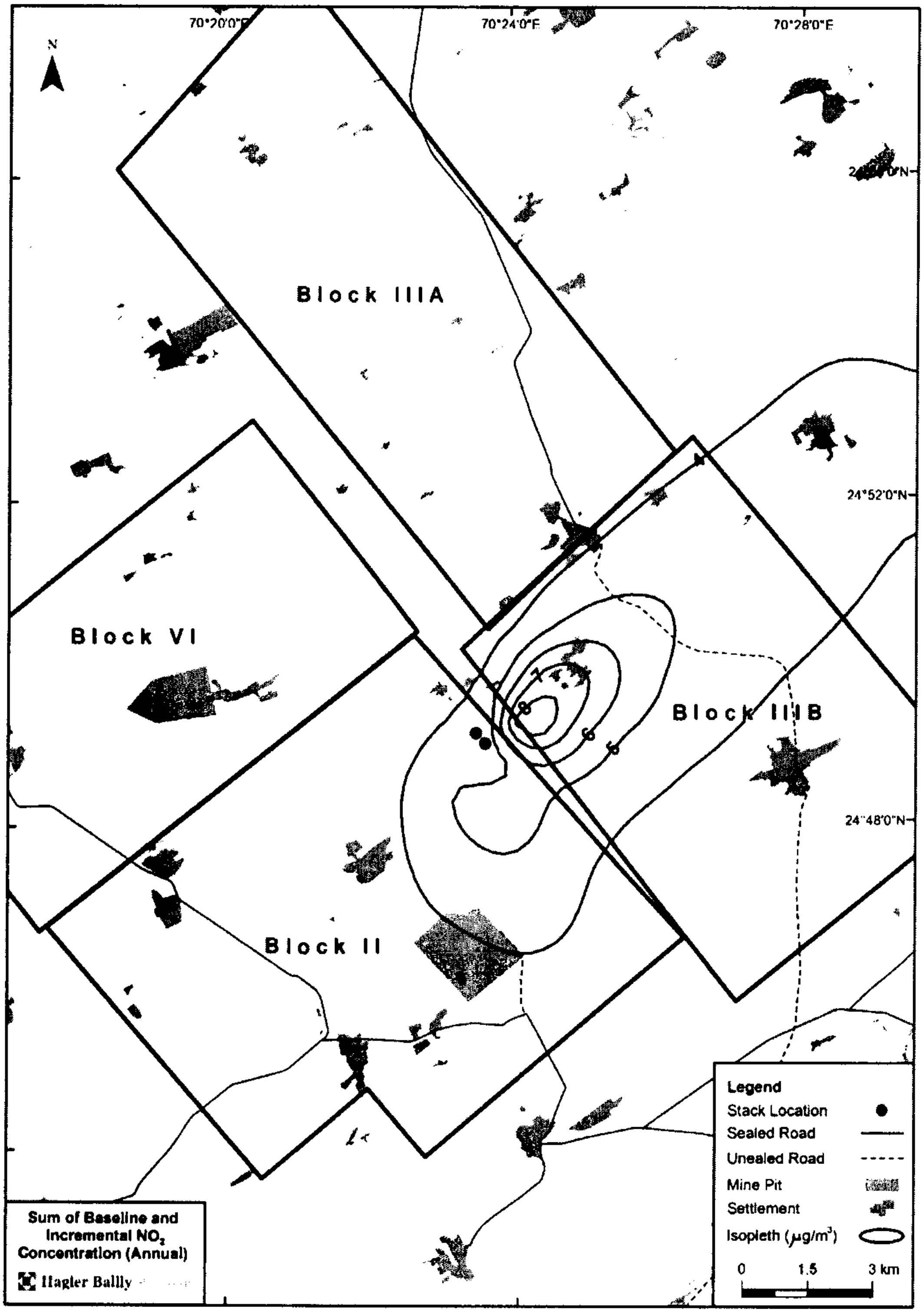


Exhibit 6.9: Sum of Baseline and Incremental NO_2 Concentration (24-hour)

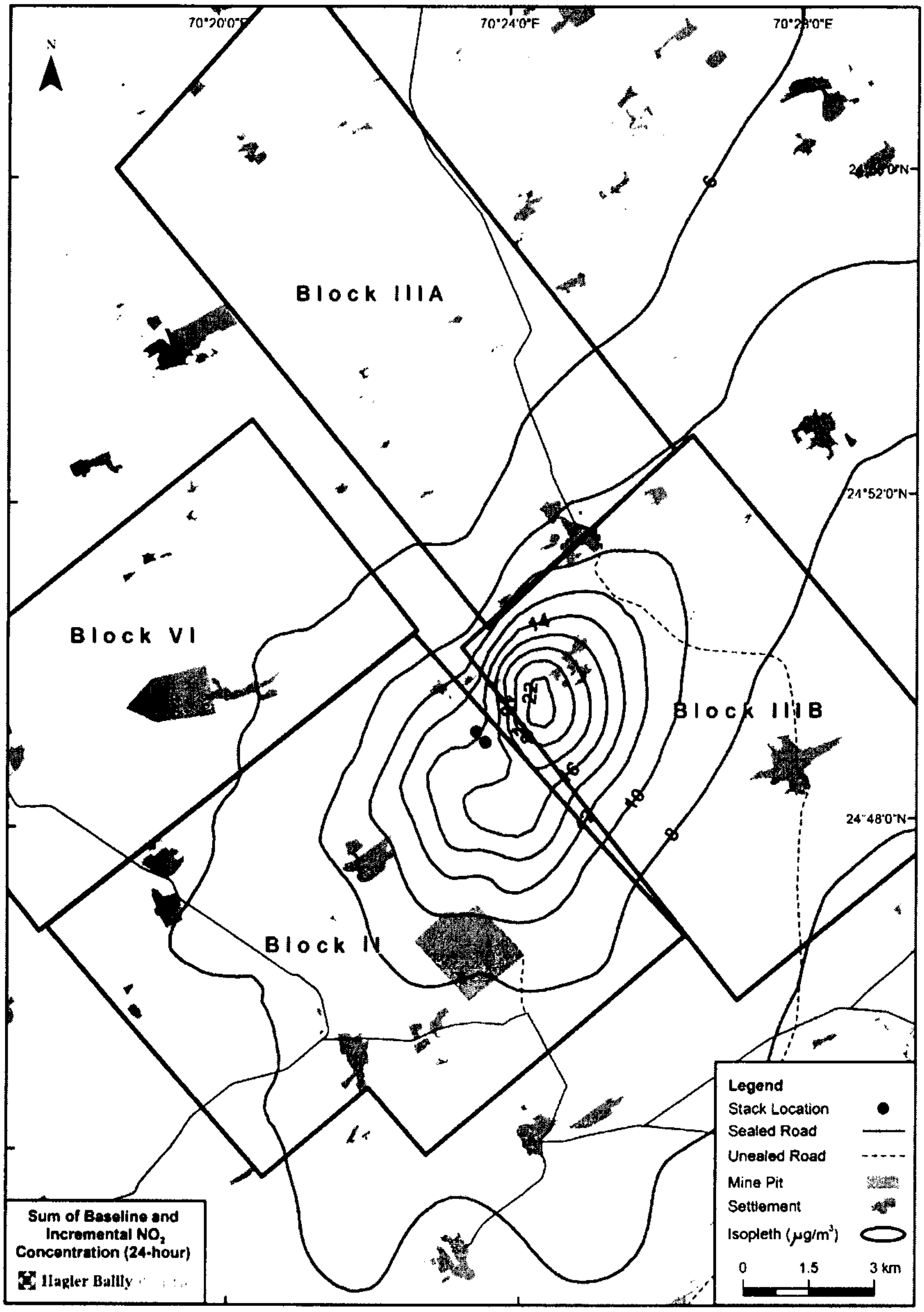


Exhibit 6.10: Sum of Baseline and Incremental PM_{10} Concentration (Annual)

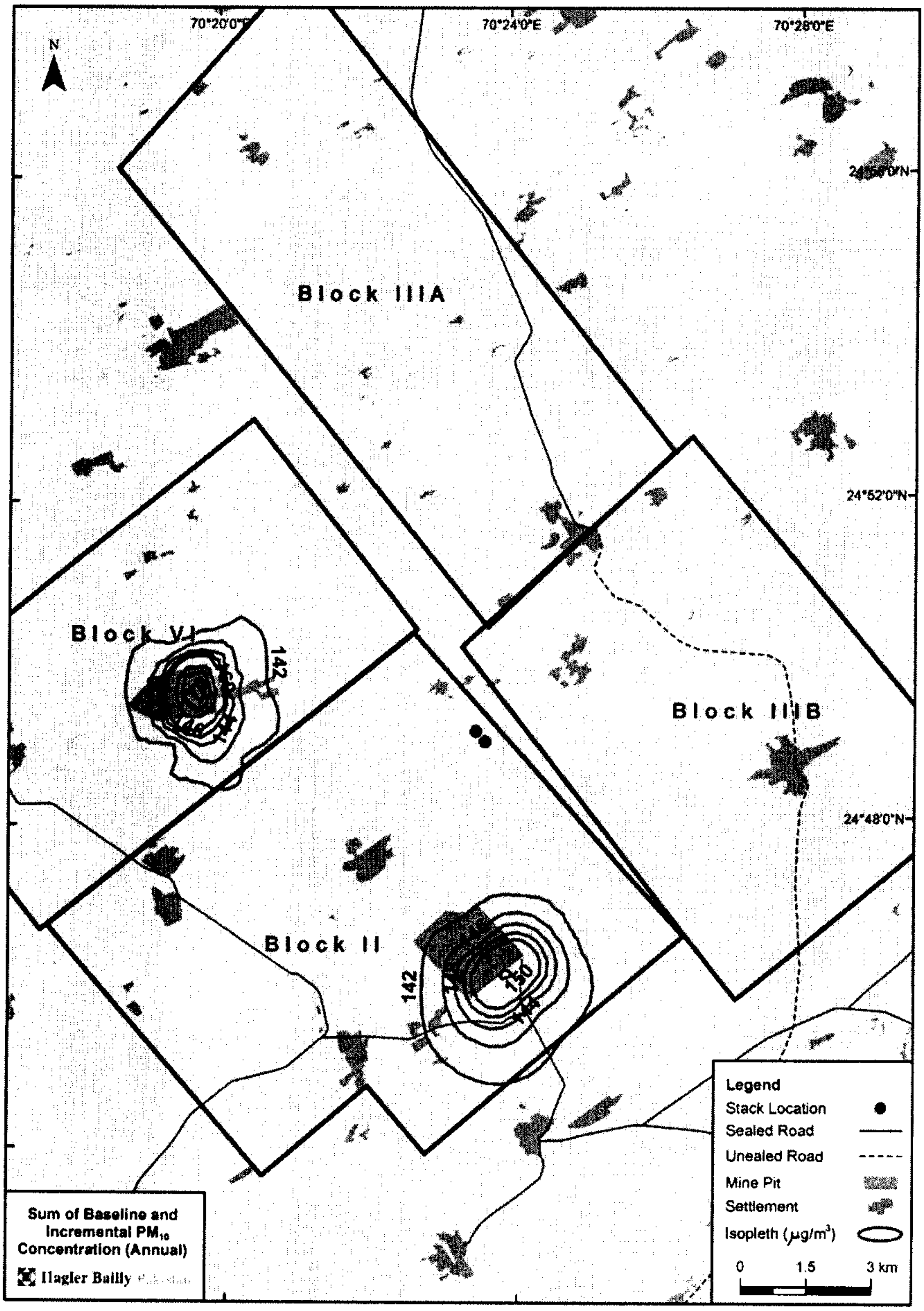


Exhibit 6.11: Sum of Baseline and Incremental PM_{10} Concentration (24-hour)

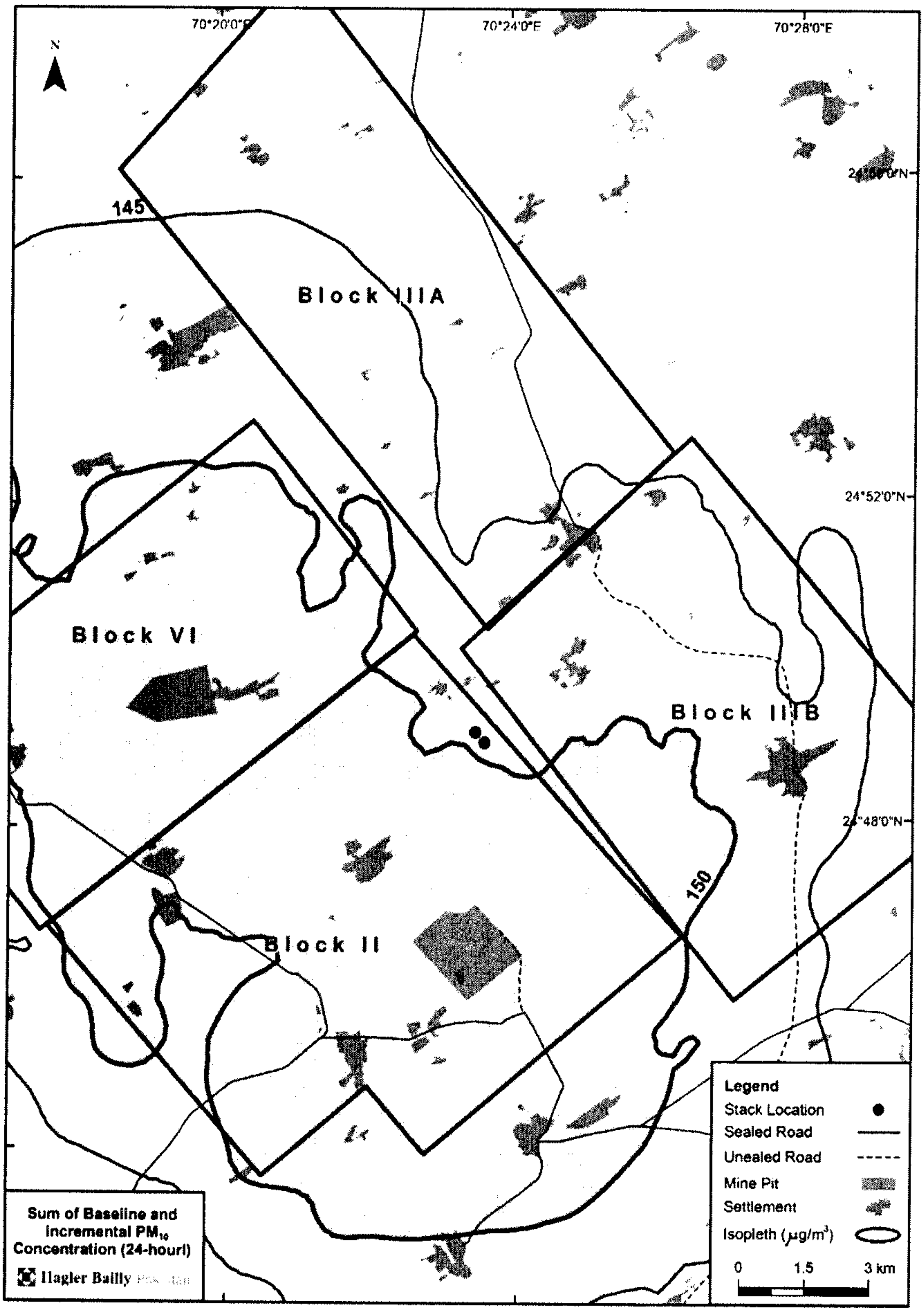


Exhibit 6.12: Sum of Baseline and Incremental $PM_{2.5}$ Concentration (Annual)

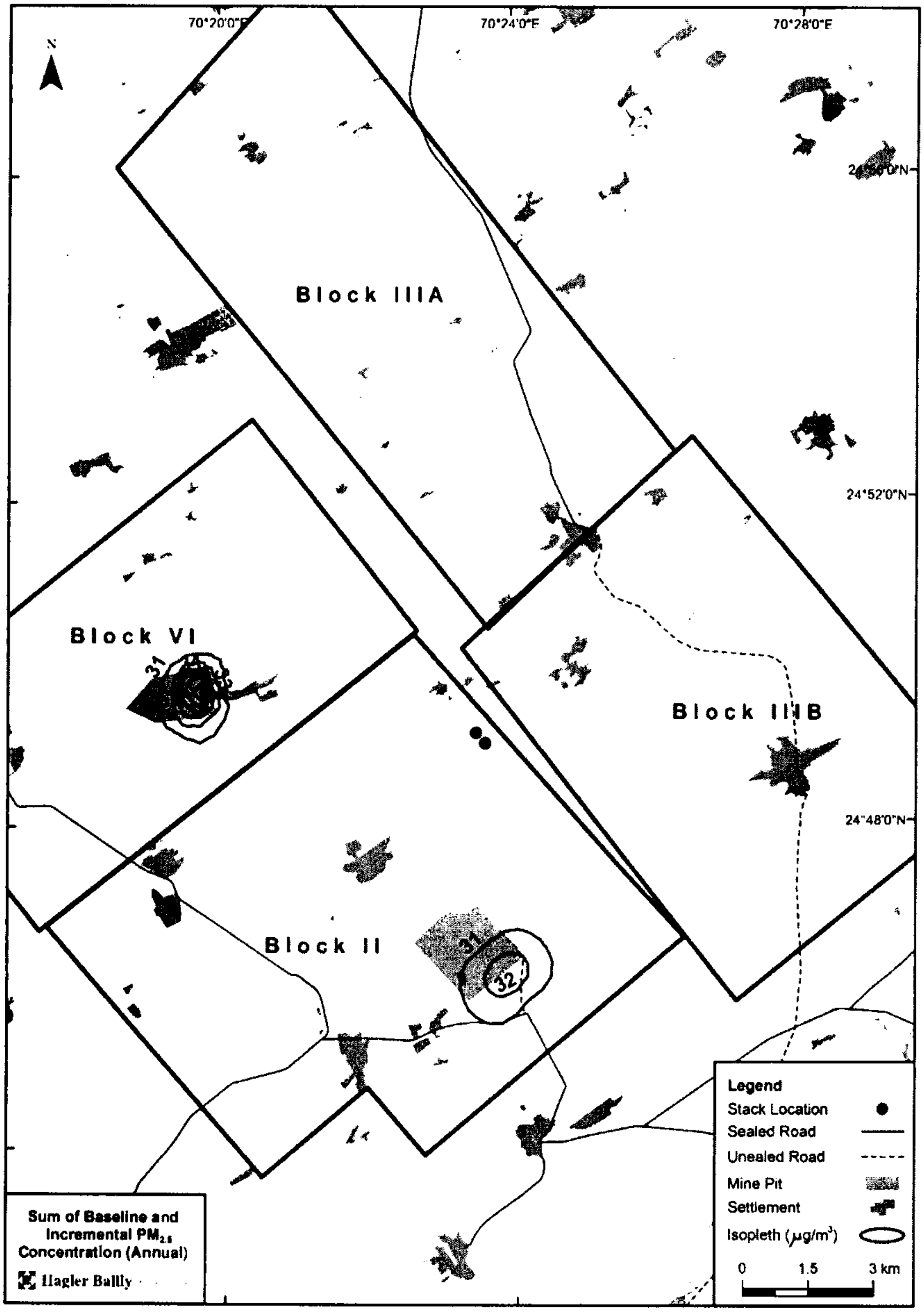


Exhibit 6.13: Sum of Baseline and Incremental $PM_{2.5}$ Concentration (24-hour)

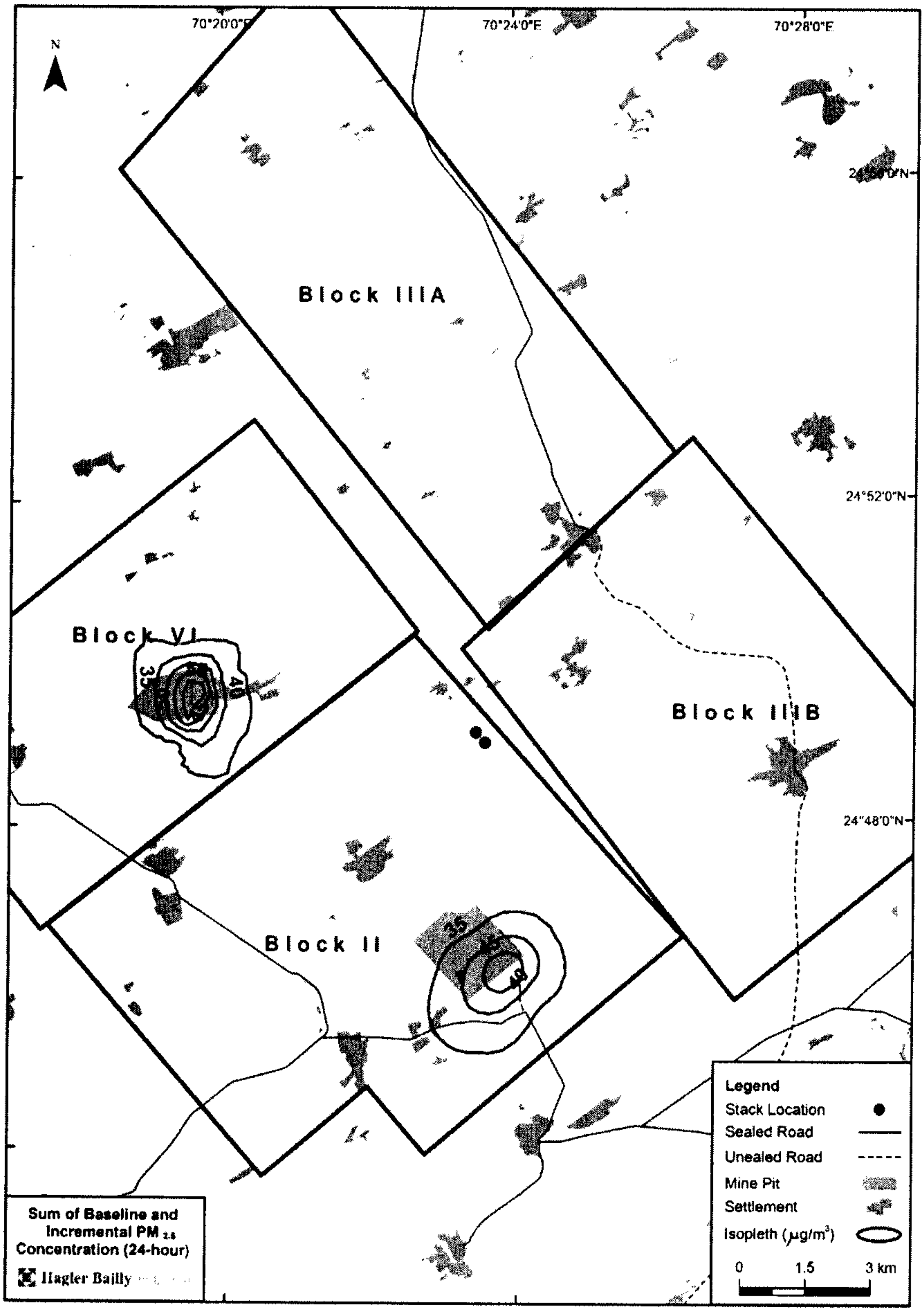


Exhibit 6.14: Impact of Proposed Plant (µg/m³)

Pollutant	*Averaging Period*	*Simulated Baseline*	*Impact of Proposed 1x330 MW Plant*		*SEQS*	*IFC EHS limits*
			Incremental	*Ambient*		
SO_2	24-hour Max	29.4	8.4	37.8	120	125
	Annual Avg.	13.4	2.9	16.3	80	-
NO_2	24-hour Max	17.6	5.5	23.1	80	-
	Annual Avg.	7.2	1.9	9.1	40	40
PM_{10}	24-hour Max	**273.534**	0.006	**273.540**	150	150
	Annual Avg.	**148.417**	0.011	**148.429**	120	70
$PM_{2.5}$	24-hour Max	42.498	0.004	42.502	75	75
	Annual Avg.	31.185	0.005	31.189	40	35

Emission Controls

Emission control technologies discussed in **Chapter 3** will significantly reduce the contribution of the Project on ambient air quality. Measures proposed in the Environmental Management Plan in **Chapter 7**, that deal with impacts during construction and operation of the Project will keep the impact of the Project to acceptable levels.

Impact of the Second 330 MW Power Plant

Another 330 MW Power plant is planned in the Energy Park simultaneously with the Proposed Project. Although the impacts of the second plant are considered in the cumulative impacts, they are also considered here because unlike the anticipated projects, this plant will be developed simultaneously and will therefore will have its impact on the air quality when the proposed Project is commissioned.

The same modeling approach and parameters were followed as discussed above.

The results are shown in **Exhibit 6.15.** It can be observed that there is an increase in the SO_2 and NO_2 concentrations due to the second power plant. The spatial distribution of this increase is shown in **Exhibit 6.16** to **Exhibit 6.19**, to identify sensitive receptors that will be impacted by the development.

No major impact of the second coal power plant on the particulate matter concentrations is observed. **Exhibit 6.10** to **Exhibit 6.13** can be referred to for the spatial distribution of particulate matter concentrations.

Although there is an increase in SO_2 and NO_2 concentrations they stay below limits. There is no visible impact on particulate matter concentrations and they are above the limits due to the baseline levels.

Exhibit 6.15: Impact of Second Plant (µg/m³)

Pollutant	*Averaging Period*	*Simulated Baseline*	*Air Quality After the Proposed Plant*	*Impact of Second 1x330 MW Plant*		*SEQS*	*IFC EHS limits*
				Increment	*Ambient*		
SO_2	24-hour Max	29.4	37.8	17.7	47.1	120	125
	Annual Avg.	13.4	16.3	5.6	18.9	80	-
NO_2	24-hour Max	17.6	23.1	11.5	29.1	80	-
	Annual Avg.	7.2	9.1	3.6	10.8	40	40
PM_{10}	24-hour Max	273.534	273.540	0.013	273.546	150	150
	Annual Avg.	148.417	148.429	0.023	148.441	120	70
$PM_{2.5}$	24-hour Max	42.498	42.502	0.003	42.506	75	75
	Annual Avg.	31.185	31.189	0.009	31.194	40	35

Conclusions

Incremental Impact of SO_2 and NO_2 Emission

The 24-hour and annual concentrations of SO_2 and NO_2 will increase due to the proposed Plant (**Exhibit 6.15**). However, the increase will be less than 10 µg/m³ in all cases (SO_2 and NO_2, annual and 24-hour). The impact of the second plant will be similar.

SO_2 and NO_2 Concentration after the Proposed Plant

The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits. This is true for the proposed Plant as well the second Plant.

Incremental impact on PM_{10} and $PM_{2.5}$ Concentrations

There is no significant impact of proposed plant on PM_{10} and $PM_{2.5}$ concentrations. The reason is as the plant is using electrostatic precipitators with 99.9% efficiency that captures almost particulate matter of each size and leaves a minute amount of particulate matter in flue gas. As can be seen from **Exhibit 6.15**, the net increase even after both plant are operational will be less than 1 µg/m³.

PM_{10} and $PM_{2.5}$ Concentration after the Proposed Plant

As discussed earlier, the ambient 24-hour and annual PM_{10} concentrations exceed both the SEQS in a large area. The 24-hour $PM_{2.5}$ concentration complies with both SEQS limits but is relatively high. This is primarily due to the natural causes.

The air quality management of an area is the responsibility of SEPA under the Sindh Act. It is proposed that SEPA, working with the developers in Thar Coalfields, develop an ambient air quality management plan to mitigate the high concentration of natural dust in the area.

Exhibit 6.16: Sum of Baseline and Two Power Plants SO_2 Concentration (Annual)

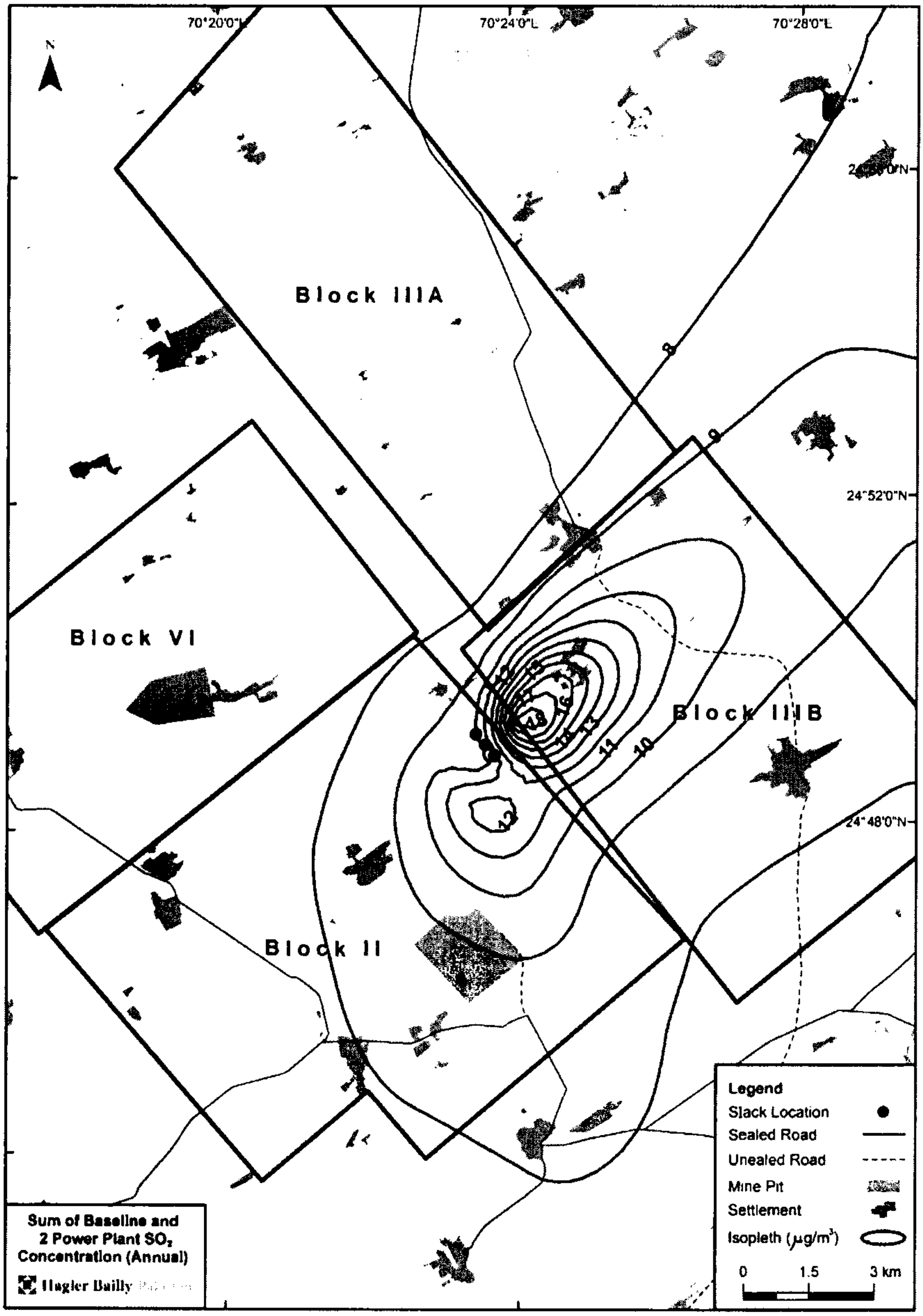


Exhibit 6.17: Sum of Baseline and Two Power Plants SO_2 Concentration (24-hour)

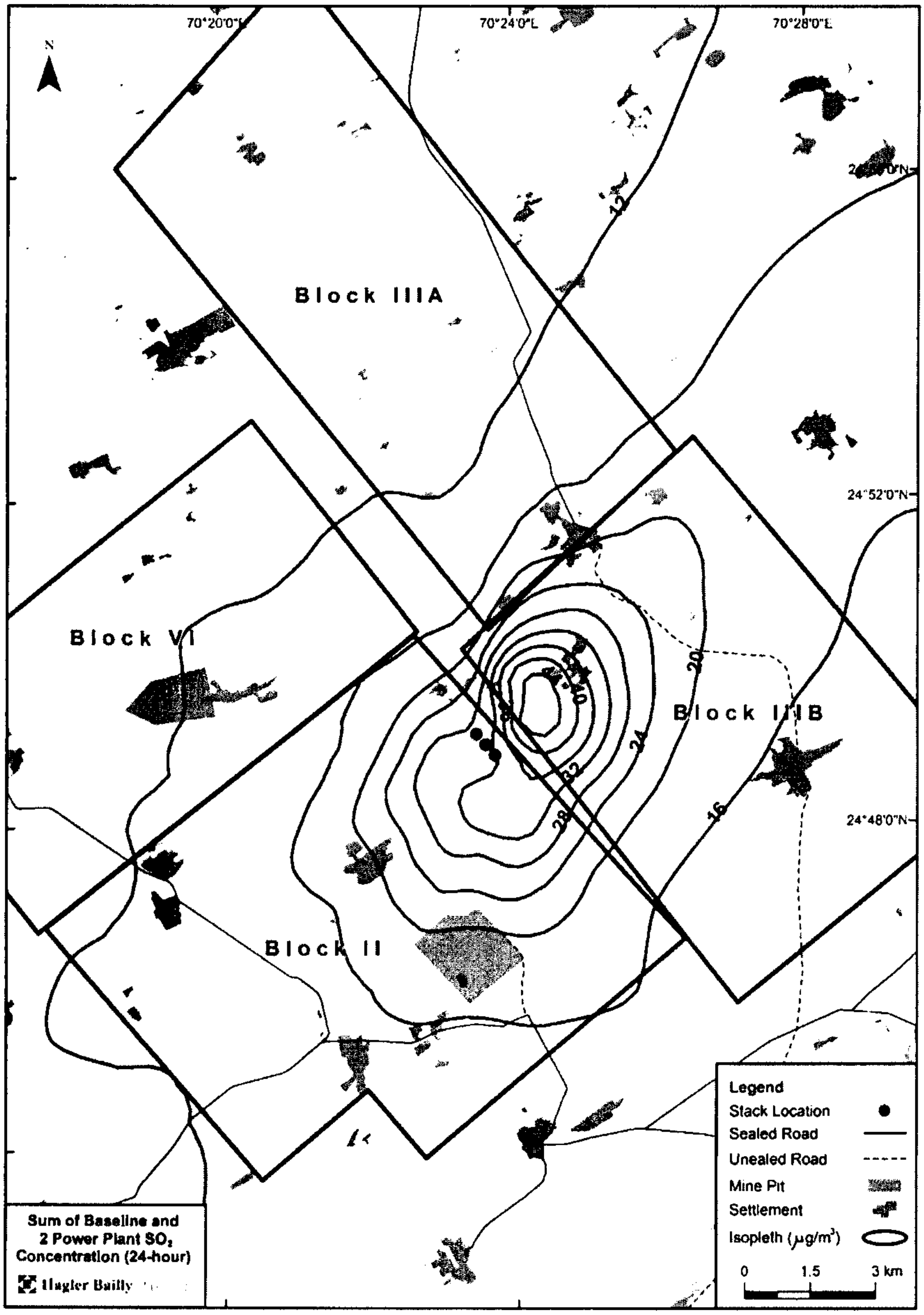


Exhibit 6.18: Sum of Baseline and Two Power Plants NO_2 Concentration (Annual)

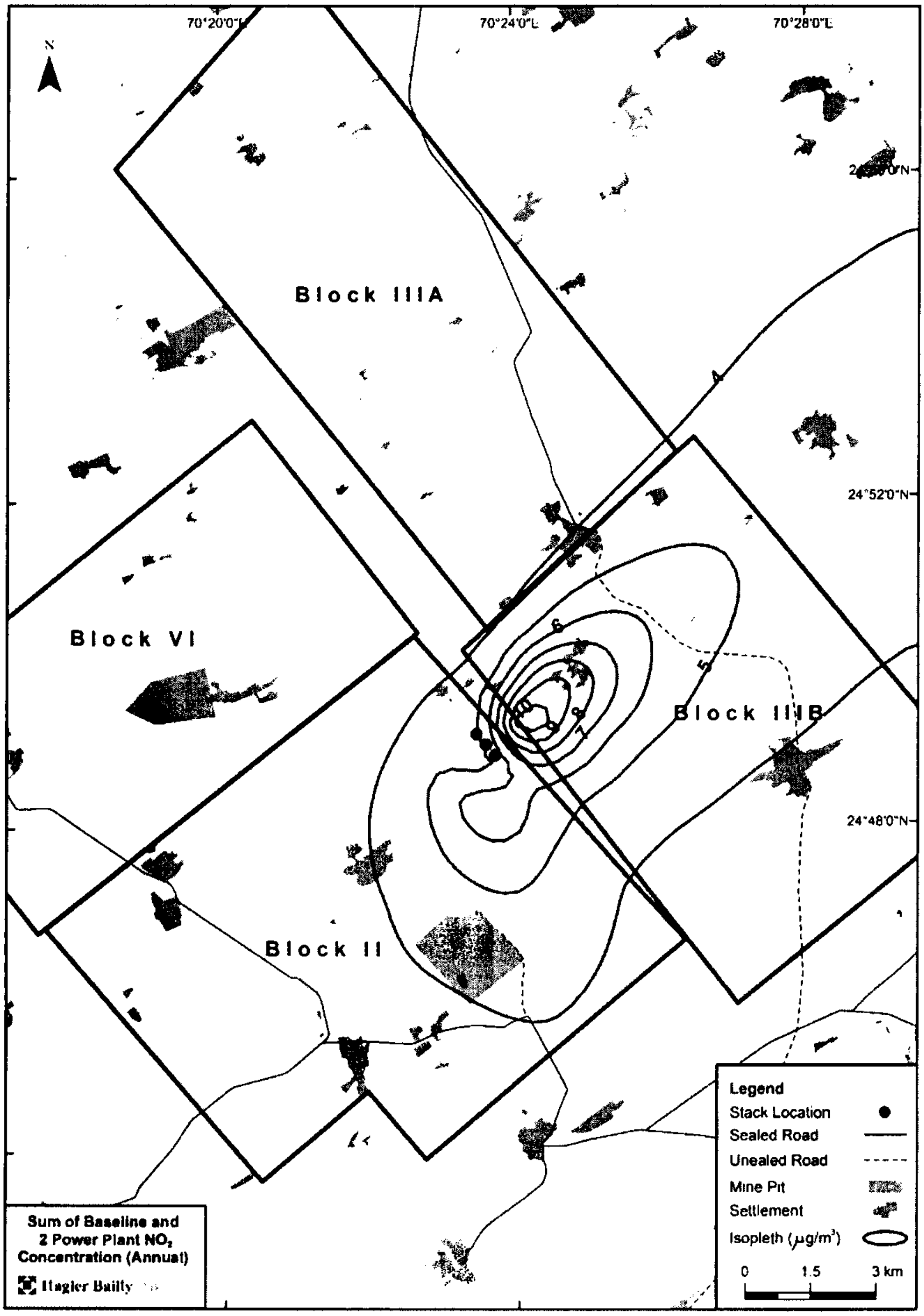
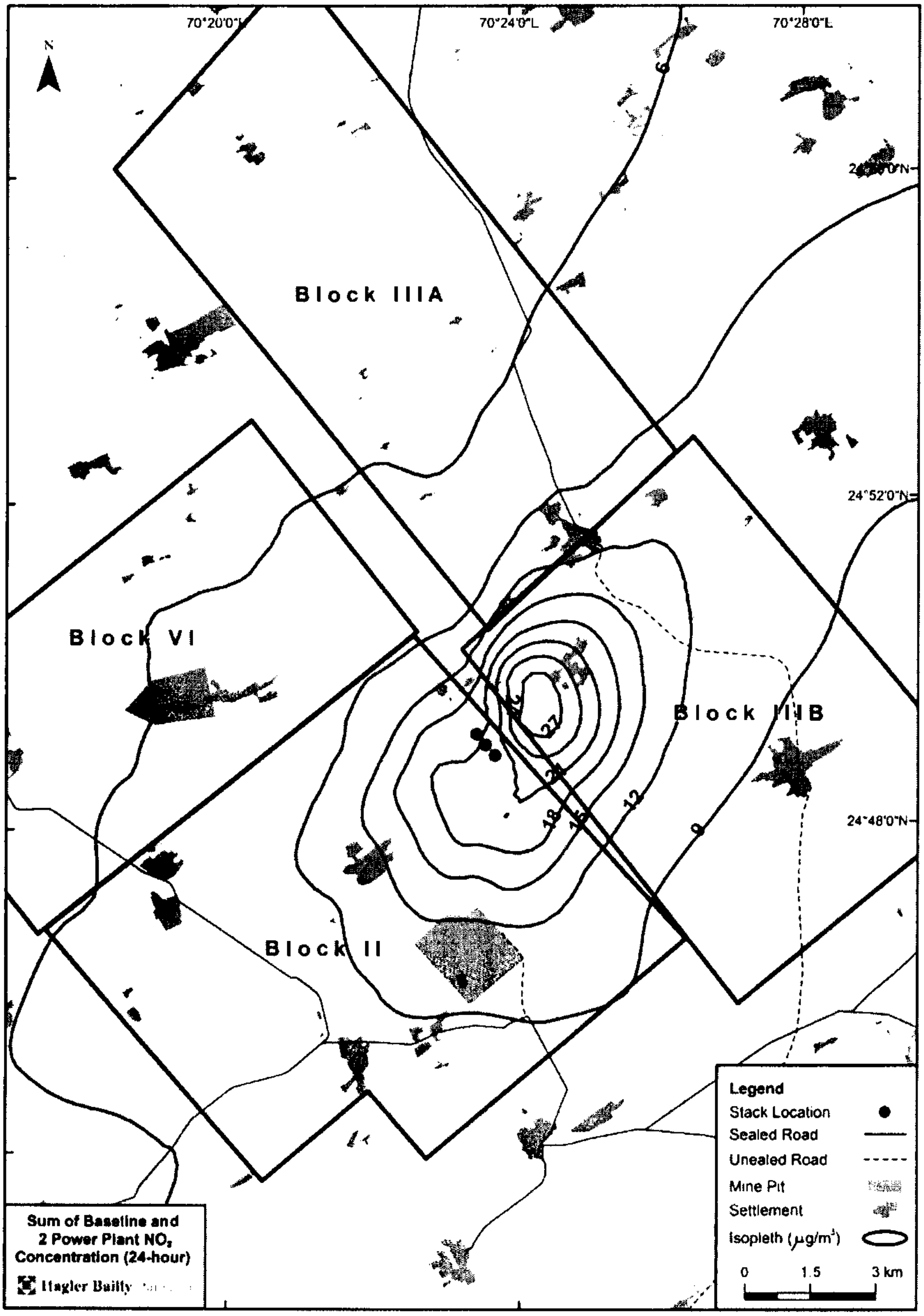


Exhibit 6.19: Sum of Baseline and Two Power Plants NO_2 Concentration (24-hour)



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.

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 TNPTL will not be able to address such conflicts by itself, TNPTL 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)[118]. 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.

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[118] BirdLife International 2010. Species factsheet: *Neophron percnopterus*. Downloaded from http://www.birdlife.org on 27/6/2010.

Future Developments

The future developments in the adjacent blocks to the Energy Park are summarized in **Exhibit 4.18**. The expected location of these developments are shown in **Exhibit 6.21**.

Exhibit 6.20: Future Developments near Study Area

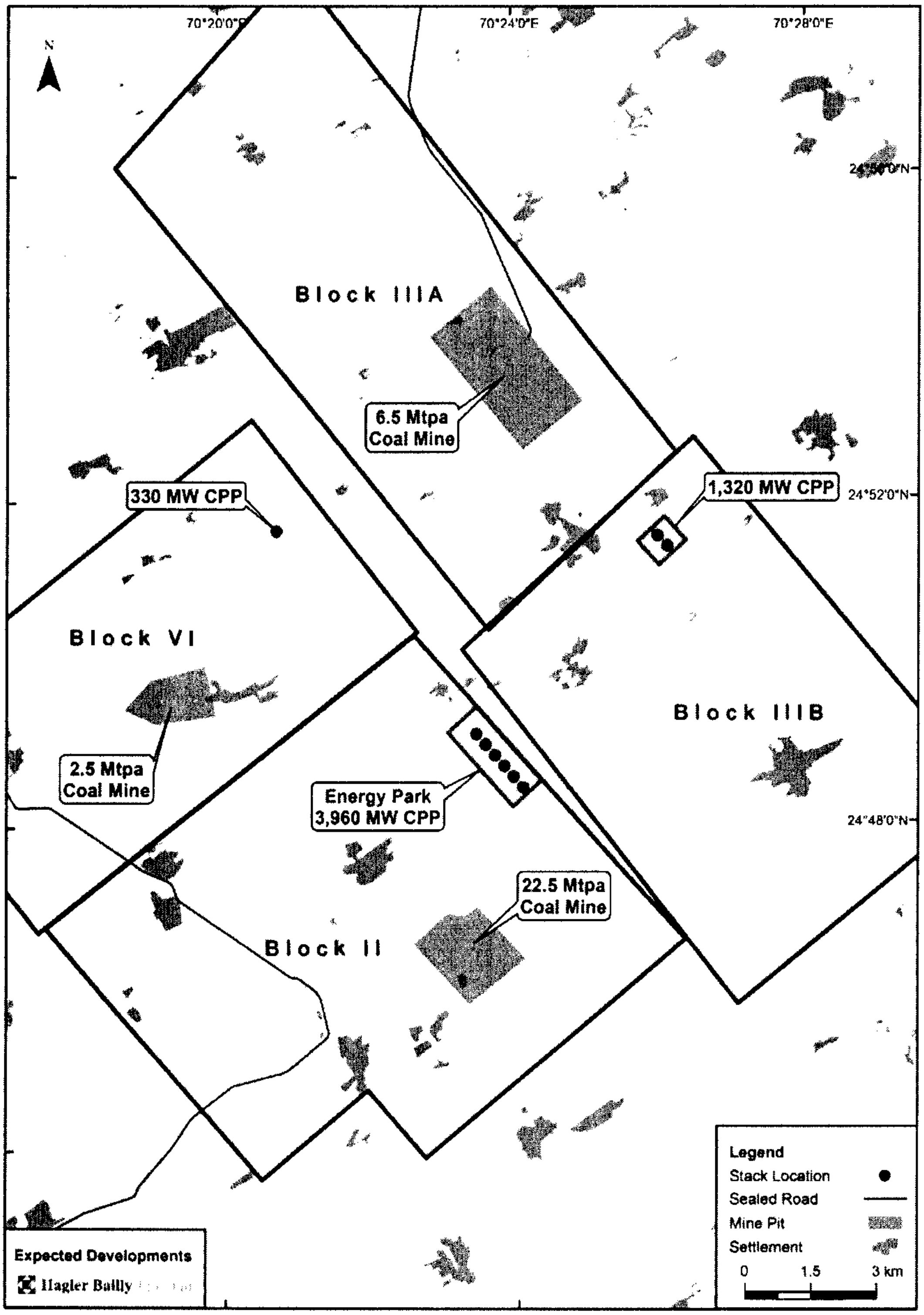
Block No.	*Coal Mine*	*Power Plant*	*Source*
Block II	22.5 mtpa	3,960 MW	ESIA of Block II Mining and Power Project[119]
Block III A & B	6.5 mtpa	1,320 MW	Background information document for ESIA of Block III A & B Mining and Power Plant Project
Block VI	2.5 mtpa	330 MW	ESIA of Block VI Mining Project[120]
Total	**31.5 mtpa**	**5,610 MW**	

The modelling method and approach discussed in **Section 6.3.2** was used. It is assumed that all coal plants follow the same specification as the current Project.

[119] Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

[120] 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 6.21: Future Developments



Modeling Results and Discussion

The measured and modeled results are compiled in **Exhibit XII.** The pollutant concentrations exceeding one of the standards have been shaded in the table. Contour maps for dispersion of each pollutant are presented in **Exhibit 6.23** to **Exhibit 6.30.** Areas that exceed standards have been shaded as hotspots.

Exhibit 6.22: Predicted Cumulative Results ($\mu g/m^3$)

Pollutant	*Averaging Period*	*Simulated Baseline*	*Ambient Air Quality after Proposed Plant*	*Ambient Air Quality after Second Plant*	*Cumulative Impact*		*SEQS*	*IFC EHS limits*
					Increment	*Ambient*		
SO_2	24-hour Max	29.4	37.8	47.1	36.7	83.8	120	125
	Annual Avg.	13.4	16.3	18.9	16.6	35.5	80	-
NO_2	24-hour Max	17.6	23.1	29.1	24.0	53.1	80	-
	Annual Avg.	7.2	9.1	10.8	10.8	21.6	40	40
PM_{10}	24-hour Max	273.534	273.540	273.546	8.886	282.432	150	150
	Annual Avg.	148.417	148.429	148.441	5.317	153.758	120	70
$PM_{2.5}$	24-hour Max	42.498	42.502	42.506	1.824	44.330	75	75
	Annual Avg.	31.185	31.189	31.194	0.779	31.973	40	35

The following conclusions can be drawn:

- The 24-hour and annual concentrations of SO_2 and NO_2 complies with both SEQS and IFC EHS limits. There is significant increment in SO2 and NO2 concentrations due to addition of more coal power plants. This leaves very narrow room for developments in other blocks.
- As the proposed plant has negligible impact on PM concentrations but when cumulated with whole developed Energy Park and Block III A and III B power plant there is an increase in PM 24-hour concentrations.
- The 24-hour PM_{10} concentrations exceed both SEQS and IFC EHS at 55% of the area (380 km^2 out of total area of 700 km^2). The spatial distribution of the area that exceeds the standards is shaded in **Exhibit 6.28.**
- The 24-hour $PM_{2.5}$ concentration complies with both SEQS and IFC EHS limits. The annual concentrations complies with SEQS but exceeds IFC EHS limits. The modeled 24-hour and annual concentrations complies with the standards. When added to the modeled baseline elevated $PM_{2.5}$ levels exceed the annual IFC EHS limits as shaded in **Exhibit XII.**

Exhibit 6.23: Predicted Cumulative SO_2 Concentration (Annual)

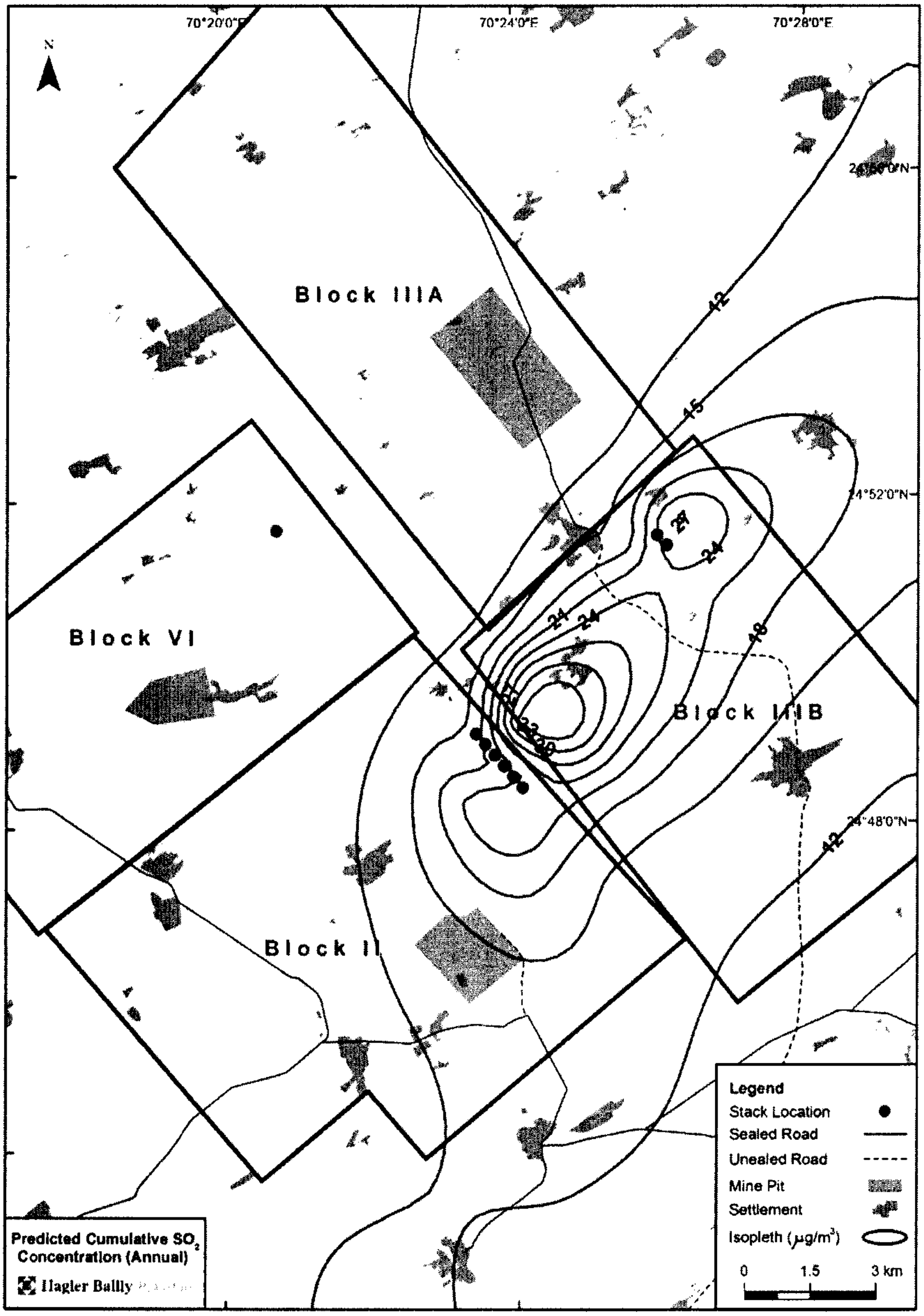


Exhibit 6.24: Predicted Cumulative SO_2 Concentration (24-hour)

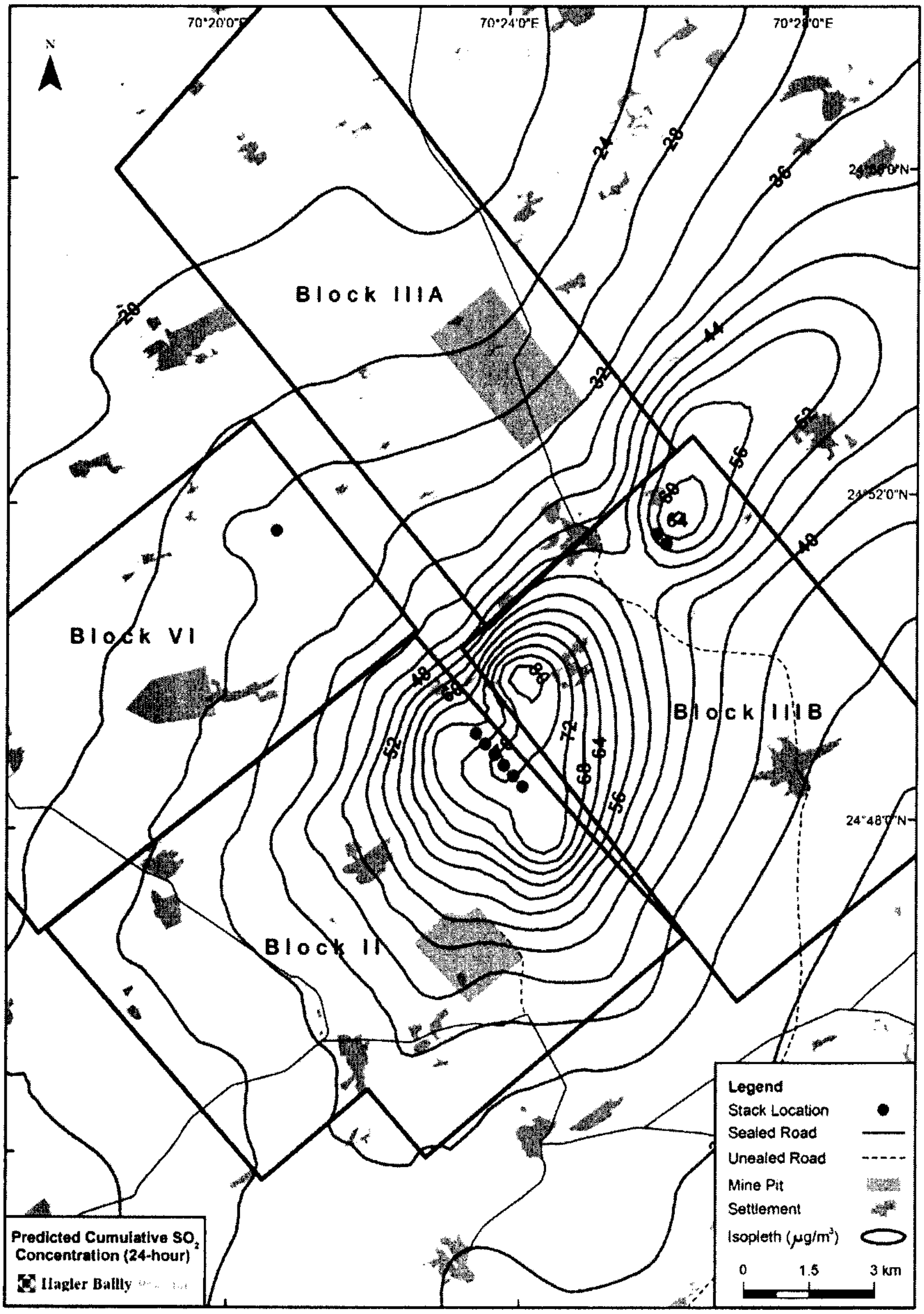


Exhibit 6.25: Predicted Cumulative NO_2 Concentration (Annual)

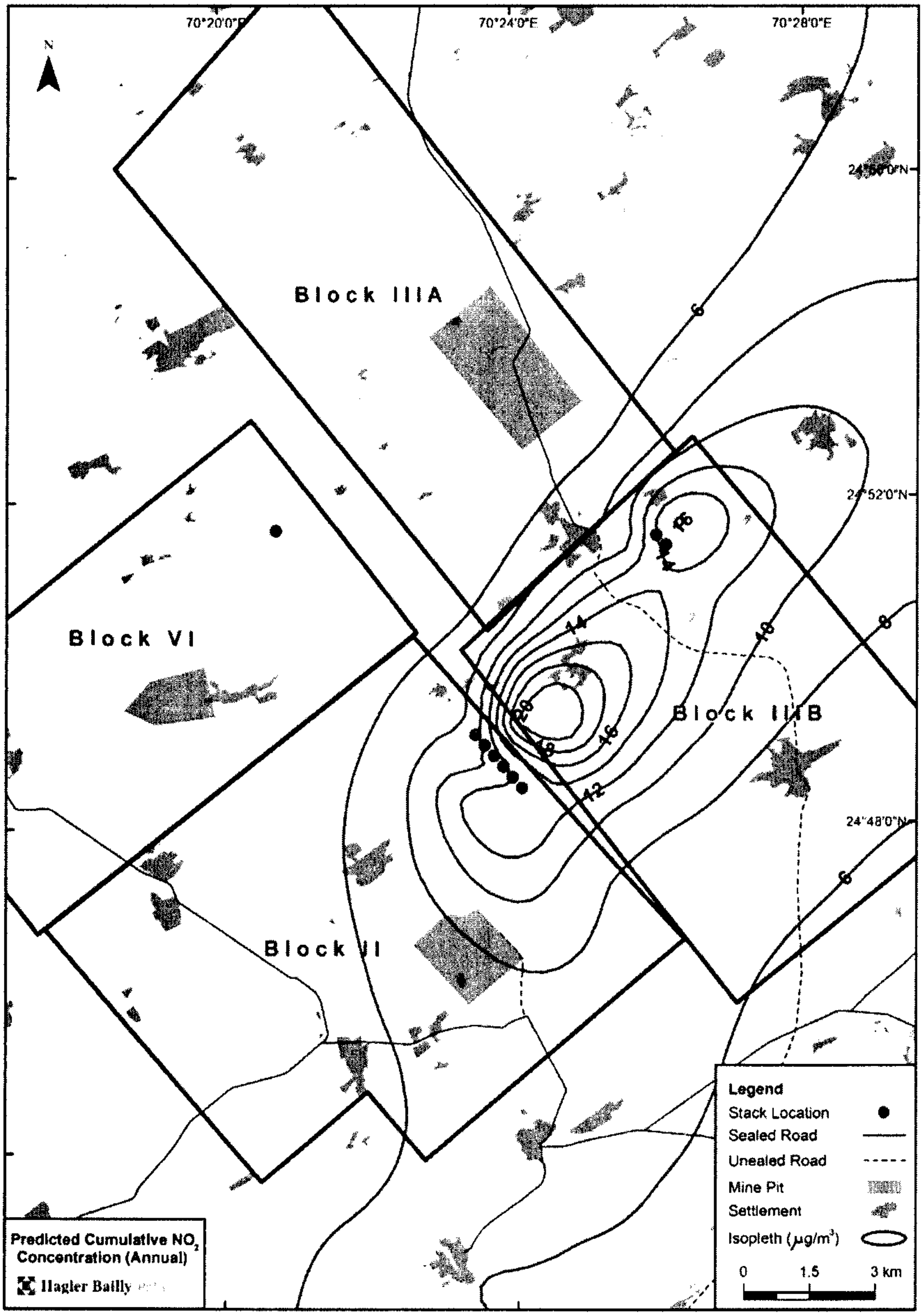


Exhibit 6.26: Predicted Cumulative NO_2 Concentration (24-hour)

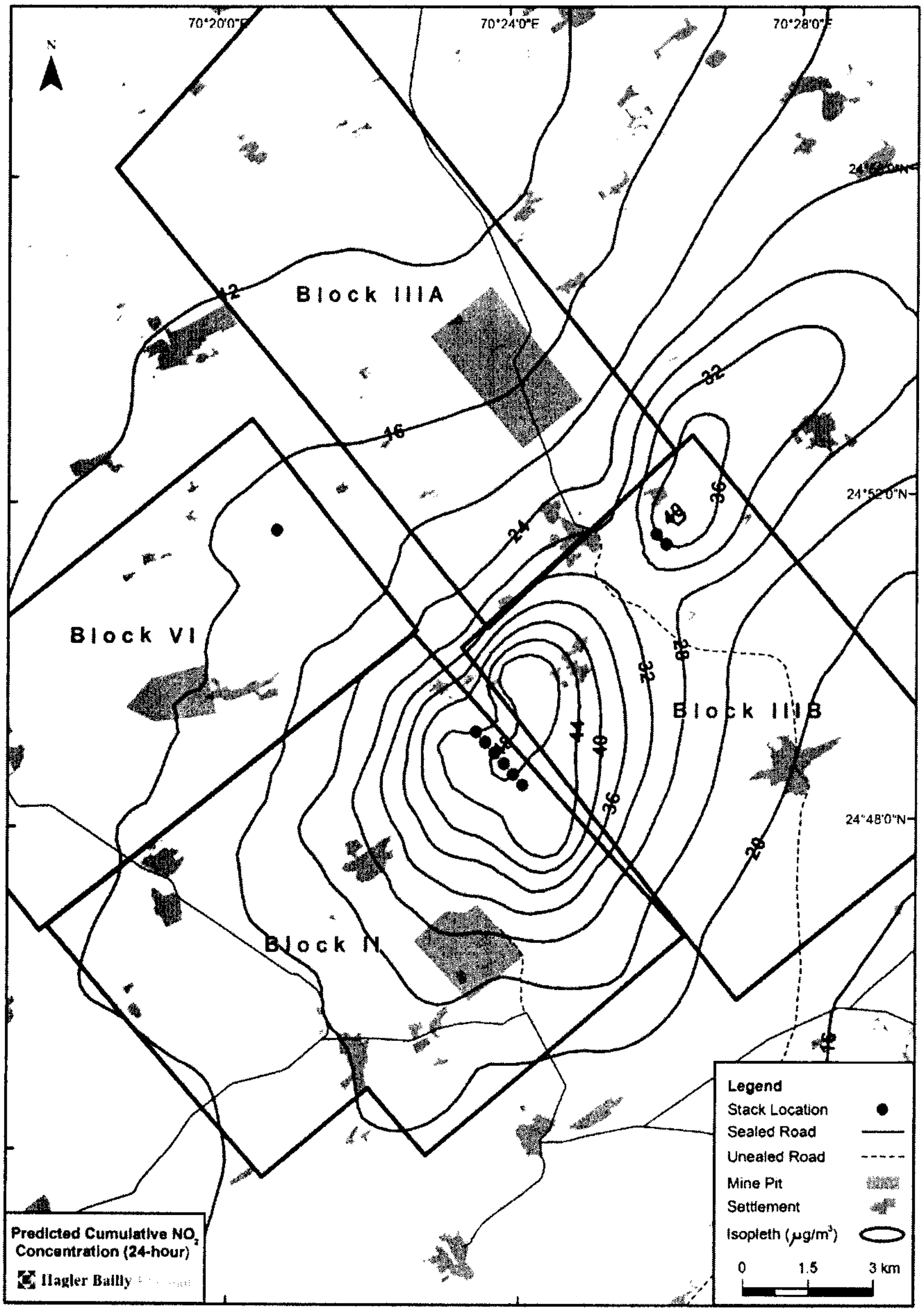


Exhibit 6.27: Predicted Cumulative PM_{10} Concentration (Annual)

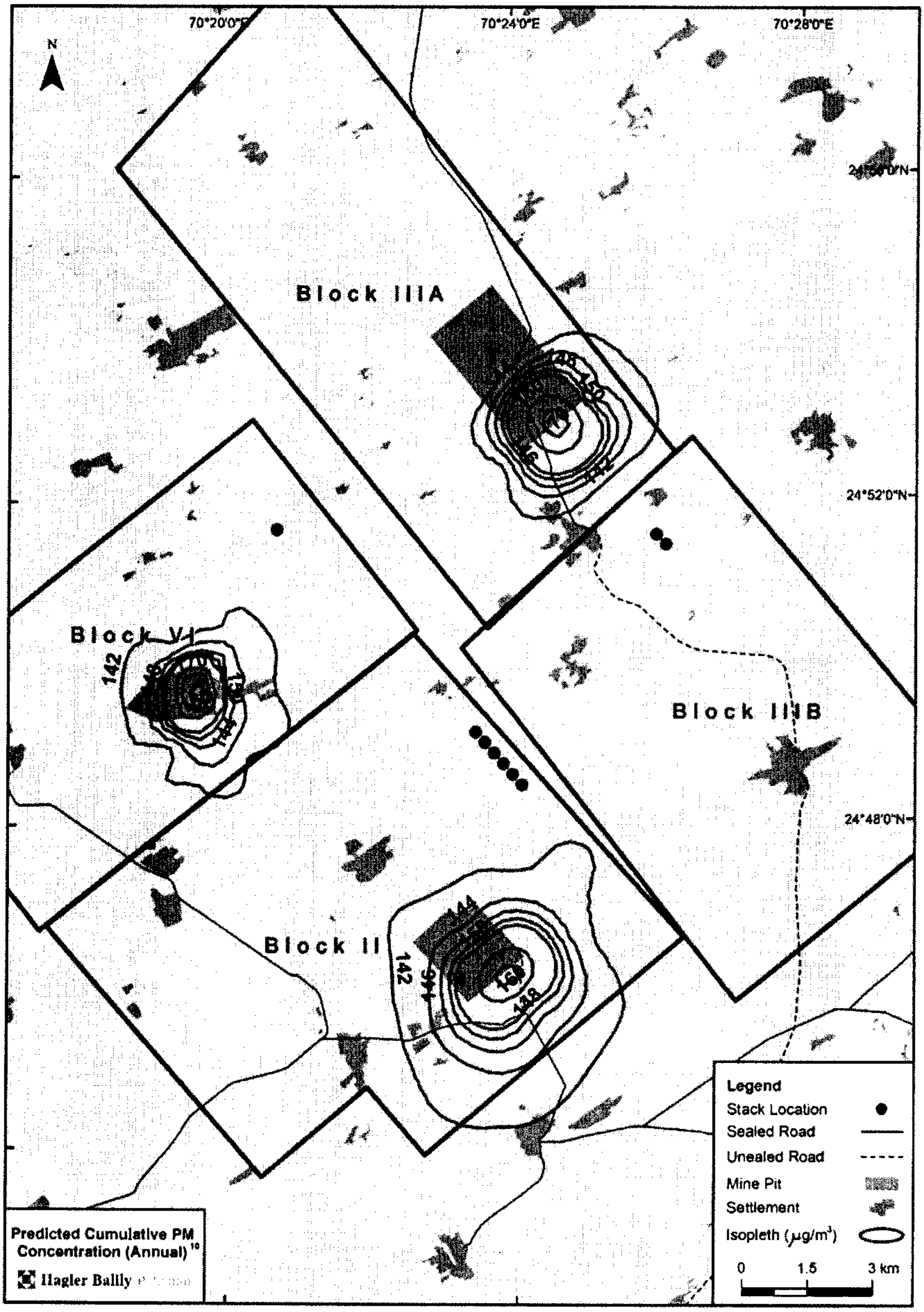


Exhibit 6.28: Predicted Cumulative PM_{10} Concentration (24-hour)

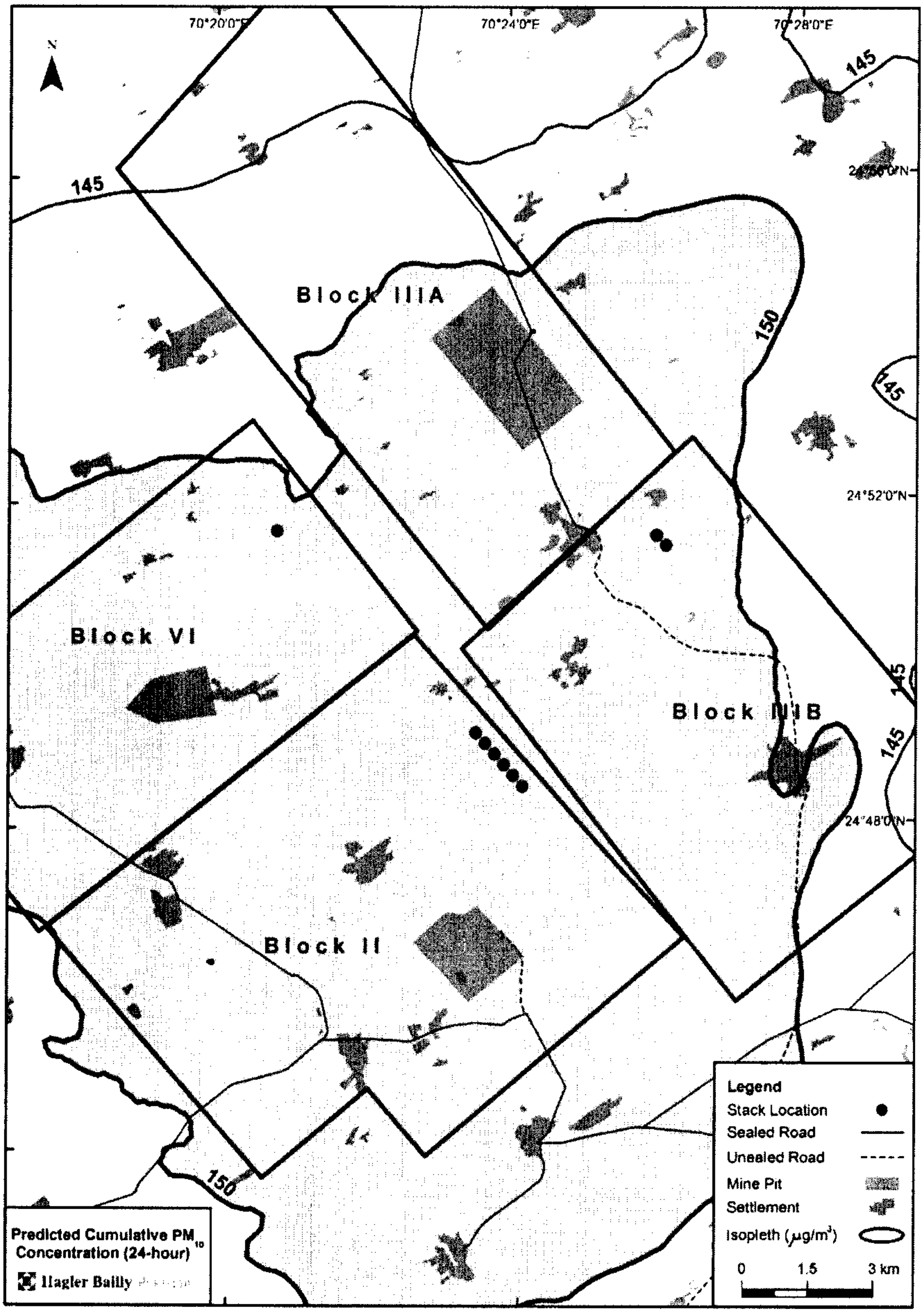


Exhibit 6.29: Predicted Cumulative $PM_{2.5}$ Concentration (Annual)

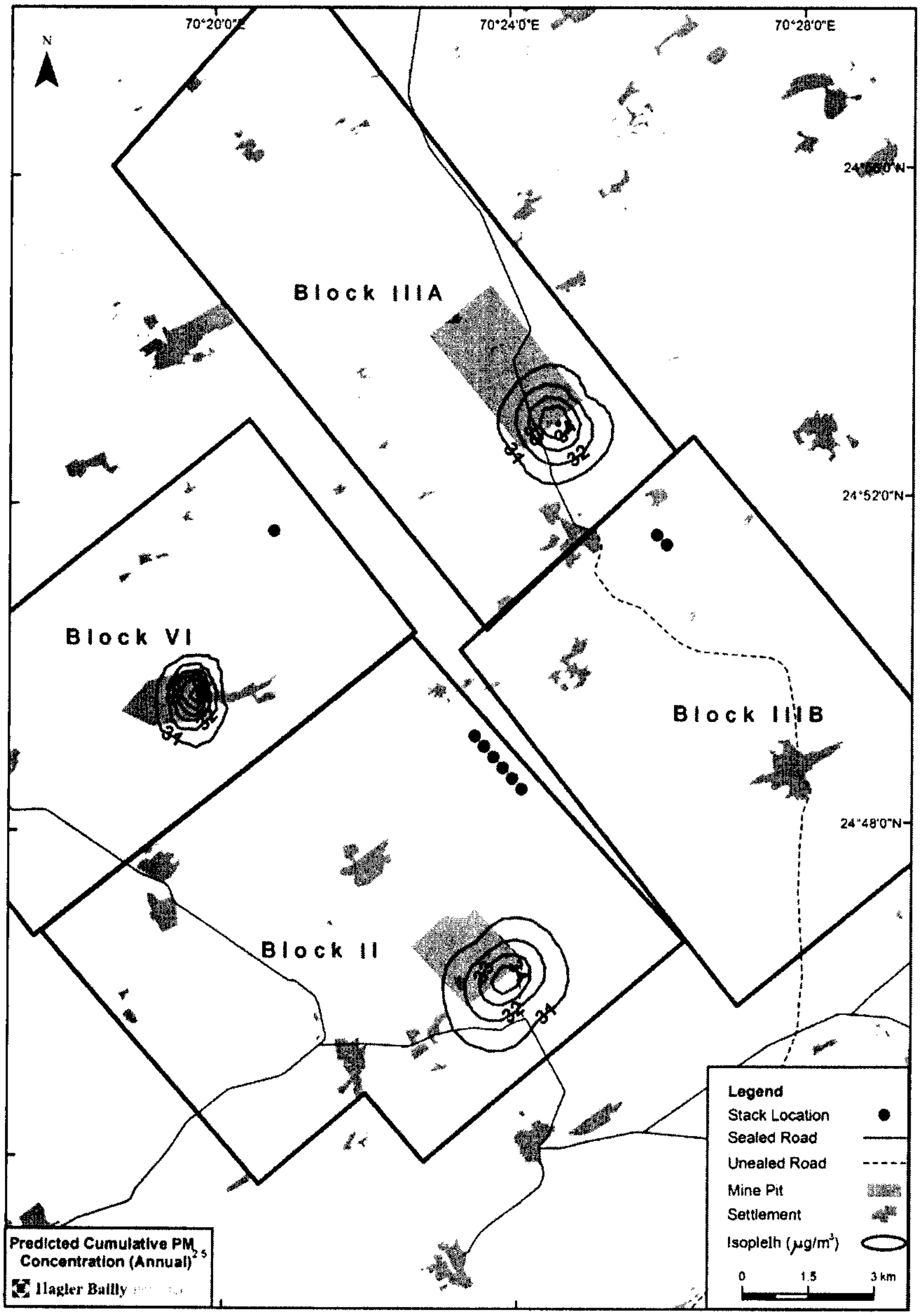
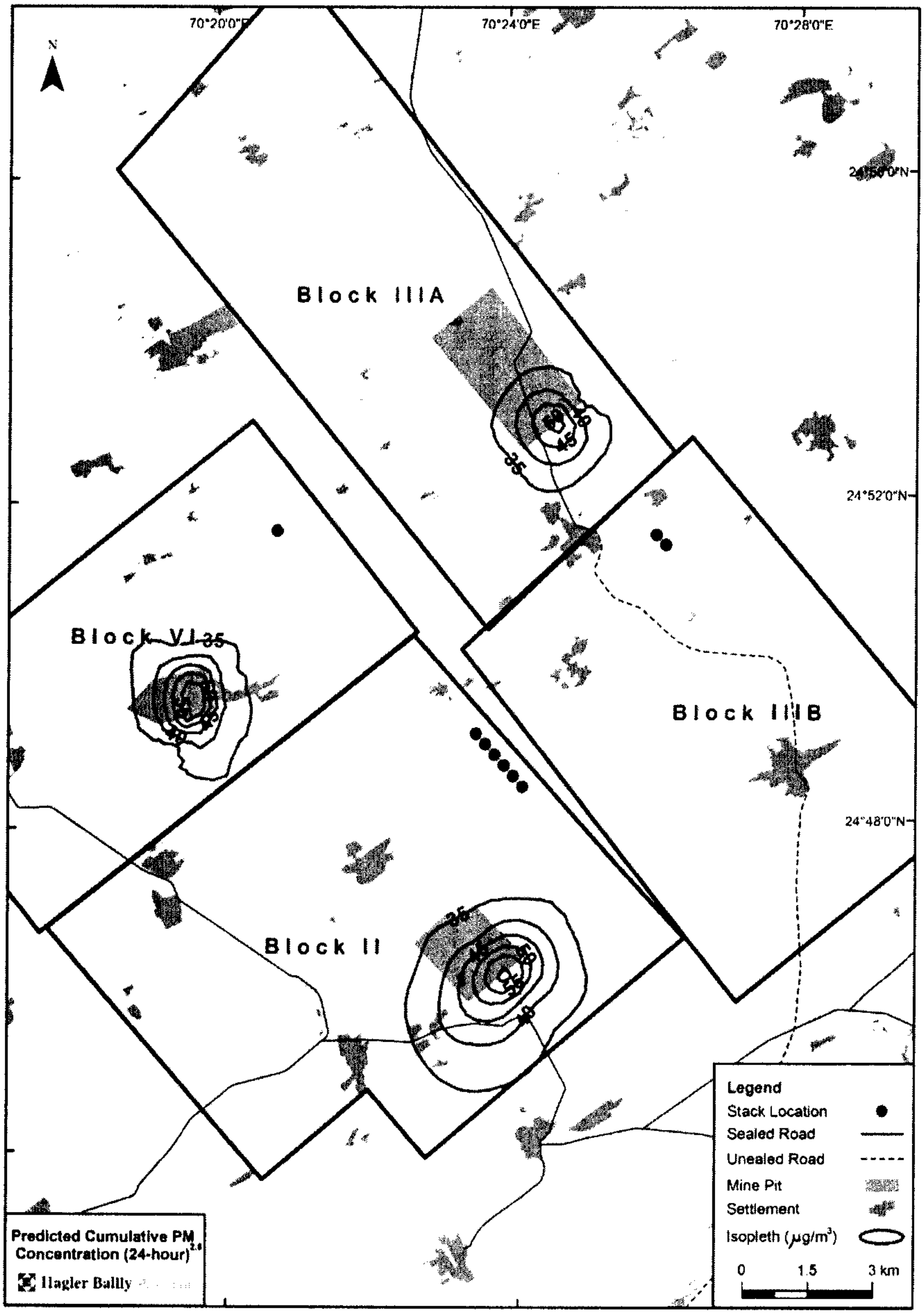


Exhibit 6.30: Predicted Cumulative $PM_{2.5}$ Concentration (24-hour)



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.[121] This is 136 persons per mpa coal extracted for a total estimated 4284 staff for the future developments. As with the power plants economies 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

[121] Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan, April 30th 2013

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.

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 TNPTL will be ultimately responsible to ensure that the EMP is implemented. For this purpose, TNPTL 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 TNPTL.

Specific roles and responsibilities for environmental monitoring are provided in **Exhibit 7.1**.

Exhibit 7.1: Roles and Responsibilities for Environmental Monitoring

Aspect	*TNPTL's Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
Contracting	Ensuring that monitoring and mitigation requirements are included in the contract between TNPTL and the construction contractor(s).	Understanding the requirements and estimating the required resources	Contract between TNPTL 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
Environmental staff	Designating an Environmental Manager for the project	Designating an Environmental Manager for the project (may be	Job descriptions

Aspect	*TNPTL's Responsibilities*	*Contractor's Responsibilities*	*Relevant Documentation*
		combined with health and safety)	
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 EIA/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: 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 EIA to Sindh EPA and obtain approval.	Before start of construction	TNPTL
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, TNPTL
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	TNPTL
		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, TNPTL
		Ensure environmental friendly disposal of cooling tower blowdown by making arrangements with the GoS	During design	TNPTL
		Ensure that the effluent disposal mechanism used has been approved by the SEPA	During design	TNPTL
		Ensure that the effluent complies with the requirements of the waste water disposal scheme.	During design	Design Contractor, TNPTL

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	TNPTL
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	TNPTL
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	TNPTL

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	TNPTL
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	TNPTL
	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	TNPTL
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	TNPTL

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: ▶ TNPTL 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, TNPTL 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, TNPTL 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	TNPTL
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	TNPTL
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	TNPTL

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	TNPTL
	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; Regularly inspect and maintain pressure vessels and piping	During operation	TNPTL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation and Management Measures	When	Responsibility
		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	TNPTL
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	TNPTL
Local culture	Increase in social ills in communities affected by in-	▶ Require non-locals employed by the Project to adhere to a social 'code of conduct' in terms of relations with local communities.	During design and planning and throughout	TNPTL

Aspect or Concern	*Potential Environmental Impact*	*Environmental Mitigation and Management Measures*	*When*	*Responsibility*
	migration of workers and job-seekers	▶ Provide employees and visitors to the site with cultural awareness training. ▶ Establish local CBOs and NGOs relating to women's issues.	construction and operation	
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	TNPTL
		▶ 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	TNPTL
Conflict	Project actions leading to tension and discord in local communities	▶ Implement a local employment policy and community development program.	During construction and operation	TNPTL

Aspect or Concern	Potential Environmental Impact	Environmental Mitigation and Management Measures	When	Responsibility
		▶ 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.		
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	TNPTL

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	TNPTL	SEQS (for gases) and baseline value as given in the EIA 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	TNPTL	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	TNPTL	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	TNPTL	NEQS
Stack Emissions	Boiler stack	Continuous monitoring of SO_2, NOx, and PM.	Continuous	TNPTL	NEQS to the extent applicable
Groundwater	All wells in the village of Bitra	Water level and TDS	Monthly	TNPTL	More than 10% change in water level or TDS as compared to seasonal average
Employment	All hiring undertaken directly by TNPTL or its contractors	Domicile, age, qualifications and salary of all employees in management, technical, skilled and unskilled category	Quarterly	TNPTL	Non-compliance with the employment policy
Grievance	Villages in the Study Area	Nature and frequency of grievances and time taken to address them	Quarterly	TNPTL	Increase in number of grievances or delay in addressing them
Hydrocarbon and chemical storage	Storage area	Visual Inspection of storage facilities	Monthly	Contractor and TNPTL	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 TNPTL	Lack of facilities
Coal and fly ash specifications	–	Heavy metals (Mainly As, Be, Cd, Cr, Pb, Hg, and Ni)	Quarterly	TNPTL through recognized laboratory	More than 10% increase over baseline
GHG emission	Stacks	Monitoring of flue gases flow and carbon content	Once in 6 months	TNPTL	–

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, TNPTL will be in charge of the operation and maintenance of the Project. HSE Department of TNPTL 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 TNPTL 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. TNPTL 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. TNPTL 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 TNPTL 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 TNPTL 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 TNPTL 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 TNPTL 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

TNPTL 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 TNPTL 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 TNPTL 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 EIA. 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 TNPTL 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 TNPTL and the contractor
- All relevant project personnel will be informed of the change

8. 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

8.1 No Project Alternative

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

- 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

8.2 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 182 billion tonnes.

A comparison of the quality of Thar lignite with that of the imported bituminous coal is summarized in **Exhibit 8.1**.

Exhibit 8.1: 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

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.

8.3 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 PF 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.

8.4 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 8.2 presents a detailed comparison among the technologies in terms of efficiencies, advantages and disadvantages.

Exhibit 8.2: 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.

8.5 Transport Route

There are two transport routes from Karachi to the Project site shown in **Exhibit 8.3**.

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

Karachi	Thatta	Badin	Mithi	Islamkot	Energy Park

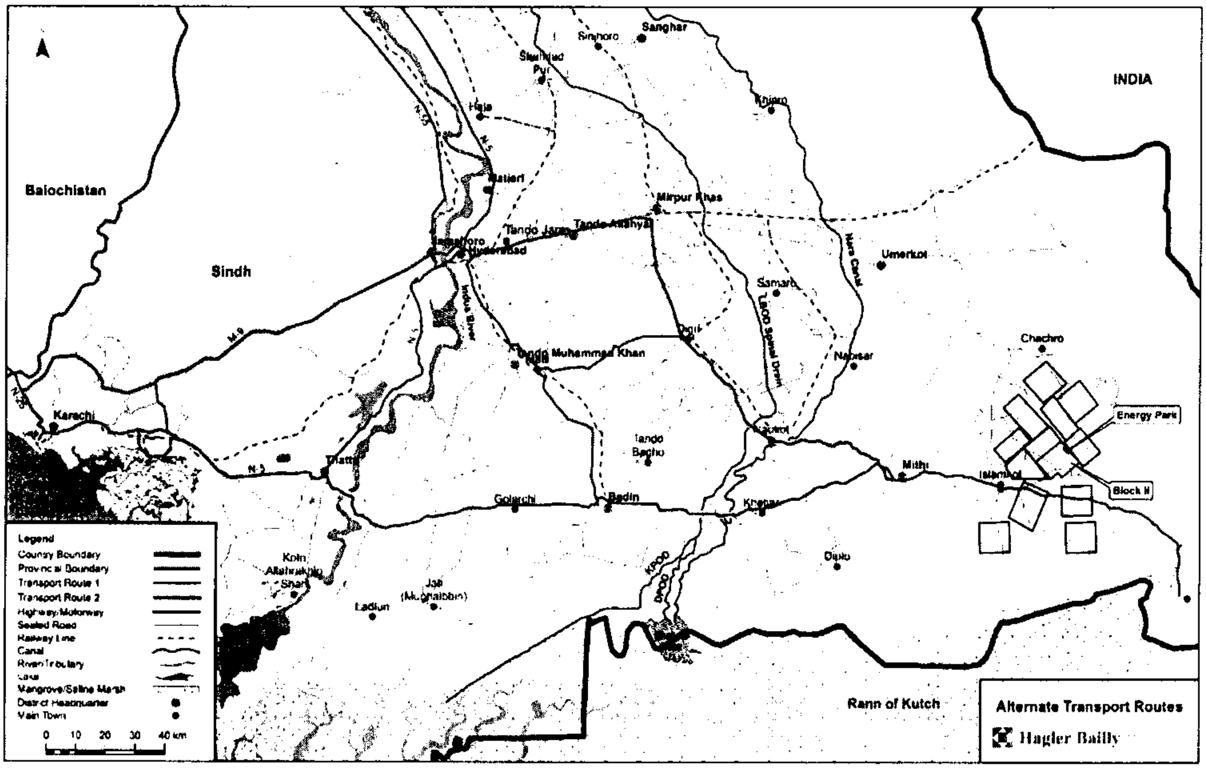
National Highway N-5 75 km Two lane 7.3 m wide	Provincial Highway 105 km Two lane 6.1-6.7 m wide	Provincial Road 114 km Two/One lane 4-6 m wide	Provincial Road 44 km Two/One lane 4-6 m wide	Provincial Road 28 km Two/One lane 4-6 m wide

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 8.3: Alternate Transport Routes



9. 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.