NARA HYDROPOWER (PVT) LTD.

1st Floor, Block 3, Hockey Club of Pakistan Stadium, Liaquat Barracks, Karachi.
Tel # +92-21-111666447 Fax # +92-213-5680533

Ref No: NHPL/GMP/1902

The Registrar
National Electric Power Regulatory Authority (NEPRA)
2nd Floor, OPF Building, G-5/2 ISLAMABAD.

February 19, 2018

APPLICATION FOR A GENERATION LICENSE

Dear Sir,

I, Gul Hassan Bhutto General Manager Engineering & Operations of the Nara Hydro Power (Pvt.) Limited, being the duly authorized representative of Nara Hydro Power (Pvt.) Limited by virtue of Board of Directors Resolution dated February 12, 2018, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to the Nara Hydro Power (Pvt.) Limited, pursuant to section Schedule I Regulation 3(1) 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 Pay order No: 00030037 February 19, 2018 for PKR. 229,392/- drawn on Summit Bank Limited, 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.

Thanks and Kind Regards,

Gul Hassan Bhutto
GM Engineering & Operations
For **Nara Hydro Power (Pvt.) Limited**

Enclosed:

1. *Three Copies of Generation License Application including all documents as per annexures.*

Cc to:

1. *Group Chief Operating Officer Nara Hydro Power (Pvt.) Ltd*
2. *Master File*

A010003

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. 0093012

I hereby certify that NARA HYDROPOWER (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 Sixteenth day of April, Two Thousand and **Fifteen**.

Incorporation fee Rs. 7000/= only

(Sidney Custodio Pereira)
Joint Registrar of Companies
Karachi

MEMORANDUM
AND
ARTICLES OF ASSOCIATION

***

THE COMPANIES ORDINANCE, 1984

A PIRVATE COMPANY LIMITED BY SHARES

MEMORANDUM

AND

ARTICLES OF ASSOCIATION

OF

NARA HYDROPOWER (PRIVATE) LIMITED

THE COMPANIES ORDINANCE, 1984

(XL VII OF 1984)

A PRIVATE COMPANY LIMITED BY SHARES

MEMORANDUM OF ASSOCIATION

OF

NARA HYDROPOWER (PRIVATE) LIMITED

NAME

I. The name of the Company is **"NARA HYDROPOWER (PRIVATE) LIMITED"**.

REGISTERED OFFICE

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

OBJECTS

III. The Sole Objects for which the company is established is as under:

1. To set up, establish, operate, manage, generate and run Power Generation Plants, from different means and sources and to generate and supply electricity to all concerns.

2. In order to carryout and fulfill the above object, the Company shall be authorized:

   a. To generate, produce, manufacture, store, sell, export to supply electricity to all concerns, by whatever means including hydral, electricity generation by hydropower and production of electrical power through the use of the gravitational force of falling of flowing water, wind-mill, thermal, gas, and solar for industrial, commercial and residential use through distribution network and to construct, install, operate and maintain thereon power house, civil and mechanical works and structures, hydro, grid stations, transmission towers, power lines, building, workshops and other facilities as may time to time be necessary for the attainment of the object of the company.

b. To construct, lay-down, establish, fix, and carry out all necessary hydral power stations, Power station, cables, wires, lines, accumulators, and works and to generate accumulate, distribute and supply electricity to cities, towns, streets, docks, markets, theaters, industrial zones, sites, areas and parks, buildings and places public and private.

c. To carry, on and undertake all hydral power, civil, electrical and mechanical works related to the aforementioned business, and to generate, accumulate, distribute and such by electricity for the purposes of light, heat, motive power and for all other purposes for which electrical energy can be employed, and to deal in all apparatuses and things required for or cable of being used in connection with the generation with the distribution, supply, accumulation and employment of electricity.

d. To manufacture, process, buy, sell, exchange, alter improve, otherwise deal in all kinds of hydral power plants, electrical plants, machinery, equipments, appliance, energy saving devices, and products, gadgets, components and parts including specialized equipments for the purposes of the business for the Company, and to manufacture, import, export, sell, buy, and deal in all accessories, articles, apparatus, equipment and goods, which may seem calculated to promote or to be capable of being used in connection with the use of electric power supply.

e. To enter into, make and perform contracts and arrangements of every kind and description with the Central, Provincial government, City Government, or Local Authority or person that may be conducive to the Company's Object and to obtain from any Government Authority, firm or person any rights, privileges, contracts, concessions, exemptions, permissions approvals and grants which the company may think desirable, and to obtain and carry out, exercise and comply with any arrangements, rights, privileges, contracts and concession and dispose of the same or turn into account the same.

f. To purchase, take on lease or in exchange, or otherwise acquire any lands and buildings in Pakistan or elsewhere, and any estates or interest therein and any rights connected with any such lands and buildings, and to buy, sell, lease, mortgage any such lands, buildings, estates, interests and rights therein, to enter into such arrangements, collaborations, joint ventures or else with local and/or foreign companies for acquiring, undertaking building, and development of power projects in Pakistan and elsewhere.

g. To manage, improve, develop, buy, sell, exchange, mortgage, charge, hypothecate, pledge, assign, transfer or otherwise deal with all or any part of the property and assets, whether movable or immovable, tangible or intangible, and any right, title and interest of the Company.

h. To carry on any other business, which may deemed to the company capable of being conveniently carried with the above or calculated directly or indirectly to enhance the value or render profitable any of the

company's properties or rights, but the company shall not do any unlawful act or business.

i. To sell or dispose off machinery, plants, equipment, materials and all articles and things belong to the company and also all the products thereof either for immediate or future delivery upon such terms and conditions as may be deem expedient.

j. To acquire technical knowledge, know how, process, recipes formulas, engineering and manufacturing data, to appoint consultants and advisers for advice on managerial, financial and technical problems of the company.

k. To apply for purchase or otherwise acquire and protect and renew in any part of the world any patents, patent rights, trade marks, designs, licenses, concessions and the like conferring any exclusive or limited right to their 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 license in respect of or otherwise turn to account the property, rights or information so acquired and to expand money in experimenting upon, testing or improving any such patents, inventions or rights.

l. To purchase, or otherwise acquire, and invest in shares, scrip, stocks, debentures, certificates, bonds or other financial instruments, of any entity, whether listed or non-listed, and public or private, and to receive dividends, profits or mark-up, and/or to sell and dispose of the same as deem fit.

m. To takeover, acquire, amalgamate and merge with any other company or spin-off its division, and to sign, execute, arrangement, schemes, and contracts relating to such arrangements, as deem expedient or necessary in achieving these objects.

n. To enter into partnership or into arrangement for sharing profits, cooperation, joint venture, reciprocal concessions with local domestic and/or international foreign companies, for expansion of business, and trade or otherwise with any persons, firms or company, to carry on any business or transaction which the company is authorized to carry on.

o. To employ professionals, and other persons well conversant with relevant knowledge, experience and skills, and having alt technical expertise as may be deemed necessary or proper for the efficient handing and carrying on the business of the company.

p. In the event of winding-up, to distribute any of the properties of the company amongst the members in species or kind but it manner that no distributing amounting to a reducing of capital be made except with the sanction (if any) for the time required by law.

q. To adopt such means of making known the articles, goods and products of the company as may seem expedients, and in particulars by advertising in the media, through books, journals, press, films, projectors and cinema houses, television, radio and through circulars, publication of books and periodicals.

r. To grant donations, make contributions and give financial assistance to charitable and other societies, association, clubs, schools, colleges and universities and other institutions as may be deemed proper.

s. To open and maintain offices, branches, commercials centers, depots, show rooms, offices, go-downs and to appoint agents, sub-agents, attorneys, representatives, distributors and to establish and run trading and distributorship agencies, factories, laboratories, testing centers, technical institutions on such terms and conditions as may be deemed reasonable and proper.

t. To sell or dispose of or transfer the business, property, whether movable or immovable, undertaking of the company or any part thereof for such consideration as the company may think fit.

u. To open account, overdraft accounts and cash credit with or without security, to keep fixed and other deposits with any banks accept/ discount, executes, sign, issue and deal in cheques, bills of exchange, drafts, promissory notes, bill of landing, debentures, bonds, warrants, debenture coupons and other negotiable instruments in connection with the business of this company.

v. To borrow money in Pakistan as well as in foreign currencies at any time and from time to time for the purpose of the company with or without securities and to avail third party guarantees and collateral, upon such terms as the directors may deem expedients, to take advances from or by cash credit or current or overdraft accounts with any bank, financial institutions, society, company or organizations, including the directors of the company and/or mortgage, hypothecation, charges, pledge or by the issue of debenture charged upon or any of the company's properties (both present and future) or by such other means as the Directors may in their absolute discretion deem fit.

w. To do such other things as are incidental or conductive in the opinion of the board of Directors to the attainment of the above objects or any of them.

x. To pay all or any costs, charges and expenses preliminary and incidental to the promotion, formation, establishment and registration, of the company.

y. To create charge on all or any of the moveable and immoveable properties/assets both present and future of the company by way of mortgage, pledge, hypothecation, lien, assignment, fixed/floating charges, guarantee, LC, or any other form of security in favor of any person including a banking company and/or financial institution in respect of any finance facility whether fund based or non-fund based allowed to it/the company or its associated companies, group concerns, subsidiaries and/or companies under common directorship and/or under common membership and/or to any company, association, firm or person and/or any other third person and to undertake and/or stand as surety, indemnifier, guarantor for performance of its/company's own obligations or the obligations of its associated companies, group concerns, subsidiaries and/or companies under common directorship and/or under common membership and/or of any company association, firm or person and/or any other third person.

It is hereby undertaking that the company shall not engage in banking, finance, leasing or the business of any investment company, or housing finance company, or insurance company or in any other unlawful business and that nothing in the object clauses shall be construed to entitle it to engage in such business. The company shall not launch multi-level marketing & prize schemes.

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

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

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

LIABILITIES OF MEMBERS

IV. The liability of members is limited.

CAPITAL

V. The Authorized Capital of the company is Rs.1,000,000/= (Rupees One Million Only) divided into 10,000 (Ten Thousand) Ordinary Shares of Rs.100/- Rupees Hundred) each, with power to increase or reduce capital of the company, and from time to time consolidate, such divided of otherwise reorganize the share capital of the company and to issue shares of various classes, and in such denominations with such special rights, privileges and conditions in accordance with the Companies Ordinance, 1984 and its statutory amendments, alternations and modifications for the time being in force and regulations of the Company and to vary, modify or abrogate such rights .

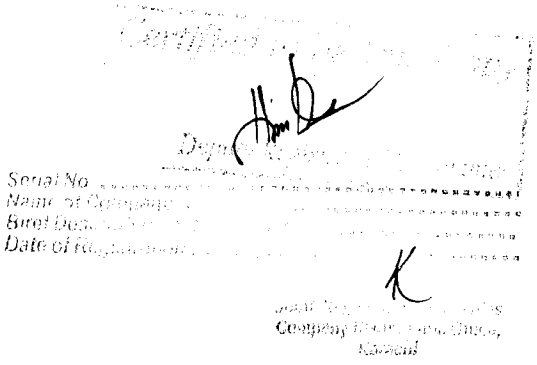
We the several persons, whose names, address and description are hereunder subscribed, are desirous of being formed into a company in pursuance of this Memorandum of Association, and we respectively agree to take the number of shares in the capital of the Company set opposite our respective names:

Name and Surname Present & Former in full	Father's/ Husband in Name full	Nationality With former Nationality	Occupation	Residential Address	Number of hares taken by each subscriber	Signature
Khawaja Nimr Majid **CNIC # 42000-1246900-5**	Khawaja Anver Majid	Pakistan	Business	12 Runnymede, Clifton, Karachi	20 (Twenty only)	
Noor Nimr Majid **CNIC # 42301-7724218-6**	Khawaja Nimr Majid	Pakistan	Business	12 Runnymede, Clifton, Karachi	20 (Twenty only)	
				TOTAL	**40 (Forty only)** ========	

Dated this 10 April, 2015

Witness to the above signatures:

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



THE COMPANIES ORDINANCE, 1984

COMPANY LIMITED BY SHARES

ARTICLES OF ASSOCIATION

OF

NARA HYDROPOWER (PRIVATE) LIMITED

PRELIMINARY

Table "A-" excluded

1. The regulations contained in Table "A" in the First Schedule to the Companies Ordinance, 1984, shall not apply to the company except in so far as they are repeated or contained in these Articles.

Interpretation

2. The chapter headings shall not affect the construction hereof, and in these Articles unless there is something in the subject or context inconsistent therewith.

Articles

"The Articles" mean the Articles of Association, as originally framed or as altered from time to time or the Company acting at a meeting or pursuant to unanimous written consent.

Books and Papers etc

"Book and Paper", "Book or Paper", or "Books of Account" includes accounts, deeds, vouchers, registers, writings and documents.

Company

"The Company" means **NARA HYDROPOWER (PRIVATE) LIMITED**

Chief Executive

"The Chief Executive" means the Chief Executive appointed from time to time by the company pursuant to these Articles.

Directors

"The Directors" mean the directors of the Company appointed from time to time pursuant to these Articles.

Debenture

"Debenture" includes stock, bonds, term finance certificate and any other security other than the shares of the company whether constituting a charge on the assets of the company or not.

Documents

"Documents" include summon, notice, requisition, order, other legal process, vouchers and register.

Dividend

"Dividend" means the distribution of profits of the company to its members, and includes bonus.

Holding Company

"Holding Company" shall have the meaning assigned to it by section 3.

Member

"Member" means a member of the company within the meaning of the provision of Section 2(1) (21).

Month

"Month" means as calendar month according to the English calendar.

Ordinance

"The Ordinance" means the Companies Ordinance, 1984 as amended and any amendment or re-enactment thereof for the time being in force.

Office

"Office" means the registered office of the Company.

Participatory Redeemable Capital

"Participatory redeemable capital" means such redeemable capital as is entitled to participate in the profit and loss of the company.

Proxy

"Proxy" includes attorney duly constituted under a Power of Attorney.

Investor

"Investor" means a corporation, a company incorporated under the Ordinance, financial institution, Federal Government, Provincial Government or such other body which holds shares in the company.

Register

"The Register" means the register of members to be kept pursuant to Section 147 of the Ordinance.

Redeemable Capital

"Redeemable capital" has the meaning assigned to it by section 2(1)(30A).

Share

"Share" means share in the capital of the company.

Secretary

"Secretary" means any individual appointed to perform the secretarial, administrative or other duties ordinarily performed by the Secretary.

Section

"Section" means section of the Ordinance.

Security

"Security" has the meaning assigned to it by section 2(1) (34).

S.E.C.P.

"S.E.C.P." means Securities and Exchange Commission of Pakistan.

Special Resolution

"Special resolution" has the meaning assigned to it by Section 2(1) (36).

Seal

"The Seal" means the common seal adopted by the company.

In Writing and Written

"In writing" and "Written" includes printings, lithography and in writing and other modes of representing or reproducing words in a visible written form.

Word importing the singular number includes the plural number and vice versa.

Word importing the masculine gender only includes the feminine gender.

Words importing persons includes bodies corporate.

PRIVATE COMPANY

Private- Company

3. The Company is a private company within the meaning of Clause 28 of Section 2(1) of the Companies Ordinance, 1984 and accordingly:

(a) No invitation shall be issued to the public to subscribe for any shares, debentures or debenture stock of the Company.

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

(c) The right to transfer shares in the company is restricted in the manner and to the extent hereinafter appearing.

Business

4. The business of the Company shall include all or any of the business objects enumerated in the Memorandum of Association and can be commenced immediately after the incorporation of the Company as the Directors may think fit, not withstanding that part of the capital has been subscribed.

Place of Business

5. The business of the Company shall be carried at Karachi or at such place in the whole of Pakistan or elsewhere as the Directors may deem proper or, advisable from time to time.

CAPITAL

Capital

6. The authorized Capital of the Company is **Rs.1,000,000** (Rupees One Million) divided into **10,000** (Ten Thousand Only) Ordinary Shares of **Rs. 100/-** each with powers to increase or reduce the capital, to divide the shares in the capital for the time being into several classes and to attach to them rights, privileges, conditions, and to vary, modify or abrogate any of such rights, privileges, conditions, as are required or permitted by the Companies Ordinance, 1984 and its statutory amendments, alterations and modifications for the time being in force.

Increase of Capital

7. Where at any time the Board decides to increase the issued capital of the company by issuing any further **Alternation** shares, then subject to any direction to the contrary that may be given by the company in general meeting, such shares shall be offered to the members in proportion to the existing shares held by each member, and such offers shall be made by notice specifying the number of shares to which the member is entitled and limiting a time within which the offer, if not accepted, will be deemed to be declined and after the expiration of such time, or on receipt of an intimation from the members to whom such notice is given that he declines to accept the shares offered, the Board may dispose of the same in such manners as they think most beneficial to the company. The notice shall be accompanied by the circular required under section 86.

Shares at the Disposal of Directors

8. The shares shall be under the control of the Directors who may allot or otherwise dispose of the same to such persons, firms or corporations, on such terms and conditions and at such time as may be thought fit.

Allotment of Shares

9. The Shares in the capital of the Company may be issued or allotted in payment or part-payment of any property, land, building, machinery, goodwill or goods supplied or any services rendered or likely to be rendered to the Company in promotion and establishment of the Company or conduct of its business and any shares so allotted may be issued as fully paid-up shares.

Consolidation or Sub-division of Shares

10. If and whenever as a result of an issue of new shares or any consolidation or sub-division of shares any member becomes entitled to hold shares in fractions, the Board shall not be required to issue such fractional shares and shall be entitled to sell whole shares at a reasonable price and pay and distribute to and amongst the members

entitled to such fractional shares in due proportion with the net proceeds of the sale thereof. For the purpose of giving effect to any such sale the Board may authorize any person to transfer the shares sold, to the purchaser thereof, and the purchaser shall be registered as the holder of the shares comprised in any such transfer and he shall not be entitled to see the application of the purchase money nor shall his title to the shares be affected by any irregularity or invalidity in the proceedings in reference to the sale.

Issue of Convertible Securities

11. The company may issue ordinary shares or grant option to convert into ordinary shares the outstanding balance of any loans, advances or credit, as defined in the. banking companies ordinance, 1962 (L VII of 1962) or other non-interest bearing securities and obligations in accordance with the provisions of section 87.

12. The company may issue to one or more schedule banks, financial institutions or such other persons, as are specified for the purpose by the Federal Government by notification in the official gazette, any investment in the nature of redeemable capital in any or several form in accordance with the provisions of section 120.

Shares for Consideration Other than Cash

13. Subject to the provision of the Ordinance and these Articles, the Board may allot and issue Shares in the capital of the company as payment for any property sold or transferred, goods or machinery supplied, or for services rendered to the company in the conduct of its business or affairs and any shares which may be so allotted may be issued as fully paid up shares and if so issued, shall be deemed to be fully paid up shares.

14. Any application or subscription signed by or on behalf of an applicant or Subscriber for shares in the company, followed by an allotment of any shares therein, shall be an acceptance of shares, within the meaning of these Articles, and every person who thus or otherwise accepts any shares and whose name is entered on the register shall for the purpose of these Articles be a member.

15. The money (if any) which the Board shall on the allotment of any shares being made by it require or direct to be paid shall immediately on the insertion of the name of the allottee in the register of members as the holder of such Shares, become a debt due to and, recoverable by the company from the allottee thereof, and shall be paid by him accordingly.

Right of ownership of Shares

16. Save as herein otherwise provided the company shall be entity to treat the person whose name appears on the register of members as the holder of any shares as the absolute owner thereof, and accordingly shall not (except as ordered by a court of competent jurisdiction or as required that law) be bound to recognize any trust or equity or benami, equitable, contingent or other claim to or interest in such shares, on the part of any other person whether or not it shall have express or implied notice thereof.

UNDERWRITING, COMMISSION AND BROKERAGE

Brokerage

17. The Company may at any time pay a commission to any person for subscribing or

agreeing to subscribe (whether absolutely or conditionally), for any shares or debentures or procuring or agreeing to procure, subscriptions, whether absolute or conditional, for, any shares or debentures of the company, but so that the amount or rate of commission shall not exceed the rate per cent of amount as may be fixed by the S.E.C.P. The commission may be paid or satisfied in cash or in any shares or debentures of the company. The company may also pay the usual brokerage not exceeding one (1) per cent in respect of any subscription for shares or debentures.

CERTIFICATES

Members Entitled to Share Certificate

18. Every member shall be entitled without payment to one certificate for all the shares registered in his name, or if the Board so approved (upon paying such fee as the Board may from time to time determine), to several certificates, each for one or more shares. Every certificate of shares shall specify the number and denoting numbers of the shares in respect of which it is issued and the amount paid thereon, such certificate shall be issued under seal and bear the signature of one Director and shall be countersigned by the Secretary or by a second Director or by some other person appointed for that purpose by the Board.

Renewal of Certificate

19. If any certificate is worn out, defaced or rendered useless, then upon production thereof to the Board, it 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 thereof, to the satisfaction of the Board and on such indemnity as the board deems adequate being given, a new certificate thereof shall be given to the party entitled to such lost or destroyed certificate.

20. The company shall, within ninety (90) days after the allotment and within forty five (45) days after the application for the registration of the transfer of any share, complete and have ready for delivery the certificates for shares and unless sent by post or delivered to the persons entitled thereto, within that period, shall give notice of the fact to the shareholder immediately thereafter.

A duplicate of a certificate of shares, shall be issued within forty-five (45) days from the date of application.

TRANSFER AND TRANSMISSION

Register of Transfer

21. The Company shall keep a book to be called the "Register of Transfer" and therein shall be fairly and distinctly entered the particulars of any transfer and transmission of any shares.

22. The instrument of transfer of any share shall be in writing in the usual common form or in the following form or as near thereto as circumstances will admit:

I _____

_____ being _____
National, in Consideration of the sum of Rs.
_____

(Rupees _____)

Paid to me by _____S/O
_____

of National _____Hereinafter called "The Transferee") do hereby transfer to the _____ Ordinary Share(s) numbered in the undertaking called **NARA HYDROPOWER (PRIVATE) LIMITED** to hold the same into the said Transferee, his (or her) executors, administrators and assigns subject to the several conditions on which I held the same immediately before the execution hereof, and I, the Transferee, do hereby agree to take the said share(s) subject to the said conditions aforesaid. As witness etc.

Condition for Transfer

23. The share shall be transferred subject to following restrictions:

(a) the shares shall in the first instance be offered to the existing shareholders.

(b) if the existing shareholders are not willing to accept the shares the Board shall approved transfer of shares, subject to the consent of all existing shareholders, to other persons.

(c) the shares shall be sold at a market value to be determined by the Auditors of the company with other experts of the company; if necessary.

No Transfer to an Infant

24. No shares in any circumstances shall be transferred to an infant, an Infant insolvent or person of unsound mind.

Closure of Transfer Books

25. The Board shall have power to close the register of transfer for such period or periods of time not exceeding thirty days at a time and 45 days in a year.

Right of Nomination

26. A person may on acquiring interest in the company as a member, nomination represented by shares, at any time after acquisition of such interest deposit with the company a nomination conferring on one or more persons the right to acquire interest in the shares specified therein in the event of his death.

Transmission of Shares

27. In the case of death of shareholders the survivor where the deceased was a joint holder, and (subject as hereinafter provided), where the deceased was a sole or only surviving holder, the execution or administrators of the deceased holding a grant of probate or letters of administration effective in Pakistan, shall be the only persons recognized by the company as having any title to the shares, but nothing herein

contained shall release the estate of a deceased holder (whether sole or joint), form any liability (whether sole or joint), in respect of any share solely or jointly held by him. In any case in which such a grant of probate or letters of administration to the estate of a deceased sole or only surviving holder has not been obtained, the Board may, but shall not be bound to, recognize the title of any person claiming to be entitled to the deceased holder's shares on production by such claimant of a succession certificate or such other evidence of title as the Board may deem sufficient, and upon the claimant furnishing such indemnity, if any, as the Board may require.

Right of persons becoming entitled to share

28. Any person becoming entitled to a share in consequence of the death or insolvency of a member shall, upon such evidence being produced as may from time to time be required by the Board, have the right either to be registered as member in respect of the share or instead of being registered himself, to make such transfer of the share as the deceased or insolvent person could have made but the Board shall, in either cases have the Same right to decline registration as they would have had in the case of a transfer of the share by the deceased or insolvent person the death or insolvency.

29. A person becoming entitled to a share by reason at the death or insolvency of the holder shall subject to Article 28 above, be entitled to the same dividends and other advantages to which he would be entitled if he was the registered holder of the share, except that he shall not before being register as a member in respect of the share, be entitled in respect of it to exercise any rights conferred by membership in relation to meeting of the company.

30. The company shall incur no liability whatsoever in consequence of its registering or giving effect to any transfer of shares made or purporting to be made by any apparent legal owner thereof (as shown or appearing in the register) to the prejudice of persons having or claiming any equitable right, title or interest to or in the same shares, notwithstanding that the company may have had notice of such equitable right, title or interest or notice prohibiting registration of such transfer, and the company shall not be bound or required to regard or attend or give effect to any notice which may be given to it of any equitable right, title or interest, or be under any liability whatsoever for refusing or neglecting so to do, but the company shall nevertheless be at liberty to regard and attend any such notice and give affect thereto, if the Board shall so thinks fit.

ALTERATION OF CAPITAL

Increase of Capital

31. The company may by a Resolution increase its Authorized Share Capital comprising of any class and denomination.

32. Except and so far as otherwise provided by the conditions of issued or by these Articles, any capital raised by the creation of new shares shall be considered part of the Authorized Capital and shall be subject to the provisions herein contained with reference to transfer and transmission, voting and otherwise.

Reduction of Share Capital

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

34. The company may in general meeting by Resolution alter the conditions of its memorandum as follows:

Consolidation and Division of Share

(a) Consolidate and divide all or any of its share capital into shares of larger amount than its existing shares;

(b) Sub-divide shares or any of them into shares of smaller amounts than originally fixed by the memorandum and subject nevertheless to the provisions of the Ordinance in that behalf;

(c) Cancel shares which at the date of such General Meeting have not been taken or agreed to be taken by any person, and diminish the amount of its share capital by the amount of the shares so canceled.

Variation of Rights

35. The variation in the right of shareholders shall be made in the manner provided by Section 108.

BORROWING POWERS

Powers to Borrow

36. The Directors may from time to time at their discretion borrow or secure the payment of any sum or sums of money for the purposes of the Company from any persons firms or companies, banks, or investment corporation, government or semi-government institutions or any other source whatsoever (expressly including any member of the Company) and may themselves but to the Company any such sum or sums on security or otherwise.

Condition on which money may be borrowed

37. The Company may create charge on all or any of the moveable and immoveable properties/assets both present and future of the company by way of mortgage, pledge, hypothecation, lien, assignment, fixed/floating charges, guarantee, LC, or any other form of security in favor of any person including a banking company and/or financial institution in respect of any finance facility whether fund based or non-fund based allowed to it/the company or its associated companies, group concerns, subsidiaries and/or companies under common directorship and/or under common membership and/or to any company, association, firm or person and/or any other third person and to undertake and/or stand as surety, indemnifier, guarantor for performance of its/company's own obligations or the obligations of its associated companies, group concerns, subsidiaries and/or companies under common directorship and/or under common membership and/or of any company association, firm or person and/or any other third person.

38. The Directors may borrow or secure the payment of such sum or sums of money in such manner and upon such terms and conditions in all respect as they think fit, either by creation of any mortgage, hypothecation as charge on the whole or any part of the property of the Company and in particular by the issue of the debentures or debenture-stock of the Company charged upon the whole or any part of the property of the Company both present and future.

Assignment of Securities

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

Issue at Discount etc.

40. Any bonds, debentures or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawings, Convertibility into shares, attending and voting at general Meeting of that company, appointment of Directors and otherwise, provided that debentures with the right to vote or be converted into shares shall not be issued without the consent of the company in General Meeting.

Liability for payment of sum due from the Company

41. If the Directors or any of them or any other person shall become personally liable for the payment of any sum primarily due from the company, the Board may execute or cause to be executed any mortgage, charge or security over or affecting the whole or any part of the assets of the company by way of indemnity to secure the Directors or persons so becoming liable as aforesaid from any loss in respect of such liability.

GENERAL MEETING

General Meeting

42. An Annual General Meeting shall be held within eighteen months from the date of incorporation of the Company, and thereafter once at least in every calendar year within a period of four months following the close of its financial year. Every Annual General Meeting shall be called during business hours on a day that is not Public holiday and shall be held either at the Registered Office of the Company or at some other place within the City, town or village in which Registered Office of the Company is situated and the notice calling the meeting shall specify it as the Annual General Meeting.

Extra-ordinary General Meeting

43. The Board may call an Extraordinary General Meeting whenever it shall think fit. An Extraordinary General Meeting may also be convened on the requisition of the members in accordance with the provision of Section 159.

Notice of Meeting

44. At least twenty-one days notice specifying the place, the day and the hour of the general meeting and in case of special business, the general nature of such business, shall be given to the members in the manner hereinafter mentioned, or in *such* other manner as may be prescribed by the Company in General Meeting but accidental omission to give such notice to or non-receipt of such notice by any member shall not invalidate the proceeding of the General Meeting, subject to the provisions of the Ordinance. The Directors may whenever they think fit, and shall on requisition in accordance with the ordinance proceed to convene of Extraordinary General Meeting.

Quorum

45. No business shall be transacted at any General Meeting unless a quorum of members is present, two members present, in person who represent twenty-five percent of the total voting power of the company either of their own account or as proxies shall be a quorum for a General Meeting.

Quorum for Adjourn Meeting

46. If within half an hour of the time appointed for the holding of a general meeting a quorum be to present, the meeting if convened on the requisition of shareholders, shall be dissolved and in every other case shall stand adjourned to the same day in the next week, at time and place as was appointed for holding the general meeting and if as such adjourned meeting the quorum is not present within fifteen minutes from the time appointed for holding the meeting the members present being not less two shall be a quorum.

PROCEEDINGS AT GENERAL MEETINGS

Chairman to Preside

47. The Chairman of the Board of Directors shall preside at every general meeting but if at any meeting he may not be present within 15 minutes after the time appointed for holding the same or is unwilling to preside, members present shall choose some Director or if no Director be present or if the Directors present decline to take chair, the members shall choose some member to be the Chairman of the meeting.

Power of Chairman to Adjourn

48. The Chairman with the consent of the meeting may adjourn any meeting from time to time and from place to place, but no business shall be transacted at any adjourned meeting other than business which might have been transacted at the meeting from which the adjournment took place. The resolution at an adjourned meeting shall for all purposes, be treated as having been passed on the date on which it was in fact passed and shall not he deemed to have been passed on any earlier dates.

Carrying of Resolution

49. At any General Meeting a resolution put to the vote of the Meeting shall be decided on a show of hands unless poll is (before or on the declaration of the result of the show of hands) demanded by one Member having right to vote on the resolution and present in person or by proxy, if not more than seven members are personally present, and by two such members present in person or by proxy if more than seven such members are personally present or by the Chairman of the Meeting or any member or members present or by proxy and holding or representing not less than one - tenth of the issued capital carrying voting rights, and unless a poll is so demanded, as declaration by the chairman then a resolution has been carried or carried unanimously or by a particular majority or lost, and an entry to that effect in the books of the proceedings of the company, shall be conclusive evidence of the fact without further proof of the number or proportion of the votes recorded in favour of or against such resolution.

Demand for Poll

50. If a poll is demanded as aforesaid it shall be taken in such manner as the Chairman of the meeting directs, and either at once or after an interval or adjournment, and the results of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded. The demand for a poll may be withdrawn at anytime by the person or persons who made the demand.

Time for taking poll

51. Any poll duly demanded on the election of a Chairman of a Meeting or on any question of adjournment shall be taken forthwith and without adjournment and a poll demanded on any other question shall be taken at such time, not more than fourteen days from the day on which it was demanded, as the chairman of the meeting may direct.

Business may proceed not withstanding demand of poll

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

Minutes

53. Minutes shall be made in book provided for the purpose of all resolutions and proceedings at General Meetings, and such minutes if signed by any person purporting to have been the Chairman of the Meeting to which it relates or by the Chairman of the Board shall be receivable as evidence of the facts therein stated without further proof.

Minutes Book

54. The books containing minutes of proceedings of General Meetings of the company shall be kept at the registered office of the company and shall during business hours (subject to reasonable restrictions as the Board may from time to time impose but so that not less than two hours each day is allowed for inspection) be open to the inspection of any member without charge.

VOTES OF MEMBERS

Votes

55. Upon a show of hands every member entitled to vote and present in person or by proxy shall have one vote, and upon a poll every member entitled to vote and present in person or by proxy shall have one vote for every share conferring voting rights as aforesaid held by him.

Right to Vote

56. Any person entitled under the Transmission Clause to Transfer any shares may vote at any General Meeting in respect thereof as if he was the registered holder of such shares, provided that at least 48 hours before the time of holding the meeting or adjourned meeting as the case may be at which he proposes to vote he shall satisfy the Directors of his right to transfer such shares unless the Director shall have previously admitted his right to vote at such meeting in respect thereof.

Appointment of Proxy

57. No person shall be appointed a proxy who is not a member of the company and qualified to vote, save that a corporation or a company being a member of the company may appoint as proxy or as its representative any person though not a member of the company, and the person so appointed shall he entitled to exercise the same powers on behalf of the corporation which he represents, as that corporation could exercise if it were an individual member of the company. Any such appointment shall be authorized by a resolution of Directors of that company or corporation.

Proxy in Writing

58. Every proxy shall be appointed in writing under the hand of the appointer or by an agent duly authorized under a power of Attorney or if such appointer is a company or corporation under the common seal of the company or corporation or the hand of its Attorney who may be the appointer.

Irrevocable Proxy

59. Any proxy declared expressly on its face to he irrevocable shall not be revoked or be deemed revoked by the member giving such proxy whether by attendant at any General Meeting held during the period of such proxy or by any other action on his part whatsoever, or otherwise during the term of such proxy if such proxy is furnished to and filed with the records of the company, and the company shall be bound to recognize and give effect to such proxy in accordance with the terms thereof.

Validity of Proxy

60. No person shall act as proxy unless the instrument of his appointment and the Power of Attorney, if any, under which it is signed shall be deposited as the office of the company at least forty eight hours before the time for holding the meeting at which he proposes to vote.

Form of Proxy

61. An instrument of proxy may be in the following form, or in any other form which the Directors, shall approve or in the form contained in Table "A" of the First Schedule of the Ordinance.

NARA HYDROPOWER (PRIVATE) LIMITED

"I _____ of _____ in the district of _____ being a member of _____ hereby appoint _____ _____ as my proxy to vote for me and on my behalf at the Ordinary/Extraordinary (as the case may be) General Meeting of the Company to be held on the _____ day of _____and at any adjournment thereof."

Validity of Vote

62. 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 of the proxy or of any power of attorney under which such proxy was signed provided that no intimation in writing of the death or revocation shall have been received at the office before the meeting.

63. No objection shall be made to the validity of any vote except at the 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 meeting or poll shall be deemed valid for all purposes of such meeting or poll.

64. If question is raised, the Chairman of the Meeting shall decide on the validity of every vote tendered at such meeting in accordance with these Articles.

DIRECTORS

Number of Directors

65.

(a) There shall be not less than two Directors of the company. The Directors shall fix the number of elected Directors of the company not later than thirty five (35) days before the convening of the General Meeting at which directors are to be elected, and the number so fixed shall not be changed except with the prior approval of the General Meeting of the Company.

(b) The following shall be the first directors of the Company.

1. Khawaja Nimr Majid
2. Mrs. Noor Nimr Majid

Term of Directors

66. The first Directors shall hold office until the election of in the First Annual General Meeting. The Directors elected shall hold office for a period of three years unless he earlier resigns, becomes disqualified or otherwise ceases to hold office. The Director so retiring shall continue to perform his function until his successor is elected.

Delegation of Power

67. The Directors may delegate either powers to committees consisting of such member or members as they think fit.

68. Any committee so formed shall in the exercise of the powers so delegated confirm to any regulations that may be imposed on them by the directors.

Remuneration of Directors

69. Until otherwise determined by the company in General Meeting, each Director shall be entitled to be paid as remuneration for his services a fee at the rate of Rs. 2500/= per meeting.

70. Any director who serves on any committee or who devotes special attention to the business of the company or who otherwise performs services which, in the opinion of the Board are outside the scope of the ordinary duties of a director may be paid such extra remuneration by way of salary or allowance as the company in General Meeting may determine.

Share Qualification of Director

71. A director shall be required to hold at least one qualification share subject to Section 187.

Nomination by Directors

72. The investor, shall have powers to nominate such number of directors in the Board of Directors of the Company, as are proportionate to its holding in the paid up capital of the company. The Directors so nominated shall not be subject to the provisions of these Articles and Ordinance relating to the eligibility for appointment, election, retirement, removal, filling of casual vacancy and vacation of office etc.

POWERS AND DUTIES OF DIRECTORS

Management of Business

73. The control of the company shall be vested in the Board and the business of the company shall be managed by the Board, which may pay all expenses incurred in forming and registering the company, and may exercise all such powers of the company as are not by Ordinance or by these Articles required to be exercised by the company in General Meeting, subject nevertheless to the regulations of these Articles, to the provisions of the Ordinance and such regulations (not inconsistent with the aforesaid regulations or provisions), as may be prescribed by the company in General Meeting but no regulation made by the company in General Meeting shall invalidate any prior act of the board which have been valid if the regulation had not been made.

Power of Board

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

Books to keep

75. The Board shall cause minutes to be made in books provided for the purpose;

(a) of the name of Director present at each meeting of the Board and of any Committee of Directors;

(b) of all resolutions and proceedings at all meetings of the company and of the Board and of committee of Directors.

Any such minutes of any meeting of Board or of a Committee of Directors or of the company, if signed or purporting to be signed by the Chairman of such meeting, or of the next succeeding meeting, shall be receivable as evidence of the matters stated in such minutes. The books containing minutes of General Meeting shall be kept at the registered office of company and shall be open to inspection as required by Section 173.

Payment of Retirement Benefits

76. The Board may pay and agree to pay pension or other retirement, superannuation,

death or disability benefits or allowances to any person in respect of any Director or former Director who may hold or may have held any executive office or employment under the company, or any subsidiary company of the company, or its holding company (if any), and for the purpose of providing any such pensions or other benefits or allowances, may contribute to any scheme or fund and may make payments towards insurance or trusts in respect of such persons.

CHIEF EXECUTIVE

Appointment of Chief Executive

77. The Directors as from a date not later than the fifteenth day after the date of its incorporation, appoint any individual to be the Chief Executive of the company. The Chief Executive shall be deemed to be its Director and be entitled to all the rights and privileges and subject to all the liabilities of that office.

Chief Executive to hold office till First Annual General Meeting

78. The Chief Executive shall, unless he earlier resigns or otherwise ceases to hold office, hold up to the First Annual General Meeting or, if a shorter period is fixed by the Directors at the time of his appointment, for such period.

Eligibility for Appointment

79. No person who is ineligible to become a director of the company shall he appointed or continue as the Chief Executive.

Term of office of Subsequent Chief Executive

80. Within fourteen days from the date of election of Directors or the office of the Chief Executive falling vacant, as the case may be the Directors shall appoint any person, including an elected Director, to be the Chief Executive, but such appointment shall not be for a period exceeding three years from the date of appointment.

Eligibility of Re-appointment

81. On the expiry of his term of office under Article 78 & 79 the Chief Executive shall be eligible for reappointment.

82. The Chief Executive retiring under Article 78 & 79 shall continue to perform his functions until his successor is appointed unless non-appointment of his successor is due to any fault on his part or his office is expressly terminated.

Removal of Chief Executive

83. The Directors by resolution passed by not less than three-fourths of the total number of directors for the time being, or the company by a special resolution, may 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 such Chief Executive.

Remuneration of Chief Executive

84. The Chief Executive shall receive such remuneration (Whether by way of salary,

commission, participation in profits, allowances perquisites, etc., or partly in one way and partly in another) as the Board may fix.

Power of Chief Executive

85. The Director may entrust to and confer upon the Chief Executive of the power exercisable by them upon such terms and conditions and with such restrictions as they may think fit, and either collateral with or to the exclusion of their own powers, and may from time to time revoke, withdraw, alter or vary all or any of such powers.

DISQUALIFICATION AND VACATION OF OFFICE OF DIRECTORS

Qualification of Directors

86. No person shall be appointed as a Director of the company if he is ineligible to be appointed as Director under any of the provisions of the Ordinance or any other law for the time being in force.

87. The office of a Director shall be vacated if:

Vacation of office of Directors

(a) he becomes ineligible to be appointed a director on anyone or more of the grounds enumerated in clauses (a) to (h) of section 187;

Absent from Meeting

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

(c) he or any firm of which he is a partner or any private company of which he is a Director:

(i) without the sanction of the company in General Meeting excepts or holds any office of profit under the Company other than that of Chief Executive or a legal or technical adviser or a banker; or

(ii) accepts a loan or guarantee from the Company in contravention of Section 195.

(d) he suspends payment to or compounds with his creditors; or

(e) he resigns office by notice in writing addressed to the Company or to the Directors; or

(f) he is removed from his office by the Company in General Meeting; or

(g) he is convicted by a court in Pakistan of any offence and is sentenced in respect thereof to imprisonment for not less than six months or is convicted by a court in Pakistan of any offence involving moral turpitude; or

(h) he acts in contravention of section 214

The appointment of an Alternate Director under these Articles shall constitute leave

of absence to the Director for whom such an alternate is appointed during such Directors absence.

Directors Contract with the Company

88. Subject to the provisions of Section 214 of the Ordinance the Directors shall not be disqualified from contracting with the company either as vendor purchaser or otherwise nor shall any such contract or arrangement entered into by or on behalf of the company with any company or partnership of or in which any director shall be a member or so interested be liable to account the company for any profit realized by any such contract or arrangement by reasons of such Director holding that office or of the fiduciary relation thereby established but the nature of his interest must be disclosed by him at the meeting of the Directors at which the contract or arrangement is determined on if the interest then exists, or in any other case at the meeting of the Directors after the acquisition of the interest. Provided nevertheless that no Directors shall take part in the discussion of such contract or arrangement 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. This provision shall not apply to any contract by or on behalf of the company to give to the Directors or any loss which they or any of advanced 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. A general notice that any Director is a director or a member of any specified company, or is a member of any specified firm and is to be regarded as interested in and subsequent transaction with such firm or company shall, as regards any such transactions, be sufficient disclosures under this Article, and after such general notice it shall not be necessary to give any special notice relating to any particular transaction with such firm or company. Any such general notice shall expire at the end of the financial year in which it is given, but may be renewed for further period of one financial year in which it would otherwise expire. No such general notice, and no renewal thereof, shall be of effect unless it is given at the meeting of the Directors, or the Directors concerned take reasonable step to ensure that it is brought up and read at the first meeting of the Directors after it is given.

Register of Directors Contract

89. A register shall be kept by the Director in which shall be entered particulars of all contracts or arrangement to which Article 87 applies.

Loan to Directors

90. The Company shall not, directly or indirectly make any loan to, or give any guarantee or provide any security in connection with a loan made by any other person to, or to any other person by such persons as are specified in and to the extent permitted by section 195.

ROTATION, ELECTION AND REMOVAL OF DIRECTORS

Election of Directors

91. Any person who seeks to contest an election to the office of Director shall, whether

he is a retiring Director or otherwise, file, with the company, not later than fourteen days before the date of the meeting at which election are to be held, a notice of his intention to offer himself or election as Director. The notice shall be transmitted by the company to the members not later than seven days before the date of the meeting.

Manner of Election of Director

92. The Director shall be elected by the members of the company in General Meeting in the following manner namely:

(a) a member shall have such number of votes as is equal to the product of the number of voting shares held by him and the number of Directors to be elected;

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

Casual Vacancy

93. Any casual vacancy occurring among the Directors may be fill up by the Directors and the person so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

Removal of Directors

94. A resolution for removing a Director elected in the manner provided for in Article 91 or for reducing the number of Directors shall not be deemed to have been passed if the number of votes against it is equal to election of a Director at the immediately preceding annual election of Director in the aforesaid manner.

PROCEEDINGS OF DIRECTORS

Meeting of Directors

95. The directors may meet together for the dispatch of business, adjourn and otherwise regulate meetings of the Board as they think fit. The Chairman or the Chief Executive if any may at time and shall on the written requisition of two Directors at and time summons a meeting of the Board. At least Ten clear days notice must he given to all Directors to summon a meeting of the Board and such notice shall set forth the purpose or purposes for which such meeting is Summoned. However with the consent of all Directors entitled to receive notice of a meeting or to attend and vote at any such meeting, a meeting of the Board may be convened by shorter notice than specified in this Article.

Quorum

96. A meeting of the board for the time being at which a quorum is present shall be competent to exercise all or any of authorities, persons and discretions by or under these Articles vested in or exercisable hy the Board generally. Two Directors personally present shall constitute a quorum.

Election of Chairman

97. The Chairman shall whenever present preside as Chairman at each meeting of the Board but if at any meeting the Chairman is present and not willing to act or is absent beyond ten minutes after the time fixed for holding the same, the Vice Chairman shall act as Chairman, in the absence of both the Chairman anal the Vice Chairman or in the event of the unwillingness of both to act, the directors present shall within fifteen minutes of the time fixed for the meeting choose one of their members to be Chairman of such meeting.

When Act of Directors or Committee valid notwithstanding defective appointment etc

98. All acts done by meeting of the Board or of a Committee of Directors, or by any person acting as a Director or Alternate Director shall, notwithstanding that it be afterwards discovered that there was some defect n 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.

Resolution in Writing

99. A resolution in writing, except for the matter specified in section 196, signed by all Directors present in Pakistan shall be effective as if such resolution had been passed at a meeting of the Directors. Any director may waive notice of the time, place and purpose of any meeting either before, at or after such meeting.

ALTERNATE DIRECTORS

Alternate Director

100. Any Director not permanently resident in Pakistan and any Director so resident but intending to be absent there from for a period of not less than three 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 in writing under the hand of the Director making the appointment. An Alternate Director so appointed shall not be entitled to appoint another Alternate Director, but shall otherwise be subject to the provisions of these Articles with regard to Directors, except that he shall require no share qualification. An Alternate Director shall be entitled to receive notices 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 such appointed an Alternate Director shall ipso facto cease to be as Alternate Director if his appointer for any reason ceases to be a Director or if and when his appointer returns to Pakistan, or removes the appointee from office by notice in writing under the hand of the appointer.

DIVIDENDS AND RESERVES

Declaration of Dividend

101. The company in General Meeting may declare dividends, but no dividends shall exceed the amount recommended by the Board.

Payment of Interim Dividend

102. The Board may from time to time pay to the members such interim dividend as appear to be justified by the profits of the company.

No Dividend Except out of profit

103. No dividends shall be paid otherwise than out of profits of the year or of any other undistributed profits from prior years or in contravention of section 235 and 248.

104. Subject to the right of any person entitled to shares with rights as to dividends the profits distributed as dividends shall be distributed among the shareholders and all such dividends shall be declared and paid according to the amounts paid on the shares. If any shares are issued on term that it shall rank for dividend as from a particular date, such share shall rank for dividend accordingly.

Creation of Reserve

105. The Board may, before recommending any dividend, set aside out of the profits of the company such sums as they think proper reserve as a reserve or reserves, which shall, at the discretion of the Board, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the company may be properly applied and pending such application may, at the like discretion, either be employed in the business of the company or be invested in such investments subject to the provisions of section 208, or any other provisions of the Ordinance (other than shares of the company) as the Board may from time to time think fit.

Payment of Dividend to Joint Holders

106. If several persons are registered as joint holders of any share, anyone of them may give effectual receipts for any dividends payable on the share.

Dividend shall bear no Interest

107. No dividend shall bear interest against the company.

Mode of payment of Dividend

108.

(a) Any dividend may be paid by cheque or warrant sent through the registered post to the registered address of the member or person entitled thereto, or in the case of joint holders to anyone of such joint holders at his registered address or to such person and at such address as the member or person entitled or such joint holders, as the case may be direct. No dividend shall be paid by the company in respect of any share therein except to the registered holder or to his order or to his banker or to a financial institution nominated by him for the purpose and the payment shall be made within thirty (30) days of the declaration.

(b) Dividends unclaimed for one year may be invested or otherwise used by the Board for the benefit of the company until claimed.

CAPITALIZATION

Capitalization of Reserves

109. Any General Meeting may, upon recommendation of the Board resolve that any undivided profits of the company (including profits carried and standing to the credit

of any reserve or reserves or other Special accounts or representing premiums received on the issue of shares and standing to the credit of the share premium account), not required for paying the Dividends on any shares issued be capitalized. Such capitalized undivided profits shall be distributed amongst such of the share-holders as would be entitled thereto as capital. All or any part of such capitalized fund 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 share or debentures of the company which shall be distributed accordingly, or for outwards payment of uncalled liability on any issued debentures and that such distribution or payment shall be accepted by such shareholders in full satisfaction of their interest in the said capitalized sum.

ACCOUNTS

Books of Account

110. The Board shall cause to be kept proper books of accounts as required under section 230.

Keeping of Books of Account

111. The books of account shall he kept at the registered office or at such other place as the Board shall think fit in accordance section 230.

Inspection of Books of Account

112. The Board shall from time to time determine whether and to what extent and at what times and places and under what conditions or regulations the accounts and books of the company or any of them shall be open to inspection of members and no member shall have any right of inspecting any account or books or document of the company except as conferred by Laws or authorized by the Board or by special resolution of the company in General Meeting.

Laying Account before the Annual General Meeting

113. Within eighteen months of the incorporation of the company, and subsequently once in every Calendar year, within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding Annual General Meeting, the Director shall lay before the company in General Meeting a balance sheet and profit and loss account, both made up in accordance with the Ordinance. Every such balance sheet shall be accompanied by auditor's report and the Director's report, in accordance with the provisions of the Ordinance in that behalf.

Dispatch of Accounts & Directors Report to Members

114. A copy of the report of the Directors and of the balance sheet (including every document required by law to be annexed thereto) and of the profit and loss account shall be sent to all members along with the notice convening the General Meeting before which the same are required to be laid.

AUDIT

Auditors

115. Auditors shall be appointed at each Annual General Meeting and their appointment, qualification, removal, casual vacancy, powers and duties etc. shall be regulated in accordance with sections 252 to 255.

116. The Auditors report shall be read before the company in general meeting and shall be open to inspection by any member.

NOTICE

Dispatch of Notices to Members and Directors

117.

(a) A notice may be given by the company to any member either personally or by sending it by post to him at his registered address or (if he has not registered address in Pakistan), to the address, if any, within Pakistan supplied by him to the company for the giving of notices to him.

(b) Where a notice is sent by post, services of the notice shall deemed to be effective by properly addressing, prepaying and posting a letter containing the notice, and unless the contrary is proved to have been effected at the time at the letter would be delivered in the ordinary course of post.

118.

(a) If a member has no registered address in Pakistan and has not supplied to the company an address within Pakistan for the giving of notice to him, a notice advertised in a newspaper circulating in the neighborhood of the registered office of the company shall be deemed to duly given to him on the day which the advertisement appears.

(b) If a member has supplied an address to the company within Pakistan as contemplated by sub-clause (a) above, the company, in addition, shall furnish to such members notice at an address outside Pakistan which has been supplied by him to the company.

Notice to Joint Holders

119. A notice may be given by the company to the joint holders of shares by giving the notice to the joint holder named first in the register in respect of the shares.

Notice at death of a member

120. A notice may be given by the company to the persons entitled to a share in consequence of the death or insolvency of a member by sending it through the post in a prepaid letter addressed to them by name, or by the title of letter addressed to them by name, or by the title of representative of the deceased, or assignee of the insolvent, or by any like description, at the address (if any) in Pakistan supplied for the purpose by the persons claiming to be so entitled, or (until such an address has been supplied) by giving the

notice in any manner in which the same might have been given if the death or insolvency had not occurred.

Notice of General Meeting

121. Notice of every general meeting shall be given in some manner here in before authorized to:

(a) Every member of the company;

(b) Every person entitle to a share in consequence of the death or insolvency of a member; and

(c) The auditors of the company;

SECRETARY

Secretary

122. A secretary shall be appointed by Directors at such remuneration and upon such terms and conditions as they may think fit and any secretary so appointed may be removed by them. The Secretary shall be responsible to ensure compliance with the secretarial formalities under the Ordinance.

THE SEAL

Affixing of Seal

123. The Board shall provide for the safe custody of the Seal, and the seal shall never be used except by the authority of the Board or a Committee of Directors previously given, and one Director at least 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 touching any authority to issue the same.

SECRECY

Secrecy

124. Every Director, Chief Executive, Manager, Auditor, Trustee member of a committee, 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 respecting all transaction of the company its customers and the statement of accounts with individuals and in matters relating thereto, and shall by declaration pledge himself not to reveal any of the matters which 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, and except as may be necessary in order to comply with any provisions in these presents contained.

Entitlement to enter the property of the Company

125. No member or other person (not being a Director), shall be entitled to enter the property

of the company, without permission of the Board or the, Chief Executive and to require disclosure of any information respecting any detail of the company's trading, or any matter which is or may be in the nature over trade secret, mystery of trade, or secret process or of any matter whatsoever which may relate to the conduct of the business of the company and which in the opinion of the Board or the Chief Executive, if any, will be inexpedient in the interest of the members to communicate.

WINDING UP

Distribution of Assets

126. If the company shall be wound up (whether voluntarily or otherwise), the liquidator may, with the sanction of a Special Resolution, divide among the members in specie any part of the assets of the company in trustees upon such trust for the benefit of the members as liquidator shall think fit.

INDEMNITY

Indemnity of Directors and Officers

127. Every Director, Chief Executive, Manager or Officer of the company or any person (whether an officer of the company or not), employed by the Company as Auditor or Advisor shall be indemnified out of the funds of the company against any liability insurrect by him, as such Director, Chief Executive, Manager, Officer, Auditor or Advisor, in defending any proceedings, whether civil or criminal, in which judgment is given or in which he is acquitted, or in Connection with any application under Section 488 in which relief to him by court.

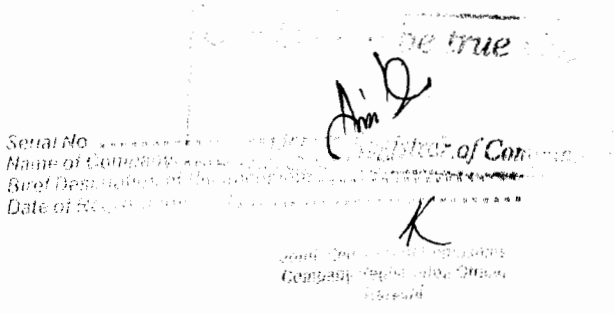
128. No Director, Chief Executive, or other Officer of the company will be liable for the acts, receipts, neglects or defaults of any other Director or any Officer or for joining in any receipt of other act for Conformity, or for any loss or expense happening to the company through the insufficiency or deficiency of title to any property acquire by order of the Directors, Chief Executive, or other Officer for or on behalf of the company, or for inefficiency or deficiency of any security in or upon which any of the monies of the company shall be invested or for any loss or damage arising from the bankruptcy, insolvency or tortuous act of any person with whom any monies, securities or effects shall be deposited, or for any loss occasioned by an error of judgment or oversight on his part, or for any other loss, damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto, unless the same happens through his own dishonesty.

We the several persons, whose names, address and description are hereunder subscribed, are desirous of being formed into a company in pursuance of this Articles of Association, and we respectively agree to take the number of shares in the capital of the Company set opposite our respective names:

Name and Surname Present & Former in full	Father's/ Husband in Name full	Nationality With former Nationality	Occupation	Residential Address	Number of hares taken by each subscriber	Signature
Khawaja Nimr Majid **CNIC # 42000-1246900-5**	Khawaja Anver Majid	Pakistan	Business	12 Runnymede, Clifton, Karachi	20 (Twenty only)	
Noor Nimr Majid **CNIC # 42301-7724218-6**	Khawaja Nimr Majid	Pakistan	Business	12 Runnymede, Clifton, Karachi	20 (Twenty only)	
				TOTAL	**40 (Forty only)** ========	

Dated this 10 April, 2015

Witness to the above signatures:
NIFT (PVT) LTD
5th Floor, AWT Tower,
I.I Chundrigar Road,
Karachi.



PROJECT TECHNICAL DETAIL

NARA HYDROPOWER PROJECT

TECHNICAL DETAILS

S#	PARAMETER	DESCRIPTION
1	**Type**	Run of the River (RoR) Small Hydro Plant
2	**Technology Details**	Bevel gear Bulb Turbines with horizontal axis and double regulated Kaplan type runners, the bevel gear arrangement allows the generator to be placed with a vertical axis and to be situated above the turbine
3	**Location**	RD-26 Nara Canal, Sukkur District, Sindh Coordinate; 27 37' 50" N, 68 54' 27" E (Map and Plan enclosed)
4	**Gross Capacity**	13.65 MW
5	**Net Capacity**	12.90 MW
6	**Auxiliary Consumption**	0.75 MW
7	**Number of Generating Units, Nos.**	The proposed power plant shall comprises of 10 units of 1.365 MW each
8	**Fuel type; Fuel Source**	Hydropower (Indigenous / Renewable)
9	**Rated Head; Rated Flow**	Rated Head 3.2 m with 50m^3 Rated Flow
10	**Generation Voltage; Power Factor and Frequency**	Generation Voltage 0.69 kV Power Factor 0.85 Lagging / 0.90 Leading Frequency 50 Hz
11	**Grid Interconnection Voltage**	11 kV
12	**Nearest Grid Station and Distance**	7 KM from nearest Rohri 132/11kV Grid Station
13	**Make / Model**	ANDRITZ HYDRO ABG2600 (Technical offer enclosed)
14	**Design life of the project**	50 Years
15	**Purpose of Plant**	Export of power to grid

Company Secretary

Y & Annex 3

Peter Rae Hydro Consulting Ltd.

Rohri and Nara Canals Hydropower Project Feasibility Study

Report Prepared for

June 2015

Rev 0

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List of Figures

1 Introduction

1.1 General

The Sukkur Barrage Sukkur Barrage is used to control water flow in the River Indus for the purposes of irrigation and flood control. The barrage controls the flow to a major nework of canals on both banks of the Indus. The largest of the left bank canals are the Rohri and the Nara canals. The barrage and its associated canals are maintained by the Sindh Irrigation & Power Department.

The Rohri and Nara Irrigation Canals Hydropower Project (the "Project") is located downstream from the Sukkur Barrage in Sindh State of Pakistan. The Project intends to exploit the power potential of the irrigation system with separate hydropower facilities for the Rohri and Nara Irrigation canals, which supply demand areas downstream from the left bank of the Indus River. The basic concept for the Project is to develop the head that is available between the Sukkur Barrage level and the respective water level in the canals at the power station locations.

Water levels along the canals are determined by the design of the channels for irrigation service and the seasonal irrigation water demand. The Project will involve modifications to the canals as well as a change in the operation of the Headworks Regulator that controls the flow into the canals.

The Rohri Hydropower project would be located at about Chainage 15+000 (ft) at an existing drop structure on the Rohri Canal. Similarly, the Nara Hydropower project would be located at about Chainage 25+000 on the Nara Canal. The approximate location of the two projects is shown in Figure 1.

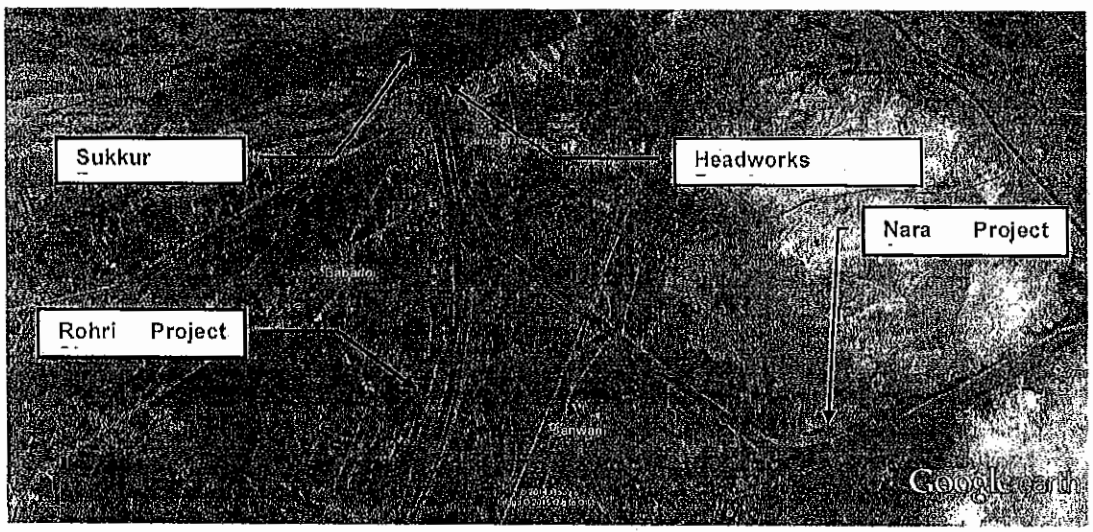


Figure 1 Project Area

Both canals have a significant flowrate during the irrigation season with flows in the order of 300 to 450 m^3/s. However, the generating head available for the power stations is limited by the hydraulic design of the irrigation canal system and its relatively flat topography. A canal

drop occurs at both of the project sites, which provides for some generating head. Additional head will be created by modification of the canals, as discussed in this report.

The water level upstream from the drop structures is determined by the flowrate and the characteristics of the free overflow structures at the sites. The water level downstream is determined by the hydraulic characteristics of the channels and the location of the various flow abstractions.

The Headworks Regulator (see Figure 2) regulates the flow into the canal based on the anticipated demands downstream. The Regulator has separate gate controls for each of the canals. The gate position is set according to the flow demand and a head drop occurs from the water level upstream from the Sukkur Barrage to the canal water level. The Headworks Regulator was apparently designed to create a head drop of about 1.5 ft (0.45 m) although this will vary depending on the flow conditions.

The generating head at the proposed generating stations might be increased if the function of the Headworks Regulator at the Sukkur Barrage could be transferred to the new power project.

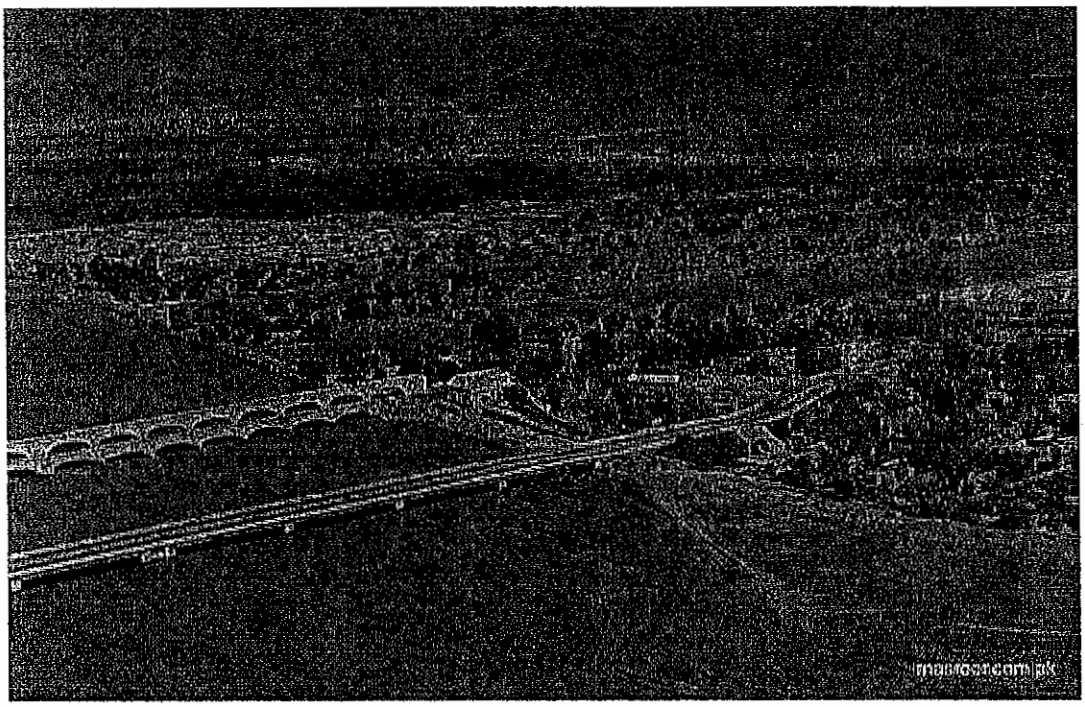


Figure 2 Sukkur Barrage and Left Bank Canals Headworks Regulator

In this scheme, the water level in the upstream of the power station would be equal to the level upstream of the Sukkur Barrage. A small drop in water level would occur from this location to the power station as required to provide the hydraulic gradient. The existing Headworks Regulator would be left with all gates in the fully open position and would no longer be used to control the flow to the canal. The flow control would be provided by the regulation of flow through the power station and over a bypass weir that would be installed at the site.

The installed generating capacity at the two sites would depend on the rated discharge and the amount of head that could be achieved.

The Project would also require provisions for discharge of flow along the canal at the site during periods when the power station is not operating. A barrage structure is necessary at both of the sites. This structure can be used as the head regulator in concert with the flow through the power station.

Modifications to the canal dikes will provide freeboard for power plant operation and to accommodate the transfer of the head regulator function downstream. The modifications will require raising and perhaps some reformation of the existing dikes.

The profile and cross section of the canal has degraded since the original construction in about 1932 due to the effects of sediment erosion and depositions. Sustenance of the full design capacity of the canals will require ongoing maintenance works because sediment deposition is likely to occur in the future.

Development of the Project is proposed as independent power projects that would be undertaken under the regulatory environment established in Pakistan. Key implementation agreements would be required if the projects are confirmed to be commercially feasible for development, including: power purchase agreement, concession agreement, transmission line access agreement, etc.

1.2 Project Background

A feasibility study was completed for the Rohri Canal project in 2013 by W.S. Atkins[1]. The study considered the hydraulic characteristics of the site, the available geological information, and other available details for the project. Five years of daily flow rate and water level data was provided for the canal drop structure. The study proposed an arrangement with eight generating units with total installed capacity of 4.8 MW. However, several details of the project remained to be confirmed and the study did not consider optimization of the site by changing the Headworks Regulator. The study provides a useful background reference for the present study.

The potential for the Nara Canal Project was identified in an earlier project ranking study, which was also prepared by W.S. Atkins[2] in 2012. No feasibility study appears to be available for the proposed Nara Canal project.

The Power Department released the Rohri Canal RD15 Project for tenders for the design, construction, and operation of the power station in 2013. The Project and its commercial framework was described in an Information Memorandum[3] prepared as part of an intended public private partnership (PPP) for the development of the Rohri RD15 Project. The Project was selected as being the most viable of the sites identified in the ranking performed by the Power Department.

The proposed Project would have been developed assuming that the water levels in the canal were according substantially unchanged from the operating experience in the period

[1] W.S. Atkins, "Run-of-River Hydroelectricity Generation, Feasibility Study – Run of River Hydropower at Rohri Canal RD15", report prepared for Power Department, Government of Sindh, 22 February 2013.
[2] W.S. Atkins, "Pre-Feasibility Study for Run of the River Hydroelectric Power, Site Analysis and Selection", report prepared for Power Department, Government of Sindh, 12 September 012.
[3] Ernst and Young, "Run of the River Hydropower Project at Rohri RD15", document prepared for the Energy Department, Government of Sindh, 14 March 2013.

since the Sukkur Barrage was completed in 1932. The intended capacity was about 4.8 MW.

The Rohri Project has not yet been successfully developed under the terms offered as part of the PPP transaction tender.

1.3 Objectives of the Study

An alternative to the Project described in the previous studies was identified to improve the financial viability of the scheme. The proposed project concept is to increase the generating head by allowing impoundment in the headrace canal up to the level in the head pond of the Sukkur Barrage. This concept would increase the installed capacity of the Rohri RD15 scheme. The Nara Canal was also identified as providing hydropower generation potential. The development of a combined project is being considered as a means to improve performance by exploiting economies of scale in the development.

A feasibility study is required for both sites to include geological investigation, topographical surveys, site optimization, and feasibility level design of the works. The study must determine the hydraulic conditions in the canals so as to confirm the head available at the power station and the scope of work required for the canal dikes. The study must also validate the available data for water levels in the canals given the large errors in measurements illustrated by the previous studies.

1.4 Feasibility Report Outline

This report describes the Project Concept for the Rohri and Nara Hydropower Projects. Section 2 describes the Project Concept and the base case conditions along the canals. Section 3 presents the hydrological data assessment that forms the basis for selecting the installed capacity and the estimate of the project revenue. Section 4 presents the available information for the geotechnical conditions relevant to the power station design. Section 5 describes the hydraulic model developed to simulate the water levels along the canals using cross sections surveyed in the field. The model was used to determined head water and tailwater levels for the canals, which results in the head available for generation.

The design of the power stations is described in Section 6 and the proposed electro-mechanical equipment is summarized in Section 7. The estimate of power and energy yield is provided in Section 8.

The construction planning, schedules, and cost estimate are summarized in Section 9. An overview of key conclusions and recommendations are presented in Section 10.

2 Project Concept

2.1 General

The project concept is to exploit the available flow and topography of the two main canals on the left bank of the Indus River at Sukkur Barrage to maximize the potential installed generating capacity. The flow rate is defined by the operation of the irrigation system, which can be defined from the available data base.

The generating head depends on the water levels in the canals and the works that can be installed control the headwater levels. Existing grade control drop structures are at both proposed power station locations.

2.2 Project Location

2.2.1 Rohri Hydropower

The Rohri Hydropower project would be located at about Chainage 15+000 (ft) at an existing drop structure on the Rohri Canal. The power station will be developed at the canal drop structure location, as illustrated in Figure 2. The drop structure is at approximately 27 38' N, 68 51' E. The power station would be located in the abandoned reach of canal adjacent to the drop structure.

Figure 3 Rohri Powerhouse Location

2.2.2 Nara Hydropower

Similarly, the Nara Hydropower project would be located at about Chainage 25+000 on the Nara Canal. The power station will be developed at the canal drop structure location, as illustrated in Figure 3. The drop structure is at approximately 27 37' 50" N, 68 54' 27" E.

The power station would be located in the abandoned reach of canal adjacent to the drop structure.

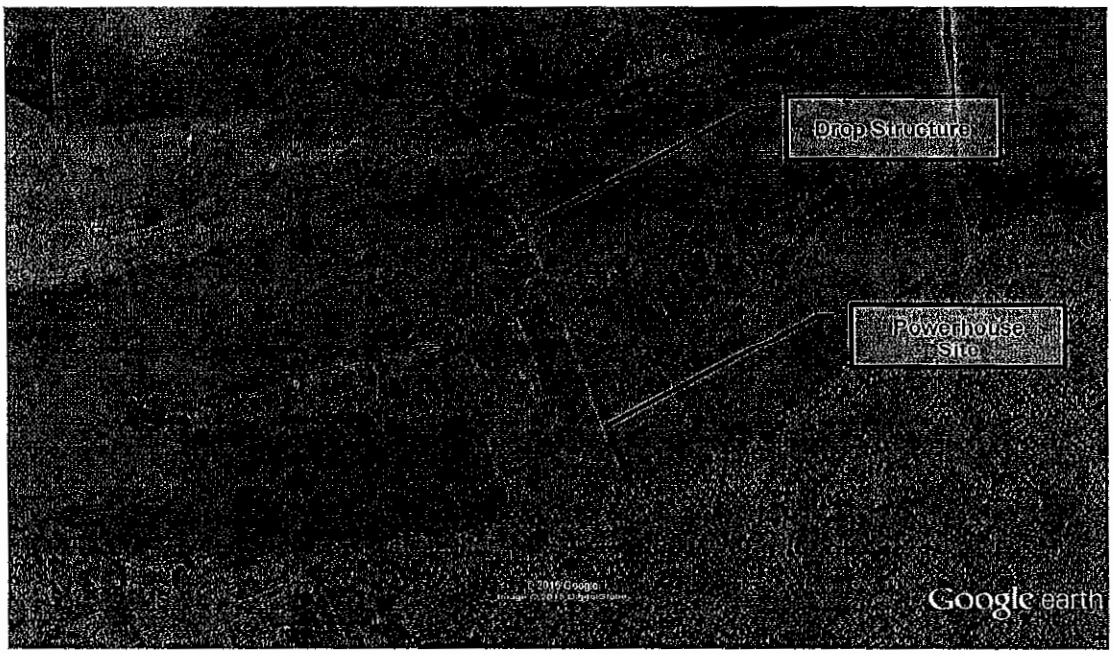


Figure 4 Nara Power Station Location

2.3 Existing Canal Infrastructure

2.3.1 Rohri Canal

Flow into the canal is control by a Head Regulator that was constructed as part of the Sukkur Barrage works. The existing canal from the regulator to the RD15 drop is reported[4] to have a bed width of 84.43 m (277 ft.) and a slope of 0.0060. The canal is designed for a flow rate of 467.28 m^3/s (16,500 ft^3/s). The bed level varies from el 176.50 ft. downstream from the regulator to 175.62 ft. at the drop structure. The water surface level varies from 192.5 to 191.62 along the reach. The design flow depth is 16 ft.

Improvements are proposed by the Water and Power Development Authority for lining of the canal. The slope would be increased to 0.0080 with a reduction in the bed width to 230 ft. The flow depth would be 14.96 ft. with a slope from 191.78 ft. upstream to 190.58 ft. downstream. The bed level would be remodeled to 176.82 ft. upstream and 175.62 ft. downstream.

The canal downstream from the drop also has a gradient of 0.0060% and a bed width of 276 ft.

The available information suggests an available generating head of about 0.66 m without any modification to the canal profile.

The water level upstream from the Head Regulator is controlled by the Sukkur Barrage. Water levels vary seasonally and with the operation of the barrage in response to flow

[4] All data is provided from Water and Power Development Authority, "Feasibility Study & Detail Design for Lining of Rohri, Dadu and Rice Canals, December 2010.

demands and the inflow of the Indus River. The median water level with the irrigation canals operating is el 197.5 ft. and the operating range[5] is from about 193.7 ft. to 199.8 ft.

The data suggest a head drop of about 1.524 m (5 ft.) through the Head Regulator to the Rohri Canal. Flow through the Regulator is controlled by gates installed as part of the original construction of the Sukkur Barrage. A total of twelve gates are believed to be in the Regulator for the Rohri Canal.

The shoreline of the canal is utilized for housing and small industrial enterprises along the first 2.5 km downstream from the Head Regulator. A major highway crossing is located at about 1500 m from the Regulator. The maximum feasible level in the Rohri canal is likely defined by the level of this bridge.

2.3.2 Nara Canal

Flow into the canal is control by a Head Regulator that was constructed as part of the Sukkur Barrage works. The Nara Canal is one of the three canals on the left bank of the Indus at Sukkur. At the Head Regulator the Nara Canal is immediately adjacent to the Rohri Canal and a smaller canal located between the two larger waterways.

The gradient of the canal after construction of the fall at the proposed power station location is 1:8,125. The canal profile has evolved due to the effects of sedimentation and erosion. The existing canal from the regulator to the RD25 drop is reported to have a bed width of 84.43 m (277 ft.) and a slope of 1:8,125. The canal is designed for a flow rate of 13,602 ft^3/s. The bed level varies from el 174.40 ft. downstream from the regulator to 171.2 ft. at the drop structure. The working water depth is believed to be about 10.5 ft. The water level at the upstream end is understood to be el 194.5 ft. although this value has not yet been confirmed in the field.

The canal gradient downstream from the fall is 1: 15,140. The bed level at the downstream from the fall is el 169.0 giving a fall height of about 2.2 ft.

The existing information suggests an available head of about 0.3 m without any changes to the canal profile.

The water level upstream from the Head Regulator is controlled by the Sukkur Barrage in the same manner as for the Rohri Canal.

The shoreline of the canal is utilized for housing and small industrial enterprises along the first 2.5 km downstream from the Head Regulator. A major highway crossing is located at about 1500 m from the Regulator.

2.4 Topographic Surveys

Topographic information from previous studies comprised limited topographic information at the Rohri powerhouse site. The available information was not sufficient for a feasibility study. Accordingly, a program of site investigations was undertaken to provide:

- A coordinate monument system for all subsequent works up to the start of construction.

[5] Based on operating period from 2006 to 2014.

- Project Site Mapping: the topography of each of the Project sites was mapped at a scale of 1:500 with 0.5 m contour intervals. A Digital Elevation Model (DEM) of the sites was prepared.
- Cross sections of the canal downstream from the powerhouse locations for a distance of about 5 km or until the first grade control structure, whichever occured first. Sections were at a spacing of 100 m for the first 2 km downstream and then at a spacing of 200 m for the remaining distance.
- Cross sections measured from the power stations upstream to the Head Regulator. Sections were located at not more than 100 m spacing and extended laterally to about 5 m from the external toe of the existing dikes.
- Water levels and flow rate were recorded at each cross section for calibration of hydraulic models.
- A proposed access road alignment, profile and typical cross sections was surveyed from the end of the nearest existing public road to the power station site.
- The dimensions of the Headworks Regulator were measured including number of openings, width and height of openings, sill elevation, and any other data relevant for the computation of flow rate through the structure.
- The dimensions of the existing drop structures were measured including the sill elevation, cross section and longitudinal sections.

The above information was collected to supplement data available from the Irrigation Department and other sources.

3 Hydrology

3.1 General

Hydrological analysis was performed to characterize the flow available in the canals. The objective was to determine the range of flow rates during irrigation operations. A flow duration curve was required to estimate the energy available from the Project.

Exploratory analysis was carried out to assess whether the data can be considered to be stationary and homogenous, as required to represent possible future flows for the power stations.

The hydrology for the power stations depends on the operation of the irrigation systems and the releases from the Sukkur Barrage. The flow in the canal will vary seasonally and inter-annually depending on the irrigation flow demand and the capacity of the canal system to service the demands. The canals are closed for a period each winter for maintenance.

3.2 Information Available

3.2.1 Flow Rate Data

Flow rate data was obtained from the Irrigation Department for the two canals. A data set prepared by W.S Atkins for the Rohri Feasibility Study was also examined for consistency with the raw data. Corrections adopted by Atkins were made in the raw data where errors in transcription or entering of data appeared.

The data from 2006 to 2014 was selected as being indicative of present operations for the system. Analysis of the longer historical period is of less interest due to the possibility of trends caused by changes in water demands, cropping patterns, or the condition of the canals.

Daily flow releases were provided for both the Nara and the Rohri canals as part of the data provided from the Irrigation Department.

3.2.2 Sukkur Barrage Water Levels

Daily water levels upstream from the Head Regulator at the Sukkur Barrage. The water level upstream is generally in the range of el 194.5 to 200 ft. The variability in the water level arises because of the operation of the Barrage gates in response to the flow of the Indus and the diversions to the irrigation canals on the right and left banks.

No information was available about the water levels downstream from the Head Regulator in the irrigation canals.

The water levels at Sukkur show a relationship between water level and flow rate in the Indus River, as illustrated in Figure 5. Note that the relationship is a result of the operational policy for the Barrage and is not a physical characteristic of the hydraulic system.

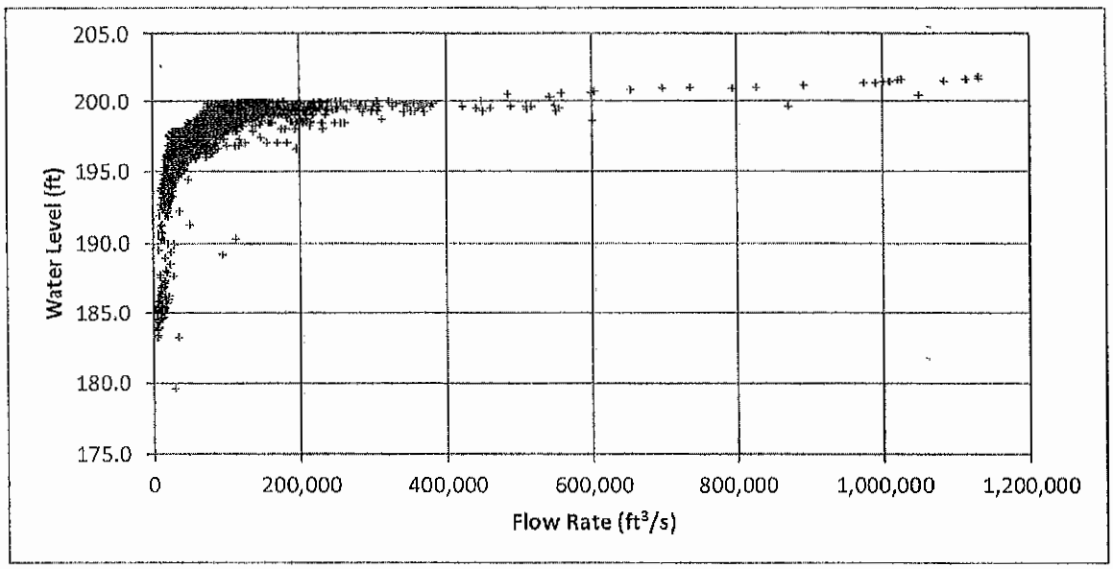


Figure 5 Sukkur Barrage Water Levels

3.2.3 Rohri Canal Water Levels

Water levels at the Rohri Canal RD15 drop structure were presented as part of the W.S. Atkins Feasibility Study. The levels are understood to be obtained from the Irrigation Department.

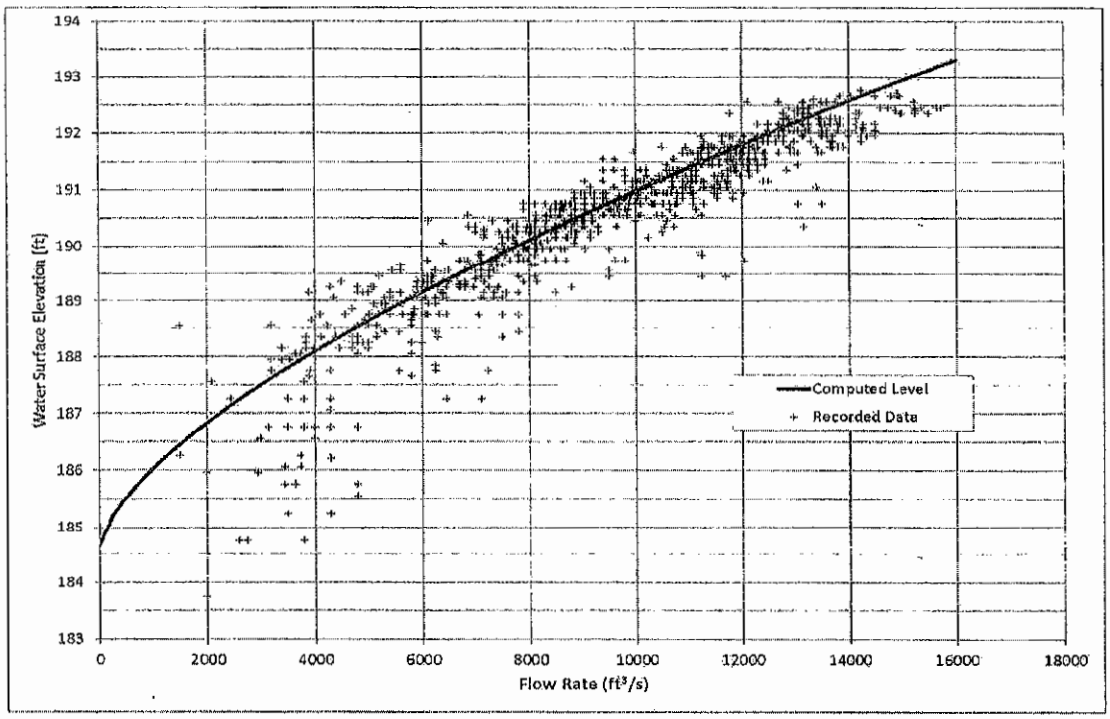


Figure 6: Measured Water Levels Upstream of RD15

Figure 6 shows the water levels measured upstream from the RD 15 drop. The data has a large amount of scatter with the range of elevation being in the order of two feet across most

of the record. This amount of scatter is not consistent with the physical situation. A computation of the water level upstream from the drop structure was prepared assuming a simple broad crested weir and the width of the existing gates. The resulting relationship is plotted in Figure 6 for comparison with the measured data.

Note that the calculated relationship follows the data but individual points deviate by about one foot either up or down. Note also that some of the data points in the record are below the level of the sill of the weir. This is clearly illogical and suggests that the data set includes systematic errors in the recording of the data.

The water level data downstream from the drop structure also show a similar scatter that is greater than should be expected for the physical conditions, as illustrated in Figure 7.

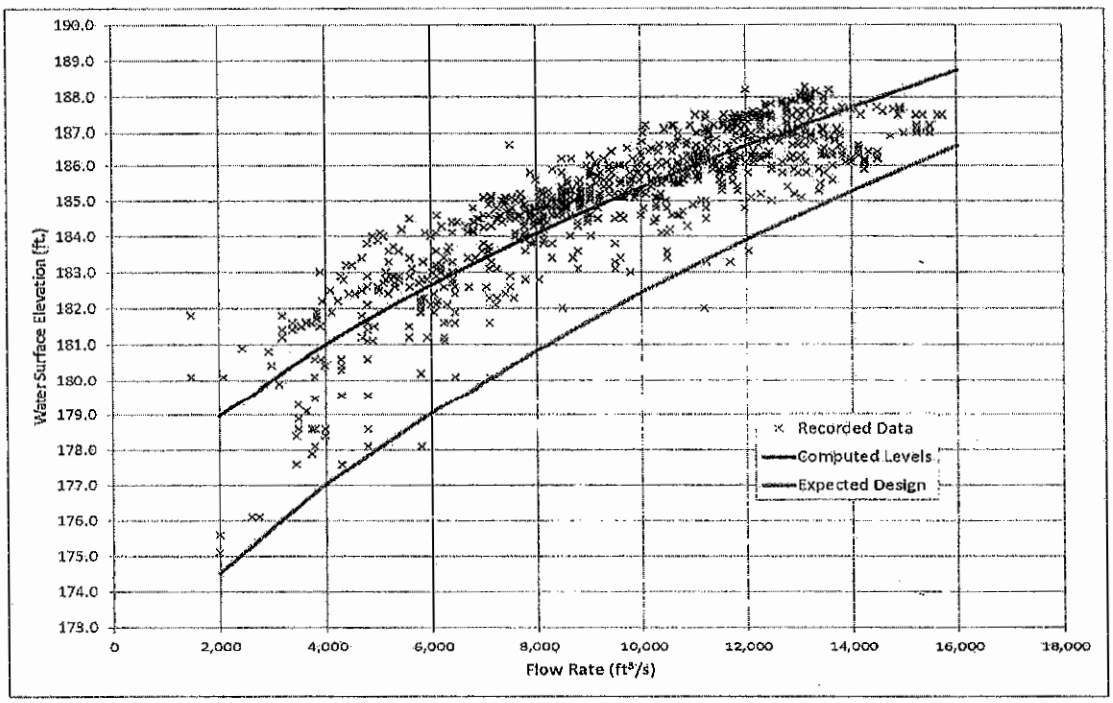


Figure 7: Water Levels Downstream from Drop Structure

A check on the data was performed by computing the Normal Depth and adjusting the slope, bed level, and Manning's "n" value to obtain a rating curve passing through the cloud of points. The analysis suggests that the actual canal bed is about 6 feet higher than the level shown in the canal profile drawing provided by the Irrigation Department. In addition, the apparent slope of the canal is in the order of 0.015% rather than the value of 0.0060% given in the available information.

The levels expected for the canal design parameters[6] provided is also shown in Figure 7 (see Green Line). The expected levels are about 2.5 feet lower than the values recorded.

The water level data upstream and downstream of the drop structure is believed to be inaccurate and is not suitable to define design parameters for the proposed power station. Errors may be due to incorrect datum elevation for the water level gauges, systematic errors

[6] Assuming Normal Depth with slope 0.006%, bed width 276 ft., bed elevation of 169.62 downstream from the drop structure, and Manning's "n" of 0.0225.

in data reading, and the canal dimensions being significantly different from the values noted in the design documents. The conclusion is that this data set is not useful for evaluation of the Project.

An independent cross section survey of the canal is required to make a hydraulic analysis of water levels. The generating head for the power stations can only be determined on the basis of new field measurements.

3.2.4 Nara Canal Water Levels

No water level data was available for the Nara Canal.

3.3 Exploratory Analysis

Hydrological analysis is required to define a time series that can represent the possible future flow rates for the power stations. Normal guidelines require that the time series is stationary, i.e. not changing in time, and homogeneous, i.e. being drawn from statistically homogenous sample. Analysis for a regulated canal is not strictly amenable to statistical analysis because the effects of changes in operations policies or irrigation demands can affect the time series.

The data set from 2006 to 2014 was selected as being representative of existing irrigation cropping patterns and water demands. This provides the best possible estimate of future demands. The maximum and minimum range of the data for this period is constrained by the hydraulic capacity of the canals and the operation policy, which involves an annual closure period. Low flows occur after each closure during refilling of the canals.

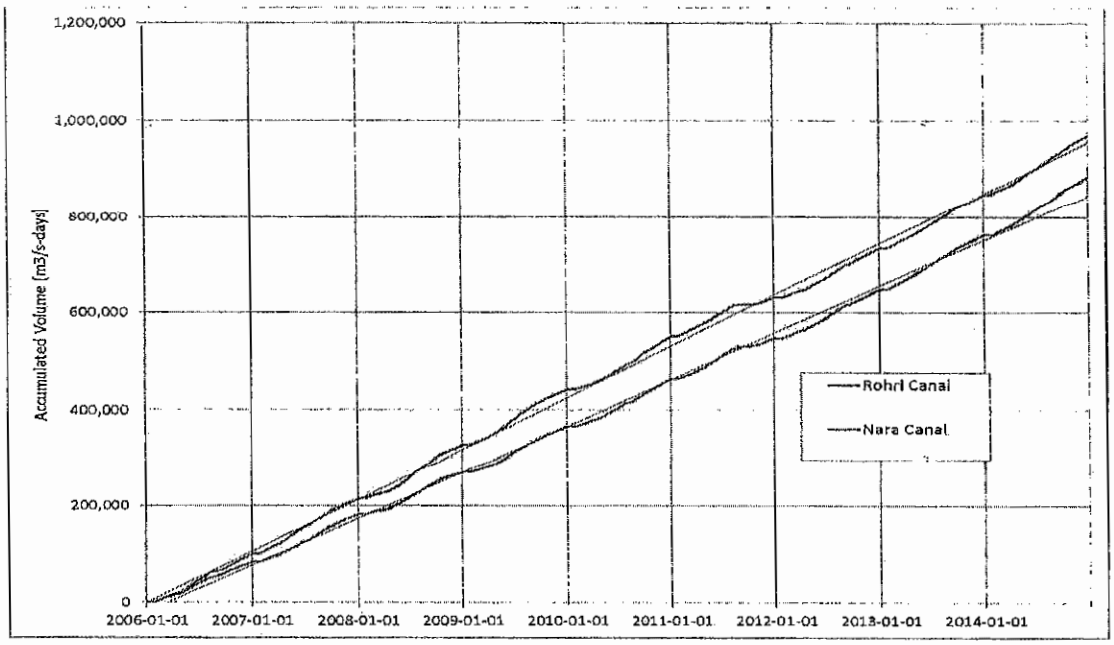


Figure 8 Mass Curves

Mass curves for the time period were developed to assess whether there have been any significant changes to the mean flow of the canals over the study period. Figure 7 shows the mass curve for both canals. Note that there are some variations representing annual and

seasonal fluctuation of the flow rate but that the overall record is consistent with the average flow trend. Based on this analysis, the record is judged to be reasonably stationary.

Homogeneity is assured by the operations of the irrigation system with the demand being defined by cropping patterns.

Long term variation of the flow rate can occur as a result of climate change, which will affect evapo-transpiration losses and irrigation demand. The effects of climate change are difficult to predict on the basis of the existing information but might be expected to increase irrigation demands and thus the flow rate of the canals. No further analysis of climate change was considered to be warranted at this stage.

3.4 Seasonal Canal Operations

The two canals operate seasonally depending on the irrigation demands. An annual outage of about two weeks occurs to accommodate maintenance works for the canals and headworks structures.

Examination of the data illustrates a similar seasonal flow distribution although there are differences among the years of the record. In general, the flow is highest during the months of April through October. The flow in the other months is still significant but somewhat less than the maximum capacity.

3.5 Hydrological Analysis

Flow duration curves were derived from the available data for use in the estimation of energy yield from the power stations. The duration curve was determined by estimating the percentile distribution from the daily flow data. Outage periods and occasional zero flow days were included in the record to represent possible outages during operations.

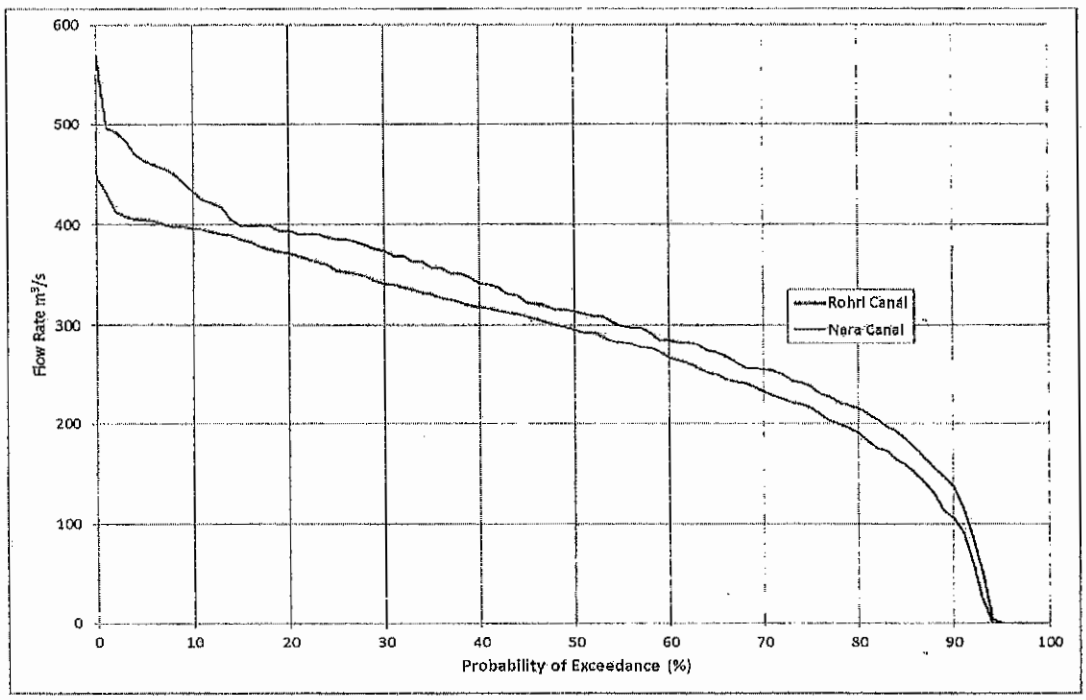


Figure 9 Flow Duration Curves

Figure 9 shows the flow duration curves for the two canals. The Nara Canal has a mean annual flow of 295 m^3/s and a maximum of 569 m^3/s. The Rohri canal has a mean annual flow of 269 m^3/s and a maximum of 447 m^3/s.

A tentative rated capacity for the power stations will be approximately the 90% exceedance value, which is 396.5 m^3/s for the Rohri site and 433.3 m^3/s for the Nara site. The maximum capacity of the power stations can be found by designing for the maximum flow rates above. The selected capacity should be derived by optimization of the equipment and energy yield.

4 Geology and Geotechnical Studies

4.1 General

The objective of the geotechnical studies was to defined engineering design parameters for the power stations and the canal dike improvement works.

Parameters were defined based on the available regional information and the results of geotechnical investigations carried out as part of the Study.

A regional geological map was available for the area of the two power projects. The map was included as part of the Atkins feasibility study for the Rohri site, see Figure 10. Geology of both sites comprises alluvium and recent soil deposits.

The Atkins feasibility study also reported results of the drilling program carried out for construction of the bridge crossing downstream from the Head Regulator and from construction of the Sukkur Barrage. No local borehole information was available at the site of either power station.

In general, the ground conditions are characterized by alluvial deposits underlain by rock layers primarily of limestone. The thickness of the alluvium varies along the river with thickness varying between 30 to 45 m. The alluvium is predominantly pervious fine silty sands with occasional lenses of sandy silty clays.

Based on the existing information, the foundation of the two power stations is expected to be on silty sandy alluvium. A geological investigations program was arranged to obtain design parameters for the Project. The scope of work for the program included:

- Definition of overburden soil properties,
- Definition of the bed rock properties,
- Determining the impermeability of foundations on which the structures will be located,
- Defining the bearing capacity of foundations,
- Defining parameters for design of slurry walls or secant piling,
- Confirming the geotechnical structure and engineering character of existing dikes.

A separate geotechnical investigations report is prepared and included as an Annex to this Report.

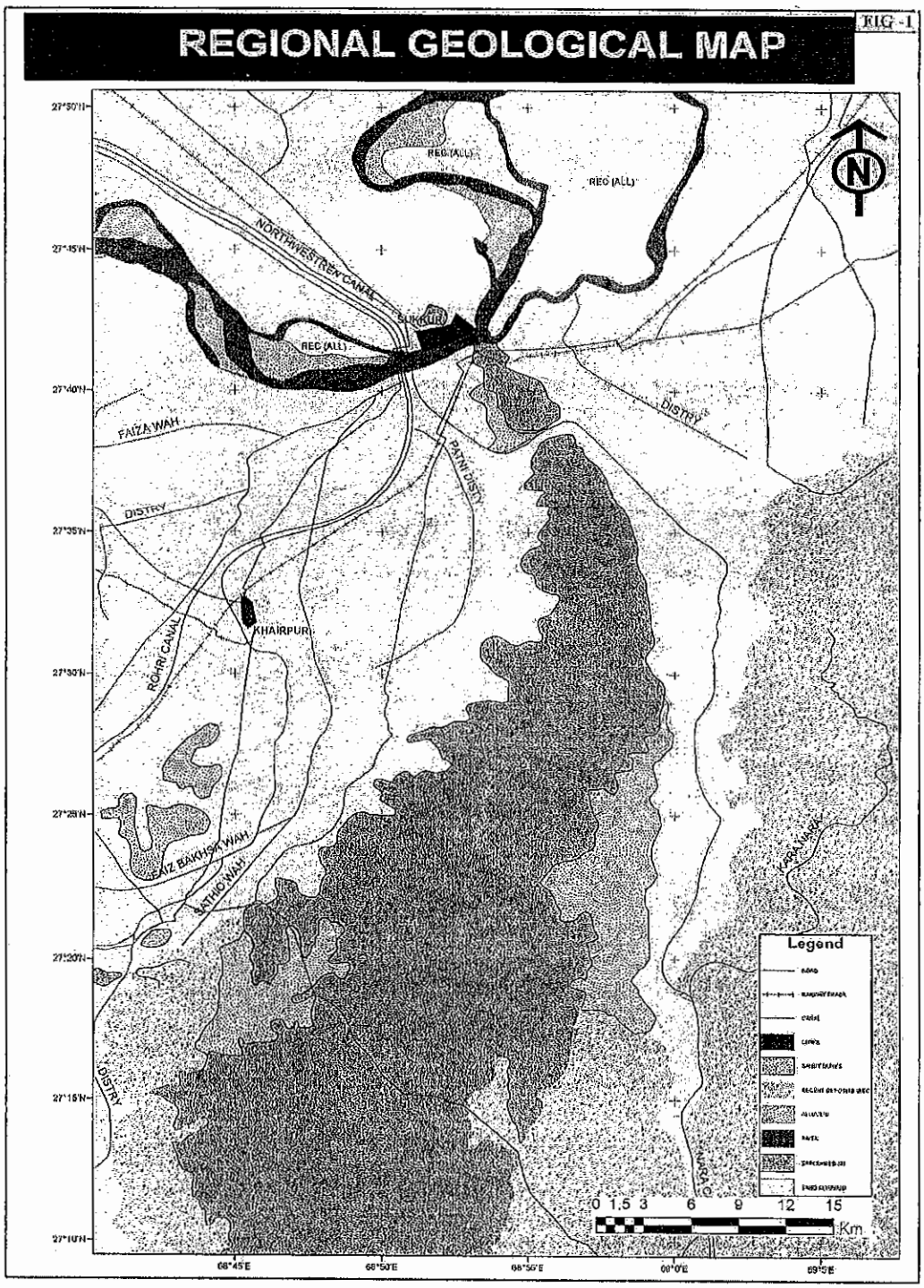


Figure 10 Regional Geological Map

4.2 Engineering Parameters

[To be inserted based on investigations]

5 Hydraulic Design and Sediment Transport Analysis

5.1 General

The water levels upstream and downstream from the power stations must be determined by hydraulic analysis of the existing canals. As noted in Section 3, the available water level data provided in the W.S. Atkins feasibility study for the Rohri power station is not reliable.

This section presents the assumptions and analysis made to derive the water levels for the power stations.

Sediment can have an important effect on the long term viability of the power station scheme because of the possibility for deposition in the headrace canal, which could affect the gradient of the water surface slope. The existing canals are understood to be affected by sediment deposition and erosion; resulting in deformation of the design section and profile.

5.2 Headworks Structures

The water level available at the upstream end of the canals, at the Headworks Regulator, will affect the water level at the power station inlet. The maximum theoretical level is the value upstream from the Sukkur Barrage. This can be achieved if the water control function of the Headworks Regulator is transferred to the power station. This change is only an operational adjustment that would require no physical modification to the structure.

Head loss would occur as water flows through the openings in the Headworks Regulator. Dimensions of the gate openings through the structure are not available at this time. An loss of 0.5 m has been assumed for the purposes of this study pending receipt of details.

The other constraint on water levels upstream is the elevation of the lower chord of the highway bridge crossing over the canals. The maximum operating water level should be below the bottom of the bridge beams with some freeboard. The elevation of this bridge crossing is not given in the available information.

A third constraint is that water level cannot be high enough to cause flooding of the private houses located along the canal banks downstream from the Headworks Regulator. The canal banks could theoretically be raised in this area but this would require relocation or reconstruction of a large number of properties. The cost of this work would add significantly to the Project cost and add complications because of the social impacts.

The maximum water level should, therefore, be set at the minimum of (i) the lower chord level (less about 1 m of freeboard) of the highway crossing, (ii) the point where flooding of private properties starts, and (iii) the Sukkur Barrage water level.

In the absence of any field information on these constraints, a maximum water level at el 59.284 m (194.5 ft.) was assumed. This represents a 61 cm (2 ft.) increase in water level from the design level for the Rohri Canal.

5.3 Hydraulic Simulation of Canals

[To be inserted when cross section data is available]

5.4 Powerhouse Headwater Levels

The headwater level at the power stations is determined by the hydraulic simulation of the canals downstream from the Headworks Regulator.

In the absence of field survey information, a water surface gradient of 0.0060% was assumed for the Rohri Canal at the rated flow rate for the power station. This results in a headwater level of el 59.01 m (193.6 ft.).

A water surface gradient of 0.0060% was also assumed for the Nara Canal from the Headworks Regulator to the power station at RD25. This represents a flatter gradient that the existing canal design slope of 0.00769%. The resulting headwater level at the power station is el 58.826 m (193 ft.).

The headwater level at flow rates below the design flow will be higher because of the lower canal gradient.

5.5 Powerhouse Tailwater Levels

The tailwater level was determined by a Normal flow calculation based on the canal design information provided by the Irrigation Department. In the case of the Rohri Canal, the tailwater curve has the following relationship:

$$Q = 28.88(WSE - 51.700)^{1.676}$$

Where, Q is the flow rate in m^3/s and WSE is the water surface elevation in meters.

In the case of the Nara Canal, the tailwater curve has the following relationship:

$$Q = 37.379(WSE - 51.511)^{1.673}$$

5.6 Sediment Transport and Deposition

Sediment in the Indus River is passed through the Regulator to the canals as there is no separate works provided in the existing design for sediment exclusion. Sediment exclusion would not be practical at the scale of the canals, therefore, the project must allow for passage of the sediment.

Note that head regulation at the power station would reduce the sediment transporting capacity of the canal from the existing Head Regulator to the power station. This could lead to some difficulties with sediment accumulation, which should be considered as a potential future maintenance dredging requirement.

Both canals are understood to have been subject to some deposition of sediment due to mis-match between the inflow sediment transport capacity and the transport capacity of the canals. This situation will continue and may be exacerbated by the power stations.

No information is available on the sediment transported by the Indus River at this location to allow for a more detailed assessment.

6 Power Station Design

6.1 General

The power station layout accommodates the proposed turbine generator equipment with the design defined according to the geotechnical and hydraulic conditions at the site. The following section outlines the proposed feasibility level design for the power station.

6.2 Powerhouse Layout

Horizontal axis, Kaplan type turbines are proposed for this power station. These turbines will allow for a compact powerhouse structure suited for the high flow rates required in the canals. A bevel gear arrangement was selected after consultation with a proposed turbine supplier. The bevel gear allows the generator to be placed with a vertical axis and to be situated above the turbine (see Section 7 for more details). The gearing arrangement also allows for a speed increaser that reduces the size of the generator.

The powerhouses were designed for the following rated conditions:

Rohrl Canal Design Data

Flow Rate		Headwater Level		Tailwater Level		Gross Head		Head Loss	Power
ft³/s	m³/s	m	ft	m	ft	m	ft	m	kW
1,766	50.00	59.28	194.49	53.09	174.17	6.19	20.32	0.09	2,645
3,531	100.00	59.27	194.46	53.80	176.50	5.47	17.95	0.09	4,489
5,297	150.00	59.25	194.40	54.37	178.39	4.88	16.01	0.09	5,994
7,062	200.00	59.23	194.32	54.87	180.03	4.36	14.29	0.09	7,117
8,828	250.00	59.20	194.22	55.33	181.51	3.87	12.71	0.09	7,891
10,593	300.00	59.16	194.10	55.74	182.88	3.42	11.22	0.09	8,334
12,359	350.00	59.12	193.96	56.13	184.16	2.99	9.80	0.09	8,456
14,124	400.00	59.07	193.79	56.50	185.36	2.57	8.43	0.09	8,271
15,890	450.00	59.01	193.60	56.85	186.51	2.16	7.09	0.09	7,778

Nara Canal Design Data

Flow Rate		Headwater Level		Tailwater Level		Gross Head		Head Loss	Power
ft³/s	m³/s	m	ft	m	ft	m	ft	m	kW
1,766	50.00	59.28	194.48	52.70	172.90	6.58	21.58	0.09	2,706
3,531	100.00	59.27	194.44	53.80	176.50	5.47	17.94	0.09	4,485
5,297	150.00	59.24	194.36	54.37	178.39	4.87	15.98	0.09	5,980
7,062	200.00	59.21	194.26	54.87	180.03	4.34	14.23	0.09	7,086
8,828	250.00	59.17	194.12	55.33	181.51	3.84	12.61	0.09	7,829
10,593	300.00	59.12	193.96	55.74	182.88	3.38	11.08	0.09	8,227
12,359	350.00	59.06	193.76	56.13	184.16	2.93	9.61	0.09	8,266
14,124	400.00	58.99	193.54	56.50	185.36	2.49	8.18	0.09	8,018
15,890	450.00	58.91	193.28	56.85	186.51	2.07	6.78	0.09	7,417
17,655	500.00	58.83	193.00	57.18	187.60	1.64	5.39	0.09	6,486
19,421	550.00	58.73	192.68	57.50	188.66	1.23	4.03	0.09	5,223

Note that the maximum head occurs at the lowest flow rates. The maximum power occurs at an intermediate flow condition when the head is higher than at the maximum flow rate.

The generating units can be designed for a nominal flow of about 55 m^3/s/Unit at both sites. The Rohri site would have eight units while the Nara site will have 10 units.

[analysis to be updated based on final water levels and selection of generating units]

The powerhouse structure will be arranged by allowing for flow over top of the powerhouse with control by flap gates. The gates could be adjusted to supplement the flow through the power station during some operating conditions. The gates would also open rapidly in the event of a power system load rejection so that the flow rate along the canal would not be disrupted.

6.3 Structural Design

6.4 Auxiliary Structures

6.5 Existing Canal Drop Structure Closure

The existing canal drop structures at each site will be permanently closed as part of the power project. The closure will be accomplished by placing an embankment across the canal immediately upstream from the drop structure during the January canal outage.

The embankment will be designed as a homogenous earth fill founded on the existing canal bed. The crest elevation will be the same as the dike bank levels and will accommodate open channel transient conditions from power station operations.

The downstream slope of the embankment will be protected by turf. The upstream slope will be covered with stone pitching founded on filter layer.

The existing structures will be left in their present condition and not demolished.

7 Electrical and Mechanical Equipment

7.1 Scope and Objectives

7.2 Turbine Selection

7.3 Power Generation Equipment

7.4 Balance of Plant Systems

7.5 Spillway Equipment

7.6 Transmission Line Connection

8 Power and Energy Yield

9 Construction Planning, Cost Estimates, and Schedule

9.1 General

9.2 Construction Plan

9.3 Construction Schedule

9.4 Cost Estimate

10 Conclusions and Recommendations

Generation License Application
Nara Hydropower (Pvt.) Limited
Prospectus
Annex E

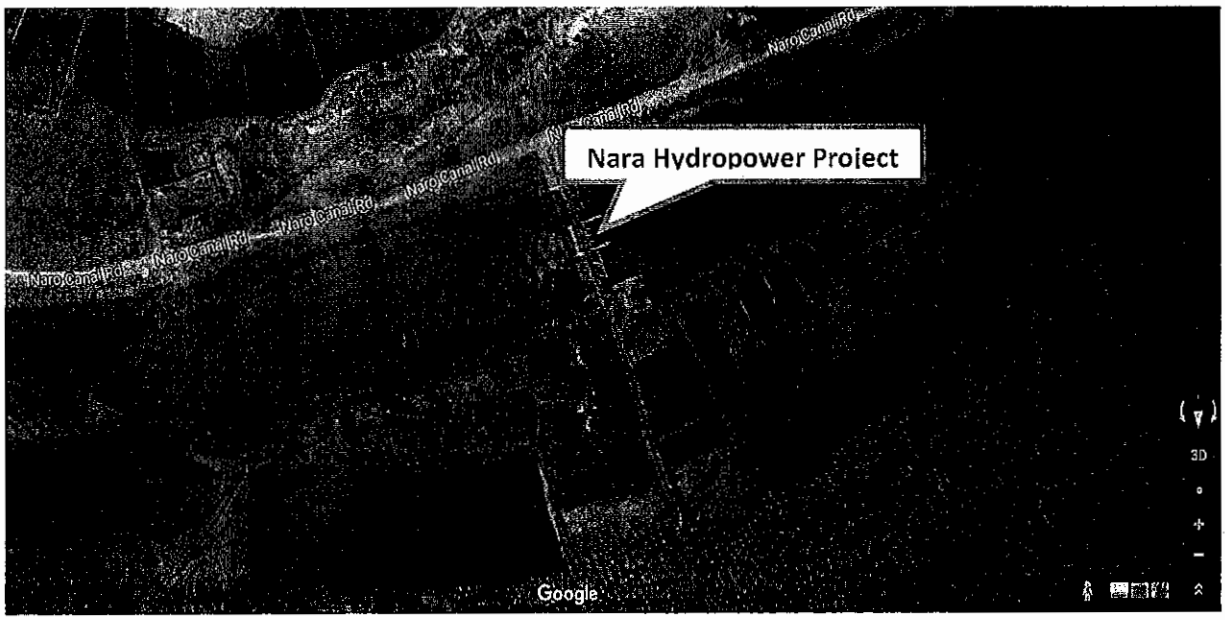
Regulation 3(5) (i) Prospectus

1. Project Brief introduction

The project is a run-of-the-river hydropower plant which will be construction at RD-26 Nara Canal, District, Sukkur Sindh Province. Nara Canal is an excavated waterway in Sindh province, Pakistan. It was built as an excavated channel off the left bank of the Indus River into the course of the old Nara River. The canal runs from above the Sukkur Barrage through the Khairpur, Sanghar, Mirpurkhas and Tharparkar Districts to the Jamrao Canal.. About 2,000,000 acres (8,100 km2) of land are irrigated by this canal.

Gross capacity of the proposed power plant will be 13.65 MW. Net power generation will be 12.9MW. The plant will not involve the construction of dam, reservoir or pondage. The location coordinates of the proposed plant are 27 37' 50" N, 68 54' 27" E. A drop structure exists at the project site.

Location of power plant site is depicted below;



1.1 Objective of Project

The objectives of the project are given as under:

- To respond to the need of reducing the gap between supply and demand of electricity in the country
- To exploit the so far untapped potential of Hydropower in Sindh province
- To provide sufficient power generation capacity at least cost
- To harness electricity from cleaner, renewable energy sources
- To generate electricity with minimal environmental footprint

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2. The salient features of the facility

1.	**Name of Applicant :**	Nara Hydropower (Pvt.) Limited
2.	**Registered Office :**	1st Floor, Block 3, Hockey club of Pakistan Stadium, Liaquat Barrack, Karachi
3.	**Business Office :**	CL 5/4 – State life Building 10, Shafi Court, Karachi.
4.	**Project Location :**	RD-26 Nara Canal, Sukkur District, Sindh Coordinate; 27 37' 50" N, 68 54' 27" E
5.	**Plant Details (Optional) :**	
	a. Manufacturer :	Andritz Hydro
	b. Make & Model :	BGB 2600/k3
	c. Plant Capacity (MW) :	13.65 MW
	d. Technology :	Bevel Gear Bulb Turbine
	e. Unit Size (MW) :	1.365 MW each
	f. Number of Units:	10 Units
6.	**Reference Site Conditions (Optional) :**	
	a. Design Net Head m :	3.2m
	b. Net rated discharge m3/sec :	500m³ Rated Flow (50 per unit)
	c. Gross annual electrical out MW :	13.65 MW
	d. Auxiliary Consumption MW :	0.75 MW
	e. Net annual energy production MWh :	74,800 MWh
	f. Net annual plant capacity factor % :	60%
7.	**Expected Date of Financial Close :**	June 2018
8.	**Expected date of Commercial Operation (COD):**	December 2020

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3. The Proposed Investment

3.1 Proposed Project Cost

Project Financing		USD
Total Project Cost		55,590,088
Total Debt Amount	75.0%	41,692,566
Total Equity	25.0%	13,897,522

4. Social and Environmental Impact

4.1 Environmental Impact

Aspect and impact related to the siting of the project area listed below:

- The Proposed project is a small hydel project to utilize the energy potential of Nara Canal to harness clean and renewable energy and to export to the national grid.
- The proposed project involves minor change in Land Use of the microenvironment.
- Minor traffic increase is envisaged only during the construction phase. Traffic during operation will involve only periodic maintenance and work vehicles.
- There are some indigenous shrubs present at project site.
- This Project would least likely to cause any annoyance to the living environment as it is a run-of-river project.
- The project site has no sensitive areas such as protected sites including wildlife sanctuaries, game reserves or national parks, or any archaeological, historical or cultural heritage in its immediate neighborhood; as such its siting would have no sensitivity in this regard.
- The project when completed will not need much time to become a component of the ecosystem; as such this add-on in the energy mix will have no significant impact on the precious ecology. Unnecessary removal of trees or greenery would not be involved.
- The air quality of the air-shed of the macro-environment as well as that of the site itself will have no significant impact due to siting of the Project.

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4.2 Socioeconomic Impacts

Positive socioeconomic impacts are envisaged from the construction and operation of 13.65MW Nara Hydropower Project. Local skilled and unskilled labor will be hired during the construction phase of project. This would improve the quality of life of the nearby communities.

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SCHEDULE III

[(Regulation 3(6))]

NEW GENERATION FACILITIES (HYDEL)

S#	PARAMETER	DESCRIPTION
1	Location (location maps, site map), land	RD-26 Nara Canal, Sukkur District, Sindh. Coordinate; 27 37' 50" N, 68 54' 27" E (Map and plan enclosed as Annex-1)
2	Plant: run of the river, storage, veir	Run of the River (RoR) Low head, Small hydro plant
3	Head: minimum, maximum	Minimum Head..... 2.7 m Gross Maximum Head.... 5.23 m Gross Rated Head..... 3.2 m Net (3.46 m Gross)
4	Technology: Francis, Pelton, etc. size, number of units	Kaplan Turbine with Horizontal axis Bevel Gear Bulb Turbine Arrangement Total 10 Units of 1.365 MW (Gross) each
5	Tunnel (if proposed): length, diameter	Tunnel not required
6	ESSA (Environmental & Social Soundness Assessment)	Initial Environmental Examination (IEE) study of the "Nara Hydropower Project" has been conducted by EMC Pakistan Pvt. Ltd. in the compliance of the mandatory requirement of Section-17 of Sindh Environmental Protection Act (SEPA) 2014 and SEPA (Review of IEE/EIA) regulations 2014. Project IEE Report enclosed as Annex-2
7	Detailed feasibility report	Enclosed as Annex-3
8	Resettlement issues	No such issues on the project site
9	Consents	Initial Environmental Examination (IEE) study approved by SEPA
10	Infrastructure development	As per feasibility report attached as Annex-3

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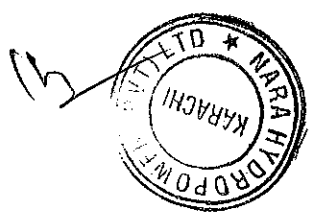
11	Interconnection with national grid company, length of transmission line(s)	Interconnection with SEPCO at 11 kV Voltage Level. Length of transmission line is 7 KM from nearest Rohri 132/11kV Grid Station
12	Project cost, information regarding sources and amounts of equity and debt	**Project Cost:** USD 55,590,088 **Total Debt Amount (75.0%)** USD 41,692,566 **Total Equity (25.0%)** USD 13,897,522
13	Project schedule, expected life	Financial Close: Oct 2018 Commercial Operation (COD): December 2020 Expected Life: 50 Years
14	Peaking/base load operation	Base Load Operations
15	Plant characteristics: generation voltage, power factor, frequency, automatic generation control, ramping rate, control metering and instrumentation	Generation Voltage: 0.69/11 kV Power Factor: 0.85 Lagging / 0.90 Leading Frequency: 50 Hz
16	System studies load flow, short circuit, stability	SEPCO Approved Grid Interconnection Study (GIS) Report covering required load flow, short circuit and stability is enclosed as Annex-4
17	Training and development	Training and development of the Operational and Maintenance staff shall be done as per the attached offer of Andritz Hydro OEM/EPC of hydro turbine



ANNEX-1

LOCATION DETAILS OF

15 MW RUN OF THE RIVER NARA HYDROPOWER PROJECT

Location:

RD-26 Nara Canal,
Sukkur District, Sindh.
Coordinate; 27 37' 50" N, 68 54' 27" E (See Map pasted below)

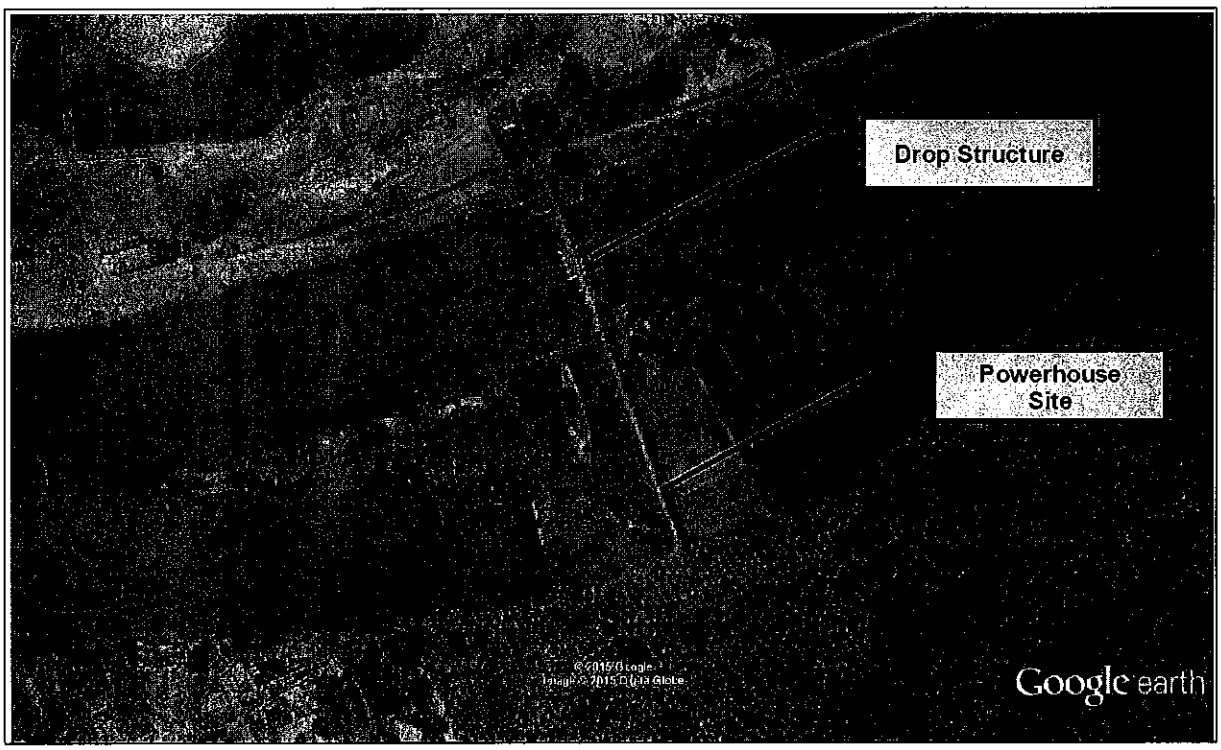


Figure 1 Nara Power Station Location

NARA HYDROPOWER (PVT) LTD * KARACHI

Annex 4

SUKKUR ELECTRIC POWER COMPANY

Phone: 0719310044
Fax: 071-9310342
Email: planningsepcogis@gmail.com

Planning Directorate,
2nd Floor, Al-Sehra Building,
Near Dist: Jail, Minara Road, Sukkur

No. CTO/SEPCO/SUK/M(P&E)/NHPPL/ 1836-38

Dated: 12-03-2018

Deputy General Manager (Tech)-II,
CPPA-G Ltd, Ground Floor
Enercon Building, G-5/2,Near SB, Islamabad

Subject: **INTERCONNECTION STUDY APPROVAL OF 15 MW HYDROPOWER PROJECT BY M/S NARA POWER PVT LTD, NEAR ROHRI CANAL, DISTRICT SUKKUR, SINDH**

Ref:
1. Guidelines/SOP for power procurement issued by your good office vide No. CPP- G/CS/ 2016 /1965 dated 31/05/2016.
2. Your letter No. Tech/DGMT-II/MT-IV/NHPPL/35181-86 dated 06/10/2017

M/s Nara Hydropower Pvt Limited is going to establish 13.65 MW Hydel Based power Project near Rohri, District: Sukkur for sale of 12.5 MW spillover power to national grid. Letter of Intent (LOI) has been issued by Directorate of Alternative Energy, Energy Department, Government of Sindh vide No.DAE/smallHydro/01/2015/06 dated 02/01/2015. The power will be evacuated at 11 kV Voltage level. SEPCO further certify that:

a. SEPCO hereby give Grid Interconnection Study approval for the subjected power plant as the power injected through above mentioned project will not have any adverse effect on SEPCO network. Moreover, comments of Planning NTDC may also be obtained as per policy.
b. SEPCO hereby give its consent to CPPA (G) for purchase of 12.5 MW spillover power from M/S Nara Hydropower (Pvt) Ltd on behalf of SEPCO.
c. A tripartite EPA/PPA will be negotiated and finalized with Project Company including CPPA-G and SEPCO. All the obligations / liabilities pertaining to technical portion (Connection part) will be the sole responsibility of SEPCO, whereas CPPA-G will have the obligations/liabilities only related to the Commercial part of the agreement
d. SEPCO will construct, operate and maintain the purchaser interconnection facilities in accordance with the project timelines agreed with the power producer as Project Director (Construction) SEPCO has confirmed that the proposed triple circuit line on osprey conductor from the site of Nara Hydropower to 132 kV Grid Station Rohri Old measuring about 7 km will be completed before March, 2021 subject to provision of funds.

This issues with the approval of worthy CEO, SEPCO.

Manager (P&D)
SEPCO Sukkur
12/3/18

NARA HYDROPOWER (PVT) LTD ★ KARACHI

Copy to:
1. PSO to Chief Executive Officer, SEPCO, Sukkur.
2. Chief Technical Officer, SEPCO, Sukkur
3. M/S Nara Hydropower Project Private Limited, 1st Floor, Block 3, Hockey Club of Pakistan Stadium, Liaquat Barracks, Karachi.

Master file/Relevant file.

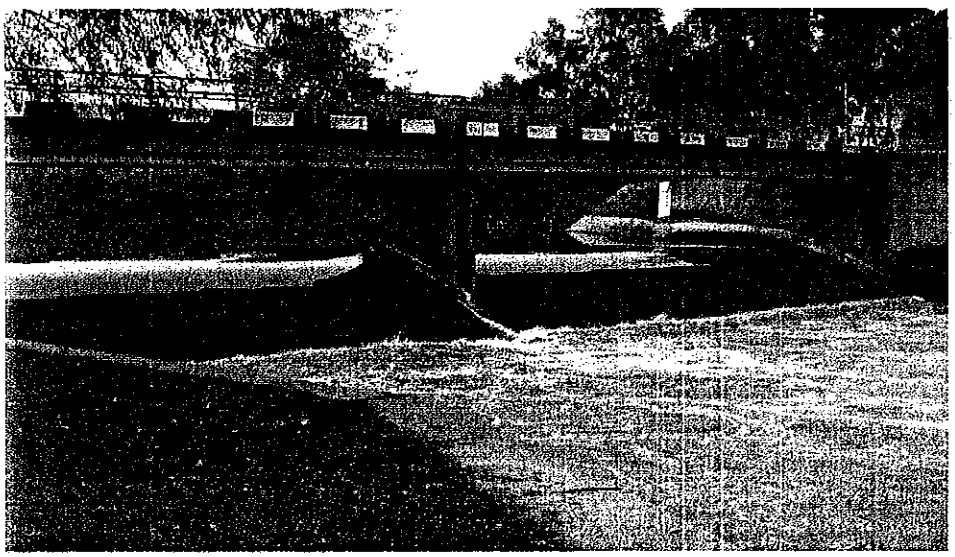
Annex-4

Report No. PPI-277.1-Final/17

INTERCONNECTION STUDY

For

15 MW Nara Hydro Power Project



Final Report
(February 2017)

POWER PLANNERS INTERNATIONAL

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www.powerplannersint.com

Report No. PPI-277.1-Final/17

INTERCONNECTION STUDY

For

15 MW Nara Hydro Power Project

Final Report
(February 2017)

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Executive Summary

- The Final Report of 15 MW Nara Hydro Power Plant is submitted herewith after incorporating the comments issued by SEPCO via letter no. CTO/SEPCO/SUK/M(P&E)/NHPPL 5578-80 Dated 10-11-2017.
- While the LOI issued for Nara Hydro Power Project was for 15 MW, the feasibility reports suggested maximum plant capacity of 13.65 MW, which is also the installed capacity of the plant out of which 1.15 MW shall be consumed by the auxiliary load of the plant leaving 12.50 MW as the spillover.
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated.
- The latest generation, transmission plan and load forecast of NTDC has been used for the study.
- The network around Nara Hydro Power Project (referred to as Nara HPP in the remainder of the report) at 132 kV and 11 kV has been modeled as shown in Appendix-B (Sketch-2).
- The nearest grid interconnection facility is Rohri 132/11 kV grid station of SEPCO. The following scheme of interconnection of Nara HPP to evacuate its maximum power of 12.5 MW is envisaged and studied in detail:
  - A direct 11 kV Triple circuit of 7 km using Osprey conductor to be laid from 11 kV Bus Bar of Nara HPP till Rohri 132/11 kV grid station.
  - In this context, three 11 kV breaker bays need to be added in the 11 kV switchgear hall of Rohri 132/11 kV grid station.
- In view of planned COD of Nara HPP in March 2021, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the Peak and Off-Peak conditions of September 2021 for maximum hydropower dispatches. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- In view of planned COD of Nara HPP Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate

the spillover of up to 12.5 MW power of the Plant under normal as well as contingency conditions

- The proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the Peak and Off-Peak conditions of September 2021 for maximum hydropower dispatches.
- The short circuit level of the Nara HPP 11 kV is 11.58 kA and 11.09 kA for 3-phase and 1-phase faults respectively for the year 2021 .Therefore, to go for standard size switchgear of short circuit rating of 25 kA at 11 kV buses of Nara HPP would suffice. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.
- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 0.69 kV bus bar of Nara HPP substation followed by the final trip of 11/0.69 kV transformer emanating from this substation, has been performed for fault clearing of 5 cycles (100 ms) as understood to be the normal fault clearing time of protection system. Also, the worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms. In all events, 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 Rohri 132 kV bus bar bus bar have also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults even 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.

Report Contents

1. Introduction

1.1 Background

Nara HPP aims to install ten units of 1.365 MW each for the aim of exporting 12.50 MW to the national grid to the national grid, where 1.15 MW is consumed by its auxiliary load. The project is expected to start commercial operation by March 2021. The electricity generated from this project would be supplied to the grid system of SEPCO through 132 kV grid of Rohri, available in the vicinity of this project.

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Nara HPP and SEPCO network, for stable and reliable evacuation of 13.65 MW of 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 132 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 132 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 Nara HPP.
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
	± 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	0.85 Lagging; 0.90 Leading

Short Circuit:

132 kV Substation Equipment Rating 31.5 or 40 kA

Dynamic/Transient:

The system should revert back to normal condition after dying out of transients without losing 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) for 132 kV and higher voltage levels.

2. Assumptions of Data

The number of generating units at Nara HPP is ten. The following data have been provided by the Client:

2.1 Nara HPP

Gross capacity of power plant	= 10 x 1.365 = 13.65 MW
Auxiliary Load	= 1.15 MW
Net Output of the plant	= 12.5 MW
Generating Voltage	= 0.69 kV
Power factor	= 0.85 lagging; 0.90 leading
GSU Transformer	= 2 x 15 MVA
GSU Transformer reactance	= 10 %

2.2 Network data

The 132 kV network in the area near Nara HPP are as shown in Sketches in Appendix-B. The system data of SEPCO/NTDC has been used as per the data permission letter of NTDC, Letter No. GMPP/TRP-300/4739-42 dated 15-08-2017.

3. Study Approach and Methodology

3.1 Understanding of the Problem

Nara Hydro Power Project intends to put up generating capacity of 13.65 MW, utilizing 10 units each of 1.365 MW. The plant has an auxiliary load of 1.15 MW making its total spillover to 12.50 MW to the national grid during high water season.

The location of the plant is around the 132 kV grid facility of Rohri. The plant generates at the low voltage of 0.69 kV, steps up to 11 kV and transmits power via three feeders of 7 km length each, of Osprey conductor. Nara HPP added to the existing network is shown in Sketch-2 in Appendix-B.

The adequacy of SEPCO network of 132 kV in and around the proposed site of Nara HPP would be 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 September 2021 after the commissioning of Nara HPP in March 2021, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in SEPCO.
- Month of September 2021 has been selected, while representing high water conditions respectively in the grid system. Thus, the high water flow patterns can be observed allowing us to judge the maximum impact of the plant on the transmission system in its vicinity.
- 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 like load flow, short circuit, and transient stability study to check the strength of the machines and the proposed interconnection scheme under

disturbed conditions. 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 like load flow, short circuit, and transient stability study to check the strength of the machines and the proposed interconnection scheme under 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 132 kV network available around Rohri 132 kV grid station is shown in Sketch-1 in Appendix-B.

Nara HPP is in District Sukkur embedded in the distribution network of SEPCO. Network is being fed from the sources substation of Guddu 500/220/132 kV, Shikarpur 220/132 kV and Sibbi 220 kV grid station.

These are multiple feeding points in the vicinity which provides reliability and voltage support to the system. All these substations provide a strong 220 kV and 500 kV network around the proposed plant. A strong system helps in stable operation of a power plant.

4.2 The Scheme of Interconnection of Nara HPP

Keeping in view of the above mentioned 132 kV network available in the vicinity of the site of the Nara HPP, the interconnection scheme has already been developed and the 132 kV transmission lines have also been constructed. The interconnection scheme has been developed by connecting the 11 kV lines emanating from the step up point of the plant by two 15 MVA transformers to the existing 132/11 kV transformers of Rohri via three circuits, each of 7 km length. The conductor used was Osprey. This proposed interconnection scheme is shown in Sketch-2 of Appendix-B.

5. Detailed Load Flow Studies

5.1 Peak Case Load Flow September 2021, without Nara HPP

A base case has been developed for the peak load of September 2021 using the network data of NTDC and SEPCO available with PPI, after updating with latest load forecast and expansion plan of NTDC and SEPCO. The peak load of the year 2021 for SEPCO have been modeled as per the latest PMS Demand forecast obtained from NTDC.

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 132 kV network feeding Rohri and its surrounding substations including Mirpur Mathelo, Panu Akil and Ghotki

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 following cases

Exhibit 0.1	Rohri-1 to SUKURSTE 132 kV Single Circuit Out
Exhibit 0.2	Arain Road to SUKURSTE 132 kV Single Circuit Out
Exhibit 0.3	Ghotki to Rohri-1 132 kV Single Circuit Out
Exhibit 0.4	Panuakil to Rohri-1 132 kV 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 Peak Case Load Flow September 2021, with Nara HPP

The scenario of Nara HPP after the COD of the plant when it starts exporting 12.50 MW to the SEPCO network has been studied. The results of load flows with Nara HPP under normal conditions have been plotted in Exhibit 1.0 in Appendix-C.

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 ± 5 % off the nominal. We find no capacity constraints on 132 kV circuits under normal

conditions i.e. without any outages of circuits.

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

Exhibit 1.1	Nara HPP 11/0.69 kV Single Transformer Out
Exhibit 1.2	Nara to T1 11 kV Single Circuit Out
Exhibit 1.3	Nara to T2 11 kV Single Circuit Out
Exhibit 1.4	Rohri-1 to SUKURSTE 132 kV Single Circuit Out
Exhibit 1.5	Arain Road to SUKURSTE 132 kV Single Circuit Out
Exhibit 1.6	Ghotki to Rohri-1 132 kV Single Circuit Out
Exhibit 1.7	Panuakil to Rohri-1 132 kV 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.

5.3 Off-Peak Case Load Flow September 2021, with Nara HPP

The scheme of interconnection modeled in the load flow for Nara HPP is as described in Chapter-4.

Load flow studies have been carried out for off-peak scenario of September 2021 allowing us to judge the maximum impact of the plant on the transmission system in its vicinity. The results of load flow with Nara HPP interconnected as per proposed scheme are shown in Appendix-C.

The results of Normal case of Off-Peak September 2021 are plotted in Exhibit 2.0. We find no capacity constraints on 132 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 ± 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	Nara HPP 11/0.69 kV Single Transformer Out
Exhibit 2.2	Nara to T1 11 kV Single Circuit Out
Exhibit 2.3	Nara to T2 11 kV Single Circuit Out
Exhibit 2.4	Rohri-1 to SUKURSTE 132 kV Single Circuit Out
Exhibit 2.5	Arain Road to SUKURSTE 132 kV Single Circuit Out
Exhibit 2.6	Ghotki to Rohri-1 132 kV Single Circuit Out
Exhibit 2.7	Panuakil to Rohri-1 132 kV 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 Transmission Losses

The transmission line losses were evaluated for normal case of peak load September 2021 from Nara Hydel PP to the point of interconnection (distance of 7 km).

% Power Loss from Nara PP towards Rohri-I 11 kV = (12.500-12.122)/12.5

= 0.03024x 100 = **3.024 %**

It can be seen that the transmission loss of the transmission line from Power plant to the point of interconnections is less than NEPRA's allowed 3.5%.

5.5 Conclusion of Load Flow Analysis

The proposed interconnection scheme of Nara HPP is adequate to evacuate the spillover electrical power from plant under normal and contingency conditions tested for peak load conditions of September 2021 after the COD of Nara HPP.

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. Hence the proposed interconnection scheme of Nara HPP has no constraints according to the Load Flow Analysis.

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 hydal, thermal and nuclear plants in the system in the year 2021 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 Nara HPP, 2021

In order to assess the short circuit strength of the network of 132 kV and 11 kV without Nara HPP for the grid of SEPCO in the vicinity of the site of the 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 Nara HPP and later on how much the contribution of fault current from Nara HPP 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 132 kV substations lying in the electrical vicinity of our area of interest i.e. Rohri-I, Arain Road, Sukkur Site, Ghotki and surrounding bus bars are shown plotted in the Exhibit 3.0

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.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV bus bars of our interest i.e. the substations connecting in the 132 kV circuits lying close to Nara HPP. 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 132 kV substations which normally are 20 kA, 25 kA or 40 kA for older substations and 40 kA for new substations.

Table-6.1

Maximum Short Circuit Levels without Nara HPP, 2021

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Rohri T-1 11kV	**16.32**	**16.70**
Rohri T-2 11kV	**11.74**	**11.93**
Rohri 132kV	**19.85**	**16.35**
Sukkur Site 132kV	**17.45**	**13.56**
Arain Road 132kV	**18.79**	**16.10**
Panu Akil 132kV	**8.43**	**6.00**
Ghotki 132kV	**13.31**	**11.53**

6.3 Fault Current Calculations with Nara HPP, Year 2021

Fault currents have been calculated for the electrical interconnection of proposed scheme. Fault types applied are three phase and single-phase at 132 kV and 11 kV bus bar of Nara HPP itself and other bus bars of the 132 kV substations in the electrical vicinity of the plant. The graphic results showing maximum 3-phase and 1-phase fault levels are indicated in Exhibit 3.1. 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 132 kV bus bars of the network in the electrical

vicinity of Nara HPP 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 Nara HPP, 2021

Substation	3-Phase fault current, kA	1-Phase fault current, kA
Nara HPP 11kV	**11.58**	**11.09**
Rohri T-1 11kV	**19.49**	**19.31**
Rohri T-2 11kV	**13.95**	**13.91**
Rohri 132kV	**20.08**	**16.45**
Sukkur Site 132kV	**17.59**	**13.61**
Arain Road 132kV	**18.84**	**16.12**
Panu Akil 132kV	**8.45**	**6.00**
Ghotki 132kV	**13.33**	**11.54**

The maximum short circuit level of Nara HPP 11 kV is 11.58 kA and 11.09 kA for 3-phase and 1-phase faults respectively. The standard size switch gear for 11 kV bus bar is 25 kA which is sufficient for Nara HPP under the existing interconnection scheme.

6.4 Conclusion of Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Nara HPP with Rohri, we don't find any problem of violations of short circuit ratings of the already installed equipment on the 132 kV equipment of substations in the vicinity of Nara HPP due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level of the Nara HPP 11 kV for 3-phase and 1-phase faults is 11.58 kA and 11.09 kA for the year 2021. Therefore, industry standard switchgear of the short circuit rating of 25 kA would serve the purpose as per NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.

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 for available in the PSS/E model library for dynamic modeling of the exciter and the governor as follows;

Excitation System	EXST1
Speed Governing System	HYGOV

GENSAL model in PSS/E for hydel generator has been employed and the parameters as provided by clients has been used in the model.

7.1.2 System Conditions

Month of September 2021 has been selected for the study because it represents the peak load season after the COD of Nara Hydro Power Plant and thus the loading on the lines in the vicinity of plant will be maximum, allowing us to judge the full impact of the plant.

All the power plants of WAPDA/PEPCO 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 simulation 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 nine seconds. Usually all the transients due to non-linearity die out within 4-5 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 Nara HPP i.e. right at the 0.69 kV bus bar of Nara HPP substation, cleared in 5 cycles, as normal clearing time i.e. 100 ms,

followed by a permanent trip of a 11/0.69 kV single transformer emanating from this substation. Fault at 11 kV bus bar of Nara HPP has also been simulated for 5 and 9 cycles.

7.2 Dynamic Stability Simulations' Results with Nara HPP, Year September 2021

7.2.1 Fault at 0.69 kV Nara HPP

We applied three-phase fault on Nara HPP 0.69 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 11/0.69 kV transformer circuit between Nara HPP 0.69 kV and Nara 11 kV. 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. 1.1 Bus Voltages

The bus voltages of 132 kV bus bars of Nara HPP 0.69 kV, Nara 11 kV, Rohri, Sukkur Site, Panu Akil and Ghotki 132 kV 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 quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generators of Nara HPP

The MW/MVAR output of both units of Nara HPP gets back to the pre-fault output quickly after fast damping of the oscillations in its output. However MVAR outputs acquires equilibrium at a slightly different value.

Fig. 1.4 Speed and mechanical power of Generators at Nara HPP

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 Nara HPP 11/0.69 kV Transformer

Followed by clearing of fault, the trip of Nara HPP 11/0.69 kV single transformer causes significant output to flow on the intact second transformer of the plant. 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 Nara HPP, Liberty, Arian Road, Engro Energy, and Foundation-P are plotted relative to machine at Hub 500 kV. The results show that the rotor angle of Nara HPP gets back after the first swing and damps down quickly. Similarly, the rotor angles of other machine 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 0.69kV Nara HPP (Stuck Breaker)

We applied single-phase fault on Nara HPP 0.69 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of a 11/0.69 kV transformer circuit between Nara HPP 0.69 kV and Nara 11 kV. 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. 2.1 Bus Voltages

The bus voltages of 132 kV bus bars of Nara HPP 0.69 kV, Nara 11 kV, Rohri, Sukkur Site, Panu Akil and Ghotki 132 kV 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 quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Nara HPP

The MW/MVAR output of both units of Nara HPP gets back to the pre-fault output quickly after fast damping of the oscillations in its output. However MVAR outputs acquires equilibrium at a slightly different value.

Fig. 2.4 Speed and mechanical power of Generators at Nara HPP

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 Nara HPP 11/0.69 kV Transformer

Followed by clearing of fault, the trip of Nara HPP 11/0.69 kV single transformer causes significant output to flow on the intact second transformer of the plant. 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 Nara HPP, Liberty, Arian Road, Engro Energy, and Foundation-P are plotted relative to machine at Hub 500 kV. The results show that the rotor angle of Nara HPP gets back after the first swing and damps down quickly. Similarly, the rotor angles of other machine 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 11 kV Nara

We applied three-phase fault on far 11 kV bus bar of Nara HPP to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 5 cycles (100 ms) as standard clearing time for 11 kV systems, followed by trip of 11 kV single circuit between Nara 11 kV and Rohri T-1 11 kV. We monitored different quantities for one second pre-fault and nine seconds 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 132 kV bus bars of Nara HPP 0.69 kV, Nara 11 kV, Rohri, Sukkur Site, Panu Akil and Ghotki 132 kV 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 quickly after fault clearance.

Fig. 3.3 MW/MVAR Output of Generators of Nara HPP

The MW/MVAR output of both units of Nara HPP gets back to the pre-fault output quickly after fast damping of the oscillations in its output. However MVAR outputs acquires equilibrium at a slightly different value.

Fig. 3.4 Speed and mechanical power of Generators at Nara HPP

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 Nara to Rohri T-1 11 kV circuit

Followed by clearing of fault, the trip of an 11 kV single circuit from Nara to Rohri T-1 causes significant loading on the intact 11 kV circuit between them. 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 Nara HPP, Liberty, Arian Road, Engro Energy, and Foundation-P are plotted relative to machine at Hub 500 kV. The results show that the rotor angle of Nara HPP gets back after the first swing and damps down quickly. Similarly, the rotor angles of other machine 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 11 kV Nara (Stuck Breaker)

We applied one-phase fault on Nara HPP 11 kV to study the impact of a disturbance in the grid on the performance of the plant. The fault is cleared in 9 cycles (100 ms) as standard clearing time for 11 kV systems, followed by trip of 11 kV single circuit between Nara and Rohri T-1. We monitored different quantities for one second pre-fault and nine seconds 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 132 kV bus bars of Nara HPP 0.69 kV, Nara 11 kV, Rohri, Sukkur Site, Panu Akil and Ghotki 132 kV 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 quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Generators of Nara HPP

The MW/MVAR output of both units of Nara HPP gets back to the pre-fault output quickly after fast damping of the oscillations in its output. However MVAR outputs acquires equilibrium at a slightly different value.

Fig. 4.4 Speed and mechanical power of Generators at Nara HPP

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 Nara to Rohri T-1 11 kV circuit

Followed by clearing of fault, the trip of an 11 kV single circuit from Nara to Rohri T-1 causes significant loading on the intact 11 kV circuit between them. 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 Nara HPP, Liberty, Arian Road, Engro Energy, and Foundation-P are plotted relative to machine at Hub 500 kV. The results show that the rotor angle of Nara HPP gets back after the first swing and damps down quickly. Similarly, the rotor angles of other machine 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.

7.2.5 Fault at 132 kV Rohri

We applied three-phase fault on Rohri 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of a 132 kV single circuit between Rohri and Sukkur Site 132 kV substation. 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. 5.1 Bus Voltages

The bus voltages of 132 kV bus bars of Nara HPP 0.69 kV, Nara 11 kV, Rohri, Sukkur Site, Panu Akil and Ghotki 132 kV are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 5.2 Frequency

We see the system frequency recovers back to normal quickly after fault clearance.

Fig. 5.3 MW/MVAR Output of Generators of Nara HPP

The MW/MVAR output of both units of Nara HPP gets back to the pre-fault output quickly after fast damping of the oscillations in its output. However MVAR outputs acquires equilibrium at a slightly different value.

Fig. 5.4 Speed and mechanical power of Generators at Nara HPP

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. 5.5 MW Flow on Rohri to Sukkur Site 132 kV circuit

Followed by clearing of fault, the trip of a 132 kV single circuit from Rohri to Sukkur Site causes significant output to flow on the intact 132 kV circuit between them. 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. 5.6 Rotor Angles

The rotor angles of the generators of Nara HPP, Liberty, Arian Road, Engro Energy, and Foundation-P are plotted relative to machine at Hub 500 kV. The results show that the rotor angle of Nara HPP gets back after the first swing and damps down quickly. Similarly, the rotor angles of other machine 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 carried out for the planned system of September 2021 show that the system is very strong and stable for the proposed scheme for the severest possible faults of 132 kV systems near to and far of Nara PP under all events of disturbances. Therefore there is no problem of dynamic stability for interconnection of Nara PP; it fulfills all the criteria of dynamic stability.

8. Conclusions

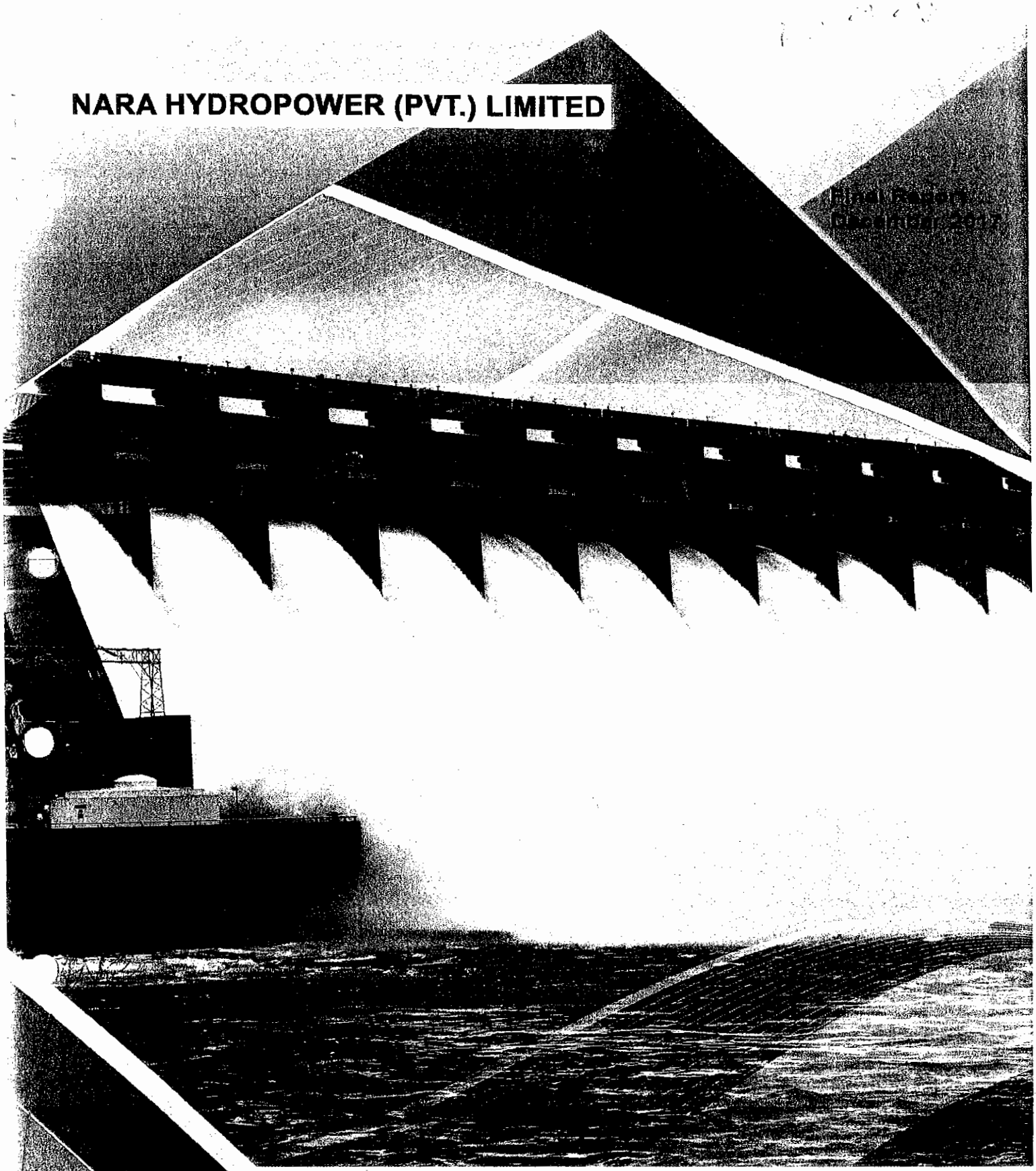
- The study objective, approach and methodology have been described and the plant's data received from the Client is validated.
- The latest generation, transmission plan and load forecast of NTDC has been used for the study.
- The network around Nara Hydro Power Project (referred to as Nara HPP in the remainder of the report) at 132 kV and 11 kV has been modeled as shown in Appendix-B (Sketch-2).
- The nearest grid interconnection facility is Rohri 132/11 kV grid station of SEPCO. The following scheme of interconnection of Nara HPP to evacuate its maximum power of 12.5 MW is envisaged and studied in detail:
  - A direct 11 kV Triple circuit of 7 km using Osprey conductor to be laid from 11 kV Bus Bar of Nara HPP till Rohri 132/11 kV grid station.
  - In this context, three 11 kV breaker bays need to be added in the 11 kV switchgear hall of Rohri 132/11 kV grid station.
- In view of planned COD of Nara HPP in March 2021, the above proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the Peak and Off-Peak conditions of September 2021 for maximum hydropower dispatches. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- In view of planned COD of Nara HPP Steady state analysis by load flow for all the scenarios described above reveals that the proposed scheme is adequate to evacuate the spillover of up to 12.5 MW power of the Plant under normal as well as contingency conditions
- The proposed interconnection scheme has been tested for steady state conditions through detailed load flow studies for the Peak and Off-Peak conditions of September 2021 for maximum hydropower dispatches.
- The short circuit level of the Nara HPP 11 kV is 11.58 kA and 11.09 kA for 3-phase and 1-phase faults respectively for the year 2021. Therefore, to go for standard size switchgear of short circuit rating of 25 kA at 11 kV buses of Nara HPP would

suffice. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

- The dynamic stability analysis of proposed scheme of interconnection has been carried out. The stability check for the worst case of three phase fault right on the 0.69 kV bus bar of Nara HPP substation followed by the final trip of 11/0.69 kV transformer emanating from this substation, has been performed for fault clearing of 5 cycles (100 ms) as understood to be the normal fault clearing time of protection system. Also, the worst case of stuck breaker (breaker failure) has been studied where the fault clearing time is assumed 9 cycles i.e. 180 ms. In all events, 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 Rohri 132 kV bus bar bus bar has also been checked. The proposed scheme successfully passed the dynamic stability checks for near and far faults even 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.

NARA HYDROPOWER (PVT.) LIMITED

Final Report
December 2017



Initial Environmental Examination

NARA HYDROPOWER PROJECT

EMC PAKISTAN PRIVATE LIMITED
EMC

NARA HYDROPOWER (PVT.) LIMITED

Initial Environmental Examination

NARA HYDROPOWER PROJECT

Final Report
December 2017
Ref: IEE/02/12/17

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Disclaimer:

This report has Attorney – Client Privilege. EMC Pakistan Pvt. Ltd has prepared this report in accordance with the information provided by Nara Hydropower (Pvt.) Limited for their sole and specific use. Any other person(s) who use any information contained herein do so at their own risk. This report cannot be used in the court of law for any negotiation or standardization.

Executive Summary

The Initial Environmental Examination (IEE) study of the proposed "Nara Hydropower Project" has been conducted by EMC Pakistan Pvt. Ltd. The proponent of the project is Nara Hydropower (Pvt.) Limited. The IEE of the proposed project has been carried out in the compliance of the mandatory requirement of Section-17 of Sindh Environmental Protection Act (SEPA) 2014 and SEPA (Review of IEE/EIA) regulations 2014.

This IEE Study has, for environmental classification of the Project, taken account of the requirements of the Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014. The Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations, 2014 divides projects in Schedule I, II & III depending upon the severity of environmental impacts. The Nara Hydropower project falls in the category of IEE since it involves construction of run-of-river hydropower plant of less than 50MW capacity. The impacts, if any will be localized within the microenvironment of the project site. Hence, an IEE of the project has been conducted.

The main purpose of the IEE study is to ensure that:

- Any major adverse impact on the environment (physical and ecological) during different stages viz. pre-construction, construction and operation are identified.
- Negative impacts, if any, are appropriately addressed and adequate mitigation measures are suggested for incorporation in the design, construction procedures and operations of project.
- Environmental Management Plan for sustainable development and operation of the project is provided.

The proposed project "Nara Hydropower Project" will be located at RD-26, of Nara Canal, District Sukkur, Sindh province. Location of the proposed project is presented in Figure EX-1.

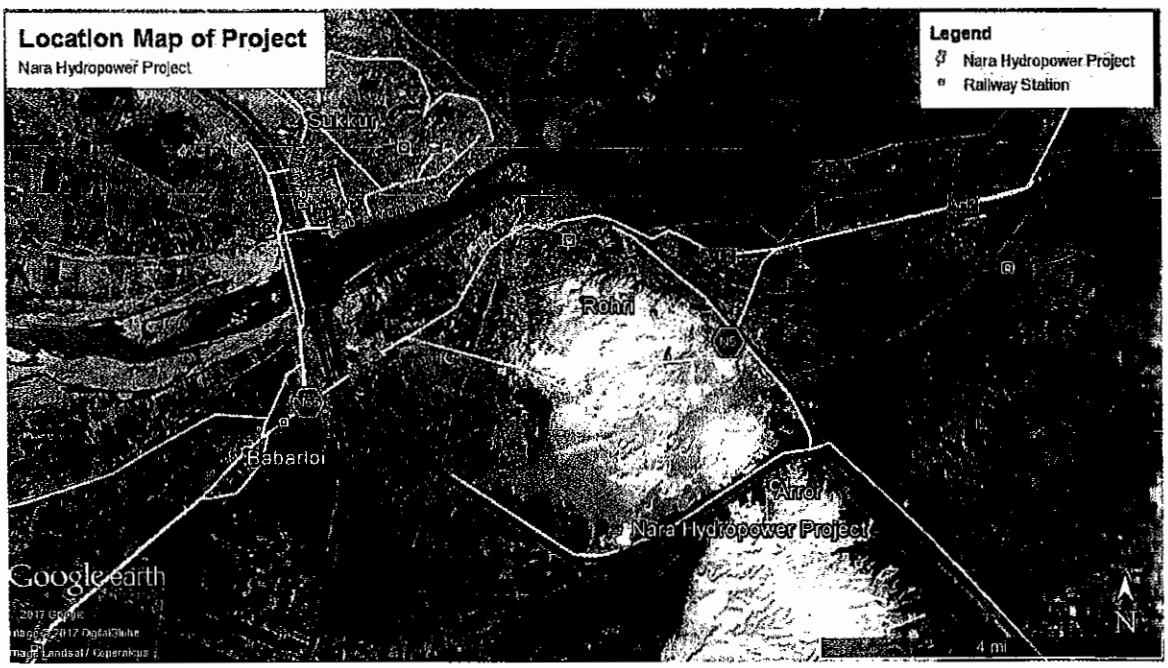


Figure EX-1: Conceptual View of Proposed Project

Saline features of the project is as follows;

Table Ex.1: Salient features of the proposed hydropower project

S. No	Feature	Description
1	Proponent name	Nara Hydropower (Pvt.) Limited
2	Prime objectives	• To respond to the need of reducing the gap between supply and demand of electricity in the country • To exploit the so far untapped potential of Hydropower in Sindh province • To provide sufficient power generation capacity at least cost • To harness electricity from cleaner, renewable energy sources • To generate electricity with minimal environmental footprint
3	Project location with coordinates	RD-26 of the Nara Canal, Sukkur District, Sindh Site Coordinates; 27 37' 50" N, 68 54' 27" E
4	Project area	1.62 acre (estimated)
5	Installed gross capacity	13.65 MW
6	Net power generation	12.9 MW
7	Estimated cost of the project	55 Million USD
8	Type of dam	No dam/reservoir required as the project is Run-of-the-River hydropower plant
9	Impounding river	Nara Canal, which originates from Sukkur Barrage, built on River Indus
10	Specifications of dam, volume of dam	No dam or pondage is involved in the project
11	Details of spillways	Flap gate spillways shall be employed with discharge capacity of about 36 m^3/s per generating unit
12	Hydraulic head	Rated net head of the proposed hydel project is 3.2 m
13	Types and number of turbines	10 Units of Bevel gear Bulb Turbines will be installed
14	Annual energy generation and efficiency	74.8 GWh of Energy will be generated annually. Turbine Efficiency varies from 88% to 93% depending on Head available
15	Details of communities and displacement if any	Project site is an uninhabited land
16	Existing condition of the project site/photographs	Green field; construction work not started
17	Timeline of project implementation	30 Months
18	Design life of the project	50 years
19	Summary of Power evacuation, transmission voltage and Grid interconnection	The generated power shall be evacuated through 0.69/11 kV step-up transformers for subsequent connection and transmission to the National Transmission and Dispatch Company (NTDC) system

The Study has taken into consideration, all the relevant national and provincial legislation, and details of construction and operation activities of the proposed project. Environmental and Socio-economic baseline data has been taken from previous studies of the same area conducted by the EMC Pakistan. The baseline has been further investigated and revalidated using secondary published literature.

The assessment has primarily focused on the pre-construction, construction activities and later on the operations of the proposed project. The major areas covered in impact analysis including, siting of the project, wastewater, solid waste, Indus River Dolphin, Freshwater Turtles and Aquatic life in general, community safety, socioeconomic factors and traffic management.

Mitigation measures are provided and an Environmental Management Plan (EMP) has been developed to assist the management and contractor of the proposed project, in implementation and monitoring of proposed mitigation measures. The project management and subsequent contractor(s) are required to follow the EMP and where necessary EMP shall be amended as per gaps arises.

Based on the findings of the IEE study of the proposed Nara Hydropower Project, it is concluded that the environmental impacts of the construction and operation of project are manageable and can be mitigated by implementing the Environmental Management Plan which forms an integral part of IEE document.

The Study therefore recommends that the Initial Environmental Examination (IEE) report should be approved with the provision that the suggested mitigation measures will be adopted and the Environmental Management Plan will be followed in letter and spirit.

Table of Contents

Annexure

Chapter 1 Introduction

This report presents the Initial Environmental Examination (IEE) Study of the Proposed Project "Nara Hydropower Project", a Run-of-the-River Hydropower plant. The report is being submitted to Sindh Environmental Protection Agency for grant of approval for the construction of the proposed project RD-26 Nara Canal, Sukkur District, Sindh with coordinates 27 37' 50" N, 68 54' 27" E.

The IEE of the proposed project has been carried out in the compliance of the mandatory requirement of Section-17 of Sindh Environmental Protection Act (SEPA) 2014. Compliance with the Provisions of SEPA 2014, Section-17 requires that: "No proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment, and has obtained from the Agency approval in respect thereof."

The compliance of said section requires the submission of IEE of the proposed project to Sindh Environmental Protection Agency for review and approval.

1.1 The Proposed Project

The project is a run-of-the-river hydropower plant which will be construction at RD-26 Nara Canal, District, Sukkur Sindh Province. Nara Canal is an excavated waterway in Sindh province, Pakistan. It was built as an excavated channel off the left bank of the Indus River into the course of the old Nara River. The canal runs from above the Sukkur Barrage through the Khairpur, Sanghar, Mirpurkhas and Tharparkar Districts to the Jamrao Canal. About 2,000,000 acres (8,100 km²) of land are irrigated by this canal.

Gross capacity of the proposed power plant will be 13.65 MW. Net power generation will be 12.9 MW. The plant will not involve the construction of dam, reservoir or pondage. The location coordinates of the proposed plant are 27 37' 50" N, 68 54' 27" E. A drop structure exists at the project site.

Location of power plant site is depicted below;

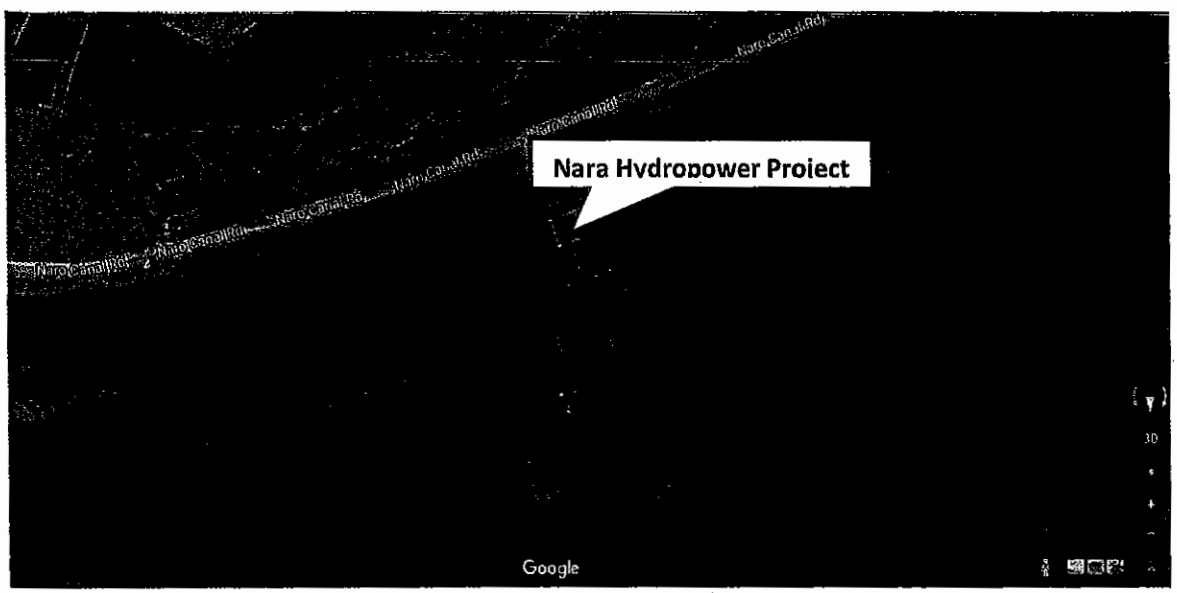


Figure 1.1: Location of the Proposed Project

1.2 Objective of Project

The objectives of the project are given as under:

- To respond to the need of reducing the gap between supply and demand of electricity in the country
- To exploit the so far untapped potential of Hydropower in Sindh province
- To provide sufficient power generation capacity at least cost
- To harness electricity from cleaner, renewable energy sources
- To generate electricity with minimal environmental footprint

1.3 Project Proponent

Nara Hydropower (Pvt.) Limited
CL 5/4 – Statelife Building 10,
Shafi Court, Karachi
T + 92-21 35205532 Ext: 311
F + 92-21-56680533

1.4 IEE Consultant

EMC Pakistan (Pvt.) Ltd.
503, Anum Estate, Opp. Duty Free Shop,
Main Shahrahe Faisal, Karachi
Phones: 9221-4311466, 4311467, Fax: 9221-4311467.
E-Mail: mail@emc.com.pk, nadeem@emc.com.pk
Website: www.emc.com.pk.

1.5 Categorization of Project

The Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations, 2014 divides projects in Schedule I, II & III depending upon the severity of environmental impacts of the project as follows:

Schedule-I: A project falls in Schedule-I if it is likely to have adverse environmental impacts, but of lesser degree and significant and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE report including EMP.

Schedule-II: Projects are categorized in Schedule-II if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through:

a) Areas declared by the Government of Pakistan as environmentally sensitive (National Parks/Sanctuaries/Game Reserves),

b) Areas of the international significance (e.g. protected wetlands as designated by the RAMSAR Convention), or

c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.

Schedule-III: Projects falling in schedule-III are small scale projects with localized and low impacts. These projects require an Environmental Assessment Checklist.

The proposed project is a hydroelelectric power station with the installed capacity of 13.65 MW, which is less than 50MW. Therefore, the proposed project falls in category B (1) of the Schedule I (List of Projects requiring IEE) of the 2014 Regulations, which provides:

B. Energy

1. Hydroelectric power generation less than 50 MW

Hence, an IEE of the project has been conducted.

1.6 Scope & Need of IEE Study

This IEE study aims to:

i) Provide the environmental profile of the microenvironment where proposed project will be located and to assess the impact of its siting on the current physical, ecological and socioeconomic environment, and

ii) Suggest measures in case the severity of negative impact is in contravention of provisions of the Sindh Environmental Protection Act 2014.

The main purpose of the IEE study is to ensure that:

- Any major adverse impact on the environment (physical and ecological) during different stages viz. pre-construction, construction and operation are identified.
- Negative impacts, if any, are appropriately addressed and adequate mitigation measures are suggested for incorporation in the design, construction procedures and operations of project.
- Severity of socioeconomic aspects is identified, and
- Environmental Management Plan for sustainable development and operation of the project is provided.

This IEE report has duly identified the environmental aspects and screened the potential impacts to ensure that the impact of proposed activities pertaining to construction at the site have been carefully assessed and are in accord with the Sindh Environmental Protection Act 2014. This IEE document responds to and is in compliance with Section 17 of Sindh Environmental Protection Act 2014 which requires that:

- Initiation of all activities of each development project in Pakistan has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA), depending on the nature and severity of impacts anticipated on commissioning of the project, and
- Procedures set out in Sindh Environmental Protection Agency (Review of IEE and EIA) Regulations 2014 are followed.

1.7 Methodology for IEE Study

The following methodology has been adopted to prepare the IEE report of the proposed project:

1.7.1 Understanding the Proposed Project

Initially, the information specific to the proposed project was obtained through questionnaire and meetings between the EMC team and proponent of the project.

1.7.2 Site Visit

EMC team conducts site visit to the proposed project to understand the baseline of the project area. The team members gather around the site and carry out a survey to collect the primary environment and social baseline data of the microenvironment of the project. Discussions are also held with surrounding community members to collect area specific information along with their views and concerns regarding the project activities.

1.7.3 Review of Literature

National legislation and environmental guidelines were reviewed to set environmental framework for the proposed project. Information form published and unpublished studies related to the proposed project and project area was reviewed and the information was compiled up in relevance to the physical, biological and social aspect prevailing in the macro environment as well as microenvironment of the project area.

1.7.4 Impact Identification

Identification of environmental aspects and their significance is fundamentally important for determination of severity of incidence of impacts at different stages of the project. This step is aimed at obtaining an inventory of the aspects. The aspects identified during this step cover all activities during construction and operation, in order to determine those which have or can have significant impact on the environment.

1.7.5 Impact Assessment and EMP

Environmental experts at EMC analyzed and assessed the anticipated impacts that are likely to arise due to the identified aspects. Each of the potential impacts identified during the scoping session was evaluated using the environmental, socioeconomic, and project information collected.

Environmental Management Plan was compiled and included in the report to make it more comprehensive and self-sustaining with the specific purpose of providing working guidelines for the project Proponent and Management personnel who shall be responsible for the construction and operations of the project, so as to enable them to maintain the environmental and social conditions in conformity with the SEPA regulations.

The management plan outlines the details required to manage environmental, safety and community risks arising from the project activities as well as social issues. It also gives the details of monitoring that would be required during the operation phase of the project in order to comply with the requirements of sustainable development.

1.7.6 Documentation

This IEE report has been prepared in accordance with the guidelines of the Pakistan Environmental Protection Agency (PEPA) and Sindh Environmental Protection Agency (SEPA). All pre-requisites of report writing in structural format, contents and presentation have been considered and met as per the standard format of the IEE document.

1.8 Organization of IEE Report

This IEE report of proposed Project is compiled up in accordance with the standard format prescribed by the EPA. The report comprises of the following sections:

Section 1 - Introduction to Project and IEE Process
Section 2 - Legal Framework
Section 3 - Project Description
Section 4 - Description of Environment
Section 5 - Screening of Potential Environmental Impacts and Mitigation Measures
Section 6 - Environmental Management Plan (EMP)
Section 7 - Conclusion

1.9 IEE Study Team

The study was carried out by EMC Pakistan Pvt. Ltd. (EMC). EMC organized the following team to carry out the IEE study:

Table 1.1: IEE Study Team

S. No.	Name	Position
1	Mr. Syed Nadeem Arif	Director/Team Lead
2	Mr. Haseeb Zaman	Senior Environmentalist
3	Mr. Syed Shakeel Ahmed	HSE Advisor
4	Mr. Lekhraj Kella	Ecologist
5	Mr. Sohaib Tariq	Environmental Engineer
6	Mr. Hassaan Haseeb	Environmentalist

Chapter 2 Policy, Legal & Administrative Framework

Presented in this section are the Policy, Legal and Administrative Framework of Project in the context of sustainable development. All legal provisions relevant to environmental protection applicable to the planning, construction and operation were identified under the scope of the IEE. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary.

2.1 Administrative Framework

Before the 18th amendment in the Constitution of Pakistan, the environmental issues were governed by three levels of the government viz. Federal, Provincial and Local Government. As a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. The Ministry of Environment at the federal level was abolished. Its functions related to 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. Punjab, Sindh, KPK and Balochistan have enacted their own environmental protection laws.

At Sindh Provincial level, the **Environmental Protection Council (EPC)** has been formed consisting of Chief Minister as Chairman with Minister in charge of Environment Protection Department, Addl. Chief Secretary, Planning & Development Department, Government of Sindh and Secretaries of Environment, Finance, Public Health Engineering, Irrigation, Health, Agriculture, Local Government, Industries, Livestock & Fisheries Forest & Wildlife, Energy, Education Departments Government of Sindh and Divisional Commissioners of Sindh. Non-official members are also included (i.e. representatives of Chamber of Commerce & Industry and from medical or legal professions etc.) along with DG, EPA & two Members of Provincial Assembly also form part of EPC.

The EPC is policy-making body under the provincial environmental legislation scheme. The functions and powers of EPC include coordination & supervision of provisions of Act, approving provincial environmental & sustainable development policies & SEQS, provide guidance for protection & conservation, consider annual Sindh Environmental Report, deal with interprovincial and federal provincial issues, provide guidance for bio safety and assist Federal Government in implementation of various provisions of UN Convention on laws on Seas (UNCLOS).

Sindh Environmental Protection Agency (SEPA) is administrative, implementation and enforcement body. The SEPA is headed by a Director General (DG) with the aim to exercise the powers and perform the functions assigned to it under the provisions of the Sindh Environmental Protection Act, 2014 (SEP-Act, 2014) and the rules and regulations made there under. The SEPA has technical and legal staff and may form advisory committees. It also prepares environmental policies, takes measures for implementation of environmental policies, prepares Sindh Environment Report & prepares or revises Sindh Environmental Quality Standards.

SEPA shall also establish systems and procedures for surveys, surveillance, monitoring, measurement, examination, investigation research, inspection and audit to prevent and control pollution and to estimate the costs of cleaning up pollution and rehabilitating the environment and sustainable development. SEPA would

also take measures for protection of environment such as to promote research; issues licenses for dealing with hazardous substances, certify laboratories, identify need for or initiate legislation, specify safeguards etc. SEPA would also encourage public awareness and education regarding environmental issues.

SEPA has powers to enter or inspect under a search warrant issued by Environmental Protection Tribunal or a Court search at any time, any land or building etc. where there are reasonable grounds to believe that an offence under the Act has been or is being or likely to be committed. SEPA may also take samples, arrange for testing or confiscate any article in discharge of their duties.

This act has also provided for Sindh Sustainable Fund derived from various sources such as voluntary contributions or fees generated etc. This fund is utilized for protection, conservation or improvement of environment. The Act is appendices in this IEE report.

2.2 Statutory Framework

The development of statutory environmental framework has progressively gained ptiority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance 1983 was the first codifying legislation on the issue of environmental protection. This was indeed a consolidated enactment to plug the gaps and remove defects / deficiencies in the legislation. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency, the primary government institution dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which concluded in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The NEQS were established in 1993 and were amended in 1995 and 2000. The Pakistan Environmental Protection Act (PEPA) 1997 was enacted to replace the 1983 Ordinance. PEPA conferred broad-based enforcement powers to the environmental protection agencies. Penalties were prescribed for those contravening the provisions of the Act. The powers of the federal and provincial Environmental Protection Agencies (EPAs) were also considerably enhanced under this legislation and these Agencies have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon registration of a complaint. This was followed by the publication of the Pakistan Environmental Protection Agency Review of IEE-EIA Regulations 2000 which provided the necessary details on the preparation, submission, and review of IEE and EIA. After 18th amendment SEP-Act, 2014 was promulgated and the rules and regulations were made there under.

2.3 Constitutional Provision

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 fourth Schedule. 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 concurrent list has been omitted and this subject is now in the exclusive domain of the provincial government.

- The Ministry of Environment at the federal level was abolished. Its functions related to 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.
- After the enactment of provincial legislation, the PEPA 1997 is technically no longer applicable to the provinces. The provinces are required to enact their own legislation for environmental protection.

As of now, Punjab, Sindh and Balochistan 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 PEPA 1997. Between 1993 and 2010, the Pak-EPA promulgated several rules, regulations, standards, and guidelines to implement the provisions of the PEPA 1997. The provincial governments have yet to draft their own instruments; therefore, rules, regulations, standards, and guidelines made under PEPA 1997 can still be benefited from where these are not made under the provincial law.

SEPA has, however taken lead in finalizing and notifying the Sindh Provincial rules, regulations and standards. The discussion on regulatory requirements applicable to this Project is, therefore, based on the Sindh law, the SEPA 2014, the Regulations; and, the rules, regulations, standards, and guidelines developed under the SEPA 2014.

- On December 16, 2014, SEPA framed the Sindh Environmental Protection Agency (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2014 (2014 Regulations").
- On December 19, 2014, SEPA framed the (i) Environmental Sampling Rules 2014, (ii) Hazardous Substances Rules, 2014, (iii) Sindh Environmental Protection (Composition of Offences and Payment of Administrative Penalty) Rules 2014, (iv) Sindh Environmental Protection Tribunal Rules, 2014, (v) Sindh Hospital Waste Management Rules, 2014, (vi) Sindh Environmental Quality Standards (Certification of Environmental Laboratories) Rules 2014, (vii) Sindh Prohibition of Non-degradable Plastic Products (Manufacturing, Sale and Usage) Rules 2014, (viii) Sindh Sustainable Development Fund (Procedure and Utilization) Rules 2014, and (ix) Sindh Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules 2014.
- On June 28, 2016, the Sindh Environmental Industrial Waste Water, Effluent, Domestic, Sewerage, Industrial Air Emission and Ambient Air, Noise for Vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards, 2015 have been notified.

2.4 Sindh Environmental Protection Act, 2014

The Sindh Environmental Protection Act, 2014 (2014 Act) was passed by the Sindh Assembly on February 24, 2014. The 2014 Act is the basic legislative tool empowering the provincial government to frame regulations for the protection of the environment. The 2014 Act envisages protection, improvement, conservation & rehabilitation of environment of Sindh with the help of legal action against polluters and green awakening of communities. It equally lays emphasis for the preservation of the natural resources of Sindh and to adopt ways and means for restoring the balance in its eco-system by avoiding all types of environmental hazards. The 2014 Act 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. A copy of Sindh Environmental Protection Act, 2014 is attached as **Annexure – I.**

The following articles of the SEPA 2014 have a direct bearing on the proposed Project:

- Article 11(1): 'Subject to the provisions of this Act and the rules and regulations therein, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely cause pollution or adverse environmental effects, as defined in Section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards…'
- Article 11(2): 'All persons, in industrial or commercial or other operations, shall ensure compliance with the Environmental Quality Standards for ambient air, drinking water, noise or any other Standards established under section 6(1)(g)(i); shall maintain monitoring records for such compliances; shall make available these records to the authorized person for inspection; and shall report or communicate the record to the Agency as required under any directions issued, notified or required under any rules and regulations.'
- Article 14 (1): 'Subject to the provisions of this Act and the rules and regulations, no person shall cause any act, deed or any activity', including;
    - (b) disposal of solid and hazardous wastes at unauthorized places as prescribed;
    - (c) dumping of wastes or hazardous substances into coastal waters and inland water bodies; and
    - (d) release of emissions or discharges from industrial or commercial operations as prescribed.
- Article 15 (1): 'Subject to the provisions of this Act, no person shall operate or manufacture a motor vehicle or class of vehicles from which air pollutants or noise are being emitted in an amount, concentration or level which is in excess of the Sindh Environmental Quality Standards or, where applicable, the standards established under sub-clause (i) of clause (g) of sub-section (1) of section 6'.
- Article 17(1): 'No proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment, and has obtained from the Agency approval in respect thereof'
- Article 17(2): The agency shall;
    - a) review the initial environmental examination and accord its approval, subject to such terms and conditions as it may prescribe, or require submission of an environmental impact assessment by the proponent; or
    - (b) review the environmental impact assessment and accord its approval subject to such terms and conditions as it may deem fit to impose or require that the environmental impact assessment be re-submitted after such modifications as may be stipulated or decline approval of the environmental impact assessment as being contrary to environmental objectives.
- Article 17(3): 'Every review of an environment impact assessment shall be carried out with public participation and, subject to the provisions of this Act, after full disclosure of the particulars of the project'.
- Article 17(4): 'The Agency shall communicate its approval or otherwise within a period of two months from the date that the initial environmental examination is filed, and within a period of four months from the date that the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which the initial environmental examination or, as the case may be, the environmental

impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations'.

- Article 20(1): 'The Agency shall from time to time require the person in charge of a project to furnish, within such period as may be specified, an environmental audit or environmental review report or environmental management plan containing a comprehensive appraisal of the environmental aspects of the project'.
- Article 20(2): The report of a project prepared under sub-section (1) shall include:
  a. analysis of the predicted qualitative and quantitative impact of the project as compared to the actual impact;
  b. evaluation of the efficacy of the preventive, mitigation and compensatory measures taken with respect to the project; and
  c. recommendations for further minimizing or mitigating the adverse environmental impact of the project.
- Article 20(3): 'Based on its review of the environmental audit report, the Agency may, after giving the person in charge of the project an opportunity of being heard, direct that specified mitigation and compensatory measures be adopted within a specified time period and may also, where necessary, modify the approval granted by it under section 17'.

2.5 Sindh EPA (Review of IEE and EIA) Regulations 2014

Sindh Environmental Protection Agency (Review of IEE / EIA) Regulations, 2014 ("2014 Regulations") made in exercise of powers conferred under section 37 of the 2014 Act provide the necessary guidelines on the preparation, submission, & review of Initial Environmental Examinations (IEEs) and Environmental Impact Assessments (EIAs). The 2014 Regulations categorize projects in three categories provided in Schedule I (list of projects requiring IEE), II (list of projects requiring EIA) and III (list of projects requiring Environmental Checklist) of the 2014 Regulations. A copy of SEPA (review of IEE/EIA) Regulations, 2014 is attached as **Annexure – II.**

The proposed project falls in category B (1) of the Schedule I (List of Projects requiring IEE) of the 2014 Regulations, which provides:

B. Energy

1. Hydroelectric power generation less than 50 MW

Hence, an IEE of the project has been conducted.

The submission and approval procedure for the IEE is summarized below:

- The IEE report shall be submitted, together with a review fee and form included as Schedule-V of the 2014 Regulations.
- The SEPA shall conduct a preliminary scrutiny and reply within 15 working days of the submittal of the report a) confirming completeness, or b) asking for additional information, if needed, or c) returning the report requiring additional studies, if necessary.

- The SEPA is required to make every effort to complete the IEE review process within two months of the issue of confirmation of completeness.
- The Director-General of SEPA may constitute a Committee of officers from within the Agency for review and may direct the proponent and Firm to present the report before the committee.
- The approval granted at the end of the review process is valid for three years for start of construction.
- Once project construction has been completed, the proponent is required to submit a request to the SEPA for confirmation of compliance. An environmental management plan for the operation phase is to accompany the request.
- The SEPA is required to communicate its decision within four months of receipt of the request. The project can commence operation only after it has received approval from the SEPA.

a. Sindh Environmental Quality Standards

On June 28, 2016, the Sindh Environmental Industrial Waste Water, Effluent, Domestic, Sewerage, Industrial Air Emission and Ambient Air, Noise for Vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards, 2015 have been notified by Sindh EPA. SEQS are attached as Annexure – III of this report.

Table 2.1 shows SEQS for ambient air.

Table 2.1: Sindh Environmental Quality Standard for Ambient Air

Pollutant	Time-weighted average	Concentration in Ambient Air	Method of Measurement
Sulfur Dioxide (SO_2)	Annual Average*	80 µg/m³	Ultraviolet Fluorescence Method
	24 hours**	120 µg/m³	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	40 µg/m³	
Oxides of Nitrogen as (NO_2)	Annual Average*	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	80 µg/m³	
O_3	1 hour	130 µg/m³	Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	360 µg/m³	High volume Sampling, (Average flow rate not less than 1.1 m³/minute)
	24 hours**	500 µg/m³	
Respirable Particulate Matter (PM_{10})	Annual Average*	120 µg/m³	B Ray absorption method
	24 hours**	150 µg/m³	
Respirable Particulate Matter ($PM_{2.5}$)	Annual Average*	40 µg/m³***	B Ray absorption method
	24 hours**	75 µg/m³	
	1 hour	15 µg/m³	
Lead (Pb)	Annual Average*	1 µg/m³	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5 µg/m³	
Carbon Monoxide (CO)	8hours**	5 mg/m³	Non Dispersive Infra Red (NDIR) method
	1hours	10 mg/m³	
*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at			

uniform interval.
**24 hourly / 8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.
*** or 9 μg/m³ plus baseline, whichever is low

Table 2.2 shows the standards for motor vehicle noise.

Table 2.2: The Motor Vehicle Ordinance (1965) and Roles (1969)

Parameter	Standards (maximum permissible limit)	Measuring method
Noise	85dB(A)	Sound-meter at 7.5meter from the source

Table 2.3 shows the proposed national environmental quality standard for noise.

Table 2.3: Sindh Environmental Quality Standard for Noise

S. No.	Category of Area / Zone	Effective from 1st January, 2015 Limit it in dB(A) Leq*	
		Day Time	Night Time
1	Residential area (A)	55	45
2	Commercial area (B)	65	55
3	Industrial area (C)	75	65
4	Silence Zone (D)	50	45
Note: 1	Day time hours: 6.00 a. m to 10.00 p. m		
2	Night time hours: 10.00 p. m to 6.00 a. m		
3	Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.		
4	Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.		
*dB(A)Leq	Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.		

The SEQS for effluents are shown in Table 2.4.

Table 2.4: Sindh Environmental Quality Standard for Municipal & Liquid Industrial Effluents

S. #	Parameter	Into Inland Waters	Into Sewage Treatment	Into Sea	unit
1	Temperature or Temp. increase	<3	<3	<3	°C
2	pH value (H^+)	6-9	6-9	6-9	
3	Biological Oxygen Demand $(BOD)_5$ at 20°C	80	250	80	mg/l
4	Chemical Oxygen Demand (COD)	150	400	400	mg/l
5	Total Suspended Solids (TSS)	200	400	200	mg/l
6	Total Dissolved Solids (TDS)	3500	3500	3500	mg/l
7	Oil and Grease	10	10	10	mg/l
8	Phenolic Compounds (as Phenol)	0.1	0.3	0.3	mg/l
9	Chloride (as Cl^-)	1000	1000	SC	mg/l

10	Fluoride (as F^-)	10	10	10	mg/l
11	Cyanide (as CN^-)total	1.0	1.0	1.0	mg/l
12	An-ionic detergents (as MBAS)	20	20	20	mg/l
13	Sulphate(SO_4^{2-})	600	1000	SC	mg/l
14	Sulphide (S^{2-})	1.0	1.0	1.0	mg/l
15	Ammonia (NH_3)	40	40	40	mg/l
16	Pesticides	0.15	0.15	0.15	mg/l
17	Cadmium	0.1	0.1	0.1	mg/l
18	Chromium (trivalent and hexavalent)	1.0	1.0	1.0	mg/l
19	Copper	1.0	1.0	1.0	mg/l
20	Lead	0.5	0.5	0.5	mg/l
21	Mercury	0.01	0.01	0.01	mg/l
22	Selenium	0.5	0.5	0.5	mg/l
23	Nickel	1.0	1.0	1.0	mg/l
24	Silver	1.0	1.0	1.0	mg/l
25	Total toxic metals	2.0	2.0	2.0	mg/l
26	Zinc	5.0	5.0	5.0	mg/l
27	Arsenic	1.0	1.0	1.0	mg/l
28	Barium	1.5	1.5	1.5	mg/l
29	Iron	8.0	8.0	8.0	mg/l
30	Manganese	1.5	1.5	1.5	mg/l
31	Boron	6.0	6.0	6.0	mg/l
32	Chlorine	1.0	1.0	1.0	mg/l

The SEQS for drinking water are shown in Table 2.5.

Table 2.5: Sindh Environmental Quality Standards for Drinking Waters (mg/l)

S.#	Properties / Parameters	Standard Values for Pakistan	S.#	Properties / Parameters	Standard Values for Pakistan
	Bacterial			Chemical	
1	All water intended for drinking (E.Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml sample		Essential Inorganics (mg/liter)	
			3	Aluminum (Al) mg/l	≤ 0.2
			4	Antimony (Sb)	≤ 0.005
2	Treated water entering the distribution system (Ecoli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	5	Arsenic (As)	≤ 0.05
			6	Barium (Ba)	0.7
			7	Boron (B)	0.3
3	Treated water in the distribution system	Must not be Detectable in any	8	Cadmium (Cd)	0.01
			9	Chloride (Cl-)	< 250

	(E.coli or thermo tolerant coliform and total coliform bacteria)	100 ml sample. In case of large supplies, where sufficient samples are examined, must not be resent in 95% of the samples taken throughout any 12 month period.	10	Chromium (Cr)	≤ 0.05
			11	Copper (Cu)	2
				Organic (mg/L)	
			12	Phenolic compounds	<0.0002
				Toxic Inorganics (mg/liter)	
			13	Cyanide (CN)-	≤ 0.05
			14	Fluoride (F)	≤ 1.5
			15	Lead (Pb)	≤ 0.05
			16	Manganese (Mn)	≤ 0.5
	Physical		17	Mercury (Hg)	≤ 0.001
4	Color	< 15 TCU	18	Nickel (Ni)	≤ 0.02
5	Taste	Non objectionable/ Acceptable	19	Nitrate (NO_3)-	≤ 50
6	Odor	Non objectionable/ Acceptable	20	Nitrite (NO_2)-	≤ 3
7	Turbidity	< 5 NTU	21	Selenium (Se)	≤ 0.01
8	Total Hardness as $CaCO_3$	< 500 mg/l	22	Residual Chlorine	0.2-0.5 At consumer end 0.5-1.5 at source
9	TDS	<1000			
10	pH	6.5-8.5			
	Radioactive				
11	Alpha Emitters bq/L	0.1	23	Zinc (Zn)	5.0
12	Beta emitters	1			

b. National Power Policy, 2013

The Ministry of Water and Power of the Government of Pakistan has developed an ambitious power policy to support the current and future energy needs of the country. This bold strategy will set Pakistan on a trajectory of rapid economic growth and social development. Simultaneously, it will address the key challenges of the power sector in order to provide much needed relief to the citizens of Pakistan. The power policy aims that the country will develop the most efficient and consumer centric power generation, transmission, and distribution system that meets the needs of its population and boosts its economy in a sustainable and affordable manner.

c. Power Generation Policy, 2015

In Pursuant to the decision of Council of Common Interest (the Council) held on 18th March, 2015, the Council approved the Power Generation Policy, 2015, which was subsequently finalized in consultation with all provincial representatives during the meeting of the Inter Provincial Coordination Committee (IPCC) on 31-03-2015 and published in the official Gazette of Pakistan. Main objectives of power policy are:

- To provide sufficient power generation capacity at the least cost
- To encourage and ensure exploitation of indigenous resources
- To ensure that all stakeholders are looked after in the process; a win-win situation
- To be attuned to safeguarding the environment

Scope of the power policy summarized below;

- Private sector power projects
- Public sector power projects, where required by the Project Sponsor
- Public-Private Partnership (PPP) power projects
- Power projects developed by the Public sector and subsequently divested

d. The Sindh Irrigation Act (1879) and the Canal and Drainage Act (1873)

This Sindh Irrigation Act covers the construction, maintenance and regulation of canals for the supply of water and for the levy of rates of water supplied in the Province of Sindh. Canals are defined as channels, pipes and reservoirs constructed and maintained by the Government for the supply for storage of water. Under section 27 of the Act a person desiring to have a supply of water from a canal for purposes other than irrigation shall submit a written application to a Canal Officer who may, with the sanction of the Provincial Government give permission under special conditions. The Act under section 61 also prohibits the damaging, altering, enlarging or obstructing the canals without proper authority.

The Canal and Drainage Act (1873) prohibits corruption or fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses), or obstruction of drainage.

The canals and associated irrigation network exists in the project area and provisions of these acts applies to certain activities like water abstraction by project contractors etc. There is no project activity planned near the canal and associated network which could directly cause physical damage to the canal or alteration in water quality. Any abstraction of water from the canal shall be only done after getting formal approval from the concerned irrigation department.

e. The Forest Act 1927

This act is applicable to all regions of Pakistan. It includes procedures for constituting and managing various types of forests, such as reserved forests and protected forests. The act empowers the provincial forest departments to declare any forest area as reserved or protected and also prohibit the breaking up or clearing of forest for cultivation, grazing, hunting, removing forest produce; quarrying and felling, lopping and topping of trees, branches in reserved and protected forests. It also defines the duties and roles of forest related public servants, and penalties for any infringement of the rules. There is no protected forest located within the IEE project area.

f. Land Acquisition Act, 1894

This Act is a colonial legacy which provides law for the acquisition of land needed for public purposes and for companies. The Act provides complete mechanism for determining the amount of compensation for land, trees, horticulture, to be made on account of such acquisitions. The law provides details of various peculiarities involved in acquisition of land such as preliminary investigation, objection to acquisition, declaration of intended acquisition, enquiry into measurements, value & claims, taking possession, reference to court and procedure thereon, apportionment of compensation, payment, temporary occupation of land, acquisition of land for companies, disputes resolutions, penalties and exemptions, etc. This Act has 55 sections addressing different areas. Section 4(2) of the Act mentions that it shall be lawful for any official authorized by the Collector to enter upon and survey, to dig or to do all other acts necessary to ascertain whether the land is suitable for such purpose.

The land will be acquired by the proponent.

g. Hazardous Substances Rules, 2014

The Hazardous Substances Rules 2014 define the hazardous substances in schedule 1 and make it compulsory for any proponent who is filing an Environmental Assessment to apply for a license for transporting any hazardous substance that it has in its plans. The rules also stipulate a waste management plan to be in place in such a facility holding hazardous materials. Further SEP Act 2014 also requires the proponent to obtain a license to store any such hazardous substance. The proponent is obligated to follow in accordance with the provisions of the act and rules.

h. Laws on protection of Archaeological Sites & Cultural Heritage

i. Antiquities Act, 1975

The act ensures the protection of cultural resources in Pakistan. It is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments etc. The Act prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area, which may contain articles of archaeological significance. The developers are obligated to ensure that no activity is undertaken within 61 m (200 ft) of a protected antiquity, and to report to the GoP's Dept. of Archaeology if any archaeological discovery made during the course of the project.

None of the archeological site exists in the microenvironment of project area.

ii. Guidelines for Sensitive and Critical Area, October 1997

The above guidelines list up a number of areas subject to protection in terms of sensitive ecosystems and archaeological importance. In Appendix II of the Guidelines, a list of eight Archaeological Sites and Monuments, of which four of them are National Monuments, in Karachi is provided. Further, there are 203 sites declared as "Protected Heritage" within Karachi District.

None of such sites however exist within the corridor of impact of the proposed Project.

iii. IFC General EHS Guidelines

The EHS guidelines published by IFC are technical reference documents that address IFC's expectations regarding the industrial pollution management performance of its projects; however, these guidelines have been benefited from for other projects as well. They are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimizing, and controlling EHS impacts during construction, operation, and decommissioning phase of a project or facility.

Environmental issues associated with the construction and maintenance activities may include, among others, noise and vibration, soil erosion, and threats to biodiversity including habitat alteration and impacts to wildlife.

Examples of the impacts addressed in the General EHS Guidelines include:

- Construction site waste generation;
- Soil erosion and sediment control from materials sourcing areas and site preparation activities;
- Fugitive dust & other emissions (e.g. from vehicle traffic, land clearing activities, & materials stockpiles);
- Noise from heavy equipment and truck traffic;

Potential for hazardous materials and oil spills associated with heavy equipment operation and fuelling activities.

Chapter 3 Description of Project

3.1 Project Setting

Nara Hydropower Project is situated at RD-26 of the Nara Canal, District Sukkur, Sindh province. Nara Canal originates from Sukkur Barrage and flows along the left bank of River Indus. Location map of the power project with nearby settlements and structures is depicted below;

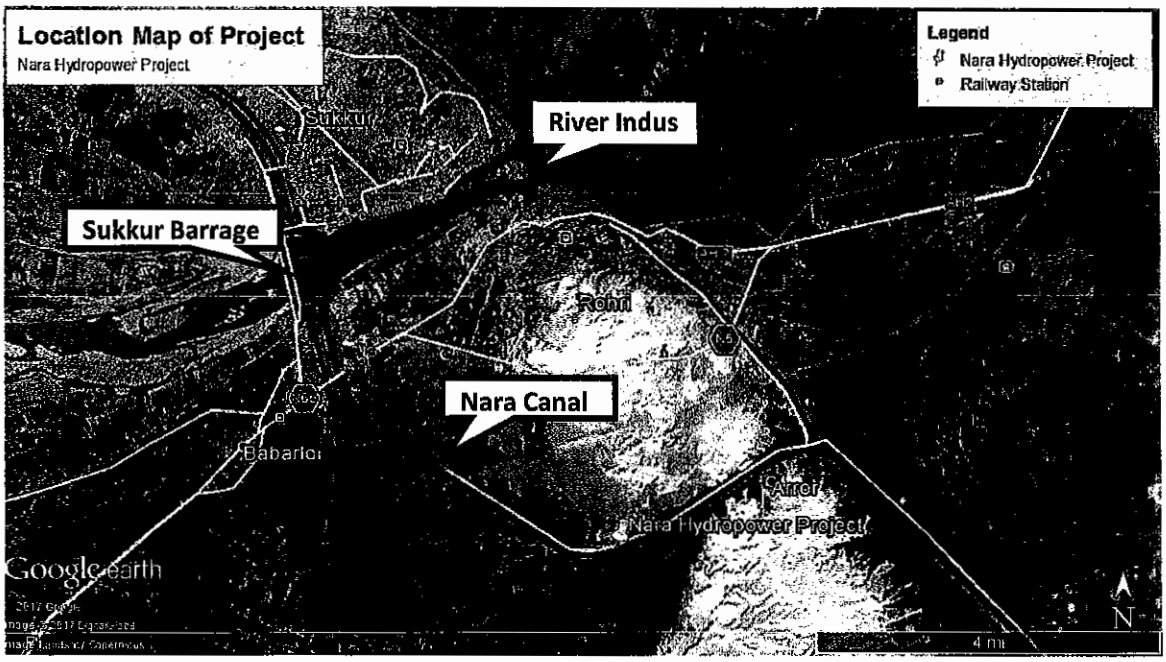


Figure 3.1: Location of Proposed Project

The distance of settlements and major structures from the proposed hydropower plant is given below in the table;

Table 3.1: Location of various settlements and structures from the proposed project site

S. No	Name	Type	Distance from Project (km)	Location from Project
1	Arror	Human settlement	3.2	Arror
2	Muhammad Hassan Khawar	Human settlement	2.0	West
3	Nandhi Patni	Human settlement	3.7	Northwest
4	Janwari	Human settlement	3.7	West
5	Haji Arab Ghanghro	Human settlement	3.8	Southwest
6	Tando Thatti	Human settlement	6.0	Northwest
7	Sukkur city	Human settlement	8.4	Northwest
8	Sukkur Barrage	Barrage	7.8	Northwest
9	Rohri	Human settlement	5.0	North
10	Rohri Railway station	Railway station	5.2	North
11	Babarloi	Human settlement	7.2	Northwest
12	N5	Highway	5.9	Northwest
13	N65	Highway	6.5	Northwest

3.2 The Project

The proposed project involves the construction of a Run-of-the-river Hydropower of the total gross capacity of 13.65 MW on RD-26 of the Nara Canal, District Sukkur, Sindh. Net power generation will be 12.9 MW.

Salient features of the proposed project are summarized below in the table;

Table 3.1: Salient features of the proposed hydropower project

S. No	Feature	Description
1	Proponent name	Nara Hydropower (Pvt.) Limited
2	Prime objectives	• To respond to the need of reducing the gap between supply and demand of electricity in the country • To exploit the so far untapped potential of Hydropower in Sindh province • To provide sufficient power generation capacity at least cost • To harness electricity from cleaner, renewable energy sources • To generate electricity with minimal environmental footprint
3	Project location with coordinates	RD-26 of the Nara Canal, Sukkur District, Sindh Site Coordinates; 27 37' 50" N, 68 54' 27" E
4	Project area	1.62 acre (estimated)
5	Installed gross capacity	13.65 MW
6	Net power generation	12.9 MW
7	Estimated cost of the project	55 Million USD
8	Type of dam	No dam/reservoir required as the project is Run-of-the-River hydropower plant
9	Impounding river	Nara Canal, which originates from Sukkur Barrage, built on River Indus
10	Specifications of dam, volume of dam	No dam or pondage is involved in the project
11	Details of spillways	Flap gate spillways shall be employed with discharge capacity of about 36 m^3/s per generating unit
12	Hydraulic head	Rated net head of the proposed hydel project is 3.2 m
13	Types and number of turbines	10 Units of Bevel gear Bulb Turbines will be installed
14	Annual energy generation and efficiency	74.8 GWh of Energy will be generated annually. Turbine Efficiency varies from 88% to 93% depending on Head available
15	Details of communities and displacement if any	Project site is an uninhabited land
16	Existing condition of the project site/photographs	Green field; construction work not started

Table 3.1: Salient features of the proposed hydropower project		
17	Timeline of project implementation	30 Months
18	Design life of the project	50 years
19	Summary of Power evacuation, transmission voltage and Grid interconnection	The generated power shall be evacuated through 0.69/11 kV step-up transformers for subsequent connection and transmission to the National Transmission and Dispatch Company (NTDC) system

Location of project and estimated project area is depicted below;

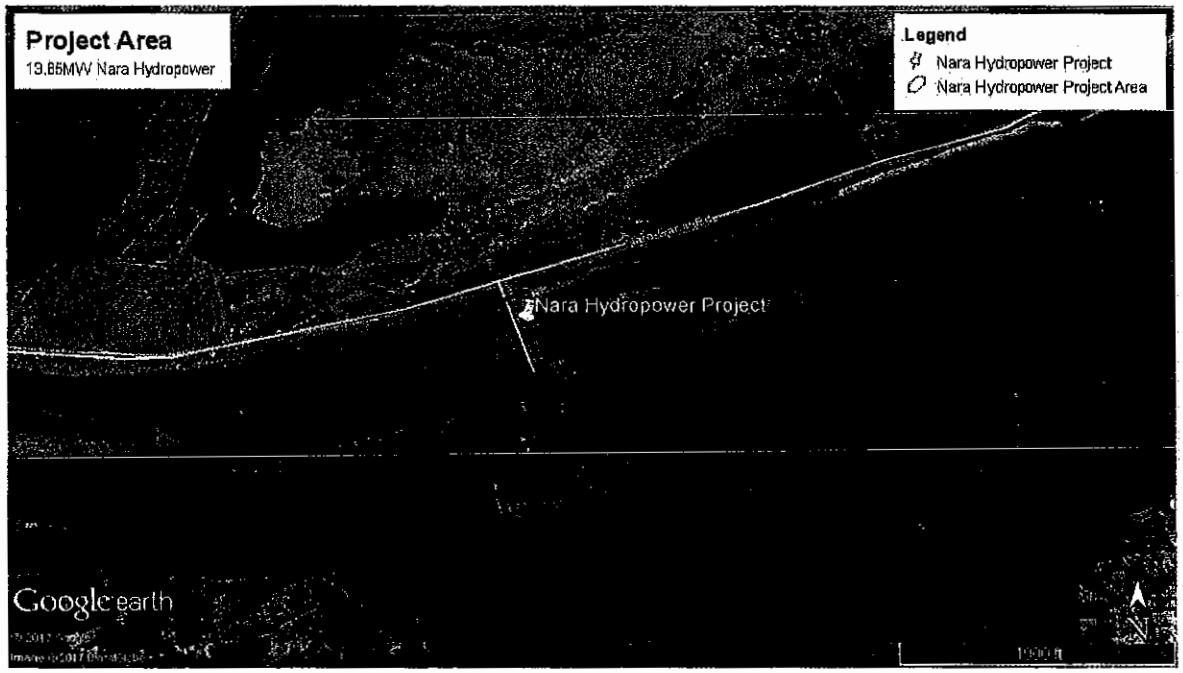


Fig 3.1: Project location and area

The project site is accessible through Nara Canal Road from north. Nara Canal has fall on RD-26, which is considered as suitable for small hydel power generating units. The power station will be developed at the canal drop structure location. Project works will be carried out during the canal closure periods and during the low flow periods.

Location of various components of the proposed project is depicted below. Main components are weir, turbine & generator units and power evacuation unit.

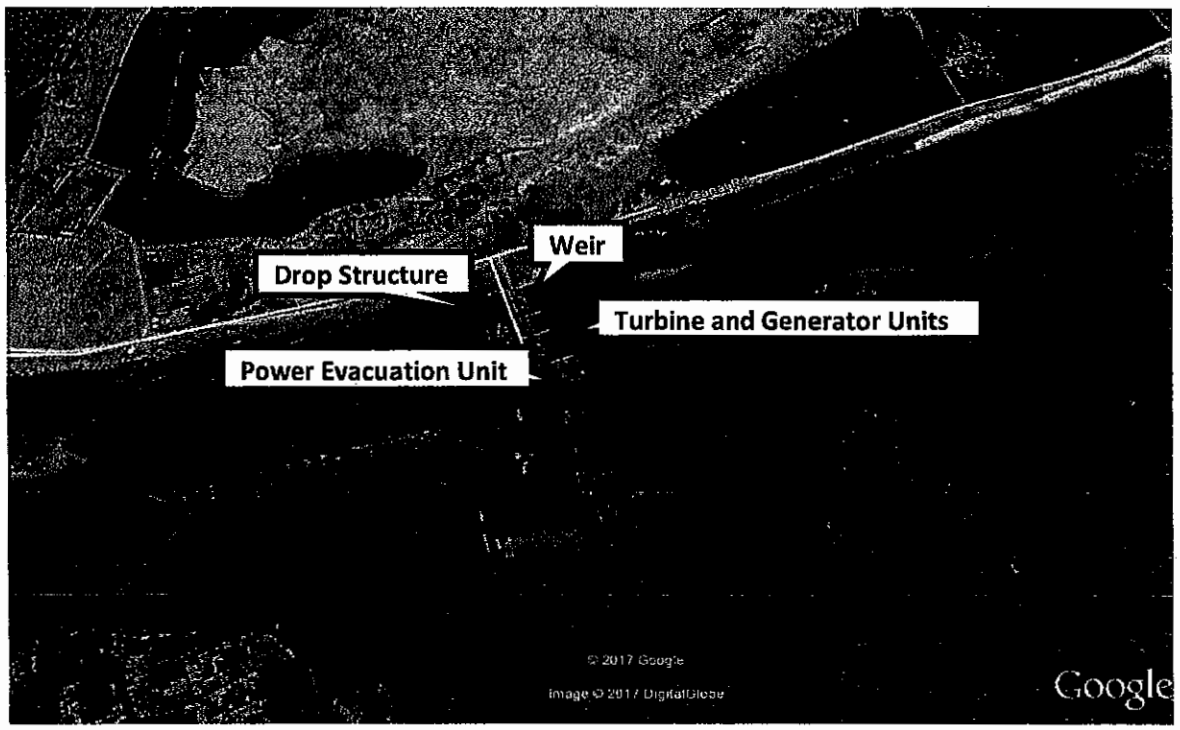


Fig 3.2: Main components of the project

Peak flow rate of Nara Canal during the irrigation season is about 569 m3/s. Mean annual flow is 295 m3/s. The potential for the Nara Canal Project was identified in an earlier project ranking study, which was prepared by consultants W.S. Atkins in 2012.

Flow into the canal is control by a Head Regulator that was constructed as part of the Sukkur Barrage works. The Nara Canal is one of the three canals on the left bank of the Indus at Sukkur. At the Head Regulator the Nara Canal is immediately adjacent to the Rohri Canal and a smaller canal located between the two larger waterways.

The gradient of the canal after construction of the fall at the proposed power station location is reported as 1:8,125. The canal profile has evolved due to the effects of sedimentation and erosion. The existing canal from the regulator to the RD-26 drop is reported to have a bed width of 84.43 m (277 ft.) and a slope of 1:8,125. The canal is designed for a flow rate of 13,602 ft3/s. The bed level varies from el 174.40 ft. downstream from the regulator to 171.2 ft. at the drop structure. The working water depth is believed to be about 10.5 ft. The water level at the upstream end is understood to be el 194.5 ft.

The nominal canal gradient downstream from the fall is 1:15,140. The bed level at the downstream from the fall is el 169.0 giving a fall height of about 2.2 ft. The existing information suggests an available head of about 0.3 m without any changes to the canal profile. The water level upstream from the Head Regulator is controlled by the Sukkur Barrage.

The shoreline of the canal is utilized for housing and small industrial enterprises along much of the reach from the Head Regulator downstream past the proposed power station location.

The encroachments appear to be located outside of the existing canal dike and should not affect the modifications to the canal for the proposed operation of the power station. The major highway crossing is

located at about 1500 m from the Regulator as for the Rohri Canal. The level of this bridge will not affect the design or operation of the proposed power station.

Site Layout

The powerhouse structure will be located adjacent to the existing canal drop structure in the abandoned reach of canal. The powerhouse will be located in the canal reach. The existing canal dikes will be extended to the inlet to the powerhouse and will transition to vertical approach channel walls. The inlet channel to the powerhouse will slope to the inlet of the structure and will be lined with a concrete apron. Similarly, the outlet channel will slope from the end of the draft tube to the canal invert. The outlet structure will have a trapezoidal cross section with concrete lining from the draft tube to the canal invert.

A control building will be located at the end of the powerhouse adjacent to the switchyard that will connect to the transmission lines.

Powerhouse Layout

A bevel gear Bulb Turbine arrangement was selected after the consultation with the proposed turbine supplier (Andritz Hydro). The turbines will have a horizontal axis and double regulated Kaplan type runners. These turbines will allow for a compact powerhouse structure suited for the high flow rates required in the canals. The bevel gear arrangement allows the generator to be placed with a vertical axis and to be situated above the turbine. The gearing arrangement also allows for a speed increaser that reduces the size of the generator.

Powerhouse was designed for a turbine with runner diameter of 2.6 m and rotational speed of 162 rpm. The rated head for the selected turbine prototype is 3.2 m and the rated flow per generating unit is 50 m^3/s. The actual turbine performance will depend on the water levels upstream from the Sukkur Barrage and the flow rate through the canals. The Nara site will have 10 generating units. All units will be of the same design to allow for economy during manufacture, installation, and operations and maintenance.

The powerhouse will house the generating units along with associated auxiliary equipment. An erection bay area will be included at the end of the powerhouse. An overhead traveling crane will be provided for initial installation of the equipment and for maintenance.

The powerhouse structure will be arranged by allowing for flow over top of the powerhouse with control by flap gates. The gates could be adjusted to supplement the flow through the power station during high flow conditions. The gates would also open rapidly in the event of a power system load rejection so that the flow rate along the canal would not be disrupted. During conditions when the power station cannot operate (e.g. when the maximum head limit is exceeded) the canal flow will be discharged entirely by the flap gates.

Control of the flow in the canal will be at the power station rather than at the Head Regulator to allow for the highest possible generating head. The flow rate in the canal can be automatically regulated by the power station control system in response to specified demands for irrigation systems downstream. The Head Regulator operating policy will be adjusted so that the water level in the canals is equal to the level in the Indus at the Sukkur Barrage but with the gates used so that the maximum water level at the upstream end of the canals is at el 60.96 m.

The maximum static water level upstream will be at el 60.96 m (el 200 ft), which will correspond with the highest level upstream from the Sukkur Barrage before the Head Regulator gates must be partially closed for flood protection.

Dewatering of the foundation excavation will be required to allow construction work to be carried out in the dry. Details of the dewatering scheme will be determined by the Contractor but is expected to include a three-stage approach. The first stage would consist of excavation to the top of the groundwater table. Tube wells would be installed to allow excavation to continue to a second stage level. A slurry wall or sheet pile wall will be installed to reduce seepage into the excavation. Additional tube wells would be installed to control seepage pressures at the ground surface.

The after bay will be concrete lined to prevent foundation scour or migration of sediment into the draft tube. The approach channel to the intake would slope down from the canal bed level to the inlet elevation. The turbines will be arranged with a horizontal axis set below the minimum water level for the power station. A minimum level at el 55 m was selected for both stations based on a review of the water levels computed as described in Section 8. The turbine centerline is set at about 6.5 m below the tailwater level.

Spillway Facilities

Flap gates will be installed on the top of each generating unit in the powerhouse, as illustrated in Appendix A. The flap gates will be used to discharge flow in excess of the generating unit capacity and in the event of an outage at the plant. The gates will open rapidly following a change in the load on the power station so as to prevent the formation of open channel surges along the canal upstream.

The proposed flap gate spillways will provide a discharge capacity of about 36 m3/s per generating unit with the water level at the maximum static level (el 60.96 m). During a load rejection for any of the units, the gates can be opened to maintain the water level upstream from the powerhouse. The sill level for the spillways will be at el 58.68 m and the crest will function as a broad crested weir when the gates are fully retracted.

The discharge capacity of the powerhouse spillway will vary depending on the upstream water level as illustrated in Figure. The spillway will be effective for management of surge conditions following unit shut down by opening gates to compensate for the unit going off line. During a full load shut down, a transient wave would be created that would be mitigated by the operation of the gates to discharge part of the original flow rate.

However, the capacity of the spillway will be less than the flow rate in the canal for many conditions with the water level upstream of the Sukkur Barrage below the maximum control level. The average water level upstream of Sukkur Barrage is at el 59.94 m, which will provide for a spillway flow capacity of only about 149 m3/s at Nara.

The capacity of the spillway emphasizes the importance of the power station to maintain the flow rate to the irrigation areas. Normal operation of the facility will require that the generating units are functioning to provide the flow rate satisfying the irrigation demand. The spillway will operate to supplement the power station discharge but would not be sufficient to pass the full flow rate in the canal system.

An auxiliary spillway would be required if the irrigation canal system were required to operate independently of the power stations.

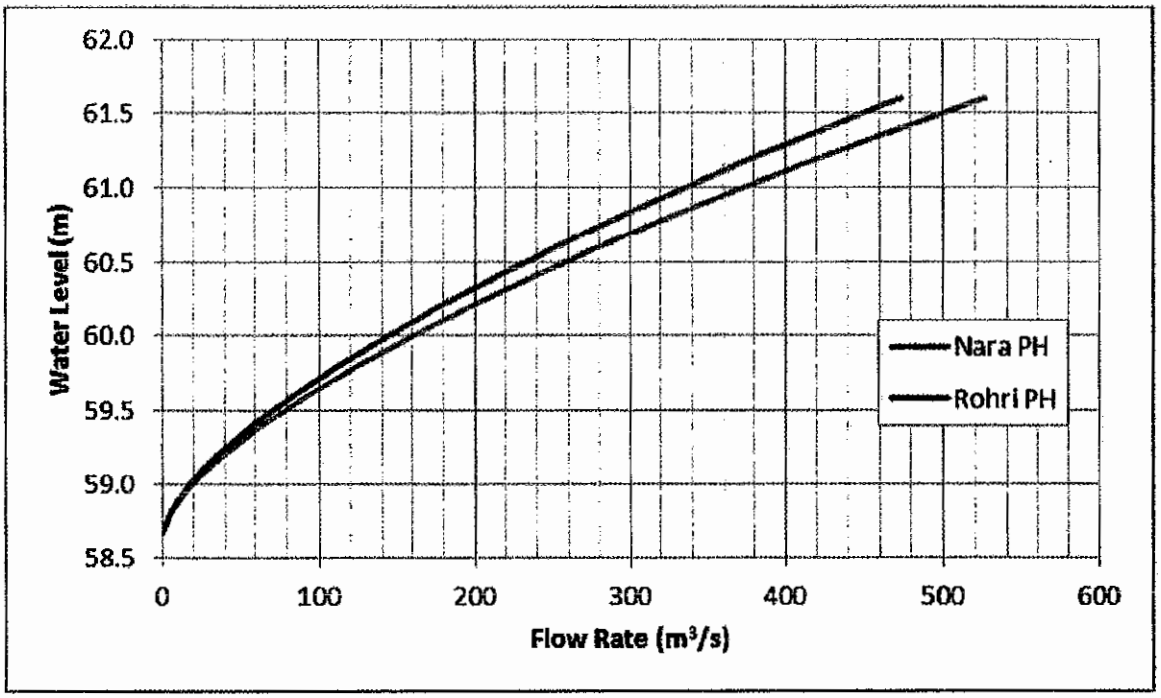


Fig 3.3: Spillway discharge capacity

Canal Dikes

Dikes must be constructed along the canals upstream from the power stations. The maximum static water level is assumed to be at el 60.96 m, corresponding to the maximum level for operation of the power station. A freeboard of 1.0 m is included from this maximum water level to the crest of the dikes to allow for open channel transients following plant load rejection.

The dikes will be constructed as homogeneous earthfill embankments with a slope of 2H:1V. The height of the dikes varies along the canal with a maximum height of about 4.5 m for the Nara Canal. The height of the dikes is estimated from the available cross section surveys. However, in some locations it is not clear whether the ground level rises above the maximum elevation in the cross section. In these cases, a dike has been estimated based on the elevation at the end of the cross section.

A nominal crest width of 3.0 m has been assumed to allow for an access track along the dike. The typical cross section will include 30 cm of stone pitching overlying a 150 mm thick transition filter of 12 to 50 mm gravel, and a 150 mm thick base filter of 3 to 12 mm gravel. The pitching will extend over the top of the dike slope with a 0.6 m horizontal surface. The slope protection will be blended into the existing slope protection along the canal.

Existing Canal Drop Structure Closure

The existing canal drop structure will be permanently closed as part of the power project. The closure will be accomplished by placing an embankment across the canal immediately upstream from the drop structure during the January canal outage.

The embankment will be designed as a homogenous earth fill founded on the existing canal bed. The crest elevation will be the same as the dike bank levels and will accommodate open channel transient conditions from power station operations.

The downstream slope of the embankment will be protected by turf. The upstream slope will be covered with stone pitching founded on filter layer. The existing structure can be left in their present condition and not demolished. This structure will no longer have any purpose for the operation of the canal.

Transmission Line Connection

The maximum power plant generation capacity at peak will be about 13 MW at Nara HPP. Each power station will transform the voltage to 11 kV for connection to the national grid system.

Energy Yield

Estimated energy yield from the hydropower project is as follows;

S. No	Parameter	Nara Hydropower
1	Generating Units	10
2	Annual Energy Generation (GWh)	74.8
3	Maximum Power (MW)	12.9

The above analysis includes all power station efficiencies as well as auxiliary consumption in the power station. The energy yield does not allow for any transmission system losses from the site to the national grid.

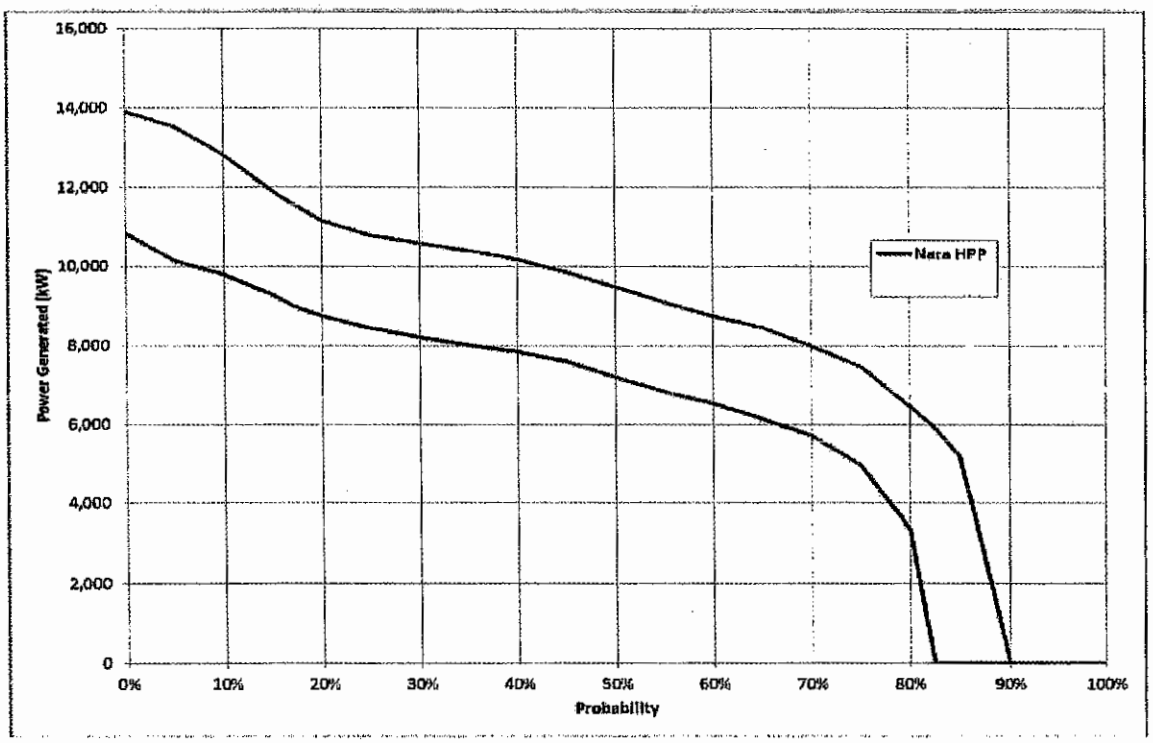


Fig 3.4: Power duration curve

3.3 Overview of Hydropower

Hydropower is considered a renewable form of energy because it is based on solar energy that drives the hydrologic cycle. The hydrologic cycle refers to the following process: the sun heats water (about 97 percent from oceans); water evaporates; rising air currents transport water vapors to the upper atmosphere where

lower temperatures condense vapors into clouds. Air currents move the clouds around the globe and eventually, water falls as precipitation. Through this process, water can reach altitudes higher than sea level.

Gravity causes water to descend from higher elevations creating opportunities to harness water energy—gravitational energy from falling water and kinetic energy from flowing water. The amount of kinetic energy available from water flow depends on the height from which the water drops, the angle of the slope, and the volume of water per unit of time, i.e., the discharge.

The energy of flowing water is harnessed by turbines, which are placed in the path of the water flow. The force exerted by water moving over turbine blades rotates the turbine runner; the turbine runner rotates the generator, which produces electricity.

Compared with other technologies, the most important advantages of hydropower are the following:

- Hydropower generation is based on a reliable proven technology that has been around for more than a century and hydropower plants can be easily rehabilitated or upgraded utilizing recent advances in hydro technologies.
- Hydropower generation is renewable because it does not reduce the water resources it uses and does not require fuel.
- In most cases, hydropower is an economically competitive renewable source of energy. The levelized cost of electricity (LCOE) is usually in the range of US$0.05 to US$0.10 per kWh [Energy Information Administration, US, 2010]. Rehabilitating or upgrading existing hydropower schemes provides opportunities for cost-effective capacity increases.
- Hydropower exploits domestic water resources, thereby achieving price stability by avoiding market fluctuations.
- Storage hydropower schemes (dams, pumped storage) offer operational flexibility because they can be easily ramped up or shut down, creating potential for immediate response to fluctuations in electricity demand. Thus storage hydro are valuable to meet peak demand or to compensate for other plants in the grid (especially solar and wind), which can experience sudden fluctuations in power output.
- The creation of reservoirs also allows water to be stored for drinking or irrigation, reducing human vulnerability to droughts. Reservoirs can provide flood protection, and can improve waterway transport capacity. Further, HPPs with reservoirs can generate energy during dry periods and regulate fluctuations in the energy supply network by using the stored water.
- Environmental impacts triggered by implementing hydropower schemes are well known and manageable.

Disadvantages of hydropower include the following:

- High up-front investment costs compared to other technologies, such as thermal power (but low operational costs since no fuel is required).
- Reservoirs may have a negative impact on the inundated area, damage river flora and fauna, or disrupt river uses such as navigation. However, most negative impacts can be mitigated through project design.

3.3.1 Design and Types

Hydropower can be generated wherever a flow of water descends from a higher level to a lower level. The difference between the two water surface elevations is referred to as head. Head can exist in nature, for instance when a stream runs down a steep hillside or when a sharp change in elevation creates a waterfall in a river. However, head can also be created artificially by constructing a weir or dam; the dam creates a barrier to water flow, raising the upstream water level to the desired elevation.

As a result of elevation differences gravitational potential energy is stored in the water; this energy can be exploited by installing turbines and generators. Water flow moves the turbine blades, thereby converting water's potential energy into kinetic energy. The turbine rotation forces the generator rotator to spin around the stator thereby converting kinetic energy first to mechanical energy, and then to electrical energy.

Each hydropower plant is site-specific, but plants can be classified according to the following parameters:

- Size or installed capacity
- Head availability
- Operation regime
- Purpose of plant structures

Classification by Size

HPPs are commonly classified based on installed capacity P (MW). Opinions vary on the threshold that separates individual classes. HPPs are also classified based on dam head. The classification that follows is approximate but widely accepted; criteria vary among different countries.

1. Micro $P < 0.1$ MW
2. Small $0.1 \text{ MW} < P < 10$ MW (some countries go up to 30-35 MW)
3. Medium $10 \text{ MW} < P < 100$ MW
4. Large $P > 100$ MW

1. Micro hydropower projects can supply electricity for an isolated industry, or small remote community. Usually, micro HPPs are stand-alone, i.e., they are not connected to the grid, and they are always run-of-river type. Small water storage tanks are sometimes constructed so that hydro generation is guaranteed for minimum period per day, even during low-water flow conditions. Micro hydropower schemes are commonly encountered in rural areas of developing countries where they provide an economical energy source without fuel dependency.
2. Small HPPs are dimensioned considerably smaller than medium and large HPPs because small HPPs usually exploit low discharges. Most small HPPs are run-of-river type that are connected to the power grid.
3. Medium hydropower schemes are either of the run-of river or storage type and they almost always feed into a grid. Their layout may include a dam to create a head pond. The E&M equipment is similar to that of large hydropower schemes.

4. Large hydropower schemes are always connected to a large grid; large HPPs can be run-of-river or storage type; each layout is site-specific and each plant's E&M equipment is designed for local needs and conditions.

Classification by Head size

Depending on the head being exploited for electricity production, HPP schemes are divided into the following categories:

1. High head: H > 100 m
2. Medium head: 30 m < H < 100 m
3. Low head: H < 30 m

Classification by Operation

HPP schemes can be classified according to the type of operation as follows:

1. Run-of-river schemes
2. Storage schemes
3. Pump storage schemes

1. *Run-of-river schemes* generate electricity by immediate use of the inflow. As a result, run-of-river HPPs are subject to weather and seasonal variations resulting in variable power generation. Most run-of-river schemes have no storage capacity, or limited storage, which limits peak power operation to a few hours.
2. *Storage schemes* are characterized by water impoundment upstream of a dam structure to create a reservoir in which water is predominantly stored during high-flow periods and consumed for energy production during low-flow periods. Using stored water for the inflow to generate energy creates some security against natural fluctuations in water availability caused by weather and seasonal variations. Reservoir size determines the level of flow regulation.
3. *Pumped storage plants* are HPPs that can store water by pumping it from a lower reservoir or a river to a higher reservoir. Water is pumped during off-peak hours (lower power demand/ lower priced supply) by reversing turbine operation to make more water available to generate electricity during peak demand periods. This process creates efficiencies of up to 80 percent—pumping uses 20 percent or more energy than the energy that is generated when an equal amount of water is released to generate electricity through the HPP.

Classification by Purpose

Multi-purpose schemes provide water for other uses for human subsistence and development. About one-third of existing hydropower projects serve other functions in addition to energy generation (LeCornu 1998).

The additional functions of HPP schemes may include the following:

- *Flood protection*: water storage reduces the impact of floods.

- *Drought mitigation*: supplement irrigation and community water supplies during dry periods.
- *Irrigation*: water for agriculture.
- *Water supply*: reservoir provides community water supply.
- *Improved conditions*: raising the water level in a reservoir improves conditions for navigation, fishing, tourism and recreation.

3.3.2 Site Layouts

Local topography, hydrology and geology characteristics vary widely, which is why hydropower scheme layouts must be developed for each site in accordance with given natural conditions. In addition, each location has unique environmental and social conditions that affect hydropower facility layout and design. Therefore, each HPP layout aims to optimize the position of individual scheme components to fully exploit the natural resources of available head and stream flow in the most efficient manner—technically, economically and financially.

One task in the design of HPP scheme layouts involves positioning the powerhouse relative to headworks used for water diversion from the river course. In general, two options exist:

- Locate the powerhouse structure adjacent to the headworks
- Construct a diversion scheme so the powerhouse is built in a remote location downstream of the headworks to exploit a higher head. If the river channel below the dam has an appreciable fall, economic studies should be made to determine whether a remote powerhouse location downstream from the dam is justifiable.

Existing topographical and geological conditions determine the length and the type of structures used to divert power water from river to powerhouse.

3.3.3 Components of Hydropower Schemes

HPP scheme components can be grouped as follows:

- Civil works
- Headworks
- Waterway
- Powerhouse and tailrace
- Electromechanical equipment
- Hydraulic steel structures
- Grid connection facilities

Civil Structures

The civil structures that comprise a HPP scheme can be grouped as follows:

- *Headworks*: creates head, extracts water from the river course toward the generating equipment and allows safe passage of flood flows

- *Waterway*: conveys water to powerhouse
- *Powerhouse*: comprises structures to accommodate electromechanical equipment that converts water energy, first into mechanical and then into electrical energy
- *Tailrace*: discharges turbine water into a receiver, a river, lake or ocean
- *Auxiliary structures*: protect HPP scheme from potential risks such as turbine abrasion, sediment deposition in the waterways, and riverbed erosion downstream of the headworks

Electromechanical Equipment

Turbines: Hydro turbines can be grouped according to the head that they exploit to harvest hydropower, and their mode of operation.

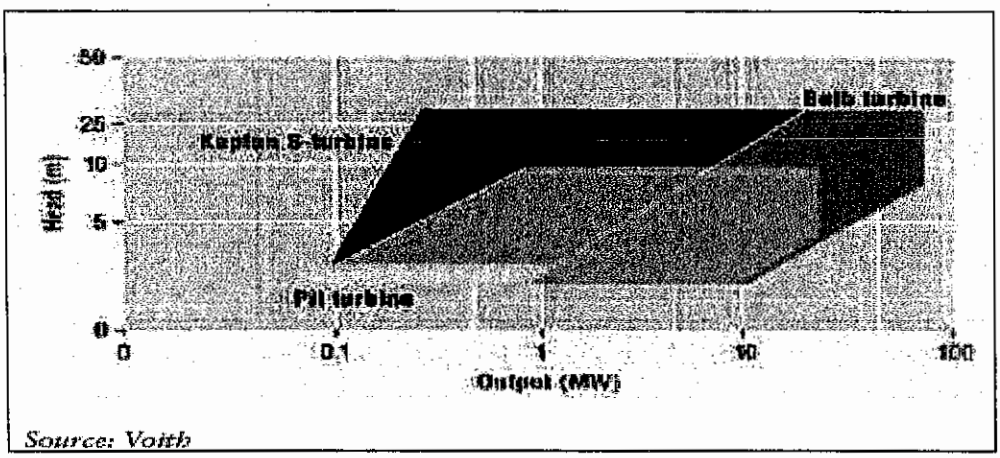
A rough classification according to the available head (H) appears below:

- Turbines appropriate for low head H < 10 m
- Turbines appropriate for medium head 50 m < H < 10 m
- Turbines appropriate for high head H > 100 m

Another common classification of hydro turbines is based on their principle of operation—impulse or reaction type—that describes how the turbine transforms potential water energy into rotational mechanical energy.

The rotor of the reaction turbine is fully immersed in water and is enclosed in a pressure casing. The runner blades are profiled so that pressure differences across them impose lift forces, just as on aircraft wings, which cause the runner to rotate. Two main types of reaction turbine are the propeller (with Kaplan variant) and Francis turbines.

In contrast, an impulse turbine runner operates in air, driven by a jet (or jets) of water. Three main types of impulse turbine are in use: the Pelton, the Turgo, and the Crossflow.



Source: Voith

Fig 3.5: Application range of bulb design turbines

Generator: The generator transforms mechanical energy into electrical energy using an excitation system. Depending on required runner speed and power station characteristics, the generator types are classified as follows:

- Horizontal and vertical hydro generators are classified by their axis locations. Usually, large and medium-sized units adopt a vertical layout; medium and small-capacity units adopt horizontal layouts.
- Brushless excitation generator and excitation with brush generator
- Synchronous generators are equipped with a DC electric or permanent magnet excitation system associated with a voltage regulator that controls output voltage before the generator is connected to the grid. Synchronous generator excitation is independent of the grid so synchronous generators can produce power even without grid connection. Asynchronous generators are unable to regulate voltage output and run at a speed related to system frequency; if isolated from the grid they cannot produce power because their excitation current comes from the grid.

Typical generator efficiency in SHPP installation schemes increases with rated power. For very small units (e.g., 10 kW) efficiency can be close to 90 percent; for larger capacities (> 1 MW) efficiency approaches 98 percent.

Hydraulic Steel Structures

Hydraulic steel structures are installed in HPP schemes to control water flow using gates or valves and are classified according to their operational purpose.

Service gates for continuous flow regulation in the waterway or of the water level in the reservoir include spillway gates, bottom outlet gates, and lock gates (for navigation).

Emergency gates are used to shut down water flow in conduits or open channels; typically they are designed only to be fully open or fully closed and they include intake gates, gates upstream of penstock service valves, draft tube gates, and gates installed upstream of bottom outlet gates

Maintenance gates are used to empty the conduit or canal for equipment maintenance (turbines, pumps or other gates); the most common type is the stoplog gate.

Distributor vanes or turbine needle valves are used for flow regulation.

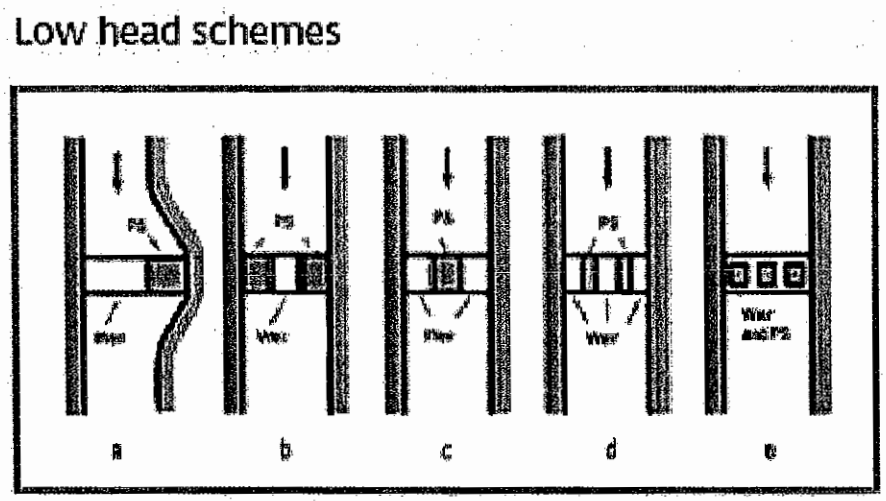
Trash racks (or screens) are nearly always required at pressure pipes entrances and intakes to prevent floating debris from entering.

Grid Connection

Before generated energy is transmitted through the grid, stepup transformers increase the voltage to reduce energy losses in the lines. Generated electricity is transmitted to a gridconnection point where electricity is converted to the voltage of the distribution network. In remote areas, new transmission lines can pose considerable planning hurdles and costs; it is easier and more economical to locate an HPP scheme closer to loads or existing transmission lines.

3.4 Overview of Run-of-the-river Hydropower

Run of River hydroelectric projects employ the natural elevation gradient of a flowing body of water to generate electricity. Water is diverted from the main channel through a series of pipes that eventually turns turbines in a power plant before returning to the river downstream. This is a method of energy generation that is low impact on all three prongs: economic, social, and environmental. There are limited storage reservoirs and large dams are not required for a project of this nature.



Note: PS = Powerstation

Fig 3.6: Low head run of river hydel power layout[1]

One downfall of RoR hydropower stems from water availability during low late season flows. Another stumbling block is that RoR systems are strictly on demand. Because there is no storage of the energy, it is only available as it is generated. This is in contrast to combustion methods of energy generation, where the fuel (coal, wood, and biofuels) can be stored and combusted when energy is needed.

3.4.1 Economics

RoR systems, like other renewable energy sources, feature a high proportion of upfront installation cost with comparatively lower investments to maintenance. The diversion weir, piping, turbine and generator costs make up 35% of the initial cost while the distribution cables alone comprise 33% of the costs. The other portion of the investment falls under project delivery. Projects with higher peak output require more resources and bigger components that can exponentially scale up in size. Thus, RoR systems have high potential in developing countries or rural areas that don't have large grids or infrastructure. Community scale hydropower projects involve materials small enough to be transported in a pickup truck. Once the materials are on site, the project just needs to be assembled. This can be done with community cooperation, which zeroes the cost of manual labor for installation.

Furthermore, maintenance is not directly related to the hydro scheme, but rather an indirect effect related to the distribution of power. The components of power generation in RoR systems, in fact, involve virtually no maintenance. The main costs include maintaining the transmission lines that connect the homes to the generator. This maintenance includes trimming trees that may interfere with wires, replacing bad wires, dealing with animals that come in contact with them and keeping the wires off the ground. This further justifies small hydroelectric projects, because the smaller scale suggests that the people using the power will live closer to the turbine and generator, reducing installation and maintenance costs since a lesser length of transmission cable is required.

[1] Strobl, Theodor, Zunic, Franz (2006). Hydraulic Engineering: Present Situation and New Developments. Springer. Retrieved from http://www.springer.com/de/book/9783540223009

According to Atlason et al. 2014, hydropower has the highest return on investment compared to many other forms of sustainable energy with Run-of-River having an even higher payback ratio than traditional storage based hydropower.

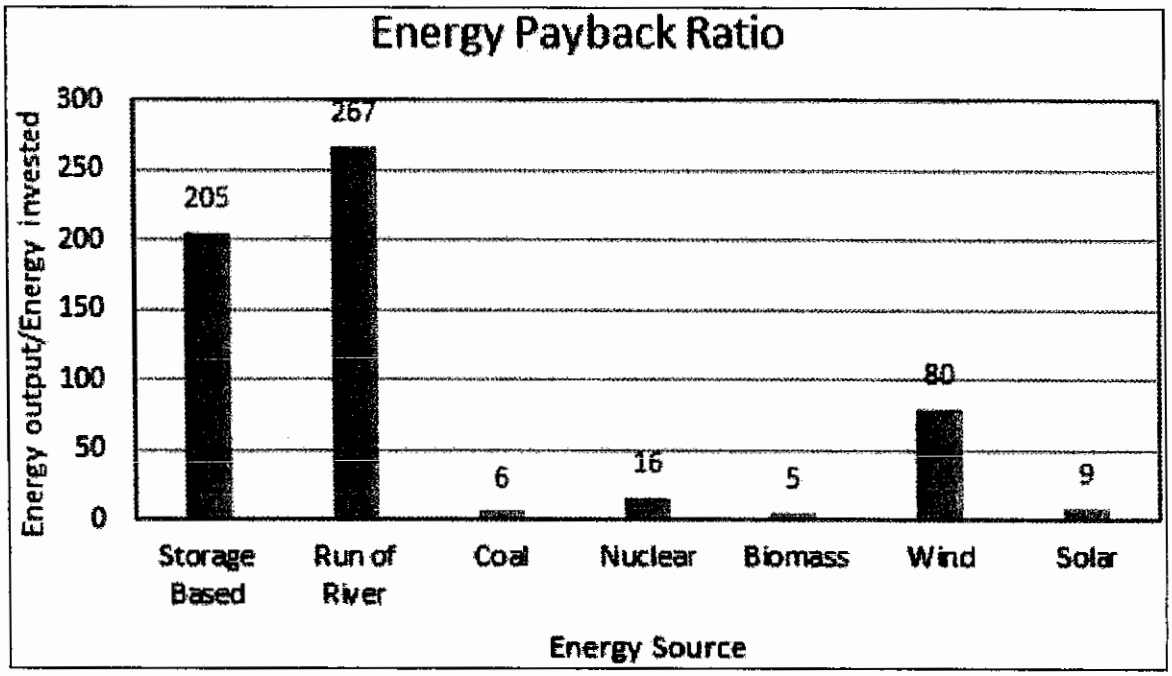


Fig 3.7: Main components of the project[2]

Energy payback ratio of seven common energy sources as a ratio of the gross energy output over gross energy invested into production including construction/production of the power plants (Atlason et al., 2014).

[2] Analysis of Reservoir-Based Hydroelectric versus Run-of-River Hydroelectric Energy Production by Cassie Modal etal. (2014)

Chapter 4 Environmental & Social Baseline of the Project Area

4.1 General

4.1.1 The Aim of Baseline Study

The baseline study relate to the physical, biological and socio-economic environment of the project area prior to the beginning of construction and operational activities.

This categorization would aid in understanding the prevalent macro and micro environment of this project and would enable assessment of possible environmental impacts that may arise as a result of the activities associated with the project. It would also assist the design team in defining the mitigation measures that would be required to minimize if not eliminate the negative impacts which are pointed out in this study.

4.1.2 Methodology

Information for this section was collected from different sources including electronic and print media, studies previously conducted in proposed project area by EMC and archives of the experts, consultations with institutions, Non-government Organizations (NGOs) and field survey. Secondary literature has also been sought.

4.1.3 Study Area – Microenvironment

Nara Hydropower Project is situated at RD-26 of the Nara Canal, at chainage 25+000, District Sukkur, Sindh province. Nara Canal originates from Sukkur Barrage and flows along the left bank of River Indus. Location map of the power project with nearby settlements and structures is depicted below;

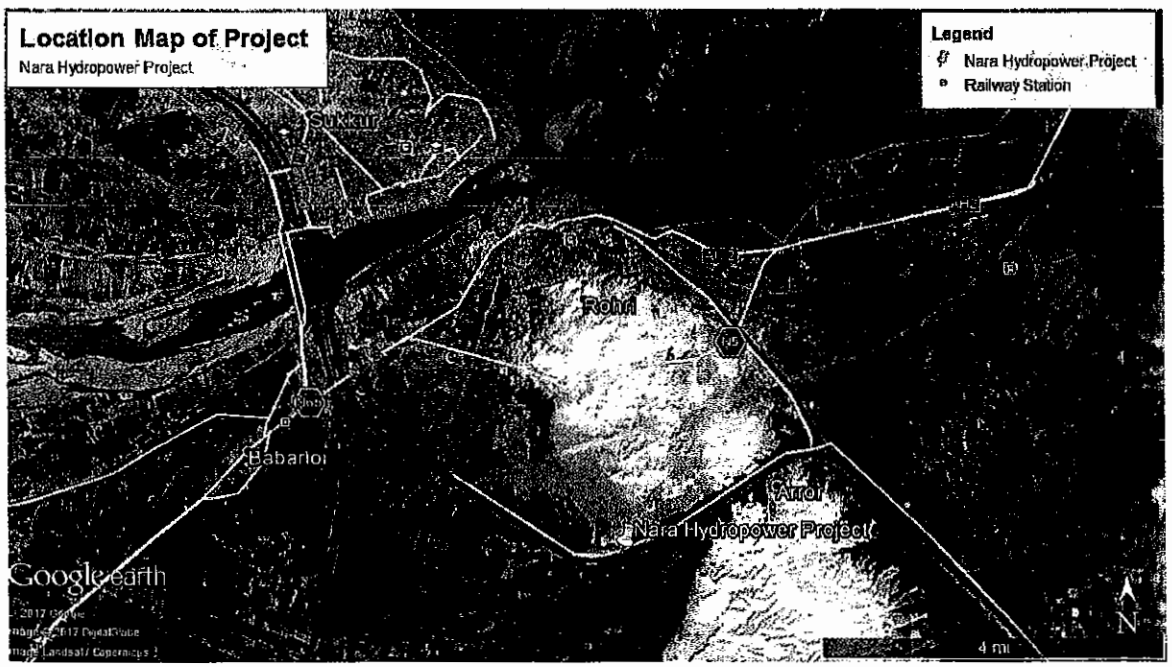


Figure 4.1: Project Location with macro environment of Sukkur Barrage

4.2 Physical Environment

4.2.1 Climate and Ambient Air Quality

Temperature: The Sukkur District experiences extreme temperatures in summer. The annual average maximum temperature is approximately 34C with mean daily maximum temperatures remaining above 40^{0}C in May, June and July. June is the hottest month with highest recorded temperatures reaching up to 50^{0}C. Daytime minimum temperatures even in winter remain above 22^{0}C. Winters are mild and short with mean minimum temperatures not falling below 8^{0}C.

Annual Rainfall: The area is exceedingly dry with mean annual rainfall Averaged over a thirty four year period less than 88mm. The available data indicates that there are two wet seasons: the first with low rainfall in February and March (with mean monthly rainfall of 5.9mm and 4.9mm respectively) and second with higher rainfall in the monsoon period of July, August, and September (with mean monthly rainfall of 44.6mm, 21.3mm and 10.5mm respectively). Approximately 78% of the mean annual rainfall occurs in the two wet seasons with 72% in monsoon. The heaviest recorded rainfall in a given day is 184.5mm in the month of July.

Wind Direction: The wind direction is generally NE (November to April) in winter and SW in summer (May to September). Dust storms are not frequent in the area. Hot winds blow during the months of June and July.

Although a comparison of meteorological data between periods 1951-1970 and 1971-2004 shows no significant meteorological changes, the pattern of rainfall and the maximum daily temperatures in the area are observed to have changed with lower occurrence of monsoon rains (the drought cycle in Pakistan is reported to have increased from 3 per year to 4 per year) and exceeds maximum summer daytime temperatures.

In the Direct Influence area of the Project there is no industrial or commercial activity is taking place, therefore, the air Quality is relatively good.

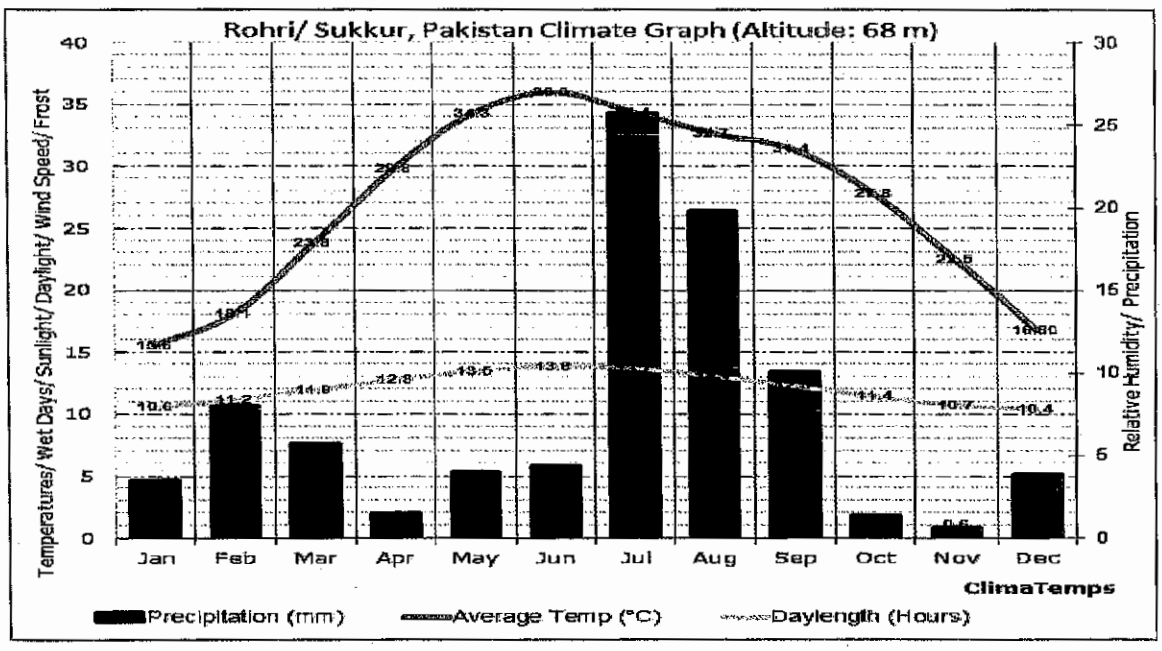


Figure 4.2: Climate of Sukkur

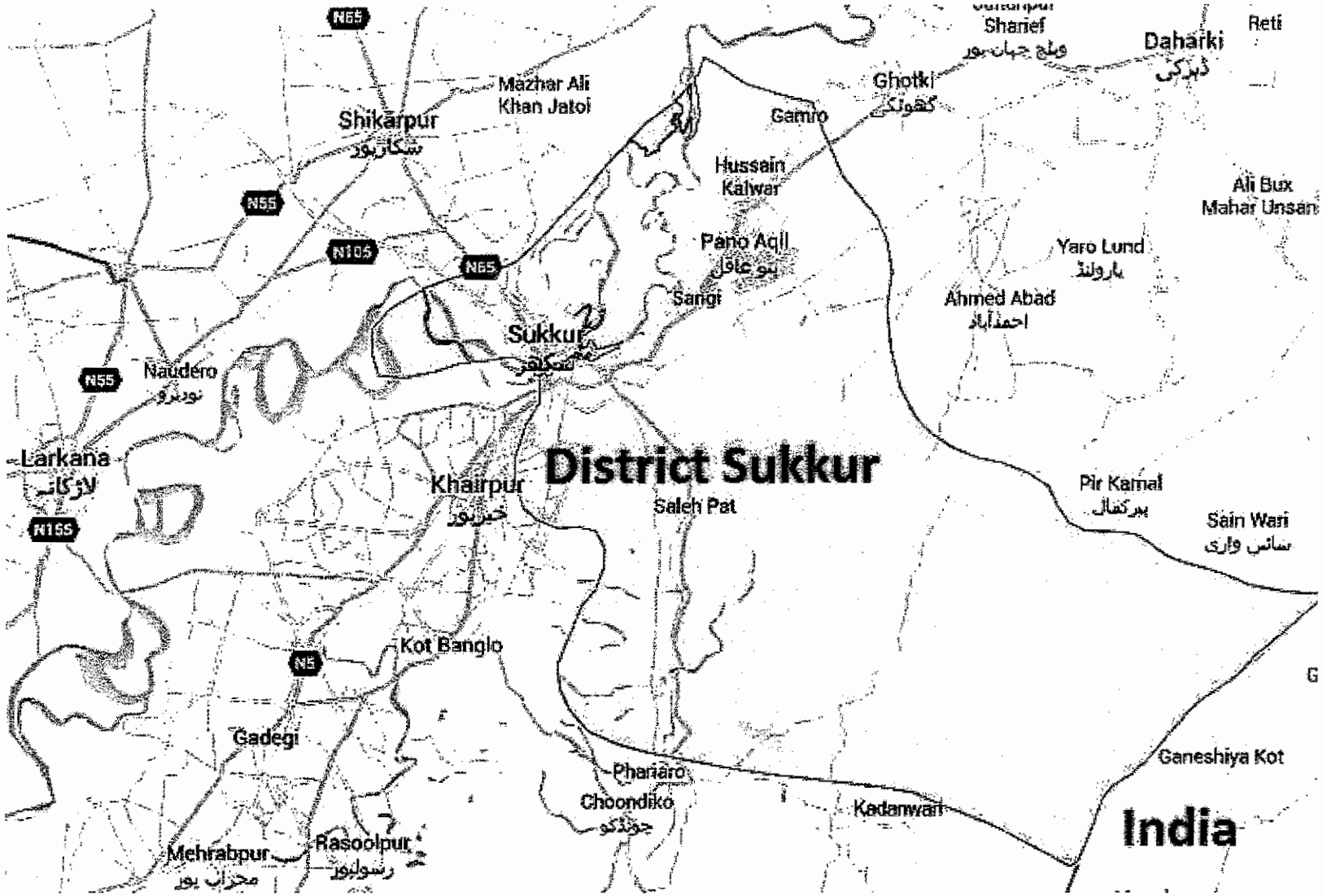


Figure 4.3: District Sukkur Map

Table 4.1: Sukkur Weather Averages

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	15											
Min. Temperature (°C)	7.8	10.7									14.5	9.2
Max. Temperature (°C)												
Avg. Temperature (°F)	59											
Min. Temperature (°F)	46.0	51.3									57.1	48.6
Max. Temperature (°F)												
Precipitation / Rainfall (mm)	6	6	6	2	2	4	54	15	4	0	2	4

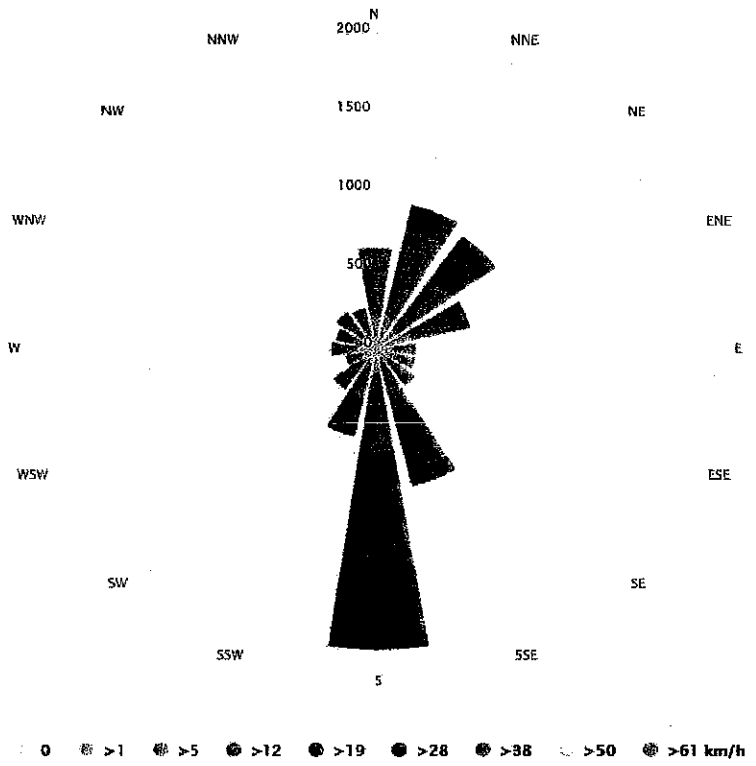


Figure 4.4: Wind rose of Sukkur

4.2.2 Hydrogeological features of Sukkur Region

1) Hydrogeology of Sukkur

Surface Hydrology:

The major surface water source in the area is the Indus River. The Indus drains an area of about 950,000 km² generates a mean annual discharge of 6,682 m³/s (236,000 cusecs). The mean annual flood at the Sukkur Barrage is 18,100 m³/s (640,000 cusecs).

The hydrograph of the river is strongly seasonal with a long low water season between October and March and a high water season between April and September – driven primarily by snowmelt in the upper catchment and monsoon rainfall. The river usually peaks in mid-August or early September. The river carries large sediment loads due to widespread and rapid erosion in its upper catchments. It is estimated that about 1 billion m^3 of sediment is deposited in its floodplain each year. As a result of this continuing deposition, the river has developed natural levees along its length.

Three barrages Guddu, Sukkur, and Kotri regulate river flows in Sindh. Six canals take off from Sukkur barrage for irrigation purposes. These include Dadu Canal, Nara Canal, Rohri Canal, Rice Canal, N.W Canal and Khirthar Canal.

Groundwater:

In Sukkur, Ground water at Numaish Gah and Bunder Road is saline. Drawing of large quantity of water makes ground water more saline. The water table in the area along canals and Indus ranges from 12ft to 20ft with a gradient generally oriented southwards. Groundwater for domestic consumption is abstracted through shallow hand pumps (with motors installed on some). These hand pumps are usually dug to a depth of 20 to 30ft. Water quality is generally sweet, but very few brackish groundwater can also be found. Tube wells installed for supplementing canal irrigation are dug to depths of 75ft to 100ft. The water supply for Sukkur and Rohri cities is also abstracted directly from the Indus.

Sweet groundwater is found in the areas along the canal network and River Indus. However a relative decline from previous years has been reported. This has mainly been due to over abstraction through deep tube wells installed for supplementing canal irrigation.

Water Quality:

Intensification of water use in Pakistan threatens the quality of water in the Indus. Rapid population growth over the past half century has intensified the pressure on agriculture and the need for irrigation water. The management of the flow has historically been inefficient because of poor water storage capacity, seepage, and inadequate maintenance of reservoirs. Heavy irrigation and seepage have overwhelmed the drainage of irrigated land, leading to accumulation of salts on the surface of the soil and rendering large tracts of land unfit for agricultural production. These inefficiencies have prevented the country from attaining food self-sufficiency.

Environmental degradation of the Indus River has created additional health risks for the population. Water pollution in the Indus comes from a number of sources, including return flow from agriculture, which adds sodium nitrates, phosphates, and pesticides to the river. Additionally, untreated or incompletely treated sewage from cities along the Indus is discharged into the river. The river also receives a wide range of industrial waste: organic matter and ions such as sodium, potassium, calcium, magnesium, carbonates, bicarbonates, and chloride as well as inorganic wastes such as fluoride, silica, and cyanide. Finally, thermal power plants along the Indus cause sudden increases in surface water temperature that harm marine life.

Much of the population along the Indus depends on the river for drinking water, and boiling does not remove polluting chemicals. Water pollution in the Indus River has reduced the species diversity of fish

and decreased the supply of subsistence food for many who live near the river. In parts of the lower Indus delta, mangroves that were once abundant with marine life and an important source of food for coastal populations have almost disappear because of the toxic effect of polluted water that flow into this ecosystem.

Regional climate change also threatens the future of the Indus water flow and the millions of people who depend on it. The recent fast pace of glacier melt and warmer temperatures may lead to a serious diminution of river flow. One of the suspected reasons for the rapid melting of these glaciers is settling of aerosolized soot and particles on the icy surface. This "Asian brown cloud," caused by the burning of fossil fuels and biomass by the more than one billion people who live on the subcontinent, can be seen from outer space. As the cloud settles on the white glacial ice, light and heat are absorbed rather than reflected, melting the ice. Even a small decrease in the flow in the rivers fed by these glaciers would have huge consequences for agricultural production and human life[3].

According to "Status of drinking water, quality of surface and ground water sources in Sindh" submitted to Sindh High Court in July 2017, 30 water samples were collected from surface and ground water sources in Sukkur and 25 (83.3pc) were found unsafe for human consumption.

Coliforms /E.Coli were also found in drinking water. Coliforms and E.coli is normal flora of human intestine and are excreted along with stool. This is an indicator group of bacteria which if present in water means that water is contaminated with feces. As disease like Typhoid, Dysentery, Diahorrea, Cholera, Hepatitis can also be transmitted through feces and it is highly risky to drink contaminated water.

According to WHO there should be no Coliforms /E.Coli in 100 ml of water. At present, sources of water contamination are open defecation, un-controlled disposal of domestic and livestock wastes (especially in tars) by local communities; however, no quantitative analysis of the extent of this Contamination is available.

Water Supply and Drainage/Sewerage:

Potable Water Supply is a pre-requisite for the health of people. Lack of proper drinking Water Supply and Sanitation in rural as well urban areas has caused wide spread water borne diseases of which diarrhea (among small children) happens to be a major killer. The diseases are transmitted by water and poor sanitation which deplete human energy resulting in sickness reducing thereby the productivity of the people.

Water Supply is vitally important sector for the urban and rural population of the district. The rural population distribution in the district is quite unique in the sense that it has fewer larger villages and a very large number of small settlements, most of which can hardly be called "Villages"; they are essentially on the farm clusters of population "Widely Scattered". According to present arrangements Water Supply and Drainage facilities are being provided to the people by the Departments i.e. Public Health Engineering Department and Rural Development Department.

[3] Gregory Pappas (2011). Pakistan and Water: New Pressures on Global Security and Human Health. Am J Public Health. 2011 May; 101(5): 786–788.

Urban Water Supply:

The Urban localities in district Sukkur are covered with water supply through a piped water system. Besides, non-mechanized source of water supply like hand pumps/wells etc. are also used by the people.

Urban Drainage:

So far provision of urban drainage facility in Sukkur district is concerned, all the urban localities are covered with drainage/sewerage or open pucca drain system.

Rural Water Supply:

The water supply facility in the rural areas of Sindh through a piped water system is to be provided according to the criteria which gives priority to "A rural settlement with population of 1000 and above preferably having brackish ground water". In Sukkur district, 82 rural settlement having population up to 1000 are categorized into 3 type of settlements in descending order according to their size of population taking into account the quality of ground water.

Presently, out of 26 rural settlements having population 2000 and above, 9 settlements have been covered by the water supply facility. In second category which includes 14 settlements with population ranging between 1999 to 1500, 3 rural settlements have been facilitated by water supply schemes while in the third category (with population from 1499 to 1000) out of 42 rural settlements 9 have been covered by such facility. Thus, out of total 82 rural settlements 21 settlements are covered with the required facility of water supply as reported.

For providing the water supply to uncovered rural settlements, 2 schemes are under implementation at the estimated cost of Rs.11.090 million during the current year i.e. 1997-98 leaving development gap of 59 uncovered villages, but according to criteria, 19 additional settlements with brackish water will require water supply schemes on priority basis.

Rural Drainage:

Drainage system in the rural areas of Sindh under the prescribed criteria is provided for "A rural settlement with population 1000 & above preferably having water system". Presently out of total 82 rural settlements, 25 settlements have been covered by the drainage facility. As per first categorization, out of 26 rural settlements having population 2000 and above, 14 settlements facilitated by the drainage facility. In second category, no settlements from 14 settlements have been covered with drainage and thirdly, out of 42 rural settlements 11 settlements are having the facility of drainage system.

Irrigation:

The areas of the district that are adjacent to the river and canal are irrigated and mainly consist of the croplands. The north western parts of the district are irrigated through Indus River. Nara canal emanates from the Sukkur Barage and irrigates the southern parts of the district. However, the rest of the district, especially the union councils of Lal Juryo, Tarai, and Salehpat, on the eastern border, due to non-availability of water are barren. As the table below shows, majority of the mouzas are irrigated through canals. Out of the 252 rural mouzas, 180 (71%) are irrigated with the help of canals, 36 (14%) are irrigated with river and 83 (33%) are irrigated through tube wells.

Table 4.2: Sources of Irrigation

ADMINISTRATIV L UNIT		RURAL POPULATED MOUZAS	NUMBERS OF MOUZAS REPORTING SOURCE OF IRRIGATION						
			CANAL	RIVER	TUBEWELL / WELL	RAVINE	SPRING/ STREAM/ KAREZ	ARID (BARANI)	FLOODING/ TORRENT
Sukkur	#	252	180	36	83	-	-	30	1
District	%	100	71	14	33			12	
Sukkur	#	2	2	-	-	-	-	-	-
Taluka	%	100	100						
Rohri	#	61	56	4	19	-	-	-	1
Taluka	%	100	92	7	31				2
Pano Aqil	#	90	63	23	42	-	-	-	-
Taluka	%	100	70	26	47				
Salehpat	#	86	51	-	13	-	-	30	-
Taluka	%	100	59		15			35	
New Sukkur	#	13	8	9	9	-	-	-	-
Taluka	%	100	62	69	69				

Source: Mouza Statistics of Sindh 2008, Agriculture Census Organization

In the year 2008-09, 91% of the net sown area was irrigated and from this irrigated area 78% was irrigated through canals and tube wells. From 2008-09 to 2009-10, there is almost 2% increase in canal-irrigated area as overall net sown area also decreased during this reporting period. The table below gives information regarding irrigation in the district.

Table 4.3: Irrigation by type in District Sukkur

Irrigation Type	2008-09	2009-10
Canal	60,015	58,960
Tube well	16,551	16,429
Total Irrigated Area	76,566	75,389
Un-Irrigated	7,135	5,046
Total Sown Area	83,701	80,435

Source: Table 4.36 Sindh Development Statistics 2011

4.2.3 Topography and soil features:

Sukkur, District headquarter town occupies the status of third large commercial and populated town of province of Sindh after Karachi and Hyderabad. The District Sukkur takes precedence over other districts of province of Sindh by having the largest irrigation system of Asia constructed in 1932 namely Sukkur Barrage. This system of irrigation covers 80 million acres of land through its canal system and is major source of provincial agricultural production. Sukkur Airport is the second busiest airport in Sindh after Karachi, connecting almost all commercially important destinations through multiple flights weekly. The biggest Army cantonment of the country located at Pano Aqil is also situated at distance of 20 miles from Sukkur city. Sukkur city itself carries historical importance having 400 years old Masoom Shah Minaret the tallest building of 26 meters build by S.Massom Shah Bukhari, an imminent writer of old history on Sindh and Governor. The archaeological site of Arore in Taluka Rohri is also situated at distance of about 10 kilometers besides Masjid Manzilgah, Zindeh Pir and Sadhubela. The city of Sukkur as well as the district is linked with important and strategic National Highway through Lillylod Bridge and Sukkur Barrage. The city acquires focal location in means of communication as it links rest of the provinces namely Punjab, NWFP and Baluchistan through double track railway line on its left side of river Indus and the single track railway line on right side of the river Indus i.e the main trade route in between Sindh and all the provinces.

The important industries of the district are sugar, edible oil/ghee, leather, tobacco, rice, cotton ginning, oil mills, flour mills, biscuit factory etc.

Topographically, the district may be divided into two broad parts. A plain cultivated area in the western half and a desert in the eastern half. With the exception of the low limestone hills running from the town of Rohri towards the south, and on the west of Nara Canal. The rest of the area of the district in the western half, is flat and level plain. The hills vary in elevation from 100 to 125 meters. There are four prominent hills namely, Adam Shah hills near Sukkur, Kalka hills at Arore, Laheri hills at Rohri and Shadi Shaheed hills at Kandahra. The eastern half of the district is a waste land. It consists of barren tract of clay and ridges of sand hills covered with caper and thorn jungle.

In the Project area, the rocks belong to Paleozoic, Mesozoic and Tertiary Geological timescale. Soils of river plain are generally loamy, clayey and seasonally flooded soils. In Some areas of Sukkur salt affected soils are also present. The Rohri hills area is designated as rough mountainous land. These soils found along river i.e. Loamy and some sandy stratified soils (Torrifluvents and Torripsamments) of recent river plains.

4.2.4 Seismicity

According to the seismic zone map of Pakistan, the Project Area lies in the zone where minor to medium damage can occur as shown in figure below;

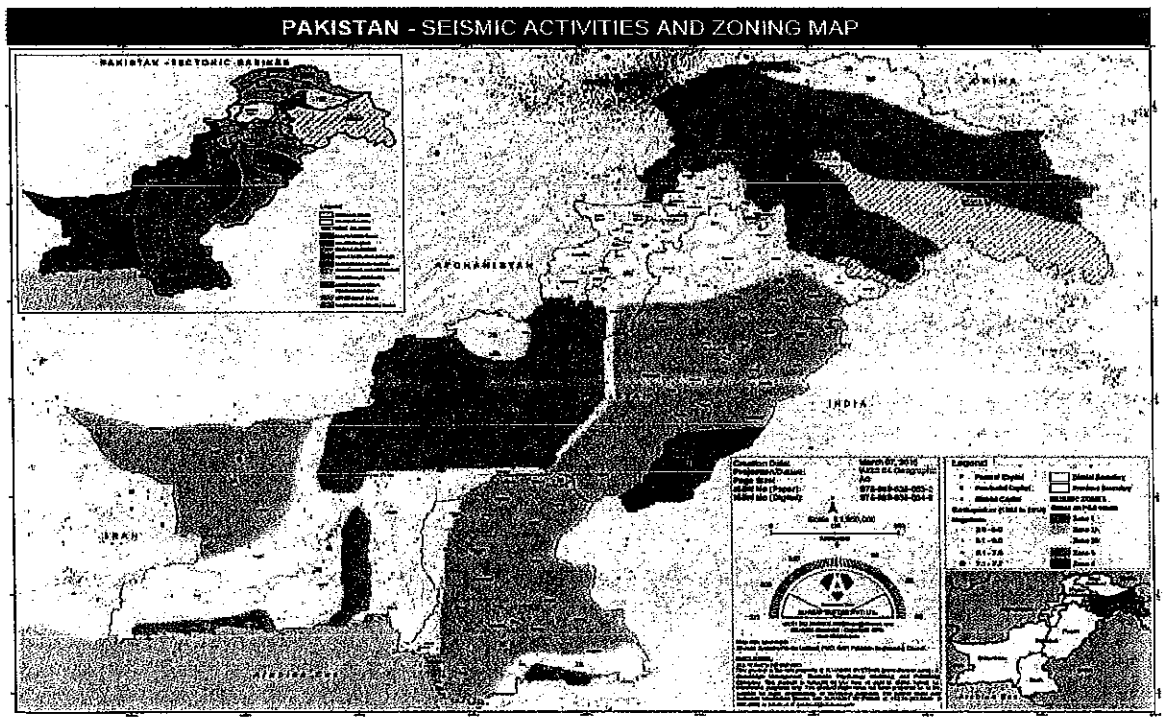


Figure 4.5: Seismic Zones of Pakistan

4.3 Description of Biological Environment

Habitats:

The main habitat within the macroenvironment of project area – Indus River along with banks and Bukkur Island. Description of the habitat along with the flora and fauna attributes is provided is the subsequent paragaphs.

Indus River habitat is an ecologically important area in respect to fauna and flora. Indus River and its associated marshes on both banks which are usually inundated during monsoon are very important as staging and wintering habitat for migratory birds. The main river course is also important for migratory species as it plays an important role for their navigation. The abundance of different invertebrates, including insects and soil biodiversity coupled with different palatable floral species, their grubs are the main source of food for resident and migratory birds.

Indus River between the Guddu to Sukkur Barrage is a very important reserve and habitat for Indus Dolphin. This part of the river contains almost 60% of entire population of this river dolphin which is endemic to Pakistan. However, some scientists are of the opinion that Indus dolphin is a sub-species of Ganges dolphin of India. Different plant species were observed from this habitat, at the river banks and Bukkur Island which is land area surrounded with river water. Floral species that grow in the island include Alhagi maurorum, Desmostachya bipinata, Saccharum spontaneum, Saccharum bengalensis, Salvadora oleoides, Salvadora persica, Tamarix indica, Tamarix aphylla and etc. Some of the submerge species are Typha domingensis, Typha elephantine and Phragmites karka.

The migratory species of birds are observed along Indus and marshes on its both sides generally. However, their concentration may be low in late winter because majority of the migratory birds start returning back in early February.

Flora:

34 plant species belonging to 18 families were reported in main habitat in the macro environment of the Project. Table below provides a list of the floral species reported from the major habitat of the macro environment. The quantitative analysis of floral composition was carried out in calculating, Relative cover, Relative density, and Relative frequency and IVI important value index of species. Life forms of the identified species are as follows:

Table 4.4: Floral life form and numbers

Life form	Number
Grass	5
Herb	9
Tree	14
Shrub	4
Sedge	2

The species found which are of importance in terms of medicinal and economical use include Desmostachya bipinnat and Typha elephantine.

Fauna:

Variety of techniques are used to establish the presence and distribution of species in the project area. These techniques are incorporated into the sampling plan to account for all types of birds, mammals, reptiles and fish species. At each sampling site a one-hour plot search is carried out by the survey team members to detect as many species of birds, reptiles and mammals as possible within a circular zone of approximately 250-meter radius. Ground surveys are conducted along banks and island for identification of water birds.

Protected Area:

Project is not located in or in a buffer zone of any protected Area. However, Indus Dolphin Reserve (IDR), the area between Guddu and Sukkur Barrages, lies over 7km from the project site.

Indus Dolphin Reserve (IDR), with an area of 125,000 hectares, notified in 1974 under the Sindh Wildlife Protection Ordinance is a 200km stretch of Indus, situated in northern part of the Sindh province starting from Guddu Barrage and ending at Sukkur Barrage. This Reserve has the biodiversity of great global significance and stronghold of the endemic river dolphin of Pakistan known as Indus or Blind Dolphin. In addition, the river bellas/belo and riverine forests provide habitat for Hog deer, Fishing cat and Smooth-coated otter in addition to game birds like Grey and Black partridges. Indus River as such provides navigation to the migratory birds when they travel to their wintering grounds (during autumn) and breeding grounds (during spring). IDR is a protected area of high profile and is continuously monitored by the Sindh Wildlife Department. In addition, this area is part of a recently launched Pakistan Wetlands Program which is being implemented jointly by the Federal Ministry of Environment and WWF Pakistan with financial assistance of UNDP/GEF and Royal Netherlands Embassy (RNE) in Islamabad. In a recent survey (April, 2011) conducted in Indus Dolphin Reserve. While the population of Indus Dolphin in IDR has been estimated 1171. According to the survey of Sindh Wildlife Department (SWD) and Global Environmental Services, 918 Dolphins including young animals were recorded within limits of the Guddu to Sukkur Barrage. IDR had been designated as Ramsar wetland site no. 1065 in 2001[4].

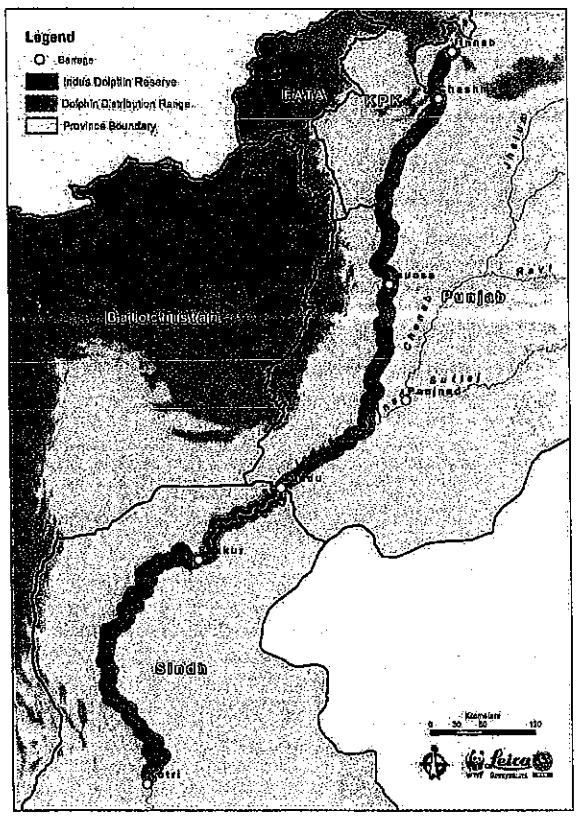


Figure 4.6: Location of Indus Dolphin Reserve

[4] Retrieved from Ramsar site information service; https://rsis.ramsar.org/ris/1065

Birds.

41 species of birds were recorded from the area. Abundant species include: bank myna, little green bee-eater, white-cheeked bulbul, crested lark, pied bushchat, common babbler, house crow, common myna and house sparrow.

Along with resident species, a few winter visitors are also recorded viz. black redstart, lesser whitethroat, Common Chiffchaff, Common Sandpiper and yellow wagtail. Out of 41 recorded species, 19 are abundant, 21 are common, 1 less common while no species is rare in Pakistan. Depending upon the degree of threat, 8 (including Cattle Egret, Eurasian Kestrel, Grey Heron, Indian Pond Heron, Large Egret, Little Cormorant, Little Egret and Marsh Harrier) are declared protected under the Sindh Wildlife Ordinance, Longtailed Grass Warbler is listed in IUCN Red List 2006, 3 (including Eurasian Kestrel, Little Stint and Redshank) are covered in CMS and 6 (including Eurasian Kestrel, Little Stint and Redshank, Eurasian Kestrel, Little Brown Dove, Marsh Harrier and Rose-ringed Parakeet) in CITES Appendices.

Mammals:

8 species of mammals were recorded during the field visit. Out of these 8, 4 are common, 3 are less common while 1 is rare. Out of these 8 mammals, one species Indus dolphin is of global significance including, which is listed in IUCN Red List 2006 and is also protected under Sindh Wildlife Protection Ordinance. As per Sindh Wildlife Department the total population of Indus Dolphin within the project area is around 40-50. However during the field visit only 6 Indus Dolphin were sighted directly. Small mammals mainly gerbils, birds, rats and mice are common as was noticed by their burrow system. These small mammals are a main source of food for raptors and carnivore species and have an important role in the food web. A brief description of the Indus. Smooth-coated Otter (*Lutrogale perspicillata*) is reported from Nara Canal. Its distribution in Sindh has greatly declined due to disturbance and habitat destruction. It is found in Upper Nara Canal in Khairpur district and lower Nara canal in Sanghar.

Blind Indus Dolphin (*Platanista minor*). Indus Blind Dolphin is probably the most specialized of the world's fresh-water dolphins. Head and body length is 1.75-2.75 meters. Its rostrum is very narrow proximally, 21-30 teeth on each side of jaw. Once it was common in Indus and all its tributaries but now it is confined to the Central Indus. It is a quite social animal and has the schools up to 10 animals. Since the Indus dolphins are blind, they continuously use echo-location technique to locate their prey and other objects.

As per observations of different scientists, the Indus dolphins start their courtship in March and early April and most of the births take place during the same period. According to the survey conducted by Worldwide Fund for Nature, Pakistan, the total population of Indus dolphin is more than one thousand in its entire habitat. More than 60% is in Indus Dolphin Reserve (between Guddu and Sukkur Barrages). During the flood season, sometimes, the dolphins are pushed to the canal system from the barrage gates. These stranded dolphins are sometimes killed by the fishermen. Sindh Wildlife Department with the help of WWF Pakistan and Lahore Zoo has started a rescue program under which these stranded dolphins are captured from canals and released back to Indus River. Because of its declining status, it is listed as "Endangered" in IUCN Red List 2004. Indus dolphin may be seen in Indus waters throughout the project area. However, upstream of Sukkur Barrage is its stronghold

Echo location method in Indus Dolphin: The Indus River dolphin is functionally blind having evolved without a crystalline lens or well-developed light sensitive organ. A deep fold just above the dolphin's mouth is the remnant of what might once have been eyes down the evolution line. However, this is not a disadvantage but an adaptation to living in the silt-laden turbid waters of the Indus where eyes are virtually useless, as very little light penetrates below the surface of the murky water. Giorgio Pilleri conducted research on two Indus dolphin kept in an aquarium in Switzerland during 1970. He has described the sonar system used by the Indus dolphins to locate any object or fish in turbid waters of Indus (The Secrets of The Blind Dolphins). Indus Dolphins has the ability to produce high-pitched clicks (Indus dolphin can produce ultrasonic frequencies of over 20,000 Hz.

While a normal human can hear the audio frequencies in the 20-20,000 Hz. (range). These sound pulses are emitted into the water through the 'melon' at the front of the dolphin's head. When these clicks hit an object, some of the sound echoes back to it. By listening to the echo and interpreting the time it took the echo to come back, the dolphin senses the distance of the object. This gives the dolphin some information about the structure and size of the object. By moving its head, the dolphin can get more information on other aspects of the object

Reptiles:

A total of 9 reptile species including 2 species of fresh-water turtles were recorded from the project area during the field visit of which 5 are common, 4 are less common and none is rare. Comparatively uncommon species include Indian cobra which is encountered in riverine and densely vegetative areas. Marsh Crocodiles are also reported in the Canal. However their main habitat is Nara Wetland Land Complex, in Khairpur District. About 198 Marsh Crocodiles are reported in the Nara Wetland Complex, out of Sindh's 480. The number of recorded species of reptiles is low during winter. It is expected that more species of reptiles may be recorded after the winter season as most of the reptiles hibernate during winters.

Out of 9 recorded species, Indian Monitor is protected under the Sindh Wildlife Protection Ordinance and 4 (including Indian Cobra, Indian Monitor, Indian Soft-shell Turtle and Indian Pound Turtle) are listed on different Appendices of CITES in view of their importance for international trade.

Freshwater Turtles

There are eight species of freshwater turtles found in the river Indus. The taxonomic classification is given below;

Table 4.5: Taxonomic Classification of Freshwater Turtles

Class	Sub-class	Order	Sub-order	Super-family	Family	Sub-family	Genus	Species
Reptilia	Anapsida	Testudines	Cryptodira	Testudinoidea	Bataguridae	Batagurinae	Kachuga	Kachuga smithii
					Bataguridae	Batagurinae	Kachuga	Kachuga tecta tecta

Table 4.5: Taxonomic Classification of Freshwater Turtles								
					Bataguridae	Batagurinae	Hardella	Hardella thurjii
					Bataguridae	Batagurinae	Geoclemys	Geoclemys hamiltonii
				Trionychoidea	Trionychidae	Trionychinae	Aspideretes	Aspideretes gangeticus
					Trionychidae	Trionychinae	Aspideretes	Aspideretes hurum
					Trionychidae	Trionychinae	Chitra	Chitra indica
					Trionychidae	Cyclanorbinae	Lissemys	Lissemys punctata andersoni
Source: WWF-Pakistan								

Fish Fauna:

9 important fish species were recorded from macro environment. The species include Notopterus chitata (gandan), Labeo rohita (Dambra), Catla catla (Thaila), Cirrhimus mrigala (Morakhi), Osteobrama cotio (Dhambra), Aorichthys aoe (Singharee), Rita rita (Khagga), Wallago attu (Malli) and Bagarius bagarius (Khagga).

The family Cyprinid is the most common family represented by 4 species while the other 28 species are divided among four families in various combinations.

Presently over-fishing of species of economic importance, use of illegal mesh size, and pollution from industrial and domestic effluents are the major problems in the opinion of local fisherman.

4.4 Description of Socio-Economic Environment

4.4.1 Overview

The socio-economic baseline provides an overview of the social and economic conditions of the project area based on primary and secondary data sources. This overview helps in understanding the socio-economic importance of the project area and contributes towards identification of any social risks that the project proponents must be aware of during the project design phase. The baseline data presented here also provides a basis for monitoring project activities during the project implementation and operations phase.

4.4.2 Macro-environment: District Sukkur

Administrative Context

Sukkur enjoys the status of a Divisional Headquarter. The total area of the district is 4798 sq.km comprising of 4 urban localities i-e Sukkur Metropolitan Corporation, Rohri Municipal Committee and Town Committees of Pano Akil and Kandhra. District Sukkur contains one District Council, 4 Talukas, 18 Union Councils and 266 Dehs. The total area is 3.5% of the Geographical area of Sindh.

Demographic Characteristics of the Micro-environment

At the time of Pakistan's partition in 1947, District Sukkur contained nearly 200,000 habitants, often engaged in fishing industry and agricultural pursuits. With the passage of time, Sukkur has seen a slight rise in population in contrast to Pakistan's, except in the late 60s and early 70s when the growth rate of population acquired 4.43% due to internal migration and development of some great bridges on River Indus. In accordance to the official census of 1998, Sukkur has 908370 habitants and density of 175.9 persons per sq. km. The present estimate indicates that Sukkur population is more than the 1 million.

Sukkur District is heavily populated by Muslims that constitutes 96% of the total population, of which the Sunni sect comprises about 80% and Shias about 16%. It also has the population of Hindus 3.28% and Christians 0.51%. Hindus are mostly living in urban areas and are involved in the trade and services sectors. The Sindhis share the greatest component of population in Sukkur ethnically and Rohri city areas (70.50%), followed by Urdu (15.50%); Punjabi (7.50%); Pashto (2.50%); Seraiki (1.00%); Baluchi (1.00%) and others (2.00%). Baloch tribes involve, Mirani Rind, Chandio, Gabol, Khoso and Leghari. Others involve Indhar, Ansaris, Mahers, Syed, Mughals, Soomro, Mangrio, chijjan, Phulpoto, Palh and many more. There are Punjabi, Memon and Seraiki sections. Culturally, Memons were linked with trade and retail businesses but during the last 2 decades, they have become the active social and economic front. Soomro are generally linked with education social departments, for their progress they perform steps immensely day and night. Terhaily family is actually Saraiki speaking, and many are associated with department of law, medical and education.

Here are the demographics indicators of Sukkur according to the census of 1998 and the provisional results of 2017 Census:

Table 4.1: Population distribution of District Sukkur in 2017 (Provisional Results)			
	Rural	Urban	Total
Population	767788	720115	1487903
Male	399295	376964	776259
Female	368485	343102	711587
Transgender	08	49	57
Household	135906	127136	263042
Source: Pakistan Bureau of Statistics			

Table 4.2: percentage of Population by Religion 1998	
Religion	Total
Muslim	96.13%
Christian	0.51%
Hindu	3.28%
Qadyani (Ahmadi)	0.04%
Other	0.1%
Source: Population Census Organization	

Table 4.3: percentage of Population by Mother Tongue 1998	
Mother Tongue	Total
Urdu	13.82%
Punjabi	6.63%
Sindhi	74.07%

Pashto	1.53%
Balochi	1.47%
Saraiki	0.99%
Other	1.49%
Source: Population Census Organization	

Religion and Culture

Sukkur has a rich traditional Sindhi culture. Women usually wear Shalwar Qameez but quite often dress in the traditional attire, Ghaghra or Parro as well. Traditionally, women wear bangles. Men usually wear a Shalwar Qameez distinguished by broader bottoms, and a traditional Sindhi style cap.

People of this district are pre-dominantly Sindhi speaking but Urdu, Punjabi, Pashto, and Balochi are also spoken in the district. A significant Muhajir (migrants) community is residing in this district, particularly in the city of Sukkur. This community is mainly associated with business and trade in this district. Major clans of this district are Syed, Arain Mahar, Soomro, Memon, Mughal, Ansariand Phulpoto.

Sukkur district is home to many political parties, however, Pakistan People's party (PPP) and the Muttahida Qoumi Movement (MQM) is more popular. The Mahar group is a potential threat to the PPP and its vote bank. Since 1985, these two parties have had almost an even share of the four provincial assembly seats in the district. However, in the general elections of 2008, PPP won all the national and provincial assembly seats.

Electricity Availability District Sukkur:

Electricity is essential for urban/rural development in all sectors of economy and in all walks of life. Provision of electricity to rural people is a source of happiness and prosperity to rural masses. Generally electricity in rural areas is provided in rural settlement with population of 200 and above. WAPDA is the sole authority to electrify villages under different programs. Sukkur Electric Power Company (SEPCO) is the Distribution company in the Sukkur, Larkana and Dadu districts.

As per population census of 1998, in district Sukkur, there were 558 rural settlements with population 200 and above. WAPDA has so far electrified 354 villages. There are still 204 villages which need to be electrified.

Table.4.4: Electricity Availability in District Sukkur		
Utilities	Yes	No
Electricity	63%	37%
Source: MICS-Sindh 2014 (Sindh Bureau of Statistics)		

Infrastructure Facilities

Irrigation

The areas of the district that are adjacent to the river and canal are irrigated and mainly consist of the croplands. The north western parts of the district are irrigated through Indus River. Nara canal emanates from the Sukkur Barage and irrigates the southern parts of the district. However, the rest of the district, especially the union councils of Lal Juryo, Tarai, and Salehpat, on the eastern border, due to non-availability of water are barren.

Land Use

The pattern of land use in a region determines crop production. Soil & climate play an important role in the management of cropping pattern of a region. Crop area used for food and cash crops can be taken as an index of the type of land system and the economic use for these crops. Land use data for latest five years reveals that the reported area in Sukkur district remained unchanged at 479.8 thousand hectares. However, not all of this area is cultivable, 67.0% was reported "uncultivable" though its share was 67.5% in 1993-94.

The share of cultivated area (in the area reported) slightly increased from 32.5% in 1993-94 to about 33.0% in 1997-98, Which however, is still much smaller as compared to overall Sindh. On the contrary it reflected higher cropping intensities as compared to Sindh. Though the cropping intensities had been increasing somewhat since last many years, and an acre of land in Sukkur district has almost cropped fully in a year. The cropped area also increased from 143.5 thousand hectares in 1993-94 to 151.2 thousand hectares in 1997-98 with 95.4% cropping intensity.

The cropped area increased by about 5.4% likewise the cultivated area also increased by 1.7% during the period of five years. A small part of the area about 6.8% is being used for grazing or forest and remaining land is lying unused due to unfavorable condition or lack of irrigation water.

Road Network

Road network is considered as a vehicle for economic development and social change. It is used as an Indicator for computing the stage of economic development. Efficient road network not only develops a quick and efficient transportation system but also opens up new area hitherto remained closed. It brings about social integration among rural and urban sectors and greatly assists in accessibility to basic needs i.e. schools, hospitals, etc. It brings rural areas in constant touch with urban segment of society and creates better understanding necessary for social change and political awakening.

The district head-quarter of Sukkur which lies on the National Highway (N5) is connected with all the taluka headquarters through metaled roads.

Archaeological and Cultural Heritage Sites

Sukkur is rich with cultural monuments and archaeological sites. The land of Sukkur has seen many phases and the remains of all those people, who inhabited this land and contributed their spice to its culture, are spread all over the country. There are many prominent and known archaeological sites and monuments in within the vicinity of the project area include:

i. Bukkur Fort entire area, including walls and Tomb of Hazarat Sadruddin.

ii. Near Lansdowne Bridge "Sat Bahan Astan" is located. A small graveyard from 15th to 17th century has beautifully decorated tombs with blue Glazed tiles.

iii. "Sadhu Belo" a Hindu Pilgrimage area on the main island in river Indus along Sukkur City, this was the asthan (Places) of a Sadhu known as Bankhandi (Forest wonderer) in 1823

Status of Education Sector

The Majority of Schools in the District belonging to Government are functioning under the supervision of District Education Officer (Male/Female). Education is basic right of the people, therefore Primary Education for Children male/Female is mandatory and it is provided free of cost in the province of Sindh. The formal Educational structure in Sindh is divided into four main streams, the first level known as primary refers to Grade I-V for age of school going population 5-9 years, 2nd stage includes middle secondary, elementary and higher secondary. The third stream is called college education which consists of higher education. After completion of the college education, a candidate is awarded Bachelor degree in Arts/Commerce or Science. Duration of post-secondary education varies in Technical and Professional fields, the Poly Technic Institutes offer four years B. Tech course. A Bachelor degree in medicines requires five years education. Similarly Bachelor degree courses in Engineering, Agriculture and Veterinary medicines are awarded of four years duration after the intermediate examination.

An additional two years after the bachelor degree are required to acquire a master degree in Arts/Commerce or Science leading to award of Ph.D. degree which may require two or three more years after the completion of master degree course.

Status of Health Sector

The total number of health facilities in district Sukkur is 72. There is only one Teaching hospital with a capacity of 330 beds. These health facilities are sufficient for only 28.6% of the estimated 2010 population of the district. Table 4.5 shows the details of these health facilities.

Table 4.5: Health Facilities in Sukkur District

Type	Number	Bed Strength
Teaching Hospital	1	330
District Headquarter Hospital	0	0
Tehsil Headquarter Hospitals	2	36
Rural Health Centers	3	34
Basic Health Units	26	52
Govt. Rural Dispensaries	37	-
MCH Centers	3	-
Sub Health Centers	0	-
Grand Total	**72**	**452**

Economy

Sources of Income and Livelihoods:

Since district Sukkur is a partly urban district, where 51% of the population resides in urban areas, sources of livelihood are diversified for the resident population. While agriculture is the main source of employment for the rural population, in the urban areas of the district, people are engaged in various other economic activities like trade, services, personal business, and government and private jobs. Sukkur city is the main trading center of this district.

Majority of the male population is associated with agriculture (in 62% of rural mouzas). While in the category of some; trade, personal business, overseas employment and industry are frequent in the male population.

Agriculture sector is the dominant employer for the population of this district. The Agriculture Census 2000 classifies rural households under three broad categories: agricultural households that operate land as owner-cultivators or tenants; livestock owners; and non-agricultural households. In district Sukkur, the share of non-agricultural households, in all the rural households, is 47.7% percent, while agricultural households and livestock owners constitute 25.5% percent and 26.8% percent respectively13. Given the cultural trait of Sindh and rural areas, where women actively work side by side with the men, the female participation in economic activity is reasonable in this district, as 101 mouzas (41%) have reported that women are also engaged in agriculture. In the category of some, personal business and casual labor are the main sources of livelihood for the female population

Agriculture

Agriculture sector plays a significant role in the overall economic performance of Pakistan. Currently, this sector provides employment opportunities to 45% of the labor force in Pakistan. This sector provides sources of livelihood to 60% of the population in the rural areas. Agriculture contributes 21% to the Gross Domestic Product (GDP) of Pakistan. Sukkur contributes significantly in agriculture sector of Sindh because its climate is suitable for production of various crops including the Kharif crops of cotton, rice, jowar and sugarcane and the Rabi crops of wheat, gram and oil seeds. In addition to these, date orchards are abundant in this district. Due to its soil and topography, Sukkur is an ideal place for date cultivation. Sukkur has the largest dates and dry dates market of Sindh. Important date varieties include Aseel, Fasli, Bhedir, Karbalian, Kupro and Mithri. The name of the dates' market is Agha Qadir Dad Agriculture Market, situated at the left bank of Indus River. Dates and dry dates are exported to India, Australia and America with a total export value of rupees two billions annually. Total reported area of the district is 480,000 hectares, out of which 153,000 hectares (31%) are cultivated. Within the cultivated area, 87,000 hectares are net sown whereas 66,000 hectares are currently fallow lands. The remaining 69% of the total reported area is un-cultivated; out of which 266,000 hectares are not available for cultivation and 26,000 hectares are cultivable waste

Livestock

Livestock sector maintains a unique position within the agriculture sector of Pakistan. It contributes 51% to the value addition in agriculture sector of Pakistan. It also contributes 9% to the GDP of Pakistan. Besides, this sector provides foreign earnings, dairy products' needs, food security and daily cash income to the people of Pakistan. It helps to reduce the income inequalities, especially in case of emergencies (floods, crop failure). Hence this sector is considered as most secure source of livelihood for small farmers and landless poor. The share of Sindh province in livestock population of Pakistan is 20%

Enterprise and Industrial Sector

There are two industrial estates in Sukkur i.e. Sindh Industrial Trading Estate (SITE) and Small Industries Estate (SIE). The former was established in 1963 over an area of about 1060 Acres. Various industries

including ghee, oil, biscuits, soap, beverages, flour, straw paper board, poultry farm, dates, sulphuric acid, ice and cold storage are established in it.

The Small Industries Estate (SIE) Sukkur was set up over an area of 110 acres. The Estate is being managed by the Sindh Small Industries Corporation. The Estate comprises of industrial units like cotton seed crushing units, RCC pipes, paints and varnishes, biscuits, flour, rice husking, printing press, ceramic wares and light engineering. Fifty-five units are currently working in the SIE and 41 are sick/ closed.

Chapter 5 Screening of Potential Environmental Impacts & Proposed Mitigation Measures

This section presents the screening process that identifies the environmental aspects and makes assessment of impact of different activities during the pre-construction, construction and operation phases of the proposed project located at RD-26 of Nara Canal, District Sukkur, Sindh. The screening process has been a thorough review of literature, primary as well as secondary baseline data, and expert judgment, made assessment of the potential impacts of the said activities on the physical, biological and socioeconomic environment of the project. Mitigation measures have been proposed to reduce, minimize or compensate for the identified potential negative impacts.

The proposed project will involve the construction and operation phase impacts associated with the activities of the project at the proposed site. The environmental aspects of the project as identified by situation analysis which are based on the following:

- Physical environment, particularly siting of the project
- Biological environment, and
- Socio-economic environment.

This section of the IEE Report presents an evaluation of the screening process and identifies the existence, if any, of significant environmental impacts during the different phases of the Project and provides, if necessary, the mitigation measures that may have to be adopted in order to reduce, minimize or compensate for the negative impact.

5.1 Impact Assessment Methodology

Potential environmental impacts of the proposed Project on different features of micro and macro-environment pertain to construction and operation of a 13.65MW Hydel Power Project. The screening process proceeds by identifying the potential environmental aspects of siting the project, identifying the potential environmental impacts at pre-construction, construction and operational stages of the project and identifying the residual impacts after adoption of mitigation measures that may be needed at the outset of activities. The impacts on environmental resources from the proposed project will be short-term and temporary in nature.

Environmental impact of a project is worked out using various factors, so that an environmental management plan can be evolved to take mitigation measures.

A systematic strategy was developed to provide an assessment of the likely impacts on the micro and macroenvironment of the Project site. The strategy included:

- Review of General Guidelines;
- Identification of potential environmental impacts by conducting survey, public consultation and using checklists;

- Assessment of the intensity and significance of potential impacts by obtaining expert opinion and carrying out environment analysis;
- Defining mitigation measures to reduce impacts to as low as practicable;
- Predicting any residual impacts, including all long-term and short-term, direct and indirect, and beneficial and adverse impacts;
- Monitoring of residual impacts.

5.2 Assessment of Aspects & Impacts related to Siting of Project

Aspect and impact related to the siting of the project area listed below:

- The Proposed project is a small hydel project to utilize the energy potential of Nara Canal to harness clean and renewable energy and to export to the national grid.
- The proposed project involves minor change in Land Use of the microenvironment.
- Minor traffic increase is envisaged only during the construction phase. Traffic during operation will involve only periodic maintenance and work vehicles.
- There are some indigenous shrubs present at project site.
- This Project would least likely to cause any annoyance to the living environment as it is a run-of-river project.
- The project site has no sensitive areas such as protected sites including wildlife sanctuaries, game reserves or national parks, or any archaeological, historical or cultural heritage in its immediate neighborhood; as such its siting would have no sensitivity in this regard.
- The project when completed will not need much time to become a component of the ecosystem; as such this add-on in the energy mix will have no significant impact on the precious ecology. Unnecessary removal of trees or greenery would not be involved.
- The air quality of the air-shed of the macro-environment as well as that of the site itself will have no significant impact due to siting of the Project.

5.3 Screening of Potential Impacts at Planning & Designing (Pre-Construction) Phase

There are some of the environmental aspects which will be taken into account in the planning and designing phase of the proposed project so that these may not impact the environment in both construction and operational phase. These impacts are as follows:

5.3.1 Land Acquisition

Land will be acquired for the project by the proponent.

5.3.2 Structural Stability

The seismic zone map of Pakistan has divided the country into 5 seismic zones ranging in term of major, moderate, medium, minor and negligible zones with respect to ground acceleration values.

Under this zoning the proposed project site lies in the medium hazard zone with minor to medium damaging impact.

The proposed project area lies into earthquake Zone 2A with respect to Peak Ground Acceleration (PGA). The intensity which is estimated in accordance with the Modified Intensity Scale will be IV to VI. The primary structure of the plant would be reinforced concrete. There are some mitigation measures which will be followed for further removing the risk involved in the stability of the project structure:

Mitigation Measures

- Standards for hydraulic and structural engineering will be followed.
- During the construction, it will be important to maintain the stability of canal bed at the project site.
- Any effects of water logging and salinity on structure should be adequately mitigated.

5.3.3 Reduce Liquefaction Hazard

There are basically three possibilities to reduce liquefaction hazards when designing and constructing structures.

a) Avoid Liquefaction Susceptible Soils

The first possibility is to avoid construction on liquefaction susceptible soils. There are various criteria to determine the liquefaction susceptibility of a soil. By characterizing the soil at a particular construction site according to these criteria one can decide if the site is susceptible to liquefaction and therefore unsuitable for the desired structure.

There are a number of different ways to evaluate the liquefaction susceptibility of a soil deposit.

Historical Criteria

Observations from earlier earthquakes provide a great deal of information about the liquefaction susceptibility of certain types of soils and sites. Soils that have liquefied in the past can liquefy again in future earthquakes. First, previous earthquakes can be investigated to see if they caused liquefaction at the site. Information may also be available in the form of maps of areas where liquefaction has occurred in the past and/or is expected to occur in the future.

Geological Criteria

The type of geologic process that created a soil deposit has a strong influence on its liquefaction susceptibility. Saturated soil deposits that have been created by sedimentation in rivers and lakes (fluvial or alluvial deposits), deposition of debris or eroded material (colluvial deposits), or deposits formed by wind action (aeolian deposits) can be very liquefaction susceptible. These processes sort particles into uniform grain sizes and deposit them in loose state which tends to densify when shaken by earthquakes. The tendency for densification leads to increasing pore water pressure and decreasing strength. Man-made soil deposits, particularly those created by the process of hydraulic filling, may also be susceptible to liquefaction.

Compositional Criteria

Liquefaction susceptibility depends on the soil type. Clayey soil, particularly sensitive soils, may exhibit strain-softening behavior similar to that of liquefied soil, but do not liquefy in the same manner as sandy soils are.

Soils composed of particles that are all about the same size are more susceptible to liquefaction than soils with a wide range of particle sizes. In a soil with many different size particles, the small particles tend to fill in the voids between the bigger particles thereby reducing the tendency for densification and pore-water pressure development when shaken.

The geological process described above produce rounded particles. The friction between angular particles is higher than between rounded particles, hence a soil deposit with angular particles is normally stronger and less susceptible to liquefaction.

State Criteria

The initial "state" of a soil is defined by its density and effective stress at the time it is subjected to rapid loading. At a given effective stress level, looser soils are more susceptible to liquefaction than dense soils. For a given density, soils at high effective stresses are generally more susceptible to liquefaction than soils at low effective stresses.

b) Build Liquefaction Resistant Structures

If it is necessary to construct on liquefaction susceptible soil because of space restrictions, favorable location, or other reasons, it may be possible to make the structure liquefaction resistant by designing the foundation elements to resist the effects of liquefaction.

A structure that possesses ductility, has the ability to accommodate large deformations, adjustable supports for correction of differential settlements, and having foundation design that can span soft spots can decrease the amount of damage a structure may suffer in case of liquefaction (Committee on Earthquake Engineering, NRC, 1985). To achieve these features in a structure there are various aspects to consider:

Shallow foundation Aspects

It is important that all foundation elements in a shallow foundation is tied together to make the foundation move or settle uniformly, thus decreasing the amount of shear forces induced in the structural elements resting upon the foundation.

Deep foundation Aspects

Liquefaction can cause large lateral loads on pile foundations. Piles driven through a weak, potentially liquefiable, soil layer to a stronger layer not only have to carry vertical loads from the superstructure, but must also be able to resist horizontal loads and bending moment induced deep foundation by lateral movements if the weak layer liquefies. Sufficient resistance can be achieved by piles of larger dimensions and/or more reinforcement. It is important that the piles are connected to the cap in a ductile manner

that allows some rotation to occur without a failure of the connection. If the pile connections fail, the cap cannot resist overturning moments from the superstructure by developing vertical loads in the piles.

c) Improve the Soil

The third option involves mitigation of the liquefaction hazards by improving the strength, density, and/or drainage characteristics of the soil. This can be done using a variety of soil improvement techniques.

The main goal of most soil improvement techniques used for reducing liquefaction hazards is to avoid large increases in pore water pressure during earthquake shaking. This can be achieved by densification of the soil and/or improvement of its drainage capacity.

Vibro flotation

Vibro flotation involves the use of a vibrating probe that can penetrate granular soil to depths of over 100 feet. The vibrations of the probe cause the grain structure to collapse thereby densifying the soil surrounding the probe. To treat an area of potentially liquefiable soil, the vibro flot is raised and lowered in a grid pattern. Vibro Replacement is a combination of vibro flotation with a gravel backfill resulting in stone columns, which not only increases the amount of densification, but provides a degree of reinforcement and a potentially effective means of drainage.

Dynamic Compaction

Densification by dynamic compaction is performed by dropping a heavy weight of steel or concrete in a grid pattern from heights of 30 to 100 ft. It provides an economical way of improving soil for mitigation of liquefaction hazards. Local liquefaction can be initiated beneath the drop point making it easier for the sand grains to densify. When the excess pore water pressure from the dynamic loading dissipates, additional densification occurs.

Stone Columns

Stone columns are columns of gravel constructed in the ground. Stone columns can be constructed by the vibro flotation method. They can also be installed in other ways, for example, with help of a steel casing and a drop hammer as in the Franki Method. In this approach, the steel casing is driven in to the soil and gravel is filled in from the top and tamped with a drop hammer as the steel casing is successively withdrawn.

Compaction Piles

Installing compaction piles is a very effective way of improving soil. Compaction piles are usually made of pre-stressed concrete or timber. Installation of compaction piles both densifies and reinforces the soil. The piles are generally installed in a grid pattern and are generally driven to depth of up to 60 ft.

Compaction Grouting

Compaction grouting is a technique whereby a slow-flowing water/sand/cement mix is injected under pressure into a granular soil. The grout forms a bulb that displaces and hence densifies, the surrounding

soil. Compaction grouting is a good option if the foundation of an existing building requires improvement, since it is possible to inject the grout from the side or at an inclined angle to reach beneath the building.

Drainage techniques

Liquefaction hazards can be reduced by increasing the drainage ability of the soil. If the pore water within the soil can drain freely, the build-up of excess pore water pressure will be reduced. Drainage techniques include installation of drains of gravel, sand or synthetic materials. Synthetic wick drains can be installed at various angles, in contrast to gravel or sand drains that are usually installed vertically. Drainage techniques are often used in combination with other types of soil improvement techniques for more effective liquefaction hazard reduction.

5.3.4 Threat to Biodiversity

The proposed project is located on RD-26 of Nara Canal. It is a run-of-river hydel project with minimal footprint on environment. The project is not a threat to biodiversity of area as it requires minimal use of land and water resources. Aquatic life protection measures will be taken into design to avoid their mortality.

5.3.5 Archaeological / Cultural / Protected Areas

There is not a protected area which has been marked in the locality of the proposed project. There is not even a trace for the existence of cultural heritage in the close vicinity of the project.

There is no evidence of any ancient civilization or there is any site belonging to the list of cultural heritage sites. Hence, no negative effects would likely to be imparted during construction; therefore, no mitigation measure is required.

5.4 Screening of Potential Impacts at Construction Phase

The activities that take place during the construction phase of the project are site clearance, leveling of site, excavation, construction and erection of structures etc. and associated equipment. The potential primary and secondary impacts on the environment due to these activities and their mitigation measures are discussed as under:

5.4.1 Site Clearance

Site preparation would include clearing, excavation, earth and fill movement and transportation of machinery and associated equipment to site and preparing the canal bed at RD-26 for construction of weir and powerhouse structures. The said activities will not lead to extensive soil erosion, or alteration of soil quality resulting from removal of topsoil. Trees removed during the site clearance will be compensated in the order of 1:3 for immature trees and 1:5 for mature trees.

5.4.2 Soil Erosion

Generally, the exposed soil after excavation for foundations is vulnerable to erosions and runoffs by rains. Such a situation is of temporary nature and limited duration. The following mitigation measures will be adopted:

Mitigation Measures

- Identify and avoid areas with unstable slopes and local factors that can cause slope instability (groundwater conditions, precipitation, seismic activity, slope angles, and geologic structure).
- Identify soil properties, engineering constraints, and plant design criteria.
- Develop a site grading and management plan to identify areas of disturbance, areas of cut and fill, slope during and after grading, existing vegetation, and measures to protect slope, drainages, and existing vegetation in the project area wherever feasible.
- Develop an erosion control and revegetation plan to delineate measures to minimize soil loss and reduce sedimentation to protect water quality.
- Minimize the amount of land disturbed as much as possible. Use existing roads, disturbed areas, when possible. Minimize vegetation removal.
- Place access roads to follow natural topography.
- Pave roads for construction traffic, if feasible.
- Design runoff control features to minimize soil erosion.
- Construct drainage ditches only where necessary.
- Use appropriate structures at culvert outlets to prevent erosion.
- Use special construction techniques in areas of steep slopes, erodible soils, and stream crossings.

5.4.3 Land Contamination

During the construction stage, the contamination of land may occur due to unchecked chemicals or fuel spillage through their improper handling, transportation and storage.

The sources of spills are:

- During refueling, the transfer of fuel from one container to the other;
- By the maintenance of vehicle and machinery;
- Leakage from the container or equipment;
- Traffic Accident;

Mitigation Measures

Actions necessary to manage the risk from contaminated land will depend on factors such as the level and location of contamination, the type and risks of the contaminated media, and the intended land use. However, a basic management strategy will include:

- Fuel oils, lubricants, and chemicals will be stored in covered dyked areas, underlain with impervious lining.
- Vehicles and equipment's maintenance will be taken place at specified site.
- Washing of vehicles will be carried out in the designated areas.
- Construction vehicles and machinery will be examined on a regular basis for leakage prevention.
- Removal of oil and contaminated soil around the fuel and oil storage areas will be made possible by the availability of appropriate implements i.e. shovels, plastic bags and absorbent materials.
- Contaminated media will be managed with the objective of protecting the safety and health of labor at the site and the environment.
- The historical use of the land will be understood with regard to the potential presence of hazardous materials or oil prior to initiation of construction activities.
- Plans and procedures will be prepared, to respond to the discovery of contaminated media to minimize or reduce the risk to health, safety, and the environment.

5.4.4 Ambient Air Quality

The major source of air pollution during the construction phase will be dust emission due to earth works and gaseous emissions from construction equipment. Impacts from each source and proposed mitigation measures are as follows:

Dust Emission: Dust emission from construction site is a concern particularly if the site is near residential areas. The main health hazards are the particles smaller than 10 microns (designated as PM10) as they are respirable. In cases where they reach the receptors, the dust is considered a nuisance as it may spoil property and affect visibility. Particulate matter emitted during construction activities may result in deterioration of ambient air quality in the vicinity of the source, and is usually a nuisance to the neighborhood besides the construction workers. The impact on the environment would be considered significant if there is an increase in suspended particulate matter within and beyond the boundaries of the project site due to activities at the site, or if the dust affects local property or results in complaints from the community. Potential sources of particulate matter emission during construction activities include earthworks (dirt or debris pushing and grading), exposed surfaces, exposed storage piles, truck dumping, hauling, vehicle movement on unpaved roads, and concrete mixing and batching. The quantity of dust that is generated on a particular day depends on the magnitude and nature of activity and the atmospheric conditions prevailing on the day.

Mitigation Measures

The following mitigation measures will be adopted during the earthwork and construction phase:

- Water will be sprinkled daily or when there is an obvious dust problem on all exposed surfaces to suppress emission of dust.
- Dust emission from soil piles and aggregate storage stockpiles will be reduced by appropriate measures.
- Construction materials that are fragile and vulnerable to raising visible dust will be transported only in securely covered trucks to prevent dust emission during transportation.

- The exposure of construction workers to dust will be minimized by provision of dust masks.

Vehicle and Equipment Exhaust: Combustion exhaust from vehicles and construction equipment can affect the ambient air quality of the site surroundings. The impact would be potentially significant when the ambient air quality deteriorates due to emissions from construction equipment and machinery or the construction generators etc. beyond the guidelines especially at the environmental receptors in the neighborhood. The exhaust emissions will include particulate matter (PM), hydrocarbons, Oxides of Nitrogen (NOx), Sulphur dioxides (SO2) and Carbon monoxide (CO).

Mitigation Measures

The emissions from operation of construction equipment and machinery as well as generators is not expected to have been significant as to affect the ambient air quality of the area in view of the observation that the site is located away from communities and from any continuous emission source and that airshed of microenvironment is not polluted. The small amount of exhaust emissions from the operation of generators and equipment are expected to have dispersed with the prevailing wind and may not have had any significant impact on the local air quality. Adoption of following mitigation measures will result in further reduction / prevention of these emissions.

- All vehicles, generators and other equipment used during the construction will be properly tuned and maintained in good working condition in order to minimize emission of pollutants.
- The stack height of the generators during operation phase will be vented through vertical stacks to minimize exposure at ground level, if generators are required.

5.4.5 Water Consumption

Water will be required during the construction activity for human consumption at the construction stage as well as for the construction activities including sprinkling of water for dust suppression.

Drinking Water: It is estimated that peak water requirement during construction phase will be about several hundred liters/day for construction workers. Potable water will be provided for drinking for the construction workers and regular testing of the water will be conducted.

Water for construction activities will be obtained from canal in a manner not to impact the downstream hydrology of canal.

Mitigation Measures

Adherence to the following measures will ensure efficient use of water during the subsequent stage of construction:

- A complete record of water consumption during the construction phase will be maintained.
- Water conservation practices will be adopted to prevent wastage of water.
- The water supply lines will be checked and repaired for leaks, if any, in order to reduce wastage of water.

- Use of water efficient sanitary fittings such as low flush toilets, water efficient shower heads, and aerators on faucets will be ensured throughout the Project cycle.

5.4.6 Wastewater Generation & Disposal

During the construction phase, the wastewater is generated from the project site is mainly due to the human activities, run-off from the project site during the season of precipitation, washing and leakage of fuel from the construction vehicles etc. Construction activities of the project may include the generation of sanitary wastewater discharges in varying quantities depending on the number of workers involved.

The source of wastewater includes toilets, washrooms, laundry and kitchen. The wastewater would be routed to the existing municipal drain/sewerage system. This wastewater would comply with the SEQS values provided that other hazardous wastes (i.e. paints etc.) are not mixed with it.

The impact of disposal of such wastewater would not be significant since it is expected to comply with the Sindh Environmental Quality Standards (SEQS) for municipal and industrial liquid effluent.

The untreated wastewater disposal will potentially deteriorate the water quality of the surface and groundwater resources as well as contaminate the soil quality near the project site.

Mitigation Measures

The following are the recommendations to reduce and control the wastewater generated during the constructional activities:

- Maintenance of vehicles and equipment's used in the construction phase of the proposed project, in order to overcome the generation of wastewater at large scale.
- Washing of vehicles and construction machinery will be restricted to a designated area.
- Wastewater will not be disposed of directly into the water bodies, but first be treated and then the effluent will be disposed of in a proper manner.
- Development of wastewater treatment facility i.e. septic tank with soakage pit, as far as possible from the canal watershed.
- The onsite wastewater treatment facility of the project will be leak proof as feasible.
- Wastewater generation will be minimized by controlling the pollutant at the source.
- Regular monitoring of the wastewater generation will be taken into consideration.
- Adequate portable or permanent sanitation facilities serving all workers will be provided at all construction sites.
- Sewage will not be mixed with any other waste.

5.4.7 Solid Waste Generation &Management

The construction phase of the project is expected to generate wastes including; packing waste; scrap, excess construction materials and debris, domestic wastes from construction camp, empty containers and

drums, used lubricating oils and chemicals etc. Besides being an eyesore, the solid waste can also pose health hazards; pollute soil surface and ground water if disposed of improperly.

The impact of solid waste disposal would be significant if the waste management is not carried out appropriately. This may adversely affect the health of workers, cause soil pollution, and deteriorate the quality of surface water and groundwater. Also, if excessive wastes are generated, recyclable wastes are not recycled, wastes are scattered, handling of wastes will result in contamination, and wastes are improperly disposed of, the result would be serious degradation of the environment.

Waste generated as a result of construction activity will be inherently less reactive and chemically inert under normal conditions however, its handling and storage may pose adverse impacts of minor nature which could be controlled by employing the recommended mitigation measures in the EMP.

Hazardous waste generated during the construction activities, if not managed properly can pose health hazards, pollute or alter quality of soil, surface and groundwater.

Waste from construction and associated activities will be properly managed by proposed measures described in the following section:

Mitigation Measures

A waste management plan has been developed for the subsequent construction stage of the project. The following are the key elements of the waste management system:

- Separate bins will be placed for different type of wastes - plastic, paper, metal, glass, wood, and cotton.
- Recyclable material will be separated at source. The recyclable waste will be sold to waste contractors for recycling.
- Non-hazardous non-recyclable wastes such as construction camp kitchen wastes will be disposed of in landfill site through municipal administration or approved waste manager/contractor.
- No wastes will he dumped at any location outside the project site boundary.
- All hazardous waste will be separated from other wastes. Hazardous wastes will be stored in designated areas with restricted access and proper marking. Hazardous wastes will be disposed of through approved waste manager/contractor.
- Surplus construction materials including partially filled chemical and paint containers will be returned to suppliers. Inert construction wastes will be disposed of onsite as fill material or sold as scrap to contractors.
- Records of all waste generated during the construction period will be maintained. Quantities of waste disposed, recycled, or reused will be logged on a Waste Tracking Register.
- Training will be provided to personnel for identification, segregation, and management of waste.
- The waste management plan developed for construction phase shall be followed in letter and spirit.

5.4.8 Construction Noise

The construction work, delivery of construction materials by heavy trucks and by the use of machinery/equipment including bulldozers and metal grinders will contribute high levels of noise within the construction site and the surrounding areas.

In general, human sound perception is such that a change in sound level of 3 dB is clearly noticeable, and a change of 10 dB is perceived as a doubling or halving of sound level. The noise in the project area may increase during subsequent construction and completion of the proposed project and may result in disturbance to the nearby receptors unless it is contained within the appropriately fenced site of the Project.

During the construction phase of the project, noise is likely to be generated by the following activities:

- Operation of pile drivers.
- Earth moving and excavation equipment.
- Concrete mixers.
- Transportation of equipment's.
- Diesel generator.
- Increase in transport noise from within the site from the nearby roads.

Elevated noise levels within the site can affect project workers, residents and passer-by and other persons within the vicinity of the project site.

Mitigation Measures

The following measures are adopted in order to keep the noise within the limits as prescribed by the EPA:

- The activities associated with greatest potential to generate noise will be planned during the day period that will result in least disturbance to the nearby residents at night.
- Noise control devices will be used such as temporary noise barriers and deflectors for impact activities.
- Transport associated with the construction of the project will be avoided or minimized through already existing residential areas.
- Noise and vibration will be minimized in the projects site and surrounding areas through sensitization of the truck drivers to switch off vehicle engines while offloading material.
- Truck drivers will be instructed to avoid gunning of vehicle engines or hooting especially when passing through sensitive areas such as mosques, schools and hospitals.
- Construction machinery will be kept in good condition to reduce noise generation.
- All generators and heavy-duty equipment's will be installed and placed in enclosures to minimize ambient noise levels.

5.4.9 Operation of Vehicular Traffic

It is envisaged that there would be considerable increase in the traffic volume during the construction and completion of Project. Vehicular traffic management will have to be undertaken to restrain unnecessary traffic jams that may cause annoyance to the commuters.

Mitigation Measures

The following mitigation measures are being adopted to remove the constraints to smooth flow of traffic:

- Project vehicles shall not be fitted with pressure horns.
- Speed of vehicles will be regulated during construction phase within the project area.
- Designated parking areas will be provided for different type of project vehicles within and around the project site.
- Traffic management plan will be introduced to manage smooth flow of vehicular traffic and to avoid traffic jam and long queues.
- Traffic management plan will be implemented and monitored.
- Parking of vehicles alongside the road would be prohibited at all time.

5.4.10 Materials Selection

General specification/details have been worked out in respect of type of structures, concrete, and all other materials required for the Construction of Project. The following measures will be adopted to ensure sustainable development of the Project:

Mitigation Measures

- The structures and materials will, in the subsequent construction stage, conform to recommended standards and follow standard practice of civil works.
- Environmentally sound materials and goods will be selected, with priority being accorded to products meeting national and international standards.
- Traditionally well-tried materials and components will be selected and selection of construction materials would be based on sustainable source.
- Construction site will be adequately isolated to prevent entry of public and general safety measures will be evocatively imposed throughout the construction period.
- Temporary inconveniences due to construction works will be minimized through planning and coordination with town administration.
- The production, use and disposal of construction materials during the construction stage of Project will utilize considerable amount of energy and resources; all attempts will be made towards efficient consumption and minimization of wastage of water, energy and materials

- The environmental impacts arising from selection of construction materials and components would take account of the environmental issues during the materials selection process, and introduce Recycling strategies such as Reuse and Reduction of Wastewater.

5.4.11 Energy Use

Electricity during construction phase will be produced from diesel generators. A back up diesel operated generator will also be installed in case of emergency or suspension of power supply from the mains. The power produced will not be significant in terms of costs both environmental and economic. Since energy produced from non-renewable resource results in CO_2, SO_2, and NOx emissions, it is important to ensure that energy is used prudently and best management practices are adopted in hydel project design.

5.4.12 Community Health and Safety

a. General Site Hazards

Projects should implement risk management strategies to protect the community from physical, chemical, or other hazards associated with sites under construction.

Risks may arise from inadvertent or intentional trespassing, including potential contact with hazardous materials, contaminated soils and other environmental media, buildings that are under construction or excavations and structures which may pose falling and entrapment hazards.

Mitigation Measures

Risk management strategies may include:

- Access to the site will be restricted through a combination of institutional and administrative controls.
- Removing hazardous conditions on construction sites that cannot be controlled affectively with site access restrictions, such as covering openings to small confined spaces, ensuring means of escape for larger openings such as trenches or excavations, or locked storage of hazardous materials.

b. Disease Prevention

Increased incidence of communicable and vector-borne diseases attributable to construction activities represents a potentially serious health threat to project personnel and residents of local communities.

Mitigation Measures

- The mobility of the community living in the area will be restricted from the project site in order to prevent from catching any type of communicable diseases.
- Any laborer found to catch any type of disease will leave the site immediately; and would be given proper medical facilities.

c. Traffic Safety

Construction activities may result in an increase in movement of heavy vehicles for the transport of construction materials and equipment increasing the risk of traffic-related accidents and injuries to workers and local communities.

Mitigation Measures

- The incidence of road accidents involving project vehicles during construction will be minimized through a combination of education and awareness-raising, and the adoption of procedures.

5.5 Screening of Potential Impacts at Operation Phase

During operational phase of the project, various activities may have impact on some environmental parameters. Various environmental attributes are to be studied during this phase for their overall impact on the surrounding environment.

5.5.1 Flooding of Natural Habitat

Hydropower with reservoirs may permanently flood extensive natural habitats causing local or even global extinctions of animal and plant species. Very large hydroelectric reservoirs in the tropics are especially likely to cause species extinctions, although such losses are rarely documented due to lack of scientific data. Particularly hard-hit are riverine forests and other riparian ecosystems, which naturally occur only along rivers and streams. From the perspective of biodiversity conservation, terrestrial natural habitats lost to flooding are usually much more valuable than the aquatic habitats created by the reservoir.

Since the project does not involve any reservoir/pondage, no natural habitat will be affected.

5.5.2 Loss of Terrestrial Wildlife

Terrestrial wildlife will not be impacted as the project will not inundate the land for any reservoir, dam or pondage.

5.5.3 Involuntary Displacement

No displacement of people is involved as the project site is not inhabited.

5.5.4 Deterioration of Water Quality

Damming rivers can reduce water quality due to lower oxygenation and dilution of pollutants by reservoirs that are relatively stagnant compared to fast-flowing rivers. Also, flooding of biomass (especially forests) creates underwater decay; and due to reservoir stratification water quality can decline because deeper lake waters lack oxygen.

Since the project does not involve dam, water quality changes is not envisaged.

5.5.5 Downriver Hydrological Changes

Major downriver hydrological changes can destroy riparian ecosystems dependent on periodic natural flooding, exacerbate water pollution during low-flow periods, and increase saltwater intrusion near river mouths. Reduced sediment and nutrient loads downriver of dams can increase so-called river-edge and coastal erosion, and damage the biological and economic productivity of rivers and estuaries. Induced desiccation of rivers below dams (when the water is diverted to another portion of the river, or to a different river) kills fish and other fauna and flora dependent on the river; it can also damage agriculture and human water supplies.

The project does not involved induced desiccation of rivers or changing the river hydrology. Therefore no downriver hydrological changes are expected. The flow of canal will not be stopped and adequate water flow downstream will be ensured. Sindh Irrigation and Drainage Authority (SIDA) will be updated for any potential changes in the flow. The major project work will be completed during canal closure periods. Remaining work will be completed during low flow periods.

5.5.6 Fish and other Aquatic Life

Hydroelectric projects often have major effects on fish and other aquatic life. Reservoirs positively affect certain fish species (and fisheries) by increasing the area of available aquatic habitat. However, the net impacts are often negative because (a) the dam blocks upriver fish migrations, while downriver passage through turbines or over spillways is often unsuccessful; (b) many river-adapted fish and other aquatic species cannot survive in artificial lakes; (c) changes in downriver flow patterns adversely affect many species, and (d) water quality deterioration in or below reservoirs (usually low oxygen levels; sometimes gas super-saturation) kills fish and damages aquatic habitats. Freshwater mollusks, crustaceans, and other benthic organisms are even more sensitive to these changes than most fish species, due to their limited mobility.

The project does not involve a reservoir; nevertheless, the key concern in the area is the presence of Aquatic life. Key species are Indus River Dolphin (*Platanista gangetica*), Freshwater Turtles, Smooth-coated Otter and Marsh Crocodile.

Indus River Dophin is listed by International Union for Conservation of Nature (IUCN) as Endangered on their Red List of Threatened Species[5]. It is the second most endangered cetacean in the world and is endemic to the Indus River System in Pakistan. It is estimated that there are only about 1,200 individuals remaining[6]. Indus Dolphin survival is threatened due to several reasons. There are many threats to their survival. Reckless and extensive fishing that reduces their prey availability is a large factor. Also, they are sometimes accidentally entangled in the fishing nets which can cause fatalities. Deforestation that occurs along the river basin is causing sedimentation which degrades the dolphin's habitat. Another factor in their decline is the construction of cross-river structures such as dams and barrages. They affect as they cause more isolation in the already small sub-populations. Lastly, human induced water pollution is a major threat

[5] Smith, B. D. & G. T. Braulik (2008). "Platanista gangetica". IUCN Red List of Threatened Species. Version 2008. International Union for Conservation of Nature.
[6] Braulik, G.T. (2006). "Status assessment of the Indus river dolphin, Platanista gangetica minor, March–April 2001". Biological Conservation. 129 (4): 579–590.

factor. This pollution is usually in the form of either industrial and human waste, or agricultural run-off containing high amounts of chemical fertilizers and poisonous pesticides. Extensive pollution in the rivers and canals of Sindh province is also substantiated by Water Commission Report of 2017, formed by Supreme Court to investigate the quality of drinking water being provided to the populace of Sindh.

In 1972, Indus Dolphins were protected under the Wildlife Act of Sindh and in 1974 the government of Sindh declared the Indus River between the Sukkur and Guddu Barrages a dolphin reserve. The government of Punjab prohibited deliberate killing of dolphins in the Punjab Wildlife Protection Act in 1974 and established the Taunsa Wildlife Sanctuary and Chashma Wildlife Sanctuary in 1983 and 1984, respectively (Chaudhry 1989, Reeves et al. 1991, Reeves and Chaudhry 1998).

Shallow waters of Nara canal is not a favored habitat for Indus River Dolphin. However, during the annual closure of sukkur barrage for maintenance, pond formation on the banks of river lead the dolphins to slip into the canals.

Freshwater turtles of Pakistan are found in the entire Indus River system including its tributaries, irrigation canals, ponds and water reservoirs. Pakistan has eight species of freshwater turtles which dominate aquatic habitats, defined the in Baseline section. Freshwater turtles play a significant role in aquatic ecosystem being scavengers. These turtles are responsible for cleaning the aquatic environment by feeding upon dead organic material and diseased fish. Freshwater turtles being a keystone species, also control the population of fish. The major problem with existing wild populations of turtles in the Indus is caused by illegal trade in body parts of softshell species on commercial scale. Other threats to freshwater turtles in Indus include habitat deterioration and fragmentation due to unsustainable development; scarcity of water in rivers, canals and water diversion and extraction projects for irrigation purpose; and water pollution. Due to lack of awareness regarding ecological role of turtles in river ecosystems, turtles are perceived to be deleterious to fish economy by the fisher folk.

A large number of freshwater lakes and ponds of varying sizes are formed due to seepage of water along different canals and annual inundation of river in Sindh water during monsoon that provide suitable habitats for Smooth-coated Otter (*Lutrogale perspicillata*) (Khan et al. 2009). Historical distribution had been along Indus River and in the wetlands provided by its major canals. However, due to disturbance and habitat distruction, they are now found in quite a few locations. They have been reported in upper Nara canal in Khairpur district and lower Nara canal in Sanghar, among other locations (Khan et al. 2010).

Marsh Crocodiles (also Indus Crocodile; *Crocodylus palustris*) has been reported in Nara canal. Their main habitat is Nara Wetland Complex in Khairpur District (Ghalib et al. 2006). The wetland complex supports 198 marsh crocodiles out of 480 reported in Sindh province (Javed and Rehman, 2003).

Detailed mitigation measures have been proposed to minimize any impact on dolphins, turtles, otters, crocodiles and aquatic life.

Mitigation Measures

- Detailed consultations with the Sindh Wildlife Department (SWD), WWF-Pakistan and IUCN-Pakistan is required prior and during the execution and operation of the project. Consultation is vital during the annual closure of Sukkur Barrage as the dolphins and aquatic life tend to slip to Nara during that period.
- Regular monitoring should be ensured upstream and downstream of hydel project for the presence of aquatic life. If dolphin, turtles, otters or crocodile is found in the vicinity, concerned departments should immediately be informed for rescue.
- Fish passage facilities (fish ladders, elevators, or trap-and-truck operations) aim to help migratory fish move upriver past a dam but are usually of limited effectiveness due to the difficulty of ensuring safe downriver passage for many adult fish and fry. An indicated example of fish protection system for juvenile fish (fry) is depicted below;

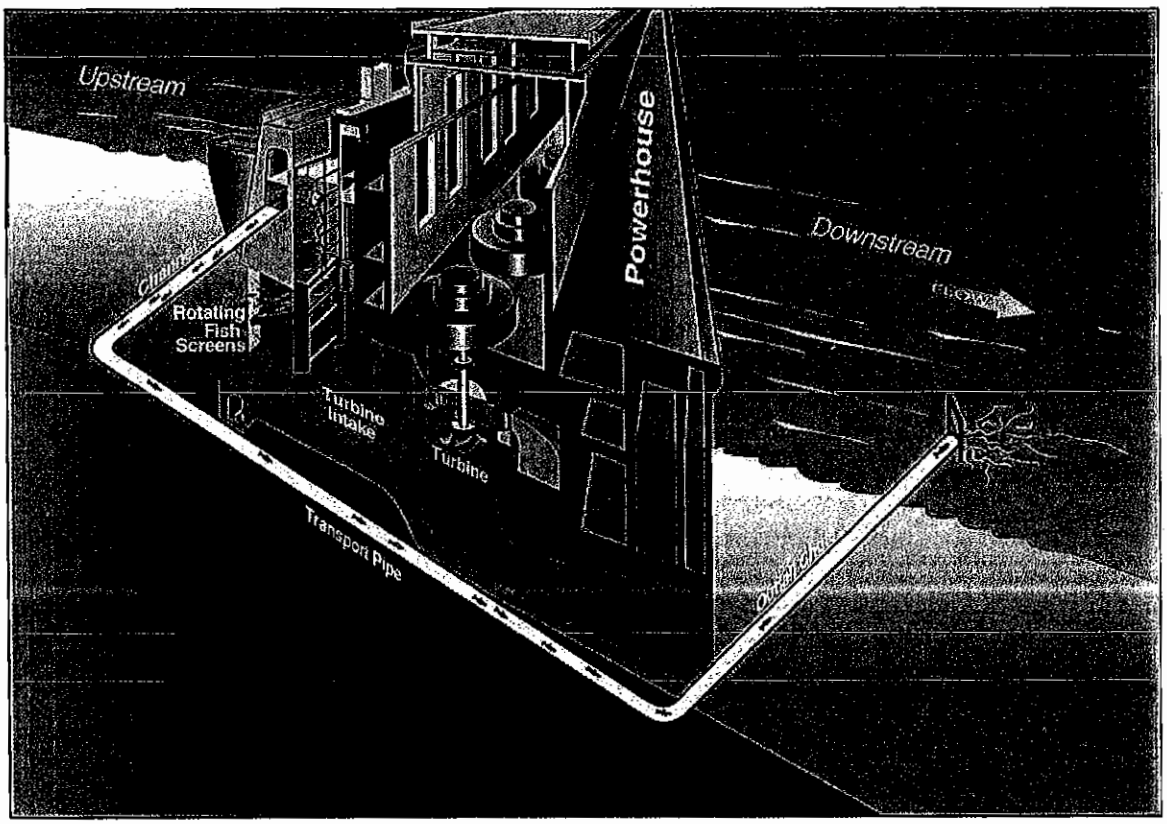


Figure 5.1: Typical Fish Passage Facility in Run of River Hydel Projects

- Fish ladders are another way that hydropower facilities mitigate impacts and help local wildlife to flourish. Structures like the one pictured below allow migrating fish to bypass the hydel power house by swimming up a series of shallow steps and into the waters on the other side of the structure. An indicative run-of-river hydel plant with fish ladder and fish bypass is depicted below;

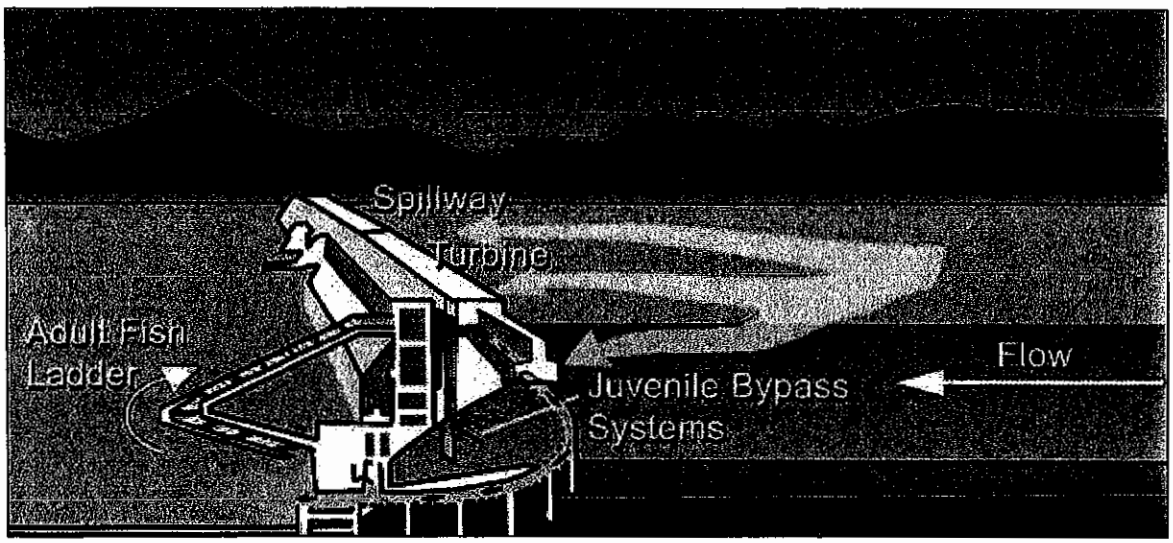


Figure 5.2: Fish bypass and Fish Ladder

- Fish Screens will be the part of water intake structure to minimize the possibility of fishes, turtles and aquatic life passing through waterway to the headrace and to the powerhouse. This will greatly reduce the chances of species mortality. An indicative diagram of fish screen is depicted below;

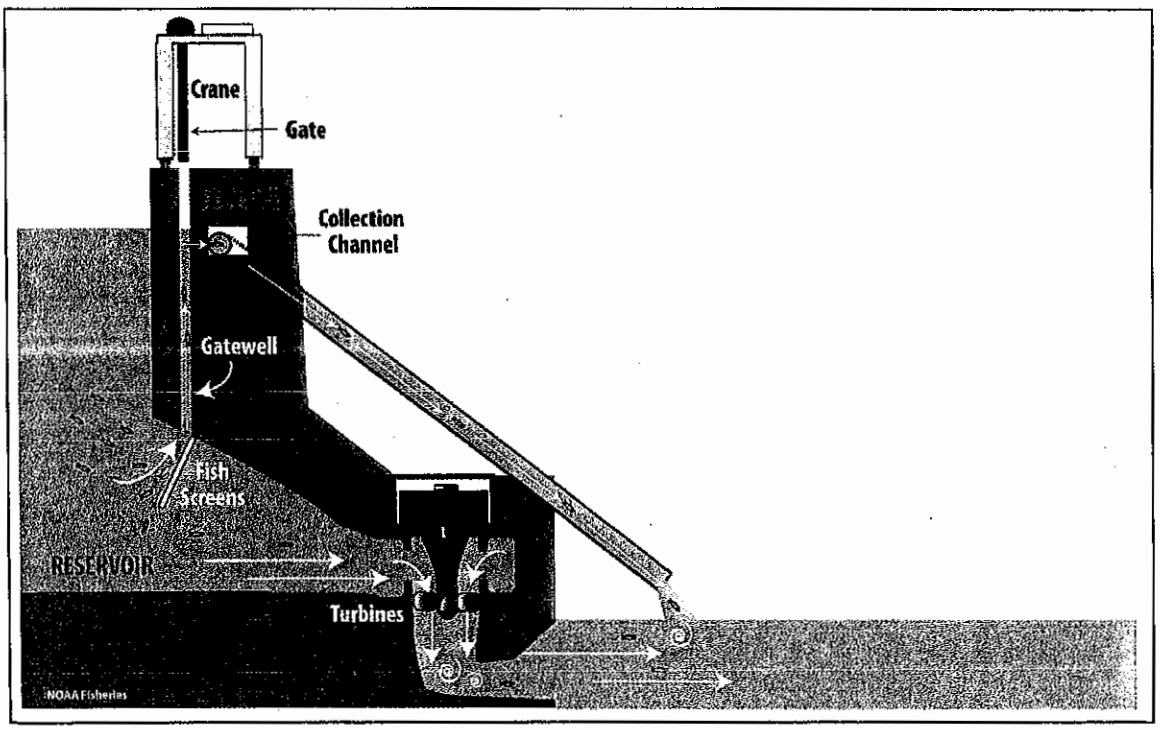


Figure 5.3: Example of Fish Screens

- There are currently a few organizations that are helping to conserve the Indus dolphin and Turtles. The World Wildlife Fund (WWF) is involved in rescue missions and helping to reduce pollution in the river in collaboration with Sindh Wildlife Department (SWD). In addition, WWF Pakistan is assisting in educating the public. Lastly, CITES (Convention on the International Trade of Endangered Species)

prohibits the hunting and trade of many endangered species, including this one. Regular discussion with such organizations will be fruitful for saving strayed dolphins.

5.5.7 Loss of Cultural Property

No cultural property exists in the microenvironment of project.

5.5.8 Greenhouse Gases

Greenhouse gases (carbon dioxide and methane) are released into the atmosphere from reservoirs that flood forests and other biomass, either slowly as flooded organic matter decomposes, or rapidly if the forest is cut and burned before reservoir filling. Greenhouse gases are widely considered to be the main cause of human-induced global climate change. Many hydroelectric reservoirs flood relatively little forest or other biomass. Moreover, most such hydro projects generate sufficient electricity to more than offset the greenhouse gases that would otherwise have been produced by burning fossil fuels (natural gas, fuel oil, or coal) in power plants.

Since the project does not involve reservoir, so there would be no additional generation of GHG rather energy generation from clean resource will save the emissions.

5.5.9 Air Emissions

Hydroelectricity is one of the cleanest energy generation technique by utilizing energy potential of flowing water. It does not generate air emissions or any direct waste.

5.6 Socioeconomic Impacts

Positive socioeconomic impacts are envisaged from the construction and operation of 13.65MW Nara Hydropower Project. Local skilled and unskilled labor will be hired during the construction phase of project. This would improve the quality of life of the nearby communities.

Table 6.1: Potential Environmental Impact during Different Stages of the Project

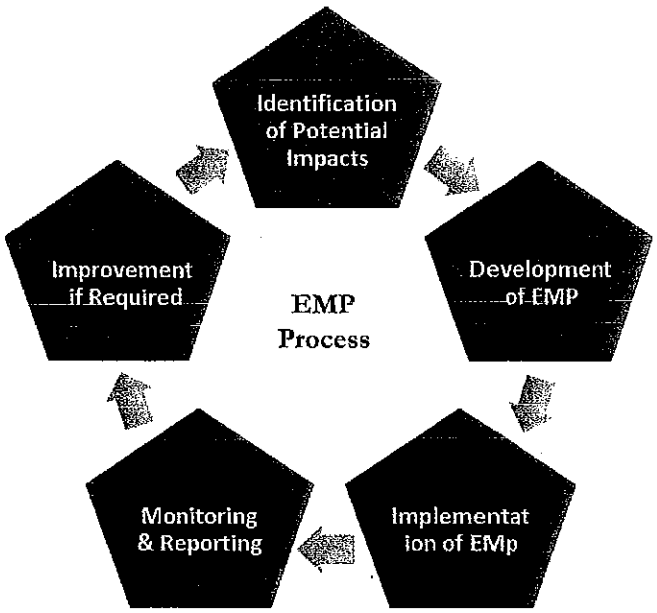
Actions Affecting Environmental Resources & Values	Damage to Environment	Recommended Mitigation Measures	Significance of Impact			
			None	Small	Medium	Major
Environmental Issues during Pre-Construction Phase						
Land Acquisition	Land will be acquired for the project by the proponent	N/A		X		
Structural Stability	Collapse during earthquake	Following the hydraulic and structural engineering standards		X		
Reduce Liquefaction Hazard	Loss of soil strength and stiffness	Building liquefaction resistant structures and improving the soil			X	
Threat to Biodiversity	Loss of flora and fauna	Protection measures regarding fish and flora will be undertaken during construction and operations phase		X		
Archaeological/Cultural/Protected Areas	No protected area or archaeological site is in the vicinity of project	N/A	X			
Environmental Issues during Construction Phase						
Site Clearance	Terrestrial vegetation may be removed for transformer/substation	Compensatory plantation for every tree removed for onsite works		X		
Soil Erosion	Soil degradation	Identification of soil properties, engineering constraints and careful associated planning			X	
Land Contamination	Land degradation due to oil and fuel spills	Adequate measures for the storage of fuel oil, lubricants and chemicals			X	
Ambient Air Quality	Air pollution due to dust emissions from earth works and gaseous emissions	Water sprinkling, vehicular maintenance			X	
Water Consumption	Inefficient water consumption will burden the already scarce resource of province	Water conservation		X		
Wastewater Generation and Disposal	Possibility of surface, groundwater contamination if disposed inadequately	Septic tank with soakage pit			X	
Solid Waste Generation & Management	Adverse effect on health of workers, soil pollution and deterioration of water resources if disposed inadequately	Waste segregation and disposal through certified waste management contractor			X	
Noise	Nuisance, hearing damage	Activity time management, use of noise control devices and measures		X		

Table 6.1: Potential Environmental Impact during Different Stages of the Project						
Actions Affecting Environmental Resources & Values	**Damage to Environment**	**Recommended Mitigation Measures**	**Significance of Impact**			
			None	**Small**	**Medium**	**Major**
Vehicular Traffic	Traffic nuisance, dust emissions	Traffic management plan will be implemented		X		
Energy Use	Air emissions from diesel generators	Prudent energy use			X	
Community Health & Safety	Hazards on project site may impact the health and safety of the nearby populace	Restricted access to site, disease prevention, education and awareness-raising			X	
Environmental Issues during Operation Phase						
Flooding of Natural Habitat	No damage to environment as no reservoir is constructed	N/A	X			
Loss of Terrestial Wildlife	Project will not impact terrestrial wildlife as it will not inundate the land	N/A	X			
Involuntary Displacement	No displacement is involved as the site is not inhabited	N/A	X			
Deterioration of Water Quality	Changes in water quality not envisaged as no dam or reservoir is built	N/A	X			
Downriver Hydrological Changes	The project will not induce desiccation of rivers or change the hydrology of canal	Collaboration with Sindh Irrigation and Drainage Authority		X		
Fish and other Aquatic Life	The key concern is Indus River Dolphin (*Platanista gangetica*) which strays or slips into the canal during annual closure of Sukkur Barrage	Detailed discussions with SWD, WWF, IUCN during the execution and operation of project; fish protection measures such as fish bypass, fish ladder and fish screens will be added; regular monitoring for any dolphin spotting			X	
Loss of Cultural Property	No cultural property exists in the microenvironment	N/A	X			
Greenhouse Gases	As no dam or reservoir is built, there would be no additional GHG emissions	N/A	X			
Socioeconomic	Positive impacts on local employment and living are envisaged	N/A			X	

Chapter 6 Environmental Management Plan (EMP)

6.1 Introduction

Environmental management plays a vital role in development of any project to ensure that all the phases of the proposed project are being carried out in environmentally sustainable way. While conducting an IEE potential environmental impacts are identified for the different phases (pre-construction, construction and operation phases in this case) of the projects and mitigation measures, management and monitoring practices, physical controls, or compensation in monetary terms are recommended to control and minimized the adverse impacts in acceptable limits.



To ensure environmentally sound development an Environmental Managements Plan (EMP) has been prepared and presented in this section. The management measures and site monitoring required to ensure that potential impacts are identified and minimized are presented in EMP. This plan is specific to the construction and operation of the proposed Project.

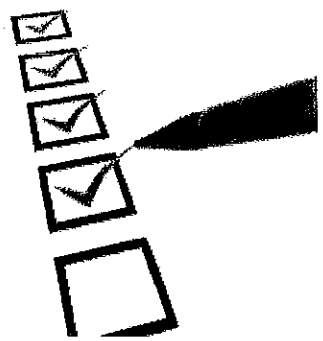
The EMP explains recommended mitigation and monitoring measures into specific actions that will be carried out by the proponent. The EMP satisfies the requirements of the Pakistan Initial Environmental Examination and Environmental Impacts Assessment Review Procedures, 2014

6.2 Objectives

The main objective of the EMP is to ensure a development in environment friendly manner with minimized adverse impacts and more project benefits.

The primary objectives of the EMP are to:

- Provide a hands-on outline regarding best practices, environmental management standards and guidelines to mitigate potential environmental impacts for each activity undertaken;
- Provide a mechanism to assist proponent and construction contractor to comply with current legislation;
- Provide ways identification of environmental issues and to provide general procedures which must be considered when undertaking construction and operational activities;



- Provide a mechanism to reduce the potential impacts of the construction and operation of the project
- Develop a monitoring mechanism and identify parameters that can confirm the implementation of the mitigation of these measures;
- Define roles and responsibilities of the project proponent for the implementation of EMP and identify areas where these roles and responsibilities can be shared with other stakeholders and
- Define the requirements necessary for documenting compliance with the EMP and communicating it to all concerned regulatory agencies.
- Identify training requirements at various levels and provide a plan for implementation.

For each impact, or activity, which could give rise to an impact, the following information is presented:

- Mitigation measure that will be implemented;
- The person(s) responsible for ensuring full implementation of the mitigation measure;
- The parameters that will be monitored to ensure effective implementation of the mitigation measure;
- The timing for the implementation of the action, to ensure that the objectives of the mitigation are fully met.

6.3 Structure of the EMP

The EMP consists of the following section.

- Legal Framework
- Organizational structure and roles and responsibilities;
- Emergency Response Plan
- Environmental aspects requiring management consideration;
- Mitigation management's matrix
- Environmental monitoring programme
- Change management plan
- Training Programme

6.4 Legal Framework

The IEE has discussed in detail all the Legal Framework (chapter 2) which has relevance to the project. Project Proponent shall ensure that the construction and operation of project is conducted in conformance to relevant legislations and guidelines and guidance is sought as and when required. Proponent shall also ensure that the key project management staff is aware of these legislations and guidelines. SEQS for municipal and industrial effluents, selected gaseous pollutants from industrial sources and motor vehicle exhaust and noise are provided in Section 2.

6.5 Organizational Structure and Roles and Responsibilities

6.5.1 Organizational Structure

The proposed project includes the following main organization:

- Nara Hydropower (Pvt.) Limited as the project proponent and owners of the EMP.
- The construction contractor as well as contractor required during the operational phase (e.g. waste contractor) as the executors of the EMP.

These organizations will have the following roles and responsibilities during the project activities.

6.5.2 Roles and Responsibilities

A. General

Nara Hydropower (Pvt.) Limited: As project proponents, Nara Hydropower (Pvt.) Limited will be responsible for ensuring the implementation of the EMP. A person holding a senior position will be responsible for the overall environmental performances during the proposed project. The person will be responsible for ensuring the implementation of the EMP by proponent and all project contractors. The proponent's Site Representative (SR) will be responsible of implementation of the EMP and liaison with project contractor and stakeholders at site regarding environmental issues during the construction phase. Further the person holding a senior position in Project Management will also be responsible for monitoring EMP's compliance and provided technical support in environmental issues.

Project Contractors: For the proposed project, Project Proponent will appoint construction contractors for different field operations. Various contractors will also be hired during the operation phase of the project (e.g. waste contractors) The contractors will be responsible for implementation of, or adherence to, all provisions of the IEE and the EMP and with any environmental and other codes of conduct required by Project Proponent. Overall responsibility of the contractor's environmental performances will rest with the person holding the highest management position within the contractor's organization reporting to their management. The contractor's site managers will be responsible for the effective implementation of the IEE and the EMP. The contractor's HSE officers will have functional responsibilities to ensure implementation of or adherence to the EMP.

Planning and Design of the Operations

Details of project Activities: Details of the project activities are provided in Chapter 3 of the IEE report. Following approval of the IEE, any changes to the proposed activities will be handled through the change Management Plan provided in this EMP.

Approvals: Obtaining no objection Certificate (NOC)/Approval from SEPA will not relieve the proponent from other legal obligation and hence Project Proponent and project contractors will obtain all other relevant clearance and necessary approvals required by the Government of Sindh and Relevant departments prior to commencing the respective operations.

Contractual Provision: Adherence to the requirements of the IEE and EMP in terms of environmental mitigation will be required from all project contractors and thus EMP will form part of their contractor with Project Proponent.

B. Implementation of the Operation

Co-ordination with Stakeholders: Project Proponent will ensure that co-ordination with the regulators and other stakeholders on environmental & social matters is maintained throughout construction & operation phase of the project.

Monitoring: Project Proponent and the contractors will ensure that monitoring of the project activities is carried out throughout the project. The Project Management site representative will monitor all project activities during the construction and operation phase. He will keep a record of all non-conformances observed and report these along with actions to Project Management for further action. The site representative will also report any impacts anticipated along with his recommendation for further action.

Emergency Procedures: Project Proponent and the contractors will prepare contingency plans to deal with any emergency situation that may arise during the construction and operation e.g. major oil spills, medical evacuation & communicate these to the regulatory agencies if required by these agencies.

Approvals: The project contractor will be responsible for obtaining all relevant approvals such as approvals for waste contractors, water source & others as specified in Mitigation Management Matrix.

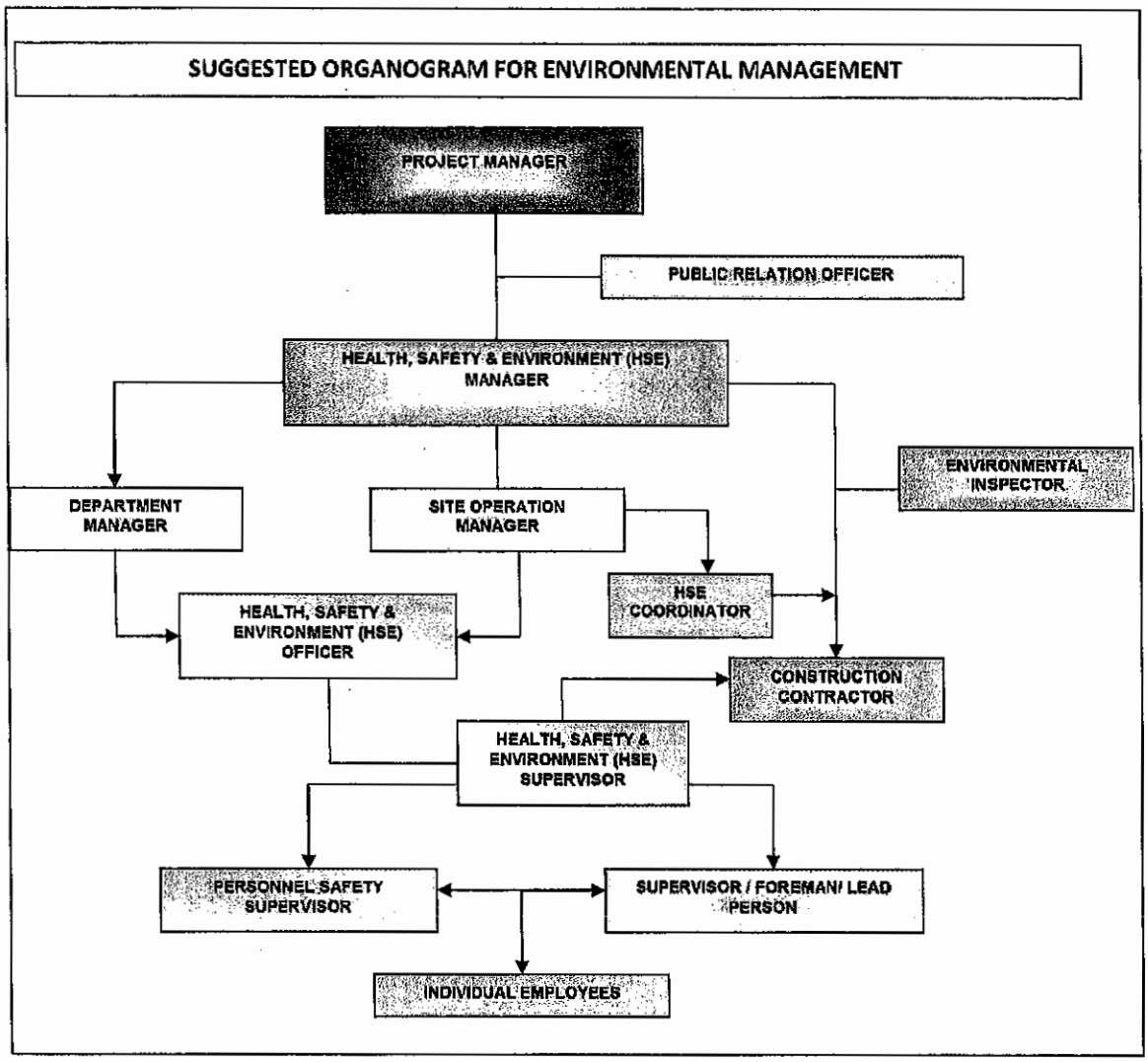
Trainings: The project contractors will be responsible for the selection and training of their staff capable of completing the project activities properly and efficiently. The contractors will be responsible for providing training to their staff members according to the training programme. The training programme is discussed briefly latter in this chapter.

C. Communication and Documentation

Project Proponent and the contractor will ensure that the communication and documentation requirements specified in the EMP are fulfilled during the construction and operation phase.

Change Management: The IEE for the proposed operation recognizes that changes in the operation or the EMP may be required during the project activities and therefore provides a Change Management Plan to manage such changes. Overall responsibility for the preparation of change management statements will be with Proponent's site representative.

Restoration: Project Proponent along with the construction contractor will be responsible for the final restoration of work areas.



6.6 Maintenance of the EMP

EMP needs to be revised on timely basis to keep up-to-date as per the requirements comes up regularly. Therefore, outlining the responsibilities and activities associated with the maintenance of the EMP is essential. The responsibilities of the Construction Contractor should be detailed and procedures for requesting EMP revisions should also be outlined. EMP revision procedures must include requirements for notification of the appropriate government and municipal agencies so that their role is also played in the overall management process.

6.7 Environmental Health and Safety Management System

Environmental, Health and Safety Management System is essential for the care of EHS issues which should outline mitigation measures and best management practices. This management system recommends carrying out a complete assessment, evaluating, monitoring, identifying and control all potential hazards and risks arise during the construction and operation phases of the proposed project. It needs to ensure that the Health and Safety Plan (HSP) along with the Health and Safety Rules is established and enforced. The Plan should outline roles, responsibilities and expected outcomes with respect to the environmental health and safety management

of the construction & operation phase of the Project. These measures should be implemented to ensure that no significant adverse environmental, health and safety impacts are created by activities associated with the construction of the project.

Protection of the public and workforce health and safety during both construction and operations is the prime responsibility of proponent. Utilizing expert personnel and the Environment, Health and Safety Management System (EHSMS), the potential health and safety hazards and risks will be identified and assessed, then the subject of substantial planning, organization, procedures for various facility are developed.

6.7.1 Health and Safety during Construction Phase

Worker Health & Safety Management Plan will also be outlined to implement mitigation measures and best management practices. The plan should be implemented to ensure that no significant adverse worker's health and safety issues arise from activities associated with the construction of the project.

Potential hazards for workers in construction include:

- Falls (from heights);
- Trench collapse;
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment; and
- Repetitive motion injuries.

6.7.2 Health and Safety during Operation Phase

Since proposed project is a hydel power project, occupational health & safety issues need to be addressed managed effectively to ensure safety of its workers in particular and the neighborhood in general.

6.8 Emergency Response Plan

Emergency may be defined as a sudden event causing or has the potential to cause serious human injury and /or environmental degradation of large magnitude. The best "cure" for an emergency is, of course, "prevention". The probable emergency situation can be:

- Serious fire or explosion
- Major gas leakage.
- Major Spillage
- Natural calamity such as heavy rain, flooding, dust storm or earthquake, cyclone, etc.
- Bomb threat or any sabotage / terrorist activity
- Any other incident involving all or large part of the premises and its workers.

Emergency Response Management is provided by a small team of senior managers (the "Control Committee") who in turn will direct all response activities through the Emergency Response Unit.

6.8.1 Objectives

The main objective of this plan is to establish the general guidelines for the actions to be taken in the event of fires, explosion, emergencies, accidents, disasters and sabotage, aimed at minimizing their effects and consequences, in order to protect:

- The lives of own or third-party personnel present in the project facilities.
- The lives of the occupants
- The lives of the nearby residents & communities coming into the direct influence of the project area.
- The lives of the ecological systems located in the surroundings of the Project.

6.8.2 Emergency Response Manuals

Based on the Risk Assessment the proponent should prepare written emergency preparedness and response plans/procedures for the project to cover emergency situations that could occur. It may be required that Emergency Response Manuals will be developed for various situations arising.

6.9 Standard Operating Procedures (During Construction phase)

6.9.1 Wastewater/ Storm water management

Purpose of Wastewater/storm water Management

The purpose of the adopted procedure is to provide guidelines and simplify the process of categorizing, quantifying, managing, and disposing of wastewater wherever and whenever arising during the project's construction phase. Wastewater management is a critical component of operating policies. Wastewater management includes the proper disposal/recycling and reuse of the wastewater generated during construction and operation phase.

Scope

Wastewater as part of construction operation will be managed as per this procedure. An integrated wastewater management system for proposed project is essential to reduce wastewater.

Substitute techniques must be investigated, including source reduction, recycling and reuse wherever possible with a view towards maximizing the benefits and minimizing the cost of each method of wastewater management.

Procedure

Main concern to manage the wastewater is listed below:

- Eliminate wastewater production wherever possible.

- Minimize wastewater production.
- Recycle or Reuse
- Wastewater disposal in an environmentally safe manner through adequately designed facility
- Proper drainage of Storm water

a) **Wastewater Minimization:** Generation of wastewater will be minimized through the following steps taken by working personnel at the facility:

- Through efficient use of raw water (minimizing the wastewater).
- Reuse of wastewater after treatment.

b) **Storage and Handling:** Wastewater shall be stored/retained in specifically designed facility or storage tanks till proper treatment and subsequently disposed off.

c) **Segregation:** Wastewater used in construction will be segregated from wastewater originating from latrines used by construction staff.

d) **Recycling:** Reuse of wastewater is a best way to reduce the quantity of the wastewater that requires subsequent treatment and disposal. Construction wastewater may be reused in construction activity because it is generally Non-hazardous.

e) **Treatment:** Wastewater originates from latrines used by construction staff requires treatment through retention in septic tanks and through soakage pits.

f) **Disposal:** Proper disposal should be done following the treatment through discharge into water bodies or sewerage system where available.

Wastewater Management Options

- All storm water run-off from construction sites will be inspected for the sediment load and may be directed to sedimentation basins to remove suspended solids (e.g., silt);
- Sewage may be collected and temporarily stored in tank(s) until it is transported to a designated treatment facility;
- Standard mobile sewage tankers may be engaged to collect and transport sewage from portable latrines and temporary storage tanks;
- Direct discharge will only be considered as a contingency option.

6.9.2 Solid Waste Management Plan

Purpose

The purpose of this procedure is to provide guidelines and simplify the process of categorizing, managing and disposing of solid wastes. Waste management includes the proper handling, collection, storage, manifesting, transportation, and disposal/recycling of the solid waste generated. The procedure is designed to assist in the

management's wide effort to provide protection to the environment and to comply with proponent's requirement, environmental laws and regulations regarding proper waste management.

Scope

The waste management plan has been developed to ensure that the Management of solid waste generated as a result of the construction is consistent, efficient, and in conformance with the laws and regulations.

With respect to monitoring, the waste management sets out the following objective:

- To monitor and inspect waste management-related facilities and activities directly resulting from executing the scope of the contract in order to ensure compliance with the WMP. Guidelines for proper handling, categorization, recording, minimization, recycling and disposal of all types of waste associated with company operations and projects are part of this procedure.

Definitions

a) **Waste:** Any material, for which no further use is intended, is considered a waste. It can be solid, semi-solid or liquid. Additionally, abandoned materials and materials intended to be recycled are considered wastes. It is very important to understand this concept, because even though something is going to be recycled, it must be managed as a waste until it is actually recycled.

b) **Hazardous Waste:** Waste is categorized as a hazardous waste if it has one or more of the following properties:

- Ignitability (flash point less than 60oC);
- Corrosivity (pH less than or equal to 2.0, or greater than or equal to 12.5);
- Reactivity (inherently unstable under ordinary conditions or when exposed to water);
- Irritability (when in contact with body causes inflammation)
- Toxicity (may cause risk of injury to health of organisms or the environment.)

c) **Non-hazardous Waste:** The wastes are categorized as non-hazardous wastes, if they do not possess any of the hazardous characteristics as defined above. However, non-hazardous waste may still present hazards to employees who handle them. All recommended safety and handling practices must be followed.

Procedure

Priorities to manage the waste are listed below:

- Eliminate waste production whenever and wherever possible. Use the material only for its intended purpose on site
- Minimize waste production
- Reuse

- Dispose of waste through properly designed waste disposal facility.

a) Waste Minimization: To minimize waste, the following steps shall be taken by all personnel working on sites (during construction phase):

- Only the needed amount of materials shall be ordered. Before purchasing hazardous material, all alternatives for non-hazardous material should be explored.
- Prior consideration shall be given to the sizes of containers available when ordering products that could potentially generate waste. The intent is to avoid unused products and/or their containers from becoming wastes that require special handling.

b) Waste Categorization: All wastes generated at facilities shall be categorized in two major categories (i.e. Hazardous wastes and Non-hazardous wastes) as per the definitions in section above. Each category has different types of requirement for handling, storage and disposal.

c) Labelling

- Name of the waste (e.g., waste oil, solvents, paints).
- Waste category (e.g., toxic, ignitable).
- Facility name and address (disposal site, etc.).
- Date of waste accumulation: (date when waste was placed in drum).
- Wastes are segregated and located in designated areas to optimize control; storage areas.

d) Segregation: The scheme of segregation is as follow:

- All hazardous waste if found shall be segregated from other types of hazardous wastes as well as non-hazardous wastes at the point of generation of waste.
- Food waste shall be collected in separate containers.
- All containers must be clearly labeled. The label must clearly mention the name or type of waste. Also, if the waste is hazardous, it should be clearly labeled on the container along with its hazardous characteristics (e.g. flammable, toxic, radioactive, etc.). This is important to workers and to emergency response teams, who need to know what they are dealing with. Missing or unreadable labels must be replaced.

e) Storage and Handling

- Waste shall be temporarily stored at waste storage facility that will be sent for recycling or off-site disposal shall be temporarily stored at designated site(s) within the project premises.
- The oily sludge, contaminated soil shall be stored in containers
- All other wastes awaiting disposal shall be kept in closed containers/boxes separately. Care must be taken to prevent wastes giving rise to secondary environmental problems, such as odors or soil and groundwater contamination through rainwater leaching.
- All stored wastes must be clearly labeled with type of waste and warning signs.
- Daily estimates of hazardous and non-hazardous waste and volumes generated on site.

- Waste segregation, waste storage containers, general housekeeping and the provision of adequate resources will be monitored.
- All workers handling wastes shall use proper PPE.

f) Reuse

Construction waste can be reused in other construction projects & excavated material can be reused in backfilling.

g) Disposal

Disposal becomes the only available alternatives, if reuse and recycling options are exhausted. A material should be classified as a waste for disposal only if no other useful purpose can be identified and if the material cannot be beneficially reused or recycled. The choice of a suitable disposal option for any waste depends on both environmental and economic considerations. The final disposal can only be off-site disposal facilities due to limited space available.

It requires properly designed and well-operated commercial waste disposal facilities such as sanitary landfill. All such facilities should be explored and evaluated for possible future use.

Recording & Reporting

The management has to record the information about source, composition, quantity, and final disposal of the waste. This information is needed for regulatory compliance, risk assessment and setting reduction targets and objectives as well as corporate statistics. The routine track of waste shall be recorded.

6.9.3 Air and Noise Emissions

Purpose

The purpose of this guideline is:

- To monitor contents of polluting substances in the atmospheric air;
- To control observance of approved limiting permissible emissions at man-made sources;
- To monitor natural sources and a number of man-made sources of emission at work sites at the construction phase;
- To identify sources of noise emissions and control noise pollution;
- To monitor noise emissions.

Scope

Scope of work includes:

- Evaluation of present ambient air quality and noise level at existing area.
- Evaluation of impact of traffic movement at the proposed site and noise level.

- Evaluation of impacts on roads and in the adjacent area due to construction.
- Evaluation of impacts of air emissions and noise from various stationary sources.
- Recommendations for mitigation techniques to redress the expected impacts both for design phase.

Definitions

Air pollution may be referred to as contamination of pollutants dispersed in air affecting ambient air quality that may be deleterious to life and property.

In common use, the word noise means unwanted sound or noise pollution. Excessive noise permanently damages hearing, but a continuous low-level sound can be dangerous too.

Procedure

Air emissions (continuous or non-continuous) from facilities such as power generators are comprising of principal gases (greenhouse gases) which typically include carbon monoxide (CO), carbon dioxide (CO_2), water vapors and other gases such as nitrogen oxides (NOx), and, in case of sour gases, sulphur dioxide (SO_2). Air quality impacts should be estimated by the use of baseline air quality assessments and atmospheric dispersion models to establish potential ground level ambient air concentrations during facility design and operations planning. These studies should ensure that no adverse impacts to human health and the environment result. All reasonable attempts should be made to maximize energy efficiency and design facilities to minimize energy use. The overall objective should be to reduce air emissions and evaluate cost-effective options for reducing emissions that are technically feasible.

Also, vehicular emissions and noise due to traffic movement in and around the project may of concern to be mitigated and monitored. Atmospheric conditions that may affect noise levels include humidity, wind direction, and wind speed. Vegetation, such as trees, and walls can reduce noise levels. Installation of acoustic insulating barriers can be implemented, where necessary.

Noise and Air Emissions Management Options

Noise and air emissions monitoring includes;

- Monitoring of air and noise emissions.
- Pollution control technology assessment,
- Emission inventory development,
- Development of parametric monitoring, periodic monitoring, and compliance assurance monitoring.

Air and Noise Quality Monitoring

Refer attached Environmental Monitoring Plan for details of air and noise quality monitoring at the proposed project site during construction phase.

a) **Performance Indicator:** Monitoring results of ambient air shall show the concentration of pollutant in ambient air.

b) **Record and Comments:** Record would be kept with the laboratory report attached. A layout of record keeping format for monitoring results is presented at the end of this EMP.

6.10 Standard Operating Procedures (During Operational Phase)

6.10.1 Wastewater Management

Purpose of Wastewater Management

The purpose of this procedure is to provide guidelines and simplify the process of categorizing, managing, and disposing of wastewater wherever and whenever arising during the project's operational phase. Wastewater management includes the proper disposal/recycling and reuse of the wastewater generated during operation phase.

Scope

Wastewater generation as part of operational activity will be managed as per this procedure. An effective wastewater management system for proposed project is essential to reduce wastewater. Substitute techniques must be investigated, including source reduction, recycling and reuse wherever possible with a view towards maximizing the benefits and minimizing the cost of each method of wastewater management.

Definitions

a) **Wastewater:** All water arising after use/consumption from the Project which can encompass a wide range of potential contaminants and concentrations.

b) **Non-hazardous Wastewater:** All wastewaters are categorized as non-hazardous wastes, if they do not possess any of the hazardous contaminant mainly comprising of consumed water arising from washing area and sanitary wastewater.

Procedure

Main concern to manage the wastewater is listed below:

- Eliminate wastewater production wherever possible.
- Minimize wastewater production.
- Recycle or Reuse
- Wastewater disposal in an environmentally safe manner through adequately designed facility

a) **Wastewater Minimization:** Generation of wastewater will be minimized through the following steps taken by working personnel at the facility:

- Through efficient use of raw water (minimizing the wastewater).

b) Storage and Handling: Wastewater shall be stored/retained in specifically designed facility or storage tanks till appropriate treatment is sought and subsequently disposed off.

c) Treatment

- Treatment of wastewater through retention in septic tanks and through primary and/or secondary treatment processes.

d) Disposal

Proper disposal should be done following the treatment through discharge into water bodies or sewerage system where available.

Drinking Water Quality and Wastewater Monitoring Plan

Refer attached Environmental Monitoring Plan for details of drinking water quality and wastewater monitoring plan.

a) Performance Indicator

Monitoring results of water quality shall show the extent of contamination in the drinking water and shall regulate and maintain the quality of potable water for establishing its suitability for human consumption as per SEQS for drinking water quality.

Monitoring results of wastewater quality shall show the lower concentration of pollutants in the sewage water after onsite treatment and reduced potential for contamination of ground water if not disposed of properly.

b) Record and Comments

Record of analysis reports shall be maintained.

6.10.2 Solid Waste Management Plan

Purpose

The purpose of this procedure is to provide guidelines and simplify the process of categorizing, managing, and disposing of solid wastes. Waste management is a critical component of management's operating policies. Waste management includes the proper handling, collection, storage, manifesting, transportation, and disposal / recycling of the solid waste generated.

Scope

The waste management plan has been developed to ensure that the Management of solid waste generated as a result of operation is consistent, efficient, and in conformance with the laws and regulations.

Definitions

a) **Waste:** Any material, for which no further use is intended, is considered a waste. It can be solid, semi solid or liquid. Additionally, abandoned materials and materials intended to be recycled are considered wastes. It is very important to understand this concept, because even though something is going to be recycled, it must be managed as a waste until it is actually recycled.

b) **Hazardous Waste:** Waste is categorized as a hazardous waste if it has one or more of the following properties:

- Ignitability (flash point less than 60°C);
- Corrosivity (pH less than or equal to 2.0, or greater than or equal to 12.5);
- Reactivity (inherently unstable under ordinary conditions or when exposed to water);
- Irritability (when in contact with body causes inflammation)
- Toxicity (may cause risk of injury to health of organisms or the environment.)

c) **Non-hazardous Waste:** The wastes are categorized as non-hazardous wastes, if they do not possess any of the hazardous characteristics as defined above. However, non-hazardous waste may still present hazards to employees who handle them. All recommended safety and handling practices must be followed.

Procedure

Priorities to manage the waste are listed below:

- Eliminate waste production whenever and wherever possible.
- Minimize waste production
- Reuse
- Dispose of waste through properly designed waste disposal facility.

a) **Waste Minimization:** To minimize waste, the following steps shall be taken by all personnel working on sites:

- Only the needed amount of materials shall be ordered. Before purchasing hazardous material, all alternatives for non-hazardous material should be explored.
- Prior consideration shall be given to the sizes of containers available when ordering products that could potentially generate waste. The intent is to avoid unused products and/or their containers from becoming wastes that require special handling.

b) **Waste Categorization:** All wastes generated at facilities shall be categorized in two major categories (i.e. Hazardous wastes and Non-hazardous wastes) as per the definitions in section above. Each category has different types of requirement for handling, storage and disposal.

c) Labelling

- Name of the waste (e.g., chemical waste, solvents, paints, biomedical etc.).
- Waste category (e.g., toxic, ignitable).
- Facility name and address (disposal site, etc.).
- Date of waste accumulation: (date when waste was placed in drum).
- Wastes are segregated and located in designated areas to optimize control; storage areas.

d) Segregation: As there are no hazardous wastes envisaged in the project therefore segregation among the waste will be done as per their matter.

The scheme of segregation is as follow:

- All hazardous waste if found shall be segregated from other types of hazardous wastes as well as non-hazardous wastes at the point of generation of waste.
- Laboratory chemical waste is also to be segregated into chlorinated and non-chlorinated solvents.
- Non- hazardous waste consists of containers, shipping cartons, bags, reject, broken bottles, rejected cartons, labels, strips, corrugated boxes, paper etc.

e) Storage and Handling

- All waste from floor and equipment is to be collected using vacuum cleaners.
- All containers must be properly and clearly labeled. The label must clearly mention the name or type of waste. Also, if the waste is hazardous, it should be clearly labeled on the container along with its hazardous characteristics (e.g. flammable, toxic, radioactive, etc.). This is important to workers and to emergency response teams, who need to know what they are dealing with. Missing or unreadable labels must be replaced.
- Non-hazardous waste shall be temporarily stored at waste storage facility that will be sent for recycling or off-site disposal shall be temporarily stored at waste storage facilities available at different sites such as junkyard, scrap yard, pits, etc.
- All other wastes awaiting disposal shall be kept in closed containers/boxes separately. Care must be taken to prevent wastes giving rise to secondary environmental problems, such as odors or soil and groundwater contamination through rainwater leaching.
- Daily estimates of hazardous and non-hazardous waste and volumes generated on site.
- Waste segregation, waste storage containers, general housekeeping and the provision of adequate resources will be monitored.
- All workers handling wastes shall use proper PPE.

f) Recycling: Non-hazardous waste can be recycled and reuse to minimize the quantity of waste requiring disposal. Some of the wastes (like one side printed paper) can be reused within the facilities while others can only be recycled at off-site recycling centers.

g) **Disposal:** Disposal becomes the only available alternatives, if reuse and recycling options are exhausted. Onsite burning or dumping of waste is strictly prohibited.

A material should be classified as a waste for disposal only if no other useful purpose can be identified and if the material cannot be beneficially reused or recycled. The choice of a suitable disposal option for any waste depends on both environmental and economic considerations. The final disposal can only be off-site disposal facilities due to limited space available.

The waste shall be disposed of through a contractor.

Recording & Reporting

The management has to record the information about source, composition, quantity, and final disposal of the waste. This information is needed for regulatory compliance, risk assessment and setting reduction targets and objectives as well as corporate statistics.

The routine track of waste shall be recorded. It is the responsibility of the proponent to assign a suitable person to sign off the record of waste tracking before the waste is dispatched outside.

6.11 Environmental Compliance Reporting, Documentation and Trainings

The management will be responsible for the regular audit and review of the environmental management and monitoring plan. This will include both on-site auditing and review of performance reports. Additional onsite inspections and investigations will be undertaken in the event of significant environmental incidents. These will be undertaken in conjunction with the Independent Monitoring Consultant (IMC).

The management will participate in the audits and inspections and investigations. The management will also be responsible for regular review of the environmental performance of the site and site personnel, and for the reporting on the implementation of commitments made in the EMP.

In particular, there will be:

- Periodic audit reports.
- A review and improvement of the EMP.

Management recognizes that periodic external compliance audits and inspections will be made through a third-party consultant (IMC) to monitor, assess and validate the level of performance and compliance pursuant to the commitments made in the accepted Environmental Management Plan. The monitoring reports shall also be submitted to Sindh Environmental Protection Agency (SEPA) on regular intervals.

Training: It an important step for the implementation of the EMP. All the employees will require to be trained to work appropriately on EMP. EHS Manager will organize trainings in consultation with HSE Officer. It will make sure that employees understand the Environment, Health and Safety issues. Trainings should be arranged on regular basis with notification that it should be attended all respective employees.

HSE Officer will determine the training requirements during both phases. Induction will be the basis of all training courses for contractor & subcontractor during construction phase.

Trainings identified in EMP are given below:

- Site induction course
- Training for emergency response and preparedness
- Training for familiarization with site environmental controls

Specific environmental training for relevant employees e.g. daily checks to maintain controls, waste minimization, etc.

6.12 Mitigation Management Matrix

The Mitigation Management Matrix will be used as a management & monitoring tool for implementation of the mitigation measures required by the IEE. Mitigation management matrix for construction and operation is provided in the table 7.1. The matrix lists down the following:

- The mitigation measure recommended in the IEE.
- The person/organization directly responsible for adhering to or executing the required mitigation measures.
- The parameters which will be monitored to ensure compliance with the mitigation measures;
- The timing at which the mitigation or monitoring has to be carried out.

It is highlighted that although responsibilities for executing and monitoring mitigation measures have been delegated to different persons, Project Proponent will hold the primary and overall responsibility for ensuring full implementation of the EMP.

6.13 Environmental Monitoring Programme

The objective of the environmental monitoring during the construction & operation phase will be as follows:

- To check compliance of the contractors with the EMP by monitoring activities of the project on a daily basis. This will be called compliance monitoring.
- To monitor impacts of the operation in which there has been a level of uncertainty in prediction such as impacts of noise, water abstraction etc. and to recommend mitigation measures if the impacts are assessed to be in excess of or different from those assessed in the IEE. The aim will be attained through effects monitoring.
- To achieve these objectives, the following monitoring programme will be implemented.

6.14 Compliance Monitoring

Compliance monitoring will be carried out to ensure compliance with the requirements of the IEE and to document and report all non-compliances. The mitigation management matrix provided in the EMP will be

used as a management and monitoring tool. The contractor's HSE Officer will be responsible for monitoring the compliance of their organization with the relevant EMP requirements. Proponent's site representative will monitor the contractor's compliance and will also ensure that during construction each activity system and plan is in place for effective compliance monitoring. The site representative will make regular checks on the contractor's works; keep records of all non-compliances observed during the execution of the project activities; & the details of all remedial actions taken to mitigate the project impacts.

6.14.1 Effects Monitoring

The effects monitoring requirements have been detailed in Table 7.2. An independent monitoring consultant (IMC) will be responsible to carry out the required effects monitoring during the construction and operation phase.

6.14.2 Environmental Reporting

A. Final Monitoring Report (Construction Phase)

After completion of construction phase, a final monitoring report will be prepared by Proponent's site representative. The report will include the following:

- Introduction.
- Details of the Project Activities.
- Natural Resource used during the Project.
- List of Non-compliances recorded.
- Effects of the Project on Communities and Physical Resources.
- Photographic Records
- Approvals provided during the project
- Change managements statements
- Trainings
- Conclusions

B. Annual Environmental Monitoring Reports (Operation Phase)

The project proponent shall prepare annual environmental monitoring reports describing the conduct of the operation phase for project along with details of the effects monitoring conducted annually during the operation phase of the project. The report shall be submitted to the SEPA.

6.15 Change Management Plan

The IEE for the proposed project recognizes that changes in the operation or the EMP may be required during the construction and operation and therefore provides a Change Management Plan to manage such changes. The management of changes is discussed under two separate headings, Additions to the EMP and Changes to the Operation and the EMP.

6.15.1 Changes to the EMP

The IEE and the EMP have been developed based on the best possible information available at the time of the IEE study. However, it is possible that during the conduct of the proposed operation additional mitigation measures based on the findings of environmental monitoring during the operation may have to be included in the EMP. In such cases following actions will be taken:

- A meeting will be held between Project Proponent and the concerned project contractors. During the meeting, the proposed addition to the EMP will be discussed and agreed upon by all parties.
- Based on the discussion during the meeting, a change report will be produced collectively, which will include the additional EMP clause and the reasons for the addition.
- The report will be signed by all parties and will be filled at the site office: A copy of the report will be sent to Project Proponent and contractor head offices.
- All relevant project personnel will be informed of the addition.

6.15.2 Changes to the Operation

The change management system recognizes three orders of changes:

A. First Order:

A first order change is one that leads to a significant departure from the project described or the impacts assessed in the IEE and consequently require a reassessment of the environmental impacts associated with the change. Example of first order change includes change in location of proposed project. Action required in this case will be that the environmental impacts of the proposed change will be reassessed by Project Proponent and sent to the SEPA for approval.

B. Second Order

A second order change is one that does not result in the change in project description or impacts that are significantly different from those detailed in the IEE. Example of second order changes includes extension in the site area. Action required for such changes will be evaluated by proponent to reassess the impact of the activity on the environment & specify additional mitigation measures if required and report the changes to SEPA.

C. Third Order

A third order change is one that does not result in impacts above those already assessed in the IEE, rather these may be made site to minimize the impact of an activity such as:

- Increase in project workforce;
- Change in layout plan.

The only action required for such changes will be to record the change in the Change Record Register.

6.16 Training Programme

Environmental training will form part of the environmental management system. The training will be directed towards all personnel for general environmental awareness.

6.16.1 Objectives

The key objective of training programme is to ensure that the requirements of the EMP are clearly understood and followed throughout the project. The trainings to the staff will help in communicating environmental related restrictions specified in the IEE and EMP.

6.16.2 Roles and Responsibilities

The contractors will be primarily responsible for providing environmental training to all project personnel on potential environmental issues of the project. The contractors will be responsible to arrange trainings and ensure the presence of targeted staff.

6.16.3 Training Programme

The environmental awareness, IEE and EMP training will be carried out during the project activities.

A. Training log

A training log will be maintained by tine contractors. The training log will include:

- Topic
- Date, time and location
- Trainer
- Participants

B. Training Needs Assessment

In addition to the training specified in the training log special/additional trainings will be provided during the project activity. The criteria to assess the need of training will be based on the following:

- When a specified percentage of staff is newly inducted in the project
- When any non-compliance is repeatedly reported refresher, training will be provided regarding that issue.
- When any incident/accident of minor or major nature occurs. Arrival of new contractor/sub-contractor.
- Start of any new process/activity.

C. Training Material

The contractors will develop & prepare training material regarding environmental awareness, sensitivity of the area, IEE, EMP and restrictions to be followed during the project. Separate training material will be prepared for each targeted staff.

Table 6.1: Environmental Management Plan (EMP)

S.#	Impact and Mitigation Measures	Responsibilities	Monitoring	Timing
1	**Land Use and Soils**			
1.1	The construction activities will be planned to minimize disturbance to soil	Project Proponent, CC	Monitoring compliance	During construction phase
1.2	To the extent possible, equipment and materials would be staged in areas that have already been disturbed	Project Proponent, CC	Monitoring compliance	During construction phase
1.3	Movement of construction equipment will be restricted to work areas only to avoid unnecessary disturbance to soil	CC	Monitoring compliance	During construction phase
1.4	Routes of water tankers, dumper trucks and other project vehicles will be monitored for any signs of soil disturbance & road damage	CC	Monitoring compliance	During construction phase
1.5	Area showing signs of unsterilized soil conditions will be compacted and watered	Project Proponent, CC	Monitoring compliance	During construction phase
1.6	Proper drainage will be provided to construction camp, construction site, especially near excavations and around proposed facility	CC	Monitoring compliance	During construction phase
1.7	Vehicle speed will be regulated and monitored to avoid excessive dust emissions	CC	Monitoring compliance	During construction phase
1.8	Total land uptake by the project and associated facilities will be kept to the minimum	Project Proponent, CC	Monitoring compliance	During construction phase
1.9	Periodic trainings will be provided to drivers on mitigation measures related to off-road travel and speed limits	Project Proponent, CC	Check training records	During construction phase
1.10	The Project will have a storm water collection system so that the storm water effluent has minimal sediment load	Project Proponent, CC	Monitoring compliance	During design and construction phase
2	**Air Quality**			
2.1	**Dust Emissions**			
2.1.1	Water will be sprinkled daily or when there is an obvious dust problem on all exposed surfaces to suppress emission of dust. Frequency of Sprinklings will be kept such that the dust remains under control, particularly when wind is blowing towards the receptors	CC	Monitoring compliance	During construction phase
2.1.2	Dust emissions from soil piles and aggregate storage stockpiles will be reduced by appropriate measures. These may include: → Keeping the material moist by sprinkling of water at appropriate frequency → Erecting windshield walls on three sides of the piles such that the wall project 0.5m above the pile, or → Covering the pile, for example with tarpaulin or thick plastic sheets, to prevent emissions. → Locating stock piles out of the wind direction	CC	Monitoring compliance	During construction phase

2.1.3	All roads within the proposed Project will be paved as early as possible after the commencement of construction work. Until the roads are paved, they will be sprinkled regularly to prevent dust emission. Other temporary tracks within the site boundary will be compacted and sprinkled with water during the construction works.	Project Proponent, CC	Monitoring compliance	During construction phase
2.1.4	Project traffic will maintain a maximum speed limit of 20km/hr on all unpaved roads within the proposed site area.	Project Proponent, CC	Check speed of vehicles	During construction phase
2.1.5	Construction materials that are susceptible to dust formation will be transported only in securely covered trucks to prevent dust emission during transportation.	CC	Monitoring compliance	During construction phase
2.1.6	The exposure of construction workers to dust will be minimized by provision of dust masks.	CC	Check for dust masks	During construction phase
2.2	**Vehicle, Equipment and Exhaust.**			
2.2.1	All vehicles, generators and other equipment used during the construction will be properly tuned and maintained in good working condition in order to minimize emission of pollutants.	Project Proponent, CC	Maintenance records of vehicles and equipment	During construction phase
2.2.2	The stack height of the generators during operation phase will be vented through vertical stacks to minimize exposure at ground level	CC	Monitor compliance	During construction phase
2.3	**Generator Emissions**			
2.3.1	The option of using natural gas as fuel in the back-up generators should be explored.	Project Proponent, Generator Vendor	Monitor compliance	During design phase
2.3.2	The generator will be properly tuned and maintained in good working condition in order to minimize exhaust emissions	Project Proponent	Check maintenance records	During construction phase
2.3.3	NOx emission reduction techniques should be employed on a regular basis	Project Proponent	Monitor NOx emission	During construction phase
3	**Construction Noise**			
3.1	Reduce equipment noise at source by proper design, maintenance and repair of construction machinery and equipment	Project Proponent, CC	Check maintenance records	During construction phase
3.2	Minimize noise from vehicles and power generators by use of proper silencers and mufflers.	Project Proponent, CC	Monitor compliance	During construction phase
3.3	Use noise-abating devices wherever needed and practicable.	Project Proponent, CC	Monitor compliance	During construction and operations phase
4	**Water Sourcing**			
4.1	A complete record of water consumption during construction and operation phase will be maintained	Project Proponent, CC	Check water consumption records	During construction and operation phase
4.2	Water conservation program will be initiated to prevent wastage of water.	Project Proponent, CC	Monitor compliance	During construction and operation phase
4.3	Recycle grey water for use for toilet flushing	Project Proponent	Monitor compliance	During operation phase
5	**Soil Contamination**			

5.1	Fuels, lubricants, and chemical will be stored in covered bounded areas	Project Proponent, CC	Monitor compliance	During construction phase
5.2	Maintenance of vehicles and equipment will only be carried out designated areas. The area will be provided with hard surface or tarpaulin will be spread on the ground to prevent contamination of soil	Project Proponent, CC	Monitor compliance	During construction phase
5.3	Vehicles will only be washed at designated areas.	CC	Vehicle Inspection record	During construction phase
5.4	Regular inspections will be carried out to detect leakage in construction vehicles and equipment	Project Proponent, CC	Check inspection / maintenance records	During construction phase
5.5	Appropriate arrangements, including shovels, plastic bags and absorbent materials, will be available near fuel and oil storage areas	CC	Monitor compliance	During construction phase
5.6	Contaminated soil will be removed and properly disposed after treatment such as incineration etc.	Project Proponent, CC	Monitor compliance	During construction phase
6	**Traffic**			
6.1	A Traffic Management Plan for the site will be made to ensure unobstructed traffic flow and that it would cause least nuisance to nearby populace	Project Proponent	Monitor compliance	During construction phase
6.2	Heavy traffic during construction phase will come to the project site during late night hours.	Project Proponent, CC	Traffic record	During construction phase
6.3	Project vehicles shall not be fitted with pressure horns	CC	Monitor compliance	During construction phase
6.4	During construction, regulate speed of vehicles	Project Proponent, CC	Monitor compliance	During construction phase
6.5	Designated parking areas will be provided for different type of project vehicles within and around the project site	Project Proponent, CC	Monitor compliance	During construction phase
6.6	Manage vehicle movement to avoid traffic jam and long queues	Project Proponent, CC	Monitor compliance	During construction phase
6.7	Prepare, implement and monitor the traffic management plan	Project Proponent	Monitor compliance	During construction phase
6.8	Vehicles to use designated parking areas during operational phase.	Project Proponent	Monitor compliance	During operation phase
7	**Wastewater Generation**			
7.1	**Wastewater Generation During Construction**			
7.1.1	Wastewater generated at the campsites will be stored temporarily in septic systems comprising of septic tanks from where it will be routed to a nearest drain/sewerage system.	Project Proponent, CC	Monitor compliance	During construction phase
7.1.2	At the time of restoration, septic tanks will be dismantled in place and backfilled with at least 1m of soil cover above the surrounding natural surface level	CC	Monitor compliance	After the completion of construction phase
7.2	**Wastewater Generation During Operation**			

7.2.2	Black water will be temporary stored in septic tanks and will be discharged into a nearby out fall sewer via trunk sewer	Project Proponent, CC	Monitor compliance	During design, construction & operation phase
7.2.3	Waste segregation measures would be employed to minimize entry of solid waste into the wastewater stream	Project Proponent	Monitor compliance	During operation phase
7.2.4	Water conservation strategies will be employed to avoid wastage of water	Project Proponent	Monitor compliance	During operation phase
8	**Solid Waste Generation and Management**			
8.1	**Solid Waste Generation and Management During Construction**			
8.1.1	Separate bins will be placed for different types of wastes- plastics, paper, metal, glass, wood, and cotton.	Project Proponent, CC	Monitor compliance	During construction phase
8.1.2	Recyclable material will be separated at source. The recyclable waste will be sold to waste contractors for recycling	Project Proponent, CC	Monitor compliance	During construction phase
8.1.3	Non-hazardous non-recyclable wastes such as construction camp kitchen wastes will be disposed of in landfill site through municipal administration or approved waste contractor.	Project Proponent, CC	Monitor compliance	During construction phase
8.1.4	No waste will be dumped at any location outside the proposed site boundary.	Project Proponent, CC	Monitor compliance	During construction phase
8.1.5	All hazardous waste will be separated from other wastes. Hazardous wastes will be stored in designated areas with restricted access and proper marking. Hazardous wastes will be disposed off through approved waste contractors.	Project Proponent, CC	Check hazardous waste disposal records	During construction phase
8.1.6	Surplus construction materials including partially filled chemical and paint containers will be returned to suppliers. Inert construction wastes will be disposed off onsite as fill material or sold as scrap to contractors.	Project Proponent, CC	Check waste records	During construction phase
8.1.7	Records of all waste generated during the construction period will be maintained. Quantities of waste disposed, recycled, or reused will be logged on a Waste Tracking Register	Project Proponent, CC	Check waste record register	During construction phase
8.1.8	Training will be provided to personnel for identification, segregation, and management of waste	Project Proponent, CC	Check training records	During construction phase
8.2	**Solid Waste Generation and Management During Operation**			
8.2.1	Waste generation will be minimized by adopting waste management strategy of reduce, reuse and recycle	Project Proponent	Monitor compliance	During operation phase
8.2.2	A waste management plan will be prepared, implemented and monitored for the safe collection, storage and treatment/disposal of the project waste	Project Proponent	Monitor compliance	During operation phase
8.2.3	Records of all waste generated will be maintained. Quantities of waste disposed, recycled, or reused will be logged on a Waste Tracking Register	Project Proponent	Check waste tracking register	During operation phase
8.2.4	Training will be provided to personnel for identification, segregation, and management of waste	Project Proponent	Check training records	During operation phase

8.2.5	All inert and non-hazardous construction wastes will be disposed to the existing tipping sites within or outside of the city limits	Project Proponent, Waste Contractor	Monitor compliance	During operation phase
8.2.6	Various waste containers for waste collection should be placed at appropriate locations in the project site	Project Proponent	Monitor compliance	During operation phase
9	**Seismicity**			
9.1	No specific mitigation measures other than to construct the facility in accordance with hydraulic and structural engineering standards	Project Proponent, Structure Design Consultant, CC	Monitor compliance	During project design phase
10	**Sustainability**			
10.1	Best practice of energy efficiency will be incorporated in the project design	Project Proponent, CC	Monitor compliance	During project design phase
11	**Fish and Aquatic Life**			
11.1	Detailed consultations with the Sindh Wildlife Department (SWD), WWF-Pakistan and IUCN-Pakistan is required during the execution and operation of the project. Consultation is vital during the annual closure of Sukkur Barrage as dolphin tends to slip to Nara during that period. Regular monitoring should be ensured upstream and downstream of hydel project for the presence of dolphins and turtles. If dolphin is found in the vicinity, concerned departments should immediately be informed for rescue. Fish passage facilities (fish ladders, elevators, or trap-and-truck operations) aim to help migratory fish move upriver past a dam but are usually of limited effectiveness due to the difficulty of ensuring safe downriver passage for many adult fish and fry. Fish ladders are another way that hydropower facilities mitigate impacts and help local wildlife to flourish. Structures like the one pictured below allow migrating fish to bypass the hydel power house by swimming up a series of shallow steps and into the waters on the other side of the structure. Fish Screens will be the part of water intake structure to minimize the possibility of fish and turles passing through waterway to the powerhouse. This will greatly reduce the chances of fish and turtles mortality. There are currently a few organizations that are helping to conserve the Indus dolphin and Turtles. The World Wildlife Fund (WWF) is involved in rescue missions and helping to reduce pollution in the river in collaboration with Sindh Wildlife Department (SWD). In addition, WWF Pakistan is assisting in educating the public. Lastly, CITES (Convention on the International Trade of Endangered Species) prohibits the hunting and trade of many endangered species, including this one. Regular discussion with such organizations will be fruitful for saving strayed dolphins.	Project Proponent, CC	Monitoring dolphins and fish population	During project construction and operation phases

12	**Socio-Economic Impacts**			
12.1	Employment preference will be given to locals of the project area	Project Proponent, CC	Monitor compliance	During construction & operation phase
12.2	Local contractors will be given preference for hiring equipment and machinery during operation	Project Proponent, CC	Monitor compliance	During construction & operation phase
12.3	Ensure maximum quantity of water to be treated and reused in order to lessen its burden on the existing resource.	Project Proponent	Monitor compliance	During design, construction & operation phase
12.4	Locals, surrounding business and city government are kept on the same page during all stages of the development of the project.	Project Proponent	Monitor compliance	During construction phase
12.5	A complaint register will be maintained on site during construction to record complaints of the nearby residents.	Project Proponent	Provision of complaint register	During construction phase
Legend: CC: Construction Contractor				

Table 6.2: Environmental Monitoring Plan

Ambient Air Quality Sampling Plan					
Phase	**Parameters**	**Locations**	**Frequency**	**Duration**	**Standards**
Construction	SOx, NOx, CO, O_3, PM_{10}	At the interface of project site and residential community	Quarterly	Continuous for 8 hours* in a full working day	SEQS (Sindh EPA)
Drinking Water Quality Sampling Plan					
Stages	**Parameters**	**Locations**	**Frequency**	**Duration**	**Standards**
Construction	Heavy metals, TDS, TSS, pH, Total Coliform, Faecal Coliform	Drinking water sources	Monthly	Grab sampling	SEQS
Operation	Heavy metals, TDS, TSS, pH, Total Coliform, Faecal Coliform	Drinking water sources	Monthly	Grab sampling	SEQS
Wastewater Quality Sampling Plan					
Stages	**Parameters**	**Locations**	**Frequency**	**Duration**	**Standards**
Construction	BOD, COD, TSS, TDS, pH, NO_3, SO_4, Oil & Grease)	Camp site discharge points into drains	Monthly	Grab sampling	SEQS (Sindh EPA)
Operation	BOD, COD, TSS, TDS, pH, NO_3, SO_4, Oil & Grease)	Effluent from wastewater treatment facility	Monthly	Composite sampling / Grab sampling	SEQS (Sindh EPA)
Noise Level Sampling Plan					
Stages	**Parameters**	**Locations**	**Frequency**	**Duration**	**Standards**
Construction	Decibels [dB(A)Scale]	At the interface of project site & residential community	Monthly	Continuous for 8 hours in a full working day	WHO Noise Guidelines
		7 m from the equipment at construction site			
Operation		At the interface of project site & facing road	Monthly		SEQS for Noise (Sindh EPA)
		7 m from the equipment at construction site			
Solid Waste					
Stages	**Parameters**	**Locations**	**Frequency**	**Duration**	**Standards**
Construction	Waste generation rate, waste composition; recyclables and non-recyclables, hazardous waste	At main solid waste collection point from where the waste is transported from site	Monthly	24 hour sample collected during week days	EPA
Operation	Waste generation rate, waste composition; recyclables and non-recyclables	At waste transfer facility of the project site prior to off-site disposal	Quarterly	24 hour sample collected during week days and holidays	EPA

Table 6.3: Sample Forms for Ambient Air Quality Monitoring Record						
Items		Measured Value (Mean)	Measured Value (Max.)	SEQS	Remarks (Measurement Point, Frequency, Method, etc.)	Comments*
SO_2	Annual Average			80 µg/m³		
	24 hours			120 µg/m³		
NO_2	Annual Average			40 µg/m³		
	24 hours			80 µg/m³		
NO	Annual Average			40 µg/m³		
	24 hours			40 µg/m³		
CO	8 hours			5.0 mg/m³		
	1 hour			10 mg/m³		
Lead Pb	Annual Average			1.0 µg/m³		
	24 hours			1.5 µg/m³		
O_3	1 hour			130 µg/m³		
	Annual Average			360 µg/m³		
Suspended particulate matter SPM	Annual Average			360 µg/m³		
	24 hours			500 µg/m³		
Respirable particulate matter PM_{10}	Annual Average			120 µg/m³		
	24 hours			150 µg/m³		
Respirable particulate matter $PM_{2.5}$	Annual Average			40 µg/m³		
	24 hours			75 µg/m³		

* (H=High, L=Low)

Table 6.4: Stack Emissions							
		CO, SO_x, NO_x, Smoke					
Location	**S.No.**	**Parameters**	**Date**	**Time (Hrs:Min)**	**Result (mg/Nm³)**	**SEQS (mg/Nm³)**	**Comments***
	1	CO				800	
	2	SO_x				1700	
	3	NO_x				600	
	4	Smoke				40% or 2 Ringlemann Scale or equivalent smoke number	
	5	PM_{10}				500	

* (H=High, L=Low)

Table 6.5: Sample Forms for Waste Water Quality Monitoring Record

Item	Unit	Measured Value (Mean)	Measured Value (Max.)	SEQS	Remarks (Measurement Point, Frequency, Method, etc.)
pH	pH			6-9	
TSS(Total Suspended Solids)	mg/L			150	
TDS(Total Dissolved Solids)	mg/L			3500	
BOD5	mg/L			80	
COD	mg/L			150	
Oil and Grease	mg/L			10	
Phenols	mg/L			0.1	
Chloride	mg/L			1000	
Cyanide	mg/L			2	
Sulphate	mg/L			600	
Sulphide	mg/L			1.0	
Ammonia	mg/L			40	
Fluoride	mg/L			10	
Pesticides	mg/L			0.15	
Cadmium	mg/L			0.1	
Chromium	mg/L			1.0	
Copper	mg/L			1.0	
Lead	mg/L			0.5	
Mercury	mg/L			0.01	
Selenium	mg/L			0.5	
Nickel	mg/L			1.0	
Total Toxic metals	mg/L			2.0	
Zinc	mg/L			5.0	
Arsenic	mg/L			1.0	
Barium	mg/L			1.5	
Iron	mg/L			8.0	
Silver	mg/L			1.0	
Manganese	mg/L			1.5	
Boron	mg/L			6.0	
Chlorine	mg/L			1.0	
An-ionic detergents	mg/L			20	
Temperature	^{0}C			$40^0 \leq 3^0$	

Table 6.6: Sample Form for Noise Quality Monitoring Record

Location	S. No.	Date	Time (Hrs: Min)	Analysis Result [dB(A)Scale	SEQS [dB(A)Scale]*	Comments**
	1				55 (Day) / 45 (Night)	
	2				55 (Day) / 45 (Night)	
	3				55 (Day) / 45 (Night)	
	4				55 (Day) / 45 (Night)	
	5				55 (Day) / 45 (Night)	
	6				55 (Day) / 45 (Night)	
	7				55 (Day) / 45 (Night)	
	8				55 (Day) / 45 (Night)	

** (H=High, L=Low)

Table 6.7: Sample Form for Drinking Water Quality Monitoring Record

Location	Date	Parameters	Sindh Standards (mg/l)	Analysis Result (mg/l)	Comments*
		Color	< 15 TCU		
		Taste	Non-objectionable/ Acceptable		
		Odor	Non-objectionable/Acceptable		
		Turbidity	< 5 NTU		
		Total Hardness as $CaCO_3$	< 500 mg/l		
		TDS	<1000		
		pH	6.5-8.5		
		Aluminum (Al) mg/l	≤ 0.2		
		Antimony (Sb)	≤ 0.005		
		Arsenic (As)	≤ 0.05		
		Barium (Ba)	0.7		
		Boron (B)	0.3		
		Cadmium (Cd)	0.01		
		Chloride (Cl^-)	< 250		
		Chromium (Cr)	≤ 0.05		
		Copper (Cu)	2		
		Phenolic compounds	<0.0002		
		Cyanide $(CN)^-$	≤ 0.05		
		Fluoride (F)	≤ 1.5		
		Lead (Pb)	≤ 0.05		
		Manganese (Mn)	≤ 0.5		
		Mercury (Hg)	≤ 0.001		
		Nickel (Ni)	≤ 0.02		
		Nitrate $(NO_3)^-$	≤ 50		
		Nitrite $(NO_2)^-$	≤ 3		
		Selenium (Se)	≤ 0.01		
		Residual Chlorine	0.2-0.5 At consumer end 0.5-1.5 at source		
		Zinc (Zn)	5.0		
		All water intended for drinking (E.Coli or Thermo tolerant Coliform bacteria)	0.0 cfu/ 100 ml		
		Treated water entering the distribution system (Ecoli or thermo tolerant coliform and total coliform bacteria)	0.0 cfu/ 100 ml		
		Treated water in the distribution system (E.coli or thermo tolerant coliform and total coliform bacteria)	0.0 cfu/ 100 ml		

(cfu=Coliform Unit), * (H=High, L=Low)

Table 6.8: Sample Form for Solid Waste Monitoring Record (Domestic / residential / commercial solid wastes)

Location: _____, Date: _____, Source: _____ (domestic/commercial)

Total Quantity (kg)	Components	Weight (as discarded)	% by weight (as discarded)	Recyclables	Non-recyclables	Organic waste
	Food/kitchen waste					
	Plastics					
	Metals					
	Paper					
	Textile/Rugs					
	Cardboard					
	Glass					
	Rubber					
	Other					
Total						

Generation Rate:

For Construction camps — Total waste generated = _____ kg/capita/day
No of persons in units

For operations phase — Total waste generated = _____ kg per unit area
Total floor area of unit

Summary:

- Total Waste Generated (as collected) = _____ kg
- Recyclable waste quantity = _____ kg
- Non-Recyclable waste quantity = _____ kg
- Organic waste quantity = _____ kg
- %age of Recyclables = _____ %
- %age of Non-recyclables = _____ %
- %age of Organic waste = _____ %
- Total waste send for recycling = _____ kg
- Total waste send for landfill = _____ kg

Comments: _____

Table 6.9: Sample Form for Solid Waste Monitoring Record (Hazardous solid wastes)

Location: _____, Date: _____, Source: _____ (domestic/commercial)

Total Quantity (kg)	Hazardous waste Components	Weight (as discarded)	% by weight (as discarded)	Characteristics (corrosive, toxic, explosive, etc.)	Non-recyclables (requiring disposal)	Recyclables
Total						

Generation Rate:
Whichever of the following applies:
For Construction Camps Total waste generated = _____ kg/capita/day
No of persons in units

Summary:

- Total Waste Generated (as collected) = _____ kg
- Recyclable waste quantity = _____ kg
- Non-Recyclable waste quantity = _____ kg
- %age of Recyclables = _____ %
- %age of Non-recyclables = _____ %
- Total waste send for recycling = _____ kg
- Total waste send for disposal = _____ kg

Comments: _____

Chapter 7 Conclusion

The Initial Environmental Examination (IEE) Study was carried out to assess the potential environmental and socioeconomic impacts of the project for construction and operation phases. The assessment was carried out keeping in view the provincial and national environmental legislation and guidelines.

Based on the findings of the IEE study of the Proposed Project, it is concluded that the environmental impacts of the construction and operation of project are manageable and can be mitigated by implementing the Environmental Management Plan which forms an integral part of IEE document.

Proposed Project site has no sensitive areas such as protected sites including wildlife sanctuaries, game reserves or national parks, or any archaeological, historical or cultural heritage in its immediate neighborhood; as such its siting would have no sensitivity in this regard. No significant flora and fauna will be disturbed. The impacts if any, will be limited to individual strayed Dolphins and aquatic life for which mitigations measures have been proposed.

The IEE Study therefore recommends that the Initial Environmental Examination (IEE) report should be approved with the provision that the suggested mitigation measures will be adopted and the Environmental Management Plan (EMP) will be followed in letter and spirit.