Lahore Xingzhong

Renewable Energy Company (Private) Limited

拉合尔兴中再生能源有限公司

Ref: No. FAX-PK-2018-25

Date: 15th, May 2018

THE REGISTRAR.

NATIONAL ELECTRICAL POWER REGULATORY AUTHORITY, NEPRA Tower, Attaturk Avenue (East) G-5/1, Islamabad

SUBJECT:

APPLICATION FOR GRANT OF GENERATION LICENSE TO LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED FOR ITS 40MW MUNICIPAL SOLID WASTE POWER GENERATION PROJECT TO BE LOCATED AT LAKHODAIR, LAHORE.

Dear Sir,

- Pursuant to Rule 3 of the National Electric Power Regulatory Authority Licensing (Generation)
 Rules 2000, LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED (the
 "Project Company") hereby submits for NEPRA's kind consideration and approval, the
 Generation License Application (together with the information and annexures attached
 thereto).
- 2. The Generation License Application (including its annexures) are submitted in triplicate, together with:
 - (a) A Pay Order No. 25503720 dated 150518 of Askari bank amounting to PKR 311,376/(Pakistani Rupees Three Hundred Eleven Thousand Three Hundred and Seventy Six
 only) drawn in favor of NEPRA, as the application fee for the Generation License
 Application (as communicated to us by NEPRA);
 - (b) Extract of Board Resolution of Lahore Xingzhong Renewable Energy Company (Private) Limited; and
 - (c) Statement of Authorized Representative of Lahore Xingzhong Renewable Energy Company (Private) Limited, Mr. Liu Yidan.
- 3. In light of the submissions set out in the Generation License Application and the information attached to the same, NEPRA is kindly requested to process the Generation License Application at the earliest, thereby enabling the Project Company to proceed further with the development of the project.

Respectfully submitted for and on behalf of:

LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED

Mr. Liu Yiban

(AUTHORIZED REPRESENTATIVE

Address: No.560, Str. 14, Sec A, Phase V, DHA, Lahore, Punjab, Pakistan Telephone; +92 0313 823 1888 / 0312 800 6666 / 0314 438 2888

Lahore Xingzhong

Renewable Energy Company (Private) Limited

拉合尔兴中再生能源有限公司

EXTRACT OF THE CIRCULAR RESOLUTION PASSED BY THE BOARD OF DIRECTORS OF LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED ON 15th, May

The following Resolutions were passed by the Board of Directors of Lahore Xingzhong Renewable Energy Company (Private) Limited (the "Project Company") through Circulation on 15th, May:

RESOLVED THAT the Company do file an application to the National Electric Power Regulatory Authority for seeking a generation license for the 40 MW Municipal Solid Waste (MSW) power project to be constructed at Lakhodair, Lahore, pursuant to and under Sections 7(2)(a) and 15 of the NEPRA Act read with other enabling provisions of the NEPRA Act, the National Electric Power Regulatory Authority Licensing (Application & Modification Procedure) Regulations 1999, National Electric Power Regulatory Authority Licensing (Generation) Rules 2000, and in accordance with the Policy for Development of Renewable Energy for Power Generation 2006.

FURTHER RESOLVED THAT Mr. Mr. Liu Yidan, Executive Director of the Project Company, be and each of them are hereby authorized to singly do, execute, transact and perform for and on behalf of and in the name of the Company all such acts deeds and things as may be necessary or required or desirable to be done or executed by the Company for or in connection with or in relation to the application to the National Electric Power Regulatory Authority for seeking a generation license under the NEPRA Act and without limiting the generality of the foregoing and in connection therewith to do any or all of the following acts deeds and things, namely, to file, withdraw or re-file applications, review documents and information, make correspondence, letters, submissions, claims, objections of all kinds and to file or submit them before the National Electric Power Regulatory Authority, either themselves or through an authorized person or attorney, and to appear and represent the Project Company before the National Electric Power Regulatory Authority or any other regulatory authority or body and to accept the terms and conditions on which a Generation License is granted by the National Electric Power Regulatory Authority.

CERTIFICATION

CERTIFIED, that, the above resolution was duly passed by the Board of Directors of Lahore Xingzhong Renewable Energy Company (Private) Limited through Circulation, on 15th, May.

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

Lahore Xingzhong Renewable Energy Company (Private) Limited

拉合尔兴中再生能源有限公司

Qan Liang Executive Officer

Lahore Xingzhong Renewable Energy Company (Private) Limited

Address: No.560, Str. 14, Sec A, Phase V, DHA, Lahore, Punjab. Pakistan Telephone: +92 0313 823 1888 / 0312 800 6666 / 0314 438 2888

6. Prospectus

6.1 Project Introduction

The Applicant obtained the Letter of Intent (LOI) from Directorate of Punjab Power Development Board (the "PPDB"), Government of Punjab on 19th October 2016 for the Municipal Solid Waste Power Project, having capacity of 40 MW (the "Project").

China ENFi Engineering Corporation - Metallurgical Corporation of China and (MCC) are the main sponsors of the Project

Lahore Xingzhong Renewable Energy Company (Private) Ltd intends to set up 40 MW Wind Power Project to be located in Lakhodair, Lahore, Punjab, which is towards the Northeast of Lahore. The Lahore Ring Road are the major connecting roads to the Project site, having a distance of approximately 25 km from Lahore city. The Project site consists of approximately 26 acres of land, which is leased to the Project Company.

6.2 Salient Features of the Project

The Project shall have an installed capacity of 40 MW with 02 turbine generators of 20 MW capacity. The scheme of interconnection with LESCO grid has been determined in the Grid interconnection studies.

The Project has achieved following milestones:

- Project Company has been incorporated in the name of Lahore Xingzhong Renewable Energy Company (Private) Ltd
- PPDB has approved the feasibility study of the Project.
- The Electrical and Grid Interconnection Studies was conducted by Power Planner International (PPI), and approved by LESCO on dated 4th December 2017.
- Initial Environmental Examination (IEE) Report was submitted to Environmental Protection Agency (EPA), Punjab and IEE Report has been approved by EPA Punjab.

The Project has applied apply for the upfront tariff simultaneously with this generation license application. Upon issuance of the Generation License and determination of tariff, the applicant would execute Energy Purchase Agreements (EPA) with the power purchaser and aims to reach financial close by December 2018; the expected commercial operation date of the Project by December 2020, subject to award of tariff, execution of concession agreements and availability of Grid.

6.3 Investment - Debt to Equity

Lahore Xingzhong Renewable Energy Company (Private) Limited intends to apply for upfront tariff Upfront Generation Tariff for Municipal Solid Waste Power Projects for its 40 MW Waste to Energy Power Project. The proposed debt equity of the project is 75:25

6.4 Social and Environmental Plan

40 MW Waste to Energy Power Project of Lahore Xingzhong Renewable Energy Company (Private) Limited will not have any social or environmental impact. Project Company has also obtained approval of Initial Environmental Examination (IEE) from Environmental Protection Department, Government of Punjab.



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SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, LAHORE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No.0105429

I hereby certify that LAPIORE XINGZHONG RENEWABLE

ENERGY COMPANY (PRIVATE) IF ITED 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 Lahore this First day of February, Two Thousand and Seventeen.

Fee Rs<u>.52,500</u>/-

GERTIFIED TO BE TRUE COPY

Deputy Registrar

No.ARL/*186*26 DATED: <u>01-02-2017</u>

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

Memorandum of Association

of

Lahore Xingzhong Renewable Energy Company (PRIVATE) LIMITED

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

FREE CONTROPY

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Memorandum of Association

of

Lahore Xingzhong Renewable Energy Company (PRIVATE) LIMITED

- I. The name of the Company is Lahore Xingzhong Renewable Energy Company (PRIVATE) LIMITED.
- II. The Registered Office of the Company will be situated in the Province of Pu
- III. The objects for which the Company is established are to carry on all, or any one or more, of the following businesses in all or any of their various aspects:
 - 1. The principal line of business of the company shall be to construct and establish power generation plants based on power generated from waste and to enter into lease agreements with any party including public sector organizations and government departments for sale and distribution of the electricity so produced, subject to permission of concerned authorities, National Electric Power Regulatory Authority (NEPRA), in accordance with prevalent rules and policies.
 - 2. To borrow or raise money by means of loans or other legal arrangements from banks, or other financial institutions, or Directors in such manner as the Company may think fit and in particular by issue of debentures, debenture stock, perpetual or otherwise convertible into shares and to mortgage, or charge the whole or any part of the property or assets of the Company, present or future, by special assignment or to transfer or convey the same absolutely or in trust as may seem expedient and to purchase, redeem or payoff any such securities.
 - 3. To guarantee the performance of contract and obligations of the Company in relation to the payment of any loan, debenture-stock, bonds, obligations or securities issued by or in favour of the Company and to guarantee the payment or return on such investments.
 - 4. To open accounts with any bank or banks and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit, and other negotiable instruments and securities.

- 5. Notwithstanding anything contained in the foregoing sub-clauses of this clause nothing contained herein shall be construed as empowering the Company to undertake or indulge, directly or indirectly in the business of a Banking Company, Non-banking Finance Company (Mutual fund, Leasing, Investment Company, Investment Advisor, Real Estate Investment Trust, Housing Finance Company, Venture Capital Company, Discounting Services), Insurance Business, Modaraba management company, Stock Brokerage business, real estate business, managing agency, business of providing the services of security guards or any other business as restricted under the law.
- 6. It is hereby declared that the company shall not:
 - a. launch multi-level marketing (MLM), Pyramid and Ponzi Schemes, or other related activities/businesses or any lottery business.
 - b. undertake any of the permissible business unless the requisite approval, permission, consent or license is obtained from competent authority as may be required under any law for the time being in force.
- IV. The liability of the members is limited.
- V. The authorized capital of the company is Rs. 10,500,000 divided into 105,000 ordinary shares of Rs. 100 each with power to enhance, reduce or consolidate the share capital and to divide the shares of the company into different classes and kinds subject to the provisions of the Companies Ordinance, 1984.



We, the several persons whose names and addresses are 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 control of

of shares in the capital of the company set opposite our respective names.

S. No.	Name and Surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No.)	Father's/ Husband's Name in full	Nationality(ies) with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Sign atur es
1.	Chengdu Xingrong Environment Co. It nited. I rough its authorized representative	Incorporati on No. 915101002 24367821D	-	Registered in China	Business	Registered Address: Wanjiawan Village: Supo Town, QingYing District. Chengdu	490/-(Four Hundred and Ninety Shares only)	
	Mr. Qian Liang	PE0519895	Qian Baozhong	Chinese	Business	Room 1101. 3rd Unit.1st Building. # 56 2nd Jinyuexi St, Gaoxin District. Chengdu China	-	
) 2	China ENFI Engineering Corporation. Through its authorized representative	Incorporati on No. 100000000 040081	-	Registered in China	Business	Registered Address: No.12 Fuxing Road, Haidian, Beijing.	410/-(Four Hundred and Ten Shares only)	
	Mr. Zou Qingzhi	PE0116370	Zou Jiandong	Chinese	Business	No.117 West Street, Xuanwu District, Beijing China	-	
3	MCC Tongsin Resources Limited. Through its authorized representative	Incorporati on No. 1380325		Registered in British Virgin Island	Business	Registered Address: Portcullis TrustNet Chambers, P.O.Box 3444,Road Town, Tortola British Virgin Islands.	100/- (One Hundred Shares Only)	-
)	ivis. Ouyang Ying	P01740536	Ouyang Jianzhong	Chinese	Business	Room No. 502, Building 6, Jiulong Huayuan, No.29 Guangqu Road, Chaoyang District, Beijing, PR of China	-	
	Registrati Lahore	On Office To	tal number of	shares taken			(1,000/-{One Tho Shares only	

Witness to above signatures.

Dated the 5th day

National Institutional Facilitation Technologies (Pvt.) Limited 5th Floo: AWT Plaza, I.I. Chundrigar Road, Karachi

DEPUTY RESISTRATION OFFICE

THE COMPANIES ORDINANCE, 1984

(Private Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF



LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED

PRELIMINARY

- 1. (1) In these regulations-
 - (a) "XR" means Chengdu Xingrong Environment Co. Limited.
 - (b) "ENFI" means China ENFI Engineering Corporation.
 - (c) "MCCT" means MCC Tongsin Resources Limited.
 - (d) "XR" Nominee Director" shall mean a director nominated by XR notified to ENFI and MCCT;
 - (e) "ENFI" Nominee Director" shall mean a director nominated by ENFI notified to XR and MCCT;
 - (f) "MCCT" Nominee Director" shall mean a director nominated by MCCT notified to XR and ENFI.
 - (2) The Regulations contained in Table 'A' to the First Schedule to the Companies Ordinance, 1984 (the "Ordinance") shall be the regulations of LAHORE XINGZHONG RENEWABLE ENERGY COMPANY (PRIVATE) LIMITED (the "Company") so far as these are applicable to a private company.

PRIVATE COMPANY

- 2. The Company is a "Private Company" within the meaning of Section 2(1)(28) of the Ordinance and accordingly:
 - (1) No invitation shall be made to the public to subscribe for the shares or debentures of the Company.
 - (2) The number of the members of the Company (exclusive of persons in the employment of the Company), shall be limited to fifty, provided that for the purpose of this provision, where two or more persons hold one or more shares in the company jointly, they shall be treated as single member; and
 - (3) The right to transfer shares of the Company is restricted in the manner and to the extent herein appearing.



SHARES AND CAPITAL

3. The authorized share capital of the Company is Rupees 10,500,000 divided into 105,000 ordinary shares of Rupees One Hundred (Rs. 100) each. The shares shall be under the control of the Board who may subject to these Articles allot the same to such persons on such terms and conditions and at such times as the Board shall determine. Shares may also be allotted in consideration other than cash.

TRANSFER OF SHARES

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

NOTICE AND PROCEEDINGS OF GENERAL MEETINGS

- 5. Twenty-one days' notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of meeting and, in case of special business, the general nature of that business, shall be given in manner provided by the Ordinance for the general meeting to such persons as are under the Ordinance or the regulations of the Company entitled to receive such notice from the Company; but the accidental omission to give notice to or the non-receipt of notice by any member shall not invalidate the proceedings at any general meeting.
- 6. All business shall be deemed special that is transacted at an Extraordinary General Meeting and also all that is transacted at an Annual General Meeting with the exception of declaring a dividend, the consideration of the accounts, balance sheet and the reports of the directors and auditors, the election of directors, the appointment of and the fixing of the remuneration of the auditors.
- 7. Decisions made by the General Meeting shall be subject to the approval of members representing no less than 75% of the voting power in the Company. Decisions relating to the following matters shall be subject to the approval of members representing 100% of the voting power in the Company:
 - (a) increase or reduction of the share capital of the Company;
 - (b) plan of merger, demerger, liquidation or alteration of company form;

- (c) creation of any mortgage or charge on property and/or assets of the Company;
- (d) alteration of the Memorandum and Articles of Association of the Company.
- 8. No business shall be transacted at any general meeting unless a quorum of members is present at the time when the meeting proceeds to business. The quorum for the general meetings shall be at the minimum three (3) persons, each representing XR, ENFI and MCCT respectively personally or through proxy.
- 9. If within half an hour from the time appointed for the meeting a quorum is not present, the meeting if called upon the requisition of members shall be dissolved; in any other case, it shall stand adjourned to the same day in the next week at the same time and place.
- 10. The chairman of the Board if any shall preside as chairman at every general meeting of the Company, but if there is no such chairman, or if at any meeting he is not present within fifteen minutes after the time appointed for the meeting, or is unwilling to act as chairman, any one of the directors present may be elected to be chairman, and if none of the directors is present, or willing to act as chairman, the members present shall choose one of their number to be chairman.
- 11. The chairman may with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting) adjourn the meeting from time to time but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for ten days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment or of the business to be transacted at an adjourned meeting.
- 12. At any general meeting a resolution put to the vote of the meeting sharon a poll in accordance with the provisions of the Ordinance.
- 13. The chairman shall not have a second or casting vote.

DIRECTORS

14. The Board of Directors shall comprise of five (5) employee directors who time employees of the Company and shall not be required to hold qualification shares under Section 187 of the Ordinance, provided always that XR shall be entitled to nominate 2 employee directors and ENFI shall be entitled to nominate 2 employee directors and MCCT shall be entitled to nominate 1 employee director. Initial subscribers to the Memorandum of Association shall determine in writing the names of the first Board of Directors. The first Board of directors who are full time

employee Directors of the Company shall be:

- I. OUYANG YING
- II. ZHAO XI
- III. QIAN LIANG
- IV. ZOU QINGZHI
- V. WEI JIAMING



POWERS AND DUTIES OF DIRECTORS

- 15. The business of the Company shall be managed by the directors who may pay all expenses incurred in promoting and registering the Company and may exercise all such powers of the Company as are not by the Ordinance or any statutory modification thereof for the time being in force, or by these regulations, required to be exercised by the Company in general meeting, subject nevertheless to the provisions of the Ordinance or to any of these regulations, and such regulations being not inconsistent with the aforesaid provisions, as may be prescribed by the Company in general meeting but no regulation made by the Company in general meeting shall invalidate any prior act of the directors which would have been valid if that regulation had not been made.
- 16. Decisions on the following matters shall be subject to the approval of no less than 75% of all the directors:
 - (a) determination of the number of directors other than as specified in the Articles;
 - (b) approval of annual budget of the Company:
 - (c) incurrence of expense which is not provided in the approved annual budget of the Company;
 - (d) declaration of dividends (including interim dividends);
 - (e) raising of financing/credit facility or creation of any security on the assets of the Company (other than credit facilities in the normal course of business like leasing of vehicles approved in the annual budget) in one transaction or in a series of related transactions;
 - (f) any change in the nature of the business of the Company;
 - (g) application for the appointment of a receiver or an administrator over assets of the Company or for the winding-up of the Company; and
 - (h) altering the share capital of the Company.

- 17. The directors shall appoint an XR Nominee Director as Chief Executive Officer in accordance with the provisions of sections 198 and 199 of the Ordinance, who shall be in charge of the day-to-day operation of the Company subject to general supervision and control by the Board. The directors shall also appoint three Deputy General Managers to assist the Chief Executive Officer in charge of the day-to-day operation of the Company each nominated by XR, ENFI and MCCT. The directors shall appoint a person nominated by ENFI or MCCT as Chief Financial Officer.
- 18. The directors may exercise borrowing powers in the manner provided in the Ordinance.
- 19. The directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force.
- 20. The directors may hold their meetings through tele/video conferencing in emergent situation where it is not possible for them to be physically present at the venue of the meeting, provided that the minutes of such meeting are approved and signed subsequently by all directors who participated in such meeting, requirements of the requisite quorum and other legal formalities relating to holding of such meetings have been observed and tele video recording of the proceedings of the meetings are kept for the purpose of the record.
- 21. The directors shall cause minutes to be made in books provided for the purpose
 - (a) of all appointments of officers made by the directors;
 - (b) of the names of the directors present at each meeting of the directors
 - (c) of all resolutions and proceedings at all meetings of the Compandirectors; and every director present at any meeting of directors name in a book to be kept for that purpose.

DISQUALIFICATION OF DIRECTORS

22. No person shall become a director of the Company if he suffers from any of the disabilities or disqualifications mentioned in section 187 of the Ordinance and, if already a director, shall cease to hold such office from the date he so becomes disqualified or disabled.

PROCEEDINGS OF DIRECTORS

- 23. The directors may meet together for the dispatch of business and adjourn and otherwise regulate their meetings, as they think fit. Provided that the Board shall at least meet twice every year.
- 24. Meetings of the directors may be held through teleconference or videoconference.

The chairman of the Board may, and the secretary on the requisition of at least two directors shall, at any time, summon a meeting of directors subject to reasonable notice. The quorum for a meeting of directors shall be at least one Director amongst XR Nominee Directors.

- 25. The directors shall appoint one of their numbers from amongst the XR Nominee Directors to be Chairman of the Board who shall chair the meetings of the Board. In the absence of the chairman the Directors may elect another one of the XR Nominee Directors to chair that meeting. Except as otherwise agreed in writing, all the decisions of the Board other than specified in article 16 shall be taken by a simple majority.
- 26. All acts done by any meeting of the directors or by any person acting as a director shall notwithstanding that it be afterwards discovered that there was some defect in the appointment of any such directors or persons acting as aforesaid or that they or any of them were disqualified be as valid as if every such person had been duly appointed and was qualified to be a director.
- 27. A resolution in writing signed by all the directors for the time being entitled to receive notice of a meeting of the directors shall be as valid and effectual as if it had been passed at a meeting of the directors duly convened and held. For the purposes aforesaid, resolutions by circulation signed by directors separately and at different places and faxed to the Company shall be valid.
- 28. Notice of each meeting of the Board including agenda, date, time and place of such meeting shall be given at least seven (7) days in advance; however if all the directors are present at a meeting, the notice requirement shall be deemed to have been waived.



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

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S. No.	Name and Surname (present & former) in full (in Block Letters)	NIC No. (in case of foreigner, Passport No.)	Father's/ Husband's Name in full	Nationality(i es) with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	3ign ature s
1	Chengdu Xingrong Environment Co. Limited. Through its authorized representative	Incorporatio n No. 915101002 24367821D		Registered in China	Business	Registered Address: Wanjiawan Village: Supo Town, QingYing District. Chengdu	490/-(Four Hundred and Ninety Shares only)	
	Mr. Qian Liang - 	PE0519895	Qian Baozhong	Chinese	Business	Room 1101. 3rd Unit.1st Building. # 56 2nd Jinyuexi St, Gaoxin District. Chengdu China	-	
2	China ENFI Engineering Corporation. Through its authorized representative	Incorporatio. n No. 100000000 040081	-	Registered in Chin	Business	Registered Address: No.12 Fuxing Road, Haldian, Beijing.	410/-(Four Hundred and Ten Shares only)	i.
,	Mr. Zou Qingzhi	PE0116370	Zou Jiandong	Chinese	Business	No.117 West Street, Xuanwu District, Beijing China	-	
3	MCC Tongsin Resources Limited. Through its authorized representative	Incorporatio n No. 1380325	-	Registered in British Virgin Island	Business	Registered Address: Portcullis TrustNet Chambers, P.O.Box 3444,Road Town, Tortola British Virgin Islands.	100/- (One Hundred Shares Only)	
	Ms. Ouyang Ying	P01740536	Ouyang Jianzhong	Chinese	Business	Room No. 502, Building 6, Jiulong Huayuan, No.29 Guangqu Road, Chaoyang District, Beijing, PR of China	-	
		ore *	tal number of	shares taken			(1,000/-(One The Shares only	usand)
	The Comment				pin for we was present the country to be the	maken kan angan dan kan angan maken dan dan dan dan dan dan dan dan dan da	ent ;	

Dated the 5th day of January 2017.

Witness to above signatures.

National Institutional Facilitation Technologies (Pvt.) Limited $5^{\rm th}$ Floor, AWT Plaza, I.I. Chundrigar Road, Karachi

COMPANY REGISTRATION OFFI

CERTIFIED TO BE TRUE GO

13. Technical and Financial proposal/plan for operation, maintenance, planning and development

The general manager shall be fully in charge of managing, directing and monitoring the operation of the Company and undertake the responsibility of implementing the decision of the Board of Directors.

Operation and Management Department shall be in charge of the management of the while production process, which mainly include the real-time monitoring of enterprise production indicators, proposal of specific work targets and clearly executing the implementation plan to achieve the targets.

Equipment Maintenance Department shall be in charge of maintaining the equipment of the whole plant. The maintenance mainly includes implementing and executing various management rules and regulations, electrical safety regulations and related laws and regulations, guaranteeing the personnel and equipment safety during production process and guaranteeing the serviceability rate of equipment. In addition, developing the annual maintenance plan, monthly work plan and safety target plan for equipment and organizing implementation of such plans are included.

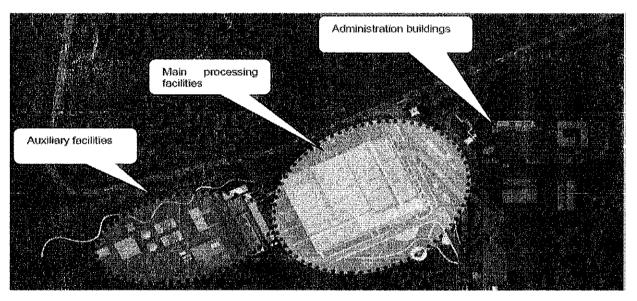
14. Type, technology, technical details and design of the facilities proposed to be constructed/developed

Type	Waste to Energy		
Technology	Municipal Solid Waste to Energy Technology		
Plant Location	Lakhodair, District Lahore, Punjab		

Plant shall be comprised of three zones, namely

- a) Main Processing Facilities,
- b) Auxiliary Facilities and
- c) Administration Buildings.

An overview of design of the Facility is provided in figure below:



a) Main Processing facilities

Main processing facilities are adjoined in Main Processing Building, which mainly include:

- Waste Receiving, Storage, Feeding System and Auxiliary System
- Incinerator and Boiler Building
- Flue Gas Cleaning Building
- Fly Ash Stabilization Building
- Turbo Generator Building
- Step-up Substation
- Stack

)

b) Auxiliary facilities

Auxiliary facilities include:

- Water Pump House and Pond
- Underground Water Treatment Station
- Oil Pump House
- Fly Ash Curing Quarter

c) Administration buildings

Administration buildings and amenities include:

- Complex Building
- Administration Building
- Trestle
- Weighbridge,
- Gate Control House,
- Fence, Gate House and Guard House etc.

15. Location Maps, Site Map, Land

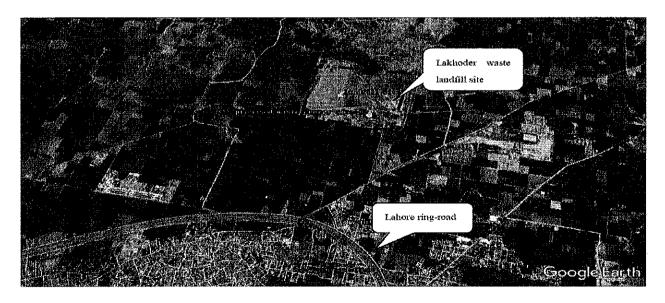
The Project shall be set up at Lakhodair waste landfill site. Lakhodair waste landfill site is Located at northeast of Lahore, N31°37′25″, E74°25′14″, 17km away from central lahore, about 52.9 Ha of overall area. At the both sides of office building currently in use, there are two plots of lands available for the Project. The land in the north of office building is about 3.8 Ha and irregular trapezoid shaped. There are 110kV high-voltage power line and tower across the area, and rain water discharge ditch is under construction in the area; in the west side of the office building, another plot of land with the area of about 7.4ha is a long strip, and 132kV high-voltage power tower is across the edge of the land.

The landscape of the site is flat. The facilities for the waste landfill site use, such as office building, weigh-bridge, vehicle washing tank, water well, sewage water collection pond have been built, and the access road connecting urban road and landfill site has been constructed, which is covered with asphalt and concrete, about 8m wide. The road is linked with the main ring-road of Lahore at the south. The traffic condition is good.

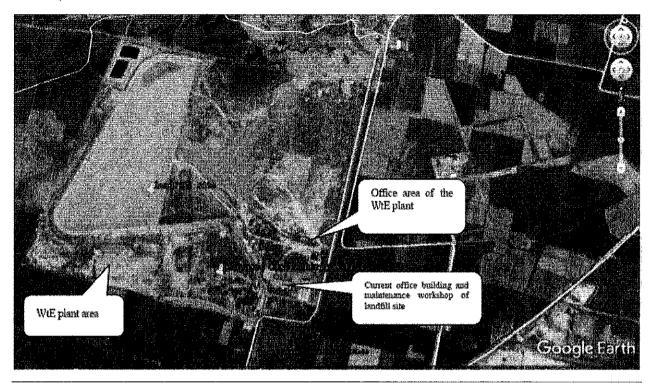
The site is located in, Lahore, which is one of the most promising areas where Municipal Solid Waste Power project can be viably installed. The site for the Project has been selected by considering:

- 1. Location nearby the Lahore
- 2. Landfill conditions at the site
- 3. Topographic conditions
- 4. Site accessibility
- 5. Location of the grid regarding the site for interconnection.

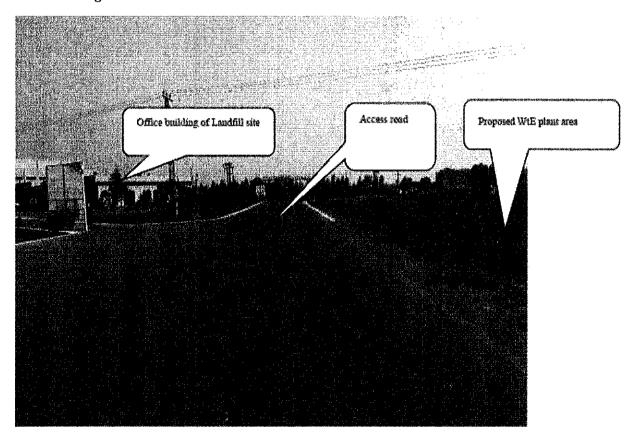
Geographical Location of the plant site



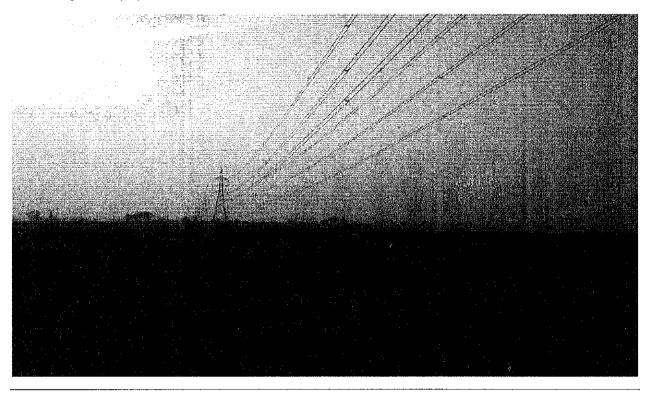
Site map



Office building and access road



132 kV High-voltage power line at site



Site for office area



Elevation of Site

As per the general layout of landfill site, the site elevation is about 217~228m, inclining from east to west, with a flat landscape. Highest level of the nearby Ravi River 20-year flood is 211.7m, and the site elevation is higher than that level.

Boundary line and topography of the land

Total area of Lakhoder waste landfill site is 52.9 ha, and gross area for this plant use is 10.73 ha. Main road of landfill site divides the land into two parts— east and west, and the east part of 3.49 ha will be used as office building and living land. The west part of 7.24 ha will be used as WtE plant building, with the longest point of 534m in the direction of east-to-west, and different widths of 73~230m from north to south, it is shaped in an irregular trapezoid as a whole. Moreover, 132kV high-voltage power line from the north of the site passes through the site in parallel in the direction of east-to-west. The site does not benefit to general layout planning design and plant expansion in the future.

Land acquisition status

The land has been acquired by waste landfill project of LWMC, and the cost is a little lower than that of plant site No.2.

Engineering geology

There is natural discharge ditch of rain water and culvert across the north of the site, and the site is wasteland and borrow area. Within the site, there is landfill waste required to be cleaned and removed, and no undesirable geological phenomenon exists. It is suitable to build the plant.

Service radius of waste collection

Waste is mainly from Zone I, and Albayrak is responsible for the collection and operation. Complete collection and transportation system within 30km of the maximum service radius has been set up.

Ash and clinker disposal and landfill

Fly ash after solidification will be buried within the built landfill site, and furnace clinker will be delivered to the outside of the plant as raw materials for construction.

Water supply conditions

Urban water supply is not available, and underground water intake facility shall be built by its own. The site is 4.5km away from the Ravi River, as the water volume of the River in the dry season is not guaranteed; in consequence underground water shall be taken into account as the water source. It shall be further demonstrated in accordance with hydro-geological report and local water resource use policy.

External road of the plant

Plant site is about 1km away from the Ring Road of Lahore. External connecting roads have been built by landfill project. The road is covered with asphalt and concrete with the width of 8~30m. The condition of the road is good for driving.

Earthwork Volume

The waste buried within the site shall be cleaned and removed. Preliminarily estimated earthwork within the site basically meets the internal balance of excavation.

Sewage discharge conditions

Urban sewage pipeline is about 4km away from the north of plant

Atmospheric diffusion conditions

Plant site is in the plain with a good atmospheric diffusion condition.

Demolition of obstacles and numbers of residents

No demolition and relocation work within the plant site, and only the existing low-voltage power poles shall be removed.

Surrounding sensitive points

The plant site is about 630m away from the nearest residential building, and about 1.1km off the populated area. It is located at the edge of the city and there is no major sensitive source near the plant site.

Site Accessibility

The major section of track from Lahore to the site is via the Lahore Ring Road. The track is a multi-lane road. It has a flat terrain, and long and heavy vehicles can easily navigate through this road. The total distance from Lahore to the site is approximately 25 km.

16. Technology, Size of the Plant, number of units

Description	landring of the second of Because and the second of t
Technology	Waste to Energy (Municipal Solid Waste)
Size of Plan	40 MW
Turbine Generator Unit	2x20 MW

17. Interconnection with national grid, distance and name of nearest grid

Lahore Xingzhong Renewable Energy Project would be connected by a double circuit of 132kV/11kV of Mominpura substation which is looped in/out between the 132 kV Batapur and 132kV Darogawala. Grid is located at about 4 to 5 km from the Project site.

18. Infrastructure: Roads, rail, staff colony, amenities

Traffic Routing

The incoming road divides the area into two parts. East land area is 2.95ha, while the west 7.69ha. 132kV HV towers pass through the north side of the site.

The existing landfill road is located in the middle of the plant, headed to the main road of Lahore – Ring 2 in the north.

MSW and raw materials come from the south side, and are separated from local traffic flow. Two gates are set for people and waste trucks respectively. A freight exit is used for slag and fly ash transport on the north side, which is close to the landfill

Transportation

The waste trucks and delivery will be under the management of LWMC.

Two full-automatic weighbridges shall be set at the passageway. IC card and metering system & LED panel shall be installed for the purpose of weighing, recording, transmission, printing and data processing. Traffic lights, camera and online monitoring system are configured to direct transport in and out.

Roads, fences and gates

Entrance roads	7m wide + 2m wide shoulder		
Width of primary road	7m		
Width of secondary road	6m		
Width of maintenance access	4m + shoulder width of 2m		
Turning radius of primary road	9m to12m		
Turning radius of secondary road	4m to 6m		
Cross slope of road	1.5% to 2%		
Maximum slope of road	8%		

Colony for Staff

The colony shall be constructed at site for labors

19. Project cost, information regarding sources and amount of equity and debt

Lahore Xingzhong Renewable Energy Company (Private) Limited intends to apply for upfront tariff Upfront Generation Tariff for Municipal Solid Waste Power Projects for its 40 MW Waste to Energy Power Project, therefore project cost is as per upfront tariff. The proposed debt equity of the project is 75:25. Debt financing for the Project shall be raised from foreign banks.

20. Project commencement and completion schedule with milestones

Provided below are the tentative timelines for completion of the Project:

Milestone	Date			
Project commencement (Issuance of LOI)	2016-10-19			
Completion of feasibility study	2017-7-20			
Completion of basic engineering	2018-5-20			
Commencement of construction	2018-5-1			
Completion of detailed engineering	2019-6-29			
Mechanical completion	2020-9-15			
Commissioning period	2020-9-16 to 2021-4-29			
Commencement of commercial operation	2021-4-30			

21. Safety plans, emergency plans

Safety Supervision Department is the management department in charge of the safety, health and fire control of the whole plant. In addition, it shall be responsible for the implementation of the policies and concepts of safety, environment protection and health. Specifically, it shall be responsible for the establishment of safety, environment protection and health regulations, safety management and safety supervision, health management and fire protection management.

Project Site Security and Safety

The Applicant is quite cognizant of the fact that security situation in the country is unsatisfactory. The Applicant has plans to use the infrastructure at Lahore in the most efficient manner to provide seamless security at offices, accommodation and site.

In addition, the EPC Contractor shall be required under the EPC Contract to comply with all applicable safety regulations according to the laws of Pakistan and take care for safety of all personnel entitled to be on the Site. The EPC Contractor shall use reasonable efforts to keep the Site clear of unnecessary obstruction. Furthermore, the EPC Contractor shall be responsible for provision of, lighting, guarding and watching of the facility during construction of the Project. The EPC Contract shall also require the EPC Contractor to provide temporary roadways, footways, guards and fences during construction for the use and protection of the public and of owners and occupiers of adjacent land

Similarly the O&M Contractor shall be required under the O&M Contract to provide security in accordance with prudent industry practices. The O&M Contractor shall comply with reasonable health and safety requirements established from time to time by the legal and regulatory authorities. The O&M Contract shall also require the O&M Contractor to take all reasonable precautions to protect the Complex, Project Company and O&M Contractor's Personnel, sub- contractors, public and the environment.

With regards to the health and safety of the personnel during the construction and operation of the Project, the guideline of "safety first, (accident) prevention foremost" will be practiced. Comprehensive management and supervision will be applied to all staff members and the whole operation process, in order to ensure safe operation of the equipment and personal safety of workers.

A safety and health supervision department will be established on the wind farm, which is to be in charge of the education, training and management of safety and health related issues after the project is put into operation. There will be safety personnel in the production section, and a part- time worker for the routine safety and health work

The systems of patrol inspection, operation guardianship, maintenance and over-haul will be established for the daily maintenance of production equipment, instruments and apparatus. The safety and health

supervision department will provide sound meter and other appropriate inspection equipment, as well as necessary public education service for production safety.

A comprehensive safety system will be established during the preparation phase, and carefully implemented during the construction and operation process. The systems of work sheet, operation sheet, shift relief, patrol inspection, operation guardianship, maintenance and over- haul will be strictly implemented. The Safety Regulation of the wind farm will also be seriously observed to preclude accidents such as fall, fire, or electric shock.

Fire Protection

Plot Plan and traffic

The general layout takes full account of the requirements of fire safety design. The distance between buildings and structures meet relevant fire protection design codes. At the same time, the 6-7m wide annular driveways are provided around such main buildings as Main Processing Building, Administration Building and complex building, with the minimum inner turning radius of 12m. Around other auxiliary production facilities are 6m or larger open spaces and turnarounds, meeting the requirements for fire truck passage and firefighting operation. The safety enclosure is provided around the oil tank area, and no tall arbor tree or oily hedge is permitted to grow within or around the plant area to reduce fire hazards. The plant access roads shall be designed to separate the pedestrians and vehicles, and gates are provided at different orientations, beneficial to emergency evacuation in case of fire, so as to ensure the fire safety of the plant.

Fire zoning of buildings

Main Processing Building

The Main Processing Building is divided into 6 fire zones according to the process arrangement, namely, waste unloading room, waste bunker, flue gas cleaning room of incineration plant, rooms at the lower floor of the unloading room, turbine generation plant and main control building, each as a separate fire zone. Fire zones are separated by firewalls and fire doors & windows. The piping passing through the fire zone shall be provided with enclosed system.

Other buildings

If the building area is less than 2,500m2, the fire zoning will not be required.

Safety evacuation design

Main Processing Building

In the Main Processing Building, the platforms at different floors within the fire zone where the incinerator building is located shall be provided with evacuation stairs at south and north sides for daily vertical evacuation of inspectors, and there are fewer than 10 workers in this zone, which means the Main Processing Building meets the personnel evacuation requirements. Other fire zones shall be provided with two exits; and all fire doors shall be opened towards the evacuation direction. Thus the requirements for evacuation exits and distance are met.

The Main Processing Building is RC frame + steel lattice column structure, with steel roof. As the Main Processing Building is listed into Type D according to the fire risk classification, the steel lattice columns are coated with thick fire-proof materials; while the steel grids and beams are coated with thin fire-proof materials.

Other buildings

The frame is RC column, while the roof and floor are cast-in-place RC roof and floor slabs.

Office and living buildings within the plant area

Office and living buildings constructed during Phase I within the plant area are complex building and Administration Building The Administration Building has 2 floors, a building area of 1,700 m2, RC frame structure, a building height of 8.8m.

Firefighting system

Fire water consumption

The WTE Project is provided with a separate fire water supply system.

The design assumes that only 1 fire occurs at a time. The severest fire conditions shall be:

Indoor/outdoor fire lasting for 2h or more, or the waste bunker fire lasting for 1h or more. This design is based on the sum of water consumptions of indoor & outdoor fire hydrants and fire monitors, i.e., the one-time firefighting water consumption is taken as 648m3, and the fire water is stored in a 1,800m3 storage pool for production and fire protection purposes. The pool is provided with continuous level signals remotely transmitted to the Fire Services Communication Center, and measures are also taken to avoid the use for purposes other than fire protection. The fire water utilizes purified water from deep well.

Firefighting facilities

Outdoor & indoor fire hydrants, waste bunker fire monitor, waste bunker feed hopper fire water, domestic fire extinguishing system and other firefighting facilities shall be provided.

Outdoor firefighting facilities

The looped fire water supply pipeline consisted of DN200 welded steel pipe and groundtype fire hydrant shall be provided outdoors along the main roads in the incineration area and living area. The temporary HP firefighting system shall be used for water supply to the fire network through fire pump in the event of fire. The fire hoses and pipe network shall be shared by the outdoor and indoor fire hydrants.

Indoor firefighting facilities

The temporary HP firefighting system shall be used indoors for water supply to the fire network through fire pump in the event of fire. The Main Processing Building is provided with fire hydrant water supply system, with two water inlet pipes led from outdoors, and the indoor fire pipes in ringed arrangement. The Main Processing Building is provided with indoor fire hydrants and 2 sets of water pump adapters.

The main incineration plant is provided with fire monitors for firefighting. The fire monitors have a unit design flow of 30L/s, an injection range not less than 60m and the required water pressure of 1.1MPa. The comprehensive water pump house is provided with 2 special pumps for fire monitors, 1 operating, 1 standby.

Fire water pressurization facilities

These shall be provided within the comprehensive water pump house. The fire monitor extinguishing system shall consist of 2 XBD-type vertical multi-stage firefighting centrifugal pumps, 1 in service and 1 standby, with Q=60L/s and H=130m.

The fire hydrant extinguishing system shall consist of 2 XBD-type vertical multi-stage firefighting centrifugal pumps, 1 in service and 1 standby, with Q=60L/s and H=75m.

The operating status of fire water pump and pressure stabilization unit shall be transmitted to the Fire Service Communication Center which can remotely control the start-up and shutdown of the firefighting equipment.

Special fire extinguishing facilities

The domestic ammonium phosphate dry chemical fire extinguishers shall be provided at each plant and in the complex building; while the domestic foam fire extinguishers shall be provided for the oil tank in the steam turbine room.

Different fire extinguishing modes of different buildings are shown in table 7-1.

Automatic fire alarm and interlocking system

Functions and equipment descriptions of fire alarm system

A 256-point centralized fire alarm controller is provided in the CCR at 7.00m level in the Main Processing Building, as the fire alarm control center of the entire plant. A 256-point centralized fire alarm control system is provided in the CCR, consisting of the power supply for firefighting linkage, the alarm controller, the straight wire linked control board, the emergency PA and the firefighting telephone switchboard, all integrated into a standard 19" cabinet. The oil pump house, purification and booster pump houses, complex building and other places shall be provided with local fire alarm controllers, in connection with the centralized fire alarm controller of the CCR, sharing cables with telecommunication system, laid in same cable but different cores.

Fire alarm power supply and grounding

The fire control room is provided with UPS, battery and power distribution cabinet. The fire alarm system uses double-circuit fire incoming power lines to be switched at ends. UPS is on-line power supply. Battery enables 3h power supply. The fire alarm system is jointly grounded, with the grounding resistance not greater than 1Ω .

Provision of detectors and alarm equipment

The integrated Main Processing Building is divided into 4 fire zones in total, and based on such zoning, the detectors and alarm equipment are provided at the following locations:

The smoke detectors shall be provided at 35kV distribution room, transformer room, distribution room, ventilation equipment room, CCR, electronic equipment room, exhibition hall, office rooms, engineer's station, meeting room, warehouse, crane control room, flue gas on-line analysis room, elevator equipment room, etc.; The flame detectors shall be provided at waste bunker and steam turbine generator plant; The heat sensitive cable detector shall be provided at the cable channel of power distribution room; The manual alarm buttons and audible & visual alarms shall be provided at main passages, exists & entrances and elevator doorway of each floor; The fire telephone extensions shall be provided at each distribution room, CCR, ventilation equipment room, air conditioning room and fire control room. The smoke detectors shall be provided at complex building offices, canteen and dormitories; the manual alarm buttons and audible & visual alarms shall be provided at the corridors and main exits & entrances.

Provision of firefighting emergency PA

The fire control room inside is provided with a set of firefighting emergency PA system, consisting of control panel, broadcasting power amplifiers and some other equipment within the broadcasting area. In the event of fire, the fire control room will send emergency broadcast to the entire plant to direct the evacuation.

Fire alarm linkage

When the plant catch on fire, push the fire hydrant alarm button manually, and the fire control room may automatically or manually start up the fire pump for fire extinguishing. When the waste bunker catch on fire, start up the fire monitor control box for fire extinguishing, and pressurize the fire monitor pump for water supply at the same time. The mechanical smoke exhaust system shall be arranged within the waste bunker by the ventilation discipline. The smoke control and exhaust system is subject to automatic and manual control. The smoke control and exhaust measures shall be provided for the centralized air-conditioning system at CCR and electronic equipment room. When the outdoor air-conditioning duct system passes through the air feeder room, 70°C fire valve shall be provided and will be closed automatically in case of fire. The air-conditioner of this system is interlocked with such valve. In the event of fire, the elevators will be forced landing to the first floor, and the power supply of the non-fire elevators will be cut off. The alarm signal on flammable gas in leachate system is transmitted to fire alarm system. Besides the fire alarm system controls the modules to automatically start up the fire pump, fire monitor pump and smoke exhaust fan; the fire control room is also set with pulling multicore fire-rated control cable connected to the electric control boxes of the above equipment, directly interlock the equipment and receive the feedback signals.

Firefighting smoke exhaust system

Smoke control and exhaust system in main control room

As the waste pool is closed and cannot meet the natural smoke exhaust requirements, the smoke exhaust facilities shall be provided in case of any accident. The smoke exhaust rate shall be taken as 60m3/(h·m2) and the total smoke exhaust volume is 106,445m3/h. The smoke exhaust duct shall also serve as the air duct for deodorization of waste bunker. When the waste pool catches on fire, waste crane control room gives orders to close the electric control valve in front of the deodorization device, and start up smoke exhaust fan and 280°C smoke exhaust fire valve. When the flue gas temperature reaches 280°C within the pipe, the exhaust fire valve on the pipe will be closed automatically to stop smoke exhaust.

Waste pit

Waste Pit is provided with emergency smoke exhaust device

Pressurized air feeding

Pressurized air feeding is provided at staircases between leachate channels

Smoke control at doorway of smoke-proof staircase and fire elevator in the incineration plant One set of mechanically pressurized air feeding facilities shall be provided at doorway. The pressurized air feeder is set within the special fan room.

Main Control building

The ±0.00m flat

The ±0.00m flat corridor is provided with one set of mechanical smoke exhaust facilities.

The 7.00m flat view corridor

The 7.00m flat view corridor is provided with one set of mechanical smoke exhaust

In the event of fire

Use the manual alarm signal in the corridor and the electric signal in CCR to open the smoke exhaust fire valve and start up the smoke exhaust fan. When the flue gas temperature reaches 280°C within the exhaust duct, the exhaust fire valve will be closed automatically and the smoke exhaust fan will be stopped.

Power supply for fire fighting

The fire pump and other firefighting consumers are connected to the security section to ensure reliable power supply.

The emergency evacuation indicator lights shall be provided at staircases, public channels and important exits & entrances.

NH-YJV22-1kV fire resistant cables shall be provided for firefighting equipment in the Main Processing Building. The cable tray shall be fire resistant.

The oil-free vacuum circuit breaker shall be used for HV cabinet, and the auxiliary transformer shall be dry type.

The automatic fire alarm system shall be provided with UPS to ensure the reliability of power supply.

Fire prevention measures

Lubricating oil system

The domestic foam fire extinguishers shall be provided nearby the indoor oil storage tank to effectively put out the sprinkling fire caused by leakage of lubricating oil.

Oil storage tank

The wheeled foam fire extinguishers as well as sand box and fire blanket shall be provided in the underground oil tank area; and the domestic foam fire extinguishers shall be provided at oil pump house, to timely put out the fire.

Waste bunker

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The fire monitor fight extinguishing system shall be provided at the upper platform of the waste bunker. The system is subject to automatic control, remote control and field control from the fire control center.

With these methods, the fire can be put out within the shortest time, and the safe operation of waste storage system can be ensured effectively.

Protective measures of electrical facilities

The electrical facilities shall be protected against fire, explosion and electric shock.

Protection against fire and explosion on electric facilities

The main transformer room shall be provided with oil storage pool laid with pebbles. The emergency oil storage pit shall be separately set outdoors. All other auxiliary electric facilities shall be designed oil-free.

The flame-retardant cable shall be used at inflammable places, high temperature-resistant cable used under high temperature services; and the fire blocking materials or fire package shall be applied to block the cable inlet/outlet or shaft, and openings at the bottom of panels/cabinets.

Protection against electric shock on electric facilities

In lightning protection grounding, working grounding and protective grounding works, the composite artificial grounding devices are respectively used as the lead wires connected to the electric equipment, and the foundation works shall be used as far as possible for grounding to reduce the electric resistance and the investment of grounding works.

All electric equipment enclosures and non-rotary metal enclosures shall be provided with protective grounding, and the step voltage at the intersections between grounding grid and channels shall be reduced.

Acoustic and light signals shall be provided for auxiliary power and distribution unit failure. As per the technical requirements for process production, the process equipment shall be provided with safety interlocking control, and the electric equipment with remote and local control shall be provided with selector switch.

For lightning of boiler body, except the electric leakage protection, the high temperature resistant cable shall be also provided for routing; and the domestic working lights for maintenance purpose shall be provided with AC12V power supply.

22. System Studies: Load flow, short circuit, stability

Load Flow Analysis

From the analysis discussed above, we conclude that the proposed interconnection scheme is adequate to evacuate the 40 MW export of power from Waste to Energy Thermal PP under normal and N-1 contingency conditions.

Short Circuit Analysis

The short circuit analysis results show that for the proposed scheme of interconnection of Waste to Energy Thermal PP, we don't find any violations of short circuit ratings of the already installed equipment on the 132 kV and 11 kV equipment of substations in the vicinity of Waste to Energy Thermal PP Feeder due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level at Waste to Energy Thermal PP 132 kV bus bar is 15.21 kA and 10.82 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed at 132 kV substation of Waste to Energy Thermal PP taking care of any future generation additions in its electrical vicinity.

Dynamic Stability Analysis

The results of dynamic stability show that the system is very strong and stable for the proposed schemes for the severest possible faults of 132 kV systems near Waste to Energy Thermal PP. Therefore there is no problem of dynamic stability for interconnection of WTE Thermal PP- HPP; it fulfills all the criteria of dynamic stability.

The further details of the system studies are provided in Grid Interconnection Study attached to this application for the grant of Generation License.

23. Plant characteristics:

Generator Voltage	11 kV
frequency	50 Hz
Auxiliary consumption	16%

24. Control, Metering, Instrumentation and Protection

Control & Instrument

Process control of the WTE Project is in a central control method. Distributed control system (DCS) in the central control room is to achieve a central, uniform and coordinated control of the whole plant, and ensure high production efficiency, energy conservation, safety and environment protection.

Plant telecommunication system and control system are designed in a coordinated and uniform manner, with advanced technology, economic rationality and strong capability.

Control mode

Central control room is in main control building, including central control room, electronic equipment room and engineer room. The control room is provided with one set of central Distributed Control System (DCS) to centrally monitor operation of each facility. Some process equipment is provided with Programmable Logic Controller (PLC), which shall be centrally monitored by central control room as well.

To better monitor waste incineration process in an all-round way, large screen display system is set in central control room.

CCTV is provided at the positions and places of key manufacturing equipment which need frequent monitoring. The actual conditions of such positions and places are directly visible through television monitor or large screen in the central control room.

In addition, real-time display bulletin board of flue gas emission online monitoring (CEMS) is set, which will showcase flue gas emission data for inspection and supervision by the public.

Composition of control system

The DCS man-machine interface equipment is provided in the central control room. The central control room is also provided with large color screen display system to improve operating conditions and management level.

Functions of control system

DCS conducts data acquisition (DAS), modulating control (MCS), sequence control (SCS), interlock protection of main equipment and other functions.

Central control room

The control room is provided with DCS equipment and relevant instrument panel, industrial television monitor, large screen monitor, etc.

Power supply of control system and instrument

To guarantee power supply of control system, uninterrupted power supply (UPS) is provided in control room to supply power to DCS, instrument and other control systems. UPS shall guarantee the power supply duration of 30min.

Instrument air supply

- Instrument air supply is mainly used for some pneumatic instrument provided.
- Instrument air must be removed with oil, water, dust, dried and subject to other air purification treatment, and the air supply quality must conform to the following requirements:
 - O Dew point: the air supply dew point at operating pressure is at least 10°C lower than the lower limit of ambient temperature;
 - O Dust content: the size of dust particles in air shall not be greater than 3um;
 - Oil content: the oil content in air shall not be greater than 10mg/m3 (8ppm);
 - o Pollutants: air supply shall be free of obvious hazardous gas or steam;
 - Air supply pressure shall be automatically maintained within 0.7MPa to 0.8MPa, and the instrument air supply shall be provided with alarm protection functions;
 - Special air storage tank is provided.

Industrial television monitoring system (CCTV)

CCTV system visually monitors key positions and equipment.

Monitoring objects includes:

- Incinerator flame status
- Boiler steam drum water level
- Waste transport vehicle at waste unloading platform
- Current condition of waste accumulation of waste bunker
- Waste accumulation of boiler-front waste hopper
- Slag stockpiling in slag pit
- Material level in slag truck hopper
- Conditions of steam turbine generation platform
- Flue gas emission of stack

Poisonous and combustible gas monitoring system

To guarantee personal health and prevent fire, leachate collecting tank, waste bunker, SNCR room, waste leachate ditch and adjacent staircase are monitored by poisonous and combustible gas detectors.

Relay Protection and Automation devices

Generator protection	Generator differential protection (with main transformer and auxiliary branch bus);
	 Compound voltage over-current protection;
	Overload protection;
	Stator grounding protection;
	Rotor grounding protection;

	Excitation loss protection.				
Main Transformer protection (As main	The electricity protection includes:				
transformer may operate under reversed power transmission, there are electricity	Differential protection (with generator and plant branch bus).				
protection and non-electricity protection	The following protection is provided on both sides of transformer:				
of the main transformer.)	 Compound voltage over-current protection; 				
	Overload protection;				
	Single-phase grounding protection.				
	Non-electricity protection includes:				
	Heavy gas protection;				
	Light gas protection;				
	Temperature protection;				
	Abnormal oil level protection;				
	Pressure relief protection.				
Protection for 11kV auxiliary backup	Short-time delayed quick break protection;				
power supply	Over-current protection;				
	Overload protection;				
	Single-phase grounding protection.				
Auxiliary LV transformer Protection	Electricity protection includes:				
	Quick break protection;				
	Over-current protection;				
	Overload protection;				
	Zero sequence current (grounding) protection.				
	Non-electricity protection includes:				
	Temperature protection.				
Automatic device	Automatically regulated excitation device of generator and				
	automatic				
	Excitation cut-off device;				
	Automatic quasi-synchronizing device of generator;				
	11kV and 0.38kV standby auxiliary power supply auto				
	switch-in device;				
	Emergency lighting auto-switch-in device.				

25. Training and Development Plan

Advanced management methods and high-quality staff will be the precondition of modern enterprise after the completion of the WTE Project. The quality of staffs plays a critical role to reach design capacity and make profit during production and operation after the WTE Project is put into operation. Therefore, employee training shall be completed conscientiously.

First of all, a certain education background and related working experience of the management personnel candidates are required. Such personnel shall have decent behavior, strong working ability and the spirit of innovation. In addition, they shall be subject to corresponding tests and strict selection before taking the posts. Before put into operation, selected personnel shall be subject to theory training, and some management personnel and production backbones shall be selected and sent for 6 months' operation training of the posts. Before taking posts, operators shall pass various evaluations about safety, operation regulations, coordination of former and rear links of production procedures, contact and accident treatment, and only those qualified can take the posts.

Operators will be recruited in Pakistan with site training of special knowledge, operation rules and safety provided. It is required to recruit local personnel with proper education background, give priority to those skilled personnel, who may take posts immediately or those may become qualified after a certain period of training before the WTE Project is put into operation

26. Type of facility for which the license is applied

Type of facility for which generation license is being applied is Waste to Energy – Municipal Solid Waste technology.



LAHORE ELECTRIC SUPPLY COMPANY

Office of Chief Engineer (Development) LESCO Qartaba Grid Station Bahawalpur Road Lahore. Ph:042-99214410 FAX 042-99214412

/CE(DEV)/P&S/PMU/607

Dated: /12/2017

To.

Customer Services Director, LESCO.

Grid Interconnection Study of 40 MW Waste to Energy Power Project at Sub: <u>Lakhodair Landfill site Lahore</u>

1-M/s Lahore Xingzhong Renewable Energy Company (Pvt.) Ltd. letter no. FAX-PK-Ref: 2017-041 dated: 20-11-2017.

2-This office letter no. 6731-34/CE (DEV)/P&S/PMU/607 dated: 14-11-2017.

3-Your office letter no.41452-54/MMT-252 dated: 14-11-2017.

Please refer to above letter at sr. no. 1 vide which the final grid interconnection study report (November 2017) of the subject cited power plant was submitted to this office after addressing the discrepancies pointed out by this office vide this office letter at sr. no. 2 above.

This office has reviewed final grid interconnection study report. In this regard it has been found that the consultant has incorporated all the comments, therefore the final report is being vetted.

However, it is clarified that the report has been vetted only for interconnectivity aspect of the subject cited power plant. It should not be considered as a go-ahead signal to execute the project. Any commitment regarding project execution or consent of power purchase, tariff etc. has to be discussed with the concerned quarters. It is further intimated that when there will be any change in the parameters assumed in the interconnection study then the study should be revised accordingly and the same should be submitted to this office for review/ vetting.

Further to above, the grid study should also be submitted to NTDCL for endorsement of the same, as per NTDC letter no. GMPP/CEMP/TRP-380/3136-39 dated: 02-06-2017.

> General Manager (Dev.) PMY LESCO

Copy to:

1. Technical Director, LESCO.

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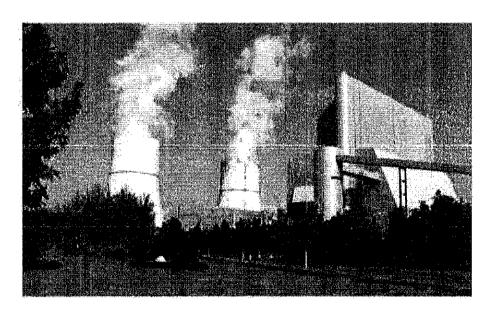
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INTERCONNECTION STUDY

For 40 MW Waste to Energy Thermal Power Plant by Lahore Xingzhong Renewable Energy Company (Private) Limited



Draft Report
(June 2017)
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Executive Summary

- The study objective, approach and methodology have been described and the plant's data received from the client is validated.
- The LESCO system data as available with PPI for other studies have been used.
- The interconnection study of Waste to Energy Thermal PP to evacuate its maximum power of 40 MW is envisaged and studied in detail.
- The following scheme of interconnection of Thermal Power Plant to evacuate its maximum power of 40 MW is proposed:
 - Looping in-out of 132 kV Mominpura to Darogawala transmission line at Waste to Energy. The in-out length is 5 km.
 - Two 132/11 kV transformers of 31.5/40 MVA each are proposed as GSU.

The proposed scheme will require the following equipment at switch yard of Waste to Energy Thermal PP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Keeping in view the expected COD of the project which is end of 2019, load flow studies have been carried out for the peak load conditions of January 2022 for the proposed scheme considered under normal and N-1 contingency conditions.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 40 MW of the plant under normal condition and N-1 contingency.
- The short circuit analysis has been carried out to calculate maximum fault levels at Waste to Energy Thermal PP at 132 kV and 11 kV and the surrounding substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from Waste to Energy Thermal PP.
- ❖ The maximum short circuit levels of Waste to Energy Thermal PP 132 kV and 11 kV have been evaluated for the peak case of 2022 to evaluate the maximum fault currents on Waste to Energy Thermal PP and the 132 kV Substations in its vicinity. The short circuit level at Waste to Energy Thermal PP 132 kV bus bar is 15.21 kA and 10.82 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating 40 kA at 132kV would be fine to be installed at switch room of Waste to

- Energy Thermal PP as per LESCO/NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.
- * 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 132 kV bus bar of Waste to Energy Thermal PP substation followed by the final trip of 132 kV circuits emanating from this substation, has been performed for fault clearing within 5 cycles (100 ms). The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems, it meets all the criteria of stability under steady state load flow, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

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Appendices

Appendix -A: NTDC Latest Generation, Transmission Plan, Load Forecast

Appendix -B: Sketches

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

Appendix -D: Results of Short Circuit Calculations for Chapter - 6

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

Appendix - F: Dynamic Data for Stability

1. Introduction

1.1. BACKGROUND

The Lahore Xingzhong Renewable Energy Company (Private) Limited intends to install "Waste to Energy" power projects in Lahore to contribute electric power in the National infrastructure of LESCO. Waste to Energy is an environmental project, other than the byproduct energy project. This project is beneficial for the public too, as it saves good land and cleans the environment. The under study Power Plant will be located at a distance of 5 km from 132/11 kV grid station Morningura near Mehmood Booti in Lahore, Punjab. It is situated in the concession area of Lahore Electricity Supply Company (LESCO). The location of Waste to Energy Thermal PP is shown in Appendix-B. The net output planned to be generated from the site is about 40 MW of electrical power. The project is expected to start commercial operation by the end of year 2022. The electricity generated from this project would be fed to the national grid of LESCO 132/11 kV Mominpura.

1.2. OBJECTIVES

The overall objective of the Study is to develop an interconnection scheme between WTE Thermal PP and LESCO network, for stable and reliable evacuation of 40 MW of electrical power generated from this plant. The specific objectives are:

- 1. To develop schemes of interconnections at 132 kV of 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 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 11 kV and 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 Waste to Energy Thermal PP.
- 4. To check if the interconnection withstands dynamic stability criteria of post fault recovery with good damping after 3-phase faults on the system.

1 -

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1.3. PLANNING CRITERIA

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

Steady State:

± 5 %, Normal Operating Conditions Voltage

50 Hz, Continuous, ± 1% variation steady state Frequency

± 5% variation Short Time

49.4 - 50.5 Hz, Short Time

0.8 Lagging; 0.85 Leading Power Factor

Dynamic/Transient:

The system should revert to normal condition after dying out of transients without losing synchronism with good damping.

- For 132 kV and above, the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 100 ms (5 cycles).
- For 11 kV and 33 kV the total normal fault clearing time from the instant of initiation of fault current to the complete interruption of current, including the relay time and breaker interruption time to isolate the faulted element, is equal to 180 ms (9 cycles).

2. Assumptions of Data

Generator Data

The detailed electrical parameters of the generators at WTE Thermal PP would be designed at the EPC stage. However for the purposes of this study, following assumptions have been made:

Waste to Energy Thermal PP data

Generator data:

Number of Generating Units

= 2

Normal rating of generating units

= 20 MW

Lump sum maximum generating capacity

 $= 2 \times 20 = 40 \text{ MW}$

Power factor

= 0.8 lagging, 0.85 leading

Lump sum MVA capacity

 $= 2 \times 25 \text{ MVA} \text{ (at PF } 0.8) =$

50 MVA

Rated Voltage

= 11 kV

Generator Step-up Transformer Data:

Transformer Rating

 $= 31.5 \, MVA$

Voltage Ratio

= 132/11 kV

Data used for dynamic stability analysis is shown in Appendix – F.

Network data

The 11 kV and 132 kV networks available for interconnection to WTE Thermal PP Thermal Power Plant are as shown in Appendix-B.

The NTDC/LESCO system data of National Grid have been assumed in the study as already available with PPI.

Study Approach and Methodology 3.

3.1. UNDERSTANDING OF THE PROBLEM

Waste to Energy Thermal PP is going to be a Thermal power project embedded in the distribution network of LESCO. Waste to Energy Thermal PP is in the vicinity of Mominpura Grid Station which is looped in/out between Darogawala and Batapur Grid stations. Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for the year 2022, comprising all 500kV, 220kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year particularly in LESCO and NTDC.
- Keeping in view the expected COD of end of 2019, Month of January 2022 has been selected for the study of the base case because it is low water season and we can judge the maximum impact of the plant on the network in these conditions.
- Interconnection schemes without any physical constraints, like right of way or availability of space in the terminal substations, have been identified and confirmed by LESCO.
- Performed technical system studies for peak load conditions to confirm technical feasibility of the interconnection schemes. The proposed scheme has been subjected to standard analysis like load flow, short circuit, and transient stability study to check the strength of the machines and the interconnection scheme under disturbed conditions.
- Determine the relevant equipment for the proposed technically feasible scheme.

4. **Development of Schemes of Interconnection**

4.1 THE EXISTING AND ONGOING NETWORK

The nearest existing LESCO interconnection facilities at the time of commissioning of WTE Thermal Power Project would be Mominpura 132/11 kV Substation which is looped in/out between the 132 kV Batapur and 132kV Darogawala.

The existing 132 kV and 11 kV network available around the 132/33/11 kV grid station is shown in Sketch-I & II in Appendix-B.

4.2 THE SCHEME OF INTERCONNECTION OF WASTE TO ENERGY THERMAL PP

Given the nearest interconnection facility for Waste to Energy Thermal PP following scheme of interconnection of Thermal Power Plant is envisaged and studied in detail:

- Looping in-out of 132 kV Mominpura to Darogawala transmission line at Waste to Energy. The in-out length is 5 km.
- Two 132/11 kV transformers of 20/26 MVA each are proposed as GSU.

The proposed scheme will require the following equipment at switch yard of Waste to Energy [hermal PP:

Two breaker panels of 11 kV for connecting two Generating Units

5 **Detailed Load Flow Studies**

A base case has been developed for the peak load of January 2022, which is the high water season and will allow us to judge the maximum impact of Waste to Energy Thermal PP on the LESCO network, using the network data supplied/authorized by LESCO/NTDC.

5.1 BASE CASE 2022: WITHOUT WASTE TO ENERGY THERMAL PP

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 132 kV network feeding Mominpura 132/11 kV Substation and its surrounding substations.

The load flow results for the normal case show that the power flows on all the circuits are within their normal rating. We find that there are no capacity constraints in terms of power flow or voltage ratings in the 11 kV or 132 kV network available in the vicinity of Waste to Energy Thermal PP for its connectivity under normal and N-1 contingency conditions.

The following N-1 contingency tests were run:

Exhibit 0.1	Darogawala to Mominpura 132kV Single Circuit Out
Exhibit 0.2	Batapur to Mominpura 132kV Single Circuit Out
Exhibit 0.3	NSMR1 to Darogawala 132kV Single Circuit Out
Exhibit 0.4	Shalimar-1 to NSMR1 132kV Single Circuit Out
Exhibit 0.5	Ghazi to Batapur 132kV Single Circuit Out
Exhibit 0.6	Ghazi to Fatehgharh 132kV Single Circuit Out
Exhibit 0.7	Ghazi Road to Ghazi 132kV Single Circuit Out
Exhibit 0.8	PWR to Fatehgarh 132kV Single Circuit Out
Exhibit 0.9	Sunny View to PWR 132kV Single Circuit Out

5.2 PEAK LOAD CASE 2022: WITH WTE THERMAL POWER PLANT

The base cases have been developed for the peak conditions of January 2022 using the network data of NTDC and LESCO available with PPI. The peak loads of the year 2022 for LESCO have been modeled as per the latest PMS Demand forecast as provided by NTDC. Detailed load flow studies have been carried out for January 2022. The results of load flows with Waste to Energy Thermal PP under normal conditions have been plotted in Exhibit 1.0 in Appendix-C.

Exhibit 1.1	WTE to Mominpura 132kV Single Circuit Out
Exhibit 1.2	Darogawala to WTE 132kV Single Circuit Out
Exhibit 1.3	Mominpura to Batapur 132kV Single Circuit Out
Exhibit 1.4	NSMR-1 to Darogawala 132kV Single Circuit Ou
Exhibit 1.5	Shalimar-1 to NSMR1 132kV Single Circuit Out
Exhibit 1.6	Ghazi to Batapur 132kV Single Circuit Out
Exhibit 1.7	Ghazi to Fatehgharh 132kV Single Circuit Out
Exhibit 1.8	Ghazi Road to Ghazi 132kV Single Circuit Out
Exhibit 1.9	PWR to Fatehgarh 132kV Single Circuit Out
Exhibit 1.10	Sunny View to PWR 132kV Single Circuit Out

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 \pm 5 % of the nominal. We find no capacity constraints on 132 kV circuits under normal and N-1 contingency conditions.

5.3 CONCLUSION OF LOAD FLOW ANALYSIS

From the analysis discussed above, we conclude that the proposed interconnection scheme is adequate to evacuate-the 40-MW export of power-from-Waste-to Energy-Thermal PP under normal and N-1 contingency conditions.

6 **Short Circuit Analysis**

METHODOLOGY AND ASSUMPTIONS 6.1

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

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

For evaluation of maximum short circuit levels we have assumed contribution in the fault currents from all the installed generation capacity of hydel, thermal and nuclear plants in the system in the year 2022 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.

FAULT CURRENT CALCULATIONS WITHOUT WASTE TO ENERGY 6.2 THERMAL PP

In order to assess the short circuit strength of the network of 132 kV and 11 kV without Waste to Energy Thermal PP for the grid of LESCO/NTDC in the vicinity of the site of the plant, fault currents have been calculated for balanced three-phase and unbalanced singlephase short circuit conditions. These levels will not only give us the idea of the fault levels of Mominpura 132kV and other grid stations in the vicinity without Waste to Energy Thermal PP but would also help us determine how much the contribution of fault current from Waste to Energy Thermal PP later on may add to the existing levels.

The results are attached in Appendix -D.

The short circuit levels have been represented graphically on the bus bars of 132 kV and 11 kV which are shown in the Exhibit 2.0 attached in Appendix-D.

The fault currents in the Exhibit are given in polar coordinates i.e. the magnitude and the angle of the current. The total fault current is shown below the bus bar.

The tabular output of the short circuit calculations is also attached in Appendix-D for the 132 kV and 11 kV bus bars of our interest i.e. the substations connecting in the 132 kV and 11 kV circuits lying close to Waste to Energy Thermal PP. 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 31.5 kA for older substations and 40 kA for new substations.

Table 6.1

Maximum Short Circuit Levels without Waste to Energy Thermal PP

Substation	3-Phase fault current,	1-Phase fault current			
Substation	kA	kA			
Mominpura 132 kV	16.70	10.60			
Darogawala 132 kV	19.92	12.87			
Batapur 132 kV	15.25	9,62			
Ghazi 132 kV	29.93	20.93			
Fatehgarh 132 kV	36.87	25.39			

6.3 MAXIMUM FAULT CURRENT CALCULATIONS WITH WASTE TO ENERGY THERMAL PP

The fault currents have been calculated for the electrical interconnection of proposed scheme for the 2022 scenario. Fault types applied are three phase and single-phase at the 132 kV and 11 kV bus bar of Waste to Energy Thermal PP itself and other bus bars of the 132 kV substations in the electrical vicinity of Waste to Energy Thermal PP. The graphic results are shown in Exhibit 2.1.

The tabulated results of short circuit analysis showing all the fault current contributions with short circuit impedances on 132 kV and 11 kV bus bars of the network in the electrical vicinity of Waste to Energy Thermal PP and the 11 kV bus bars of Waste to Energy Thermal PP 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 Waste to Energy Thermal PP-2018

Colon de Allen	3-Phase fault current,	1-Phase fault current,				
Substation	kA	kA				
WTE T1 11 kV	34.01	36.82				
WTE T2 11 kV	34.01	28.25				
Waste to Energy 132 kV	15.21	10.82				
Mominpura 132 kV	13.90	9.43				
Darogawala 132 kV	20.12	13.66				
Batapur 132 kV	14.13	9.25				
Ghazi 132 kV	30,10	21.31				
Fatehgarh 132 kV	37.53	26.13				

Comparison of Tables 6.1 and 6.2 show slight increase in short circuit levels for three-phase and single - phase faults due to connection of Waste to Energy Thermal PP on the 11 kV bus bars in its vicinity; and some rise on the 132 kV substation of Mominpura. We find that even after some increase, these fault levels are much below the rated short circuit values of the equipment installed on these substations.

The short circuit level at Waste to Energy Thermal PP 132 kV bus bar is 15.21 kA and 10.82 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating of 40 kA would be fine to be installed 132 kV substations of Waste to Energy Thermal PP. It would provide large margin for any future increase in short circuit levels due to future generation additions and network reinforcements in this area.

6.4 CONCLUSION OF SHORT CIRCUIT ANALYSIS

The short circuit analysis results show that for the proposed scheme of interconnection of Waste to Energy Thermal PP, we don't find any violations of short circuit ratings of the already installed equipment on the 132 kV and 11 kV equipment of substations in the vicinity of Waste to Energy Thermal PP Feeder due to fault current contributions from this power house under three-phase faults as well as single phase faults.

The short circuit level at Waste to Energy Thermal PP 132 kV bus bar is 15.21 kA and 10.82 kA for 3-phase and 1-phase faults respectively. Therefore industry standard switchgear of the

short c	ircuit rati	ng of 40	kA w	vould b	e fine	to be	instal	led at	132	kV	substation	of	Waste	to
Energy	/ Thermal	PP takin	g care	of any	future	e gene	ration	additi	ons	in it:	s electrical	vic	inity.	

7 Dynamic Stability Analysis

7.1 ASSUMPTIONS & METHODOLOGY

7.1.1 Dynamic Models

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

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

Generator

GENROU

Excitation System

EXST1

Speed Governing System

TGOV1

7.1.2 System Conditions

We have used the system conditions of January 2022, which represents the high water season. We have carried out the Dynamic Stability analysis for Waste to Energy Thermal PP with the proposed interconnection scheme. All the power plants of WAPDA /NTDC 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 that 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 2-3 seconds after disturbance is cleared from the system.

7.1.4 Worst Fault Cases

Three phase faults are considered as the worst disturbances in the system. Normally we apply 3 phase fault on the bus bar of the power plant, followed by tripping of a circuit emanating from that bus, and trip one of the generators of the plant and / or trip one of the inter-bus transformers if there are two voltage levels in the switching station of the plant. Also we apply 3-phase fault at bus bars at far end of the interconnection of the plant and trip circuit or transformer as the case may be. The fault clearing time of 11 kV breakers has been assumed 9 cycles as the switchgear of the medium voltages are slow.

7.2 DYNAMIC STABILITY SIMULATIONS' RESULTS

All the simulations have been run using H = 2.69 (MWs/MVA) as per original assumption mentioned in Ch.2.

7.2.1 Three-Phase Fault at 132 kV Waste to Energy Thermal PP: Trip WTE Thermal PP to Mominpura 132 kV Single Circuit

We applied three-phase fault on Waste to Energy Thermal PP 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of WTE Thermal PP to Mominpura 132 kV Single Circuit. We monitored different parameters 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. 1.1 Bus Voltages

The 132 kV bus bars of Waste to Energy, Mominpura, Darogawala, Ghazi, Fatehgarh and Batapur, are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 1.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 1.3 MW/MVAR Output of Generators of Waste to Energy Thermal PP

The pre-fault output of Waste to Energy Thermal PP was 40 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

- Fig. 1.4 Speed and mechanical power of Generators at Waste to Energy Thermal PP 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/MVAR Flow on WTE Thermal PP to Darogawala 132 kV Single Circuit Followed by clearing of fault, the trip of one 132 kV circuit between WTE Thermal PP and Mominpura caused the output of 40 MW to flow from WTE to Darogawala circuit. We plotted the flows of MW and MVAR on this 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 Waste to Energy Thermal PP, Saba P, Halmore-P, Saphire, and Orient-P are plotted relative to machines at Hub. The results show that the rotor angle of WTE Thermal PP recovers its normal condition after the first swing and damps

down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.2 Single-Phase Fault at 132 kV Waste to Energy Thermal PP: Trip WTE Thermal PP to Mominpura 132 kV Single Circuit

We applied Single-phase fault on Waste to Energy Thermal PP 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of WTE Thermal PP to Mominpura 132 kV Single Circuit. We monitored different parameters 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. 2.1 Bus Voltages

The 132 kV bus bars of Waste to Energy, Mominpura, Darogawala, Ghazi, Fatehgarh and Batapur, are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 2.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 2.3 MW/MVAR Output of Generators of Waste to Energy Thermal PP

The pre-fault output of Waste to Energy Thermal PP was 40 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output

acquires equilibrium at a new value.

- Fig. 2.4 Speed and mechanical power of Generators at Waste to Energy Thermal PP 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/MVAR Flow on WTE Thermal PP to Darogawala 132 kV Single Circuit Followed by clearing of fault, the trip of one 132 kV circuit between WTE Thermal PP and Mominpura caused the output of 40 MW to flow from WTE to Darogawala circuit. We plotted the flows of MW and MVAR on this 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 Waste to Energy Thermal PP, Saba P, Halmore-P, Saphire, and Orient-P are plotted relative to machines at Hub. The results show that the rotor angle of WTE Thermal PP recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.3 Three-Phase Fault at 132 kV Mominpura: Trip Mominpura to Batapur 132 kV Single Circuit

We applied three-phase fault on Mominpura 132 kV bus bar, cleared fault in 5 cycles (100 ms) followed by trip of WTE Thermal PP to Mominpura 132 kV Single Circuit. We monitored different parameters 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 132 kV bus bars of Waste to Energy, Mominpura, Darogawala, Ghazi, Fatehgarh and Batapur, are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 3.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

- Fig. 3.3 MW/MVAR Output of Generators of Waste to Energy Thermal PP
- The pre-fault output of Waste to Energy Thermal PP was 40 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.
- Fig. 3.4 Speed and mechanical power of Generators at Waste to Energy Thermal PP 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/MVAR Flow on Mominpura to Batapur 132 kV Single Circuit Followed by clearing of fault, the trip of one 132 kV circuit between WTE Thermal PP and Mominpura caused an increased in power flow from batapur to mominpura. We plotted the

flows of MW and MVAR on this 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 Waste to Energy Thermal PP, Saba P, Halmore-P, Saphire, and Orient-P are plotted relative to machines at Hub. The results show that the rotor angle of WTE Thermal PP recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.2.4 Single-Phase Fault at 132 kV Mominpura: Trip Mominpura to Batapur 132 kV Single Circuit

We applied three-phase fault on Mominpura 132 kV bus bar, cleared fault in 9 cycles (180 ms) followed by trip of WTE Thermal PP to Mominpura 132 kV Single Circuit. We monitored different parameters 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 132 kV bus bars of Waste to Energy, Mominpura, Darogawala, Ghazi, Fatehgarh and Batapur, are plotted. The results show quick recovery of the voltages after clearing of fault.

Fig. 4.2 Frequency

We see that the system frequency recovers its normal condition quickly after fault clearance.

Fig. 4.3 MW/MVAR Output of Generators of Waste to Energy Thermal PP

The pre-fault output of Waste to Energy Thermal PP was 40 MW and it gets back to the same output quickly after fast damping of the oscillations in its output. However MVAR output acquires equilibrium at a new value.

- Fig. 4.4 Speed and mechanical power of Generators at Waste to Energy Thermal PP 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/MVAR Flow on Mominpura to Batapur 132 kV Single Circuit

Followed by clearing of fault, the trip of one 132 kV circuit between WTE Thermal PP and Mominpura caused an increased in power flow from batapur to mominpura. We plotted the flows of MW and MVAR on this 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 Waste to Energy Thermal PP, Saba P, Halmore-P, Saphire, and Orient-P are plotted relative to machines at Hub. The results show that the rotor angle of WTE Thermal PP recovers its normal condition after the first swing and damps down quickly. Similarly the rotor angles of other machines swing little after the fault and damp fast after clearing of fault. The system is stable and very strong in damping the post fault oscillations.

7.3 CONCLUSION OF DYNAMIC STABILITY ANALYSIS

The results of dynamic stability show that the system is very strong and stable for the proposed schemes for the severest possible faults of 132 kV systems near Waste to Energy Thermal PP. Therefore there is no problem of dynamic stability for interconnection of WTE Thermal PP- HPP; 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 LESCO system data as available with PPI for other studies have been used.
- The interconnection study of Waste to Energy Thermal PP to evacuate its maximum. power of 40 MW is envisaged and studied in detail.
- The following scheme of interconnection of Thermal Power Plant to evacuate its maximum power of 40 MW is proposed:
 - Looping in-out of 132 kV Mominpura to Darogawala transmission line at Waste to Energy. The in-out length is 5 km.
 - Two 132/11 kV transformers of 31.5/40 MVA each are proposed as GSU.

The proposed scheme will require the following equipment at switch yard of Waste to Energy Thermal PP:

- Two breaker panels of 11 kV for connecting two Generating Units
- Keeping in view the expected COD of the project which is end of 2019, load flow studies have been carried out for the peak load conditions of January 2022 for the proposed scheme considered under normal and N-1 contingency conditions.
- Steady state analysis by load flow reveals that proposed scheme is adequate to evacuate the maximum power of 40 MW of the plant under normal condition and N-1 contingency.
- The short circuit analysis has been carried out to calculate maximum fault levels at Waste to Energy Thermal PP at 132 kV and 11 kV and the surrounding substations in its vicinity. We find that the fault currents for the proposed scheme are much less than the rated short circuit capacities of switchgear installed at these substations. There are no violations of the equipment ratings due to contribution of fault current from Waste to Energy Thermal PP.
- ❖ The maximum short circuit levels of Waste to Energy Thermal PP 132 kV and 11 kV have been evaluated for the peak case of 2022 to evaluate the maximum fault currents on Waste to Energy Thermal PP and the 132 kV Substations in its vicinity. The short circuit level at Waste to Energy Thermal PP 132 kV bus bar is 15.21 kA and 10.82 kA for 3phase and 1-phase faults respectively. Therefore industry standard switchgear of the short circuit rating 40 kA at 132kV would be fine to be installed at switch room of Waste to



- Energy Thermal PP as per LESCO/NTDC requirement taking care of any future generation additions and system reinforcements in its electrical vicinity.
- * 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 132 kV bus bar of Waste to Energy Thermal PP substation followed by the final trip of 132 kV circuits emanating from this substation, has been performed for fault clearing within 5 cycles (100 ms). The system is found strong enough to stay stable and recovered with fast damping.
- The proposed scheme of interconnection has no technical constraints or problems, it meets all the criteria of stability under steady state load flow, short circuit currents and dynamic/transient conditions; and is therefore recommended to be adopted.

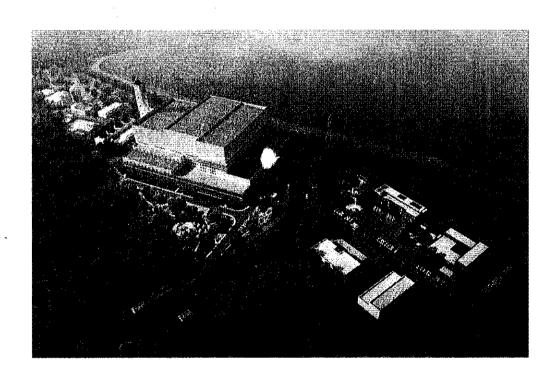


Project No.: DF930-2017

FEASIBILITY STUDY

FOR

LAHORE 2000T/D WASTE TO ENERGY PROJECT IN PAKISTAN



CHINA ENFI ENGINEERING CORPORATION

JUNE 2017

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THE FEASIBILITY STUDY IS DIVIDED INTO FOLLOWING DOCUMENTS:

VOLUME I:TECHNICAL REPORT

VOLUME II: ENGINEERING DRAWINGS

VOLUME III: WASTE CHARACTERIZATION STUDY*

VOLUME IV: GEOTECHNICAL INVESTIGATION REPORT, TOPOGRAPHICAL SURVEY REPORT*

VOLUME V: INITICAL ENVIRONMENTAL EXAMINATION (IEE) REPORT*

VOLUME VI: ELECTRICAL & GRID INTERCONNECTION STUDIES*

*Note:

- (1) Volume III, IV and V are prepared and updated separately by sub-consultant Environmental Consultancies & Options (ECO).
- (2) Volume VI is prepared and updated by sub-consultant Power Planners International (PPI).

PROJECT NO.: DF930-2017

FEASIBILITY STUDY

FOR

LAHORE 2000T/D WASTE TO ENERGY PROJECT IN PAKISTAN

VOLUME I : TECHNICAL REPORT

CHINA ENFI ENGINEERING CORPORATION

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LIST OF ABBREVIATIONS

AC	Alternative Current
ACC	Auto Combustion Control
BEP	Break-even Point
BOQ	Bill of Quantities
C&I	Control & Instrument
CAPEX	Capital Expenditure
CCTV	Closed Circuit Television
CCR	Central Control Room
CEMS	Continuous Emission Monitoring System
DAS.	Data Acquisition System
DC	Direct Current
DCS	Distributed Control System
DED	Detailed Engineering Drawing
EIA	Environmental Impact Assessment
ENFI	China ENFI Engineering Corporation
EPA	Environmental Protection Act
WBS	Feasibility Breakdown Structure
FS	Feasibility Study
GIS	Gas Insulated Switchgear
HVAC	Heating, Ventilation and Air Conditioning
I/O	Input and Output
ID	Induced Draught
IEE	Initial Environment Examination
IRR	Internal Rate of Returns
LAN	Local Area Network
LCD	Liquid Crystal Display
LHV	Lower Heating Value
LWMC	Lahore Waste Management Company

LOI	Letter of Interest
MCCT	MCC Tongsin Resources Co., Ltd
MCS	Modulating Control System
MCR	Maximum Continuous Rating
MGF	Moving Grate Furnace
MIS	Management Information System
MSW	Municipal Solid Waste
МТО	Material Take-off
MGF	Moving Grate Furnace
NCF	Net Cash Flow
NPV	Net Present Value
PEPO	Pakistan Environmental Protection Ordinance
PEQS	Punjab Environmental Quality Standards
PLC	Programmable Logic Controller
PPDB	Punjab Power Development Board
RC	Reinforced Concrete
SCR	Selective Catalytic Reduction
SIS	Supervision Information System
SNCR	Selective Non-catalytic Reduction
sow	Scope of Work
SPV	Special-purpose Vehicle
UPS	Uninterrupted Power Supply
VFD	Variable Frequency Drive
WHB	Waste Heat Boiler
WTE	Waste To Energy

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Chapter 1 Executive Summary

1.1 Project overview

Project Name: Lahore 2000T/D Waste to Energy Project in Pakistan (hereinafter referred to as 'The WTE Project')

Project Site: Lakhodair Landfill, northeast of Lahore, Pakistan (proposed plant site I)

Name of SPV: Lahore Xingzhong Renewable Energy Company (Private) Limited (hereinafter referred to as 'Xingzhong')

Project Capacity: processing total of 2000t/d of MSW

Processing Configuration: Three sets of 670t/d MGF and two sets of condensing steam turbine generator (air cooling) of 20MW

1.2 Project background & SPV Company

1.2.1 Background

Lahore, the capital of Punjab Province, is the second largest city of Pakistan. It is known as "Garden City", and the culture and art center of Pakistan with over 2,000 years' history, once being the capital of Mughal Empire. After independence of Pakistan in 1947, Lahore, covering an area of 1,770km² with population of over 9 million, became the richest city of Punjab Province with a booming economy.

Total MSW to dispose in Lahore was about 5,200t/d in 2016. With rapid growth of population, waste quantity is also rising. In order to dispose MSW in an effective, sustainable, and environmentally friendly manner, Lahore Waste Management Company (LWMC) made a Waste Disposal Strategy shown in figure 1-1, with the priority of preferred options from bottom to top. The planned capacity of MSW disposal is totally 6,000t/d including 2,000t/d for The WTE project.

Prior Bio Sun Project Compositing

Application

Application

Modern Santzary Landfill Site

Controlled open Liumsing

Figure 1-1: Priority of Preferred Options for Waste Disposal

1.2.2 SPV Company

The Letter of Interest (LOI) for the Feasibility Study (FS) of The WTE Project was issued by Punjab Power Development Board (PPDB) on October 19, 2016. Xingzhong, as the SPV Company, was registered on 1st February, 2017. It shall be responsible for investment, construction, operation and property transfer of The WTE Project.

Xingzhong-was-jointly-established-by-China-ENFI-Engineering-Corporation-(hereinafter-referred to as "ENFI"), MCC Tongsin Resources Co., Ltd. (hereinafter referred to as "MCCT") and Chengdu Xingrong Environment Co., Ltd. (hereinafter referred to as "Xingrong Environment"), as per the Three-side Cooperation Framework Agreement of Lahore 2000T/D Waste to Energy Project in Pakistan signed on 30th May, 2016.

In accordance with the framework agreement, ENFI shall be responsible for FS preparation.

ENFI has invested and constructed 4 WTE projects with BOT model in Wuxi, Xiangyang, Harbin and Ganzhou, China. The daily disposal capacity of the WTE Projects is up to 5,600t in total. ENFI has undertaken successfully consultation and engineering of over 30 WTE projects in China, 20 of which have a MSW disposal capacity of 1,000t/d or above.

1.3 Scope of work (SOW) & work breakdown structure (WBS)

The WTE plant mainly consists of main processing facilities, auxiliary facilities, administration buildings as well as roads, gates and fences, etc.

Work Breakdown Structure (WBS) is defined in Table 1-1. Be noted WBS-001 is general notion of combined processing building and made up of WBS-002 to 007.

Table 1-1: Work Breakdown Structure

No.	Facility Name
001	Main Processing Building
002	Waste Receiving, Storage, Feeding System and Auxiliary System
003	Incinerator and Boiler Building
004	Flue Gas Cleaning Building
005	Fly Ash Stabilization Building
006	Turbo Generator Building
007	Main Control Building
800	Step-up Substation
009	Sfack
010	Water Pump House and Pond
011	Underground Water Treatment Station
012	Leachate Treatment Station
013	Oil Pump House
014	Complex Building
015	Administration Building
016	Fly Ash Curing Quarter
017	Trestle
018	Weighbridge and Gate Control House
019	Fence, Gate House and Guard House
020	Water Intake Pump House

1.4 Engineering standards & codes

The engineering of The WTE Project shall mainly comply with the following:

The Punjab Power Generation Policy, 2006 Revised 2009

Pakistan Environmental Protection Act, 1997

Pakistan Environmental Protection Act, 1997 amended 2012

Punjab Environmental Quality Standards (PEQS) 2016

National Environmental Policy 2005

Pakistan Environmental Protection Ordinance (PEPO) 1983

Pakistan Environmental Protection Agency Review of IEE and EIA Regulation, 2000

Punjab Local Government Ordinance, 2001

Environmental Guidelines of the Pakistan EPA

Standard for Pollution Control on the Municipal Solid Waste Incineration (China standard GB18485-2014)

Relevant standards and codes applicable in WTE projects in China (if no Pakistan standards applicable)

Environmental Guidelines of the World Bank (if no Pakistan or China standards applicable)

1.5 Key project data

Table 1-2: Key Project Data

No.	Description	Unit	Quantity	Remarks
1	Waste disposal capacity	V d	2,000	667*10³f/a
2	Power generation	10³ ∶kWh/a	279,120	
3	Including: power output	10 ³ kWh/a	234,461	
4	Generator capacity	MW	40	
5	Utilization	h/a	8,000	
6	Incinerator	Set		670t/d per set
7	Turbine generator unit	Set	2	20MW per se
8	Calculation period	a. a. a.	28	
9	Including: construction period	a	3	
10	Staffing	Person	80	
11	Process water supply	m³/d	1,585	
12	Domestic water consumption	m³/d	21	reis (2000) filosofic filosofic Anticologo (2000)
13	Total drainage	m³/d	823	
14	Including: wastewater sewage	m³/d	7	
15	Domestic sewage	m³/d	19	
16	Wastewater from leachate treatment	m³/d	500	
17	Rain drainage	m³/d	297	
18	Installed capacity	kW	17,037	
19	Working capacity	kW	14,338	

No.	Description	Unit	Quantity	Remarks
20	Calculated load	kVA	11,875	
21	Auxiliary power rate	%	16	
22	Plant floor area	Acre	26,3	10.64 ha
-23	Project cost	1,000 USD	232,561	
	Including: Capital cost	1,000 USD	219,813	
	Interest during construction	1,000 USD	11,112	
	Working capital	1,000 USD	1,637	
24	Source of funding	1,000 USD	232,561	
	Including: Equity	1,000 USD	69,440	
	Long-term loan	1,000 USD	161,975	
7 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Working capital loan	1,000 USD	1,146	
25	Total operation cost	1,000 USD/a	21,417	
A CONTRACTOR OF THE CONTRACTOR	Cost per ton waste disposal	USD	32.11	
26	Operation cost	1,000 USD/a	10,901	
100000000000000000000000000000000000000	Cost per ton waste disposal	USD	16.34	
27	Operation revenue	1,000 USD	36;262	From power output tariff of 0.16 USD/kWh
28	Sales tax	1,000 USD	2,745	
29	Total profit	1,000 USD	10,870	i i i i i i i i i i i i i i i i i i i
30	Income tax	1,000 USD	ŇĿ	
31	After-tax profit	1,000 USD	10,870	
32	Evaluation on project cost basis	The second secon		enter de la company de la comp
	FIRR	%	8.04	
F. (MIC)	NPV (i≐8%)	1,000 USD	643	
	Investment payback period	<u>a</u>	12.66	uniteriteraturatur
33	Evaluation on equily basis	The second section of the sec		
\$20 100 1 100 100 100 100 100 100 100 100	FIRR	%	10.30	
	NPV (i=10%)	1,000 USD	2,282	
	Investment payback period	a	15.68	
34	Return on investment	%	4,67	
35	Return rate of project cost	%	5,67	

No. [Description	Únit C	uantity Remarks
36 Rate of return	n on equity	%	15,65
37 Break-even p	oint	%	57,54
38 Loan payback	(a	14,27 Including 3-ye construction

Ħ

Chapter 2 MSW Status & Prediction

2.1 Status & strategy of MSW disposal in Lahore

A MSW collection and transportation system has been established in Lahore, which is so far under the management of LWMC. Downtown MSW collection and transportation system consists of the east and west area, operated by two subcontracting Turkish companies, Albayrak and OzPak. Rural waste cleaning and transportation is undertaken by LWMC itself.

Dumping and sanitary landfill are mainly adopted for the current domestic waste treatment of Lahore. The waste management system was established in 2012 and expected daily output is about 6,000t waste. In accordance with requirements of Lahore Environmental Sanitation Bureau, 50% urban waste shall be disposed by landfill. 2,000t/d waste of the rest will be handled with The WTE Project, while 1,000t/d waste will be recycled.

Lakhodair Landfill is a comprehensive disposal site in full operation, lying in the northeast of Lahore and covering an area of 52.9ha. Its landfill capacity is 2,500t/d with a service period of 10 years. Meanwhile, a new landfill of 63ha is planned in the southwest of the city with a capacity of 2,500t/d.

2.2 MSW characterization study and calorific value forecast

2.2.1 MSW characterization

Compositions of domestic wastes are affected by economic development, life style, climate conditions, etc.

It is predicted that proportion of food waste will drop stably with the trend of urbanization. At the same time, plastic packaging is being replaced by paper with more stringent measures of environmental protection. Domestic waste will be food and paper waste oriented with more combustibles, resulting in higher calorific value.

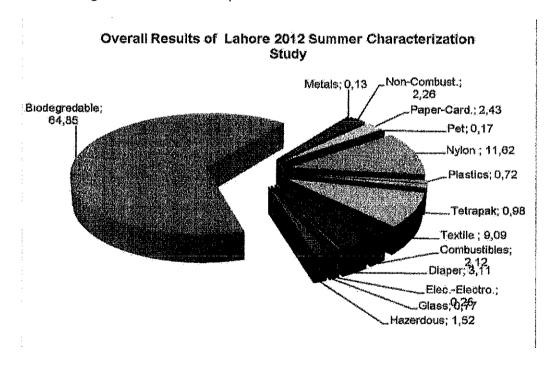
Waste physical composition analysis from LWMC is revealed in Table 2-1, and waste composition diagram is shown in Figure 2-1.

Table 2-1: Physical Compositions of Waste in Lahore in 2011

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Waste Type	Composition	Treatment Method	Proportion (Unit: %)	Sub Total
Organic matter	Biomass/food waste		72.86	72.86
	Combustible	Landfill	3.38	
	Diaper	Landfill	5.35	
	Electronic waste	Recycling	0.05	
	Glass	Recycling	0.43	27.06
	Metal	Recycling	0.18	
Inorganic matter/non-	Non-combustible	Landfill	3.42	
dangerous	Paper	Recycling	2.34	
	Carcass	Landfill	0.08	
	Nylon products	Landfill	5.58	
	Plastic	Recycling	0.45	
	Food packaging	Recycling	0,77	
	Textile	Landfill	4.71	
Hazardous	Hazardous waste		0.18	0.18
	Total		100	100

Figure 2-1: Waste Compositions of Lahore In Summer of 2012



2.2.2 Waste calorific value

The fuel to the WTE Project is MSW.

The design basis is shown in Table 2-2.

Table 2-2: Design Basis of Waste Calorific Value

Item	Calorific Value	Equivalent to
Upper limit	LHV=9,211 kJ/kg	2,200 kcal/kg
Lower Limit	LHV=5,024 kJ/kg	1,200 kcal/kg
Where auxiliary fuel is required	LHV=4,605 kJ/kg	1,100 kcal/kg
MCR design point	LHV=7,500 kJ/kg	1,790 kcal/kg

Chemical compositions and waste calorific value are analyzed by sampling and laboratory testing.

Details are described in Volume III: WASTE CHARACTERIZATION STUDY.

Chapter 3 Engineering Proposal & Analysis

- 3.1 Processing option
- 3.1.1 Determination of waste disposal incinerator
- (1) Waste disposal approach in China and worldwide

At present, three main approaches are adopted for disposal of waste in modern cities: Sanitary landfill, high-temperature composting and incineration.

Incineration technology is superior to sanitary landfill from perspective of capital cost and environmental protection. Landfill requires a large area of land, and the site is difficult to seek.

Comparison of these approaches are elaborated in Table 3-1.

Table 3-1: Comparison of Three Waste-Disposal Approaches

Description Sanitary landfill Incinerati		Incineration	Composting
Operation safety	Fairly good	Good	Good
Technology reliability	Reliable	Reliable	Fairly reliable
Footprint	Big	Big	Moderate
Siting	Fairly difficult. Consideration to be given to topology, geology and hydrogeology in order to prevent surface water and groundwater pollution. Located generally far away from urban areas, thus, longer transport distance.	Easy, Can be located in urban areas, with shorter transport distance.	Fairly easy. Only need to keep away from dense populated areas; odor; moderate transport distance.
Application condition	Inorganic matter>60% Density >0.5t/m³ Moisture moderate	Additional fuels not needed @ lower calorific value of waste >5000kJ/kg	From harmless disposal perspective, biodegradable organic matters in the waste to be ≥10%, which should be >40% from perspective of manorial effect.
Final disposal	Though separate final disposal not needed, volume is huge.	Only slag needs landfill disposal, 20% to 30% of the initial volume.	Non-compostable substance subject to landfill disposal, being 30~40% of initial volume.
Product market	Marsh gas can be recycled and used for	Producing thermal or electric energy.	Fairly difficult to establish a secure

Description	Sanitary landfill	Incineration	Composting
	power generation.	The state of the s	compost market
Unit capital cost	Low	High	Low
Resource recycling	No practice on onsite sorting and recycling, but potentially possible	Part of materials can be recovered in the pretreatment procedure; however, it depends on the content of usable materials in the waste.	Same as left
Surface water contamination	Possible, but possibility can be reduced by taking certain measures.	None in the plant area; possibility of surface water contamination similar to landfill approach during landfill disposal of slag.	Not applicable
Groundwater contamination	Possible: Although seepage proofing measures can be adopted, but there is still the possibility of seeping.	Relevant to slag disposal, possible if improperly handled	Same as left
Air pollution	Yes. But can be controlled by covering and compacting among other measures.	Standard compliance is possible through proper control	Slight odor, Low possibility of non- compliance with pollution indexes.
Soil contamination	Limited to landfill site area	Not applicable	Content of heavy metals in compost products to be controlled
Management skill requirement	Moderate	Fairly high	Fairly high

(2) Comparison of the incinerators

Four types of incinerators are available in waste disposal projects. Through comparison, both moving grate furnace (MGF) and fluidized bed incinerator are applicable. However, fluidized bed incinerator has following disadvantages:

- Waste pretreatment and sorting are immature and performance is unstable;
- Higher cost on maintenance and more frequent overhaul;
- Poor operating environment due to large amount of dust and fly ash.

Therefore, MGF is recommended for The WTE Project.

Table 3-2: Performance Comparison of Common Domestic Waste Incinerators

Ifem	Moving Grate Furnace (MGF)	Fluidized bed incinerator	Pyrolytic incinerator	Rotary kiln
Characteristics of hearth and body	Mechanical moving grate, with big grate surface and hearth	Fixed grate, with small grate surface and hearth volume	Mostly vertical fixed grate, having two combustion	Having no grate, movement of waste being driven by rotating furnace
	volume	and nearth volume	chambers	body
Waste pre-treatment	Not needed	Needed	Needed at low calorific value of the waste	Not needed
Equipment footprint	Big	Small	Medium	Medium
Slag ignition loss	Easy standardcompliance	Standard compliance possible by continuous combustion support given to primary waste	Difficult standard compliance in case of primary waste	Difficult standard compliance in case of primary waste
Flue gas retention time in furnace	>2 sec	≥2 sec	Longest	Long
Excess air coefficient	Big	Medium	Small	Big
Unit maximum waste disposal capacity of a single incinerator	1,200 V d	600t/d	200t/d	500Vd
Supply of combustion air	Allowing for easy adjustment per operating condition	Easy adjustment	Difficult adjustment	Difficult adjustment
Applicability for moisture in waste	Poor	Good	The worst	Fairly good
Applicability for unevenness of waste	Waste can be stirred uniform by grate	Poor	The worst	Fairly good
Dust content in flue gas	Fairly low	High	The lowest	Low
Heat carrier	No need for carrier	Quartz	No need for carrier	No need for carrier
Control of combustion condition	Fairly easy	Not easy	Not easy	Easy
operation cost	Low	Fairly low	Fairly high	Fairly high
Maintenance work	Fairly little	Fairly more	The least	Slightly more
Operation track records	The most	Slightly more	Less	Mostly used for industrial waste

Item	Moving Grate Furnace (MGF)	Fluidized bed incinerator	Pyrolytic incinerator	Rotary kiln
Comprehensive evaluation	High applicability for waste, minimal failure, good treatment and environment protection performance, fairly low cost	Pretreatment of	Slag difficult to burn through, high burning loss, difficult to meet the environmental protection standard	Required calorific value of waste to be ≥2,500kcal/kg, and high operation cost
Applicability for this project	Applicable	Fairly applicable	Not applicable	Not applicable

3.1.2 Technical option for Flue Gas Cleaning

Emission after flue gas cleaning shall not only meet local requirements such as PEQS 2016, but also China standard GB18485-2014.

The process of flue gas cleaning is "Rotary Atomization Semi-dry Reactor + Lime Dry Powder Injection + Activated Carbon Injection + Bag Filter + SNCR".

Fly ash will be treated by process of "Chelating Agent + Cement Stabilization".

(1) Acid gas absorption

The methods for flue gas deacidification is compared in Table 3-3. Semi-dry method is taken as preferred proposal.

Table 3-3: Comparison of Three Methods for Flue Gas Deacidification

	Dry Method	Semi-dry Method	Wet Method
Absorbent Medicament	Slaked Lime or Soda Powder	Lime Slurry	NaOH Solution
Reactor	Dry Reaction Tower or Flue Gas Duct	Dry Reaction Tower + Lime Slurry Preparation	Washing Tower + Supporting Systems
Acid Removal Efficiency	60%	85%	90%
Advantages	Simple Process, Less Equipment & Investment, Simple Maintenance	Higher Removal Efficiency and No Water Discharge. Lower Investment and Operating/maintenance Cost Compared with Wet Method	Highest Removal Efficiency, Low Absorbent Consumption
Disadvantages	Low Removal Efficiency, Higher Absorbent Consumption	Complicated Lime Slurry Preparation	Complicated Process with More Supporting Systems. Flue Gas to be Reheated as Temp Lower than Dew Point. High Cost on Investment, Operation & Maintenance
In Which Country	Japan	Europe, China	US & Other Developed Countries

(2) Semi-dry cleaning

Rotary atomizer, fixed nozzle and circulating fluidized bed semi-dry reactors are commonly used. Through comparison in Table 3-4, rotary atomizer is recommended.

Table 3-4: Comparison of Three Semi-dry Reactors

	Rotary atomizer semi-dry	Fixed nozzle semi-dry	Circulating fluidized bed semi-dry
Description	The commonly-used nozzle structure of the deacidification reactor is mainly mechanical rotary atomizer, which is driven and rotated by a high-speed motor to atomize the absorbent (lime slurry) under strong centrifugal force.	Use fixed two-fluid nozzle to atomize the alkaline absorbent (lime slurry or caustic soda solution) with compressed air and spray it into the reactor so as to have reactions with flue gas.	Use spray water at inlet section for humidification, so as to enhance absorbent activity.
Process flow	Both slurry and flue gas entering from the upper part of the reactor and outflowing from the lower part.	Both slurry and flue gas entering from the upper part of the reactor and outflowing from the lower part.	The flue gas enters the absorption tower from the bottom, and water is injected through two-fluid atomizing nozzle at the lower part of the tower. The slaked lime and the circulating ash are sent through the fluidizing fan to the absorption tower, and are fully mixed with flue gas and water at a very high mass transfer rate and then go the bag filter
Performance	Good atomization effect but with high equipment investment, high operation costs, and complex maintenance management during operation.	Relatively poor atomization effect than that of rotary atomizer and easy to wear; but with low equipment investment.	Higher cleaning efficiency than the original dry method; without secondary pollution of water in the wet method; eliminates the preparation and atomizing process of absorbent solution in the spray drying cleaning method; but have large absorbent consumption, with lower cleaning efficiency than spray drying method.

(3) Dioxin and heavy metals removal

In order to remove dioxin and heavy metals in flue gas, an extra Activated Carbon Injection is added in flue gas cleaning system.

Activated carbon is widely used as an adsorbent with large surface area. Activated carbon is evenly mixed with flue gas, and has sufficient contact time, thus, a higher adsorption and cleaning efficiency can be achieved.

(4) Control of CO

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The CO in flue gas is caused by incomplete combustion in furnace. Selection of incineration equipment with mature and high efficient technology is the key to achieve the complete combustion and the control of CO.

In addition, flow of secondary air in the incinerator can be controlled to enable the full combustion of CO, which can effectively lower the CO concentration in flue gas, for the sake of emission.

(5) Control of NOx

MGF is featured by low-temperature combustion, air blowing by stages, and low level of surplus air supply, etc., which restrains NOx generation in furnace.

SNCR (Selective Non-catalytic Reduction) alone is able to ensure NOx off the stack to meet both local requirement and China standard. Use of urea or ammonia as the reductant can guarantee NOx concentration at outlet of boiler lower than 200mg/Nm³ and removal efficiency of 45% or higher.

SNCR and SCR (Selective Catalytic Reduction) are used to remove NO_X in flue gas. Removal efficiency of both is shown in Table 3-5.

Method	
SNCR	50%
SCR	

Table 3-5: Removal Efficiency of NOx in Flue Gas

(6) Fly ash stabilization process

Stabilization methods for fly ash include solidification by using cement, melting and stabilization by using chemical agents. Organic chelating agent stabilization plus cement solidifying is recommended in the WTE project. Solidified products will meet the technical requirements of landfill, in terms of physical strength and heavy metal concentration.

The following is the comparison of the three methods.

Solidification by using cement

Cement is an inorganic bonding material, which can form hard solidified body after hydration reaction. In the process of hydration reaction, heavy metals in the fly ash react with cement by a number of means, including adsorption, chemical absorption, precipitation, ion exchange and passivation, etc., and ultimately reside on the surface of hydrated silicate cement body C-H-S in the form of hydroxide or complex compound. Additionally, addition of cement can also provide a caustic environment for the heavy metals, suppressing their leachate.

However, since cement solidification requires addition of solidifying material, it results in a higher mass of the solidified product.

Melting of fly ash

For melting the fly ash, a certain amount of fluxes is blended with the fly ash before the mixture is sent into a high-temperature melting furnace, in which the fly ash is molten at a temperature higher than 1000°C. The mixture is then cooled down into solid or glass, as a result, and harmful substances are totally solidified inside the melt and would not be leached out.

This method can produce an excellent solidification effect; however, investment cost is high in addition to high energy consumption. Melting is critical of moisture in the fly ash. Fly ash shall be dried before it is sent into the high-temperature furnace, which makes whole process more complicated.

Stabilization by using chemical agent

Chemical agent stabilization is a process in which the toxic and harmful substances are transformed into low-solubility and low-toxicity substances as a result of chemical reactions. It uses organic chelating agent, a water-soluble chelated high-molecule, which reacts with ions of heavy metals to produce water-insoluble high-molecular compound and enables heavy metals in fly ash to be neutralized.

Chelating agent has an excellent capture effect on ions of heavy metals, including Pb²⁺, Cd²⁺, Ag⁺, Ni²⁺ and Cu²⁺, with a removal efficiency of 98% or higher. The capture efficiency for Cr³⁺ can be more than 85%. A small proportion of cement can be blended into in order to strengthen stabilized products for sake of ensuing landfill disposal.

3.2 Moving Grate Furnace suppliers

In China, there have been abundant MGF suppliers with the development in the last several decades. Their products are manufactured locally but with technologies imported from worldwide brands. This combination ensures the advanced technology, reliable equipment and high automation level as well as a cost-effective investment.

(1) MGF suppliers in China

Major MGF suppliers in China and their technologies are summarized in Table 3-6 and Table 3-7.

Table 3-6: Major MGF Suppliers in China

No.	Supplier	Imported Technology
1	Shanghai SUS Environment	VonRoll incinerator technology
2	Wuxi-Huaguang-Boller-Co., Ltd.	L-type technology from Hitachi
3	China Everbright International Limited	Martin technology from Germany
4	Chongqing Sanfeng Environmental Industrial Group Co., Ltd (CSEG)	Martin SITY2000 of French Alton Inc.
5	Hangzhou New Century Energy Environmental Protection Engineering Co., Ltd.	Martin reverse pushing grate from Japan MHI

Table 3-7: Comparison of MGF Suppliers in China

Tech: From	Hitz, Japan	Martin, Germany	Seghers, Belgium	
Grates	Von Roll L	Inclined & Reciprocating	KSBE	
Furnace • Characteristics	Grates Can Cut & Stir Waste in Furnace: Two Cascading Stages.	Three Stages: Drying, Combustion & Ember Burning, Grates Reversed.	5 Groups of Reciprocating Grates. Each Group Comprises of Fixed Grates, Sliding Grates & Rotating Grates with Separate Hydraulic Control System.	
Market Share in China	High	Medium	High	
Equipment Supply	Grates either Imported or Made in China	Grates either Imported or Made in China	Grates either Imported	
Agent in China	Shanghai Kangheng, Wuxi Huaguang	Chongqing Sanfeng	None	

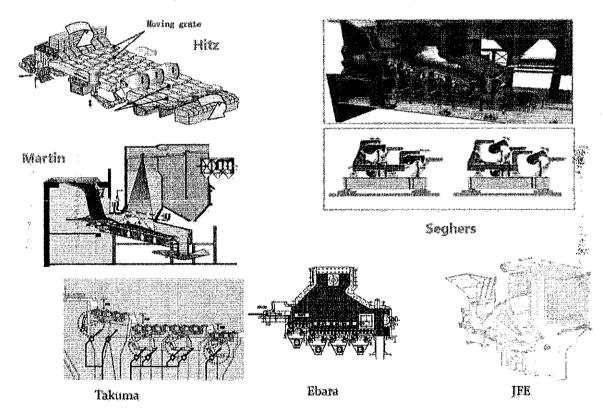
(2) International suppliers of MGF

Refer Table 3-8 and Figure 3-1 for major international suppliers.

Table 3-8: Major International Suppliers of MGF

No.	Supplier	Technology	
1	MHI Mitsubishi, Japan	Martin Grate Furnace	
2	Seghers, Belgium	Inclined scrolling grate (KSBE)	
3	Impregilo Group, Italy	Steinmuller grate incinerator	
4 .	TAKUMA , Japan	SN Grate	
5	Hitachi Zosen Corporation(Hitz), Japan	Von Roll L-type grate	
6,	JFE Shoji Trade Corporation, Japan	JFE Hyper Stoker	
7	Ebara Corporation, Japan	Ebara grate furnace	

Figure 3-1: MGFs from International Suppliers



Chapter 4 Project Environmental Conditions

Key stakeholders of the WTE project, including PPDB, LWMC and the SPV Company, conducted a plant site study on two locations:

Lakhodair, the existing landfill site;

-Tibba, a planned landfill site.-

As concluded in Annex 1: Report of Plant Site Selection, Lakhodair landfill is recommended as construction site. The basic data and conditions of the recommended site are illustrated in Table 4-1.

Table 4-1: Plant Environmental Conditions

ltem	Lakhodair waste landfill (Site 1)	Reference
Geographic location	Lakhodair, northeast of Lahore, N31°37'25", E74°25'14"	
Elevation of site	As per the general layout of landfill site, the site elevation is about 217 to 228m, inclining from east to west, with a flat landscape. Highest level of the nearby Ravi River 20-year flood is 211.7m.	
Boundary line and topography of the land	Total area of Lakhodair waste landfill site is 52.9ha, and the gross area for this plant use is 10.64ha. Main road of landfill site divides the land into two parts – east and west, and the east part of 3.49ha will be used as office building and living land.	
	The west part of 7.24ha will be used as WTE plant building, with the longest point of 534m in the direction of east-to-west, and different widths of 73 to 230m from north to south, it is shaped in an irregular trapezoid as a whole. Moreover, 132kV high-voltage power line from the north of the site passes through the site in parallel in the direction of east-to-west. The site does not benefit to general layout planning design and plant expansion in the future.	
Meteorological data	The project area has hot summers and cold winters. Summer starts from May and lasts till September. The winter seasons lasts from November to February. Temperature in the Project Area vary from 47°C to 9°C.	Volume V : IEE, Social& Resettlement Studies
	Monsoon rain constitutes a definite rainy season between July and September. The average rainfall is about 629 mm per year.	and the second s

ltem	Lakhodair waste landfill (Site I)	Reference	
Seismology	The region is not in the active earthquake zone.	Volume V : IEE, Social& Resettlement Studies	
External road of the plant	Plant site is about 1km away from the Ring Road of Lahore. External connecting roads have been built by landfill project. The road is covered with asphalt and concrete with the width of 8 to 30m. The condition of the road is good for driving.		
Water supply conditions	City water network is not available nearby. The water supply of the WTE Project will be underground water.		
Grid connection conditions of the power generated	One 132kV power grid is near the plant and connection point is at the booster station of the plant.		
Waste supply	Domestic waste shall be collected by LMWC and transported to the incineration plant after compressed by transfer station.		
Auxiliary fuel supply	Light diesel oil shall be adopted for ignition and auxiliary combustion, which will be delivered into the plant through commercial tanker.		

Chapter 5 Project Engineering Description

The following description outlines engineering and design criteria, processing, and equipment of each facility, which is defined by WBS in Chapter 1. Also introduced are plant general layout, C&I, architecture, civil, HVAC, etc.

5.1 General layout and transportation

5.1.1 Project site

Locality of Lakhodair Landfill (Site I) and Tibba Landfill (Site II) are shown in Figure 5-1.

As compared and analyzed in Annex 1: Report of Plant Site Selection, Site $\,\,\mathrm{I}\,\,$ is proposed as plant site.

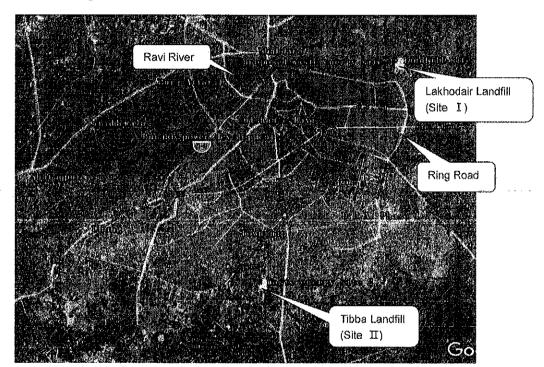


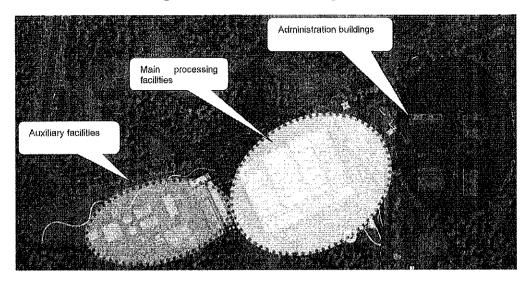
Figure 5-1: Location of Two Sites Available in Lahore

5.1.2 General layout

Detail layout is illustrated in drawing DF930-0-GPP-GA-01 in Volume II.

In principle, the plant is comprised of three zones, as shown in Figure 5-2, namely main processing facilities, auxiliary facilities and administration buildings.

Figure 5-2: Plant Functioning Zones



Main processing facilities are adjoined in Main Processing Building (WBS-001), which mainly include:

Waste Receiving, Storage, Feeding System and Auxiliary System (WBS-002)

Incinerator and Boiler Building (WBS-003)

Flue Gas Cleaning Building (WBS-004)

Fly Ash Stabilization Building (WBS-005)

Turbo Generator Building (WBS-006)

Step-up Substation (WBS-008)

Stack (WBS-009)

Auxiliary facilities include:

Water Pump House and Pond (WBS-010)

Underground Water Treatment Station (WBS-011)

Oil Pump House (WBS-013)

Fly Ash Curing Quarter (WBS-016)

Besides, administration buildings and amenities include Complex Building (WBS-014), Administration Building (WBS-015), Trestle (WBS-017), Weighbridge and Gate Control House (WBS-018), Fence, Gate House and Guard House (WBS-019), etc.

5.1.3 Traffic routing

The incoming road divides the area into two parts. East land area is 2.95ha, while the west 7.69ha, 132kV HV towers pass through the north side of the site.

The existing landfill road is located in the middle of the plant, headed to the main road of Lahore – Ring 2 in the north.

MSW and raw materials come from the south side, and are separated from people traffic flow. Two gates are set for people and waste trucks respectively. A freight exit is used for slag and fly ash transport on the north side, which is close to the landfill. Routing of people, waste and visitors are shown in Figure 5-3.

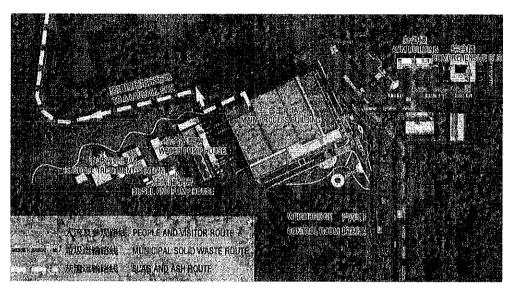


Figure 5-3: Onsite Traffic Routes

5.1.4 Vertical design and earthworks

Terrain of the site is flat with ground elevation ranging between 217m and 229m, which is higher in the northeast and lower in the southwest. There is a RC rainwater drainage culvert under existing road of the landfill on the north side of the site. The rainfall flows from east to west through the natural earth ditch under the road sloping to the low-lying areas on the west site.

Elevation of the transportation road on the north side ranges between 224m and 232m, while elevation of the freight transportation road in the middle ranging within 228m and 231m and elevation of office area road about 229m.

Slope shall be no less than 0.3% gradient around the building toward the rainwater ditch inlets on the road side, so that clean rainwater can be collected through the inlets and pipeline network and then discharged out of the plant, before reporting to the wastewater treatment station.

A rainwater & flood storage tank in a low-lying place on the south is taken into consideration. Clean rainwater is collected by pipe network and discharged to the storage tank, and utilized for afforestation and farmland irrigation nearby.

Elevation of other facilities:

Area of administration buildings and amenities: 229.5m (indoor floor elevation 229,95m);

Area of main processing facilities and auxiliary facilities: 224m to 229m;

Indoor floor of main processing facilities: 229m.

Excavation and filling balance shall be maintained as much as possible while the site elevation can satisfy the flood prevention and rainwater drainage, and surplus soil excavated will be used for backfill. Earthwork is estimated in Table 5-1.

Table 5-1: Estimated Earthwork Onsite

Filling Excavation	_ 200,000m³ 150,000m³
Construction earthwork to be removed from plant site	50,000m³
Total earthwork	400,000m³

5.1.5 Transportation

Transportation quantity of material in and out of plant is listed in Table 5-2. The waste trucks and delivery will be under the management of LWMC.

Two full-automatic weighbridges shall be set at the passageway. IC card and metering system & LED panel shall be installed for the purpose of weighing, recording, transmission, printing and data processing. Traffic lights, camera and online monitoring system are configured to direct transport in and out.

Table 5-2: Transportation Volume

No.	Description	Unit	Quantity	Transport Mode	Remarks
	Incoming transportation				
1	MSW	<i>V</i> a	667,000	Waste trucks	
2	0# diesel oil	Va	300	Trucks (by vendors)	And the second s
3	Slaked lime	Va	7,992		A SAME AND
4	Activated carbon	t/a	266		
5	Urea	t/a	533		
6	Lubricating oil	Va	2		
7	Chelating agent	t/a	400		
8	Cement	. Va	2,000		The state of the s
ll.	Outgoing transportation				
1.02	Slag -	ta	177,400	Trucks	To the landfill
2	Stabilized fly ash	t/a	28,638	Sealed truck	To the landfill

5.1.6 Roads, fences and gates

Key engineering data:

Entrance roads: 7m wide + 2m wide shoulder

Width of primary road: 7m

Width of secondary road: 6m

Width of maintenance access: 4m + shoulder width of 2m

Turning radius of primary road: 9m to12m

Turning radius of secondary road: 4m to 6m

Cross slope of road: 1.5% to 2%

Maximum slope of road: 8%

Sixty-four parking lots are set for visitors and internal staff near the gates and buildings.

The plant is configured with 4 gates. Three electric swing gates are prepared for waste trucks and people. A manual swing gate is on the back of the plant for slag and fly ash transport.

5.1.7 Plantation and horticulture

Plantation and horticulture are an important part of engineering to achieve friendly and cozy environment as well as isolation and buffer from pollutants, especially dust and odor.

Total plantation area is about 33,950m². To adapt site layout, plantation and horticulture will be distributed into various areas, shown in Figure 5-4.

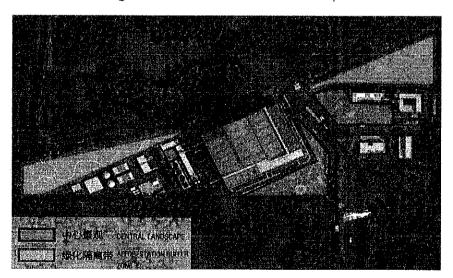


Figure 5-4: Plantation and Landscape

5.2 Facility engineering description

Process of MSW treatment is described with each facility as the following.

5.2.1 Waste Receiving, Storage, Feeding System and Auxiliary System (WBS-002)

(1) Waste Receiving and Unloading

MSW is weighed at the gate before transported to unloading platform through the trestle. Maximum load of 40t for waste trucks is assumed.

Waste unloading sealing doors are set in the unloading hall. State of the unloading door can be indicated by the red and green lights in the hall and monitored in crane control room. Since zebra stripes are set in front of each door, and car stops are set near the door, waste truck driver can be able to align the truck with the waste door accurately and dump waste right into the waste bunker. In order to prevent odor diffusion out of waste bunker, unloading doors are equipped with automatic open-close hydraulic drive to minimize air leakage. Moreover, air curtain is set at the entrance of the hall.

(2) Waste storage

Waste storage is a sealed RC structure of corrosion proof. Its effective volume is about 26,880m³, which can store MSW for 6 to 7 days. Waste stockpiling in waste bunker can not only facilitate fermentation of waste and hike of waste calorific value, but also guarantee buffer time of waste receiving during downtime.

In waste bunker, MSW is constantly stirred and mixed by crabs of waste cranes. The underlying layer of waste is compacted to increase its density from 50% to 80%, which enlarges actual stockpiling capacity of the waste.

(3) Waste feeding

Waste cranes are furnished on top of the waste bunker. They are equipped with weighing devices, having the functions of measuring, pre-warning, over-load protection, swing-preventing, inclination preventing, self-positioning and collision prevention. In addition, the cranes can record and summarize waste data. Manual and automatic operation can be chosen by the crane operators to control feeding to incineration as well as waste mixing, handling and stirring, etc.

The operators in the control room are responsible for entire control of the cranes. Waste is grabbed and lifted from the pit to feed the hoppers of MGFs.

(4) Leachate collection and transfer system

Waste leachate collecting system is near the waste pit. Two-layer grizzly screens are embedded in the pit wall at a lower height, so as to drain leachate into the ditch of the underground channel. The leachate is directed into a small collecting pit underneath the unloading platform.

The leachate, assumed to be 25% to 30% of total waste by weight, is pumped to the leachate treatment station. Considering the maximum moisture of waste in summer, the leachate treatment station is designed with a disposal capacity of 500t/d.

5.2.2 Incinerator and Boiler Building (WBS-003)

(1) Incinerator system

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Incineration system is made up of waste feeding system, incinerator, ignition and auxiliary combustion system.

Waste in the feeding hoppers slips to the incinerator through the water cooling feeding chute, and then is pushed by the feeding grates of MGF, which are hydraulically driven.

Primary air is sucked from sidewall of the waste bunker, while secondary air is taken from the incinerator building. The slag out of the furnace bottom is extracted and transported to the slag pit by slag transfer system.

The combustion control of the incinerator is in Figure 5-5. X-axis symbolizes the waste incineration volume and Y-axis the heat of the waste.

MCR point is the point of waste input heat (58.125MW) when the LHV of the waste is at the rated value of 7,500kJ/kg and the treatment volume is the rated capacity (27.9t/h).

Continuous operation area is the area surrounded by points MCR-A-B-C (D) -E-F-G.

The overload operation area is the area surrounded by points H-I-A-MCR-G-F-J, and the area which needs combustion supporting is the area surrounded by points C (D) -E-F-G.

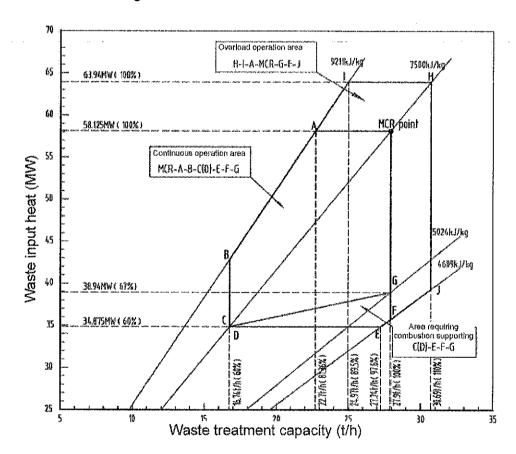


Figure 5-5: Incinerator Combustion Features

(2) Waste Heat Boiler (WHB)

Natural circulation boilers are utilized for recovery heat in flue gas. Since horizontal layout will occupy relatively large area, boilers of vertical circulation layout are commonly used.

Design data of waste heat boilers:

Superheated steam flow: 64.2t/h per unit

Superheated steam pressure: 4.0MPa

Superheated steam temperature: 400°C

Feed water temperature: 130 ℃

Outlet temperature of flue gas: 190℃ to 210℃

● Utilization: ≥8,000h

Boiler thermal efficiency: 80%

(3) Slag disposal

Quantity of wet slag from incinerators is estimated in Table 5-3.

Table 5-3: Quantity of Wet Slag from Incinerators

Item : Hourly Output Daily Output	
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The state of the s	
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The same of the sa	

The main elements of slag include Si, Al and Ca. Incinerated slag mainly consists of clinker, ferrous and non-ferrous metals, ceramic, glass, other incombustibles and unburnt organic matters. Therefore, slag is considered generally as harmless solid waste, which can be landfilled or used as construction material in a recycled way.

Typical testing data of slag from one WTE plant is in Table 5-4.

Table 5-4: Representative Chemical Composition of Slag

			LONG VICE CONTROL OF LONG CONTROL OF SECURITY OF SECUR
Unemical 6.6	CO NO MAO	V O No O Fo O	CI CO Othan
La Cau	SiO ₂ Al ₂ O ₃ MgO	N2U Na2U Fe2U3	UI SU2 UHIEIS
Composition (%)	Territory, resulted to access months of a relative posterior.		
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The processing details are displayed in related drawings in Volume II:

PFD: DF930-0-003-PR-PFD-01

P&IDs: DF930-0-003-PR-P&ID-01

GA: DF930-0-001-PR-GA-01/02/03/04/05/06/07

5.2.3 Oil pump house (WBS-013)

0[#] diesel, as auxiliary and ignition fuel is delivered to the plant by oil tanks of vendors. The diesel is unloaded by the oil pumps of the tanks into two storage tanks. The oil feed pumps in the oil pump house deliver diesel towards the incineration building.

The processing details are displayed in related drawings in Volume II:

P&IDs: DF930-0-013-PR-P&ID-01

GA: DF930-0-013-PR-GA-01

5.2.4 Flue Gas Cleaning Building (WBS-004)

Design data for flue gas from boilers are shown in Table 5-5.

The processing details are displayed in related drawings in Volume II:

PFD: DF930-0-004-PR-PFD-01

P&IDs: DF930-0-004-PR-P&ID-01/02/03/04/05

Table 5-5: Design Data of Flue Gas Out of Boilers

ltem	Unit	Data
Flow rate	Nm³/h	140,250
Temperature	°C	190
Moisture	% (Volume)	22.2
O ₂	% (Volume)	7.15
Dust	g/Nm³·dry11%O₂	-3.5
HCI	mg/Nm³·dry11%O ₂	970
SO ₂	mg/Nm³·dry11%O₂	800
NOx	mg/Nm³·dry11%O₂ 350	
CO	mg/Nm³·dry11%O ₂	50
Dioxin	ngTEQ/Nm³ dry11%O ₂	5

Flue gas cleaning system consists of:

- SNCR
- Lime storage and lime slurry preparation
- Lime dry powder storage and injecting

- Activated carbon storage and injecting
- Rotary atomizer + semi-dry reactor
- Bag filter
- ID fan and flue gas exhaust to stack
- Fly ash conveying and storage

(1) SNCR

One SNCR will be fed to three waste incineration lines, and urea is used as the reductant.

One set of urea solution preparation tank and storage tank is in SNCR room. 40% urea solution is diluted by water prior to being sprayed into hearth of the incinerators.

NOx removal efficiency can be high when temperature of flue gas ranges between 800°C and 950°C, and compressed air is introduced for sake of atomization of urea solution.

(2) Lime storage, lime slurry preparation

One set of lime storage and slurry preparation system is used with slaked lime powder as raw material, whose quality is shown in Table 5-6.

Slaked lime powder from suppliers is pneumatically conveyed to the lime bin of the flue gas cleaning system.

Table 5-6: Quality of Slaked Lime Powder

	Purity	>90%
St	pecific gravity	0.5 to 1.0t/m³
	urface area	14 to 18m²/g
Reaction t	emperature rise 60°C	1min
	otal impurity	≤3%:
	≤0.150mm	95%
	≤0.063mm	93%
Particle size (mm)	≤0.045mm	88%
	≤0.020mm	_73%
	≤0.010mm	62%

(3) Lime dry powder storage and distribution

Slaked lime is injected by air from Roots blower into the pipe between semi-dry reactor and bag filter. The powder is retained on surface of bags after entering into filters, and then reacts with acidic pollutants in flue gas passing through.

The storage and distribution system is tripped when semi-dry process is not able to ensure gas cleaning efficiency. It is also used during overhaul of rotary atomizer or in case temperature of flue gas exhausted becomes excessively low.

(4) Activated carbon storage and distribution

The system includes three injection devices and one bin of activated carbon.

Activated carbon, with quality in Table 5-7, is continuously and separately fed to flue gas cleaning system. Dosage of activated carbon is controlled by a feeder which directly injects activated carbon into outlet pipe of the reactor.

Table 5-7: Quality of Activated Carbon

Purity		>90%		
	Ash Content	≤10%		
	Humidity	≤10%		
	Surface Area	>900m²/g		
Specific Gravity		Approximately 500kg/m³		
lodir	e Adsorption Rate	>600		
	≤0.150	97%		
Particle size	≤0,074	87%		
: ^(mm)		72%		
	≤0.010	40%		

(5) Semi-dry reactor and rotary atomizer

Flow control of lime slurry entering rotary atomizer is automatically determined by concentration of HCl and SO₂ monitored by CEMS.

In case that injected lime slurry cannot reduce the flue gas temperature from 190°C to 150°C, additional water will be replenished into the reactor. Dosage of the water is automatically controlled, so that temperature of flue gas emitted can be 20°C to 30°C higher than dew point to avoid gas condensation.

(6) Bag filter

Low-pressure pulse is adopted to collect dust in flue gas, which enters from air inlet at lower part of the filter. The filtered gas moves upward in the filter and exhausts from the outlet.

Bag filter is equipped with insulation and heating to prevent acid and water from condensation.

Pressure drop of filter bag is continuously monitored, and compressed air jet pulse starts when the pressure loss is high. The compressed air passes through each pulse valve successively in a very short time, and then is injected into bags through nozzles in blowing

pipes. Offline dust removal is adopted to ensure more stable operation of bag filter.

Bag filtration velocity reaches 0.8m/min during dust removal. Compressed air is supplied by air compressor units.

(7) ID fan and flue gas exhaust

Incinerator, waste heat boiler, semi-dry reactor and bag filter are all in negative pressure operation. Each production line is provided with one ID fan which keeps negative pressure for the entire flue gas system.

Operation of the ID fan is controlled automatically by its VFD based on negative pressure signal from MGF. Vibration of bearing and overheating are monitored in the control system. Rated capacity of ID fan is 115% of maximum flow of flue gas, and the head is 120% of maximum pressure loss calculated.

(8) Fly ash conveying and storage

After flue gas enters semi-dry reactor, coarse particles are attached to the wall of reactor by centrifugal force, and finally fall into bottom of the reactor. The collected matters on bottom of the reactor are mixture of reaction products and coarse dust in flue gas, which is sent by the chain conveyor under the reactor to the common chain conveyor.

Fly ash in flue gas (including injected activated carbon and lime powder) is collected into the ash hopper of bag filters, and sent by two chain conveyors to the common chain conveyor. Dust and ash are transported finally to fly ash bin for storage through the bucket elevator. Volume of the ash bin can store fly ash for 4 days or more.

Main data of flue gas system:

•	Desulfurization	efficiency	in flue	gas cleaning	≥90%
•	TO COULDING COROLL	CITICICITICS	III IIUG	gas ocarning	

Dechlorinating efficiency in flue gas cleaning ≥95%

Denitrification efficiency in flue gas cleaning ≥45%

Dust collection efficiency of bag filter ≥99.9%

Total air leakage rate of flue gas cleaning system ≤5%.

Total pressure loss (boiler excluded) ≤3,200Pa

5.2.5 Stack (WBS-009)

Purified flue gas is sent by ID fan to stack outside the building and emitted to the atmosphere. CEMS is installed at the upper part of stack. Sampling hole and platform are also in place.

Stack height: 80m

Inner diameter of stack outlet: 2.20m

Outlet flow velocity: 16.6m/s

5.2.6 Fly Ash Stabilization Building (WBS-005)

Fly ash will be stabilized in a separate building, and cement and chelating agent are used as agents of solidification and stabilization.

Fly ash in ash bin is sent to weight scale through screw conveyor. Cement tank blows bulk cement to cement bin through pneumatic conveying. The fly ash stabilization station includes chelating agent preparation tank and storage tank. The scale is installed under each tank. Fly ash and cement are sent proportionately to the mixer, and chelating agent solution and water are added under control as well. Ratio of cement, chelating agent and water is close to 10%, 1.5% and 30% of fly ash weight respectively.

The stabilized fly ash is sent by enclosed truck to the landfill site nearby. The station is run 8h/d, 5 to 6 days per week.

The stabilized fly ash shall meet the following requirements:

Moisture content <30%

Ħ

Dioxin content <3µgTEQ/kg</p>

The processing details are displayed in related drawings in Volume II:

PFD: DF930-0-005-PR-PFD-01

P&IDs: DF930-0-005-PR-P&ID-01/02

5.2.7 Turbo Generator Building (WBS-006)

Condensing steam turbines are selected, which features lower cost than extraction steam turbine set, but with slightly higher efficiency. As source of ground water for The WTE Project is scarce, air cooling system are adopted for turbine generator units.

The processing details are displayed in related drawings in Volume II:

PFD: DF930-0-006-PR-PFD-01

P&IDs: DF930-0-006-PR-P&ID-01/02/03

(1) Thermodynamic system and auxiliary equipment

According to the characteristic that waste incineration power plant is mainly used for waste treatment, the steam turbine generator unit is adopted with operation mode of "generator following boiler". To ensure stable operation of incinerator during steam turbine failure or maintenance, steam turbine bypass system is provided to send main steam to condenser by two-stage temperature and pressure reduction during steam turbine shutdown. Condensate is sent to deaerator and then sent by feed pump to waste heat boiler after being deaerated and heated by deaerator, to maintain normal operation of waste incineration boiler. The extraction steam of condensing generator unit is non-adjustable extraction steam, and the pressure and flow of extraction steam changes with the load of generator unit.

In case of low load of steam turbine, the pressure of first-stage and second-stage extraction steam cannot meet the requirements of heating steam pressure of air preheater and deaerator. Attemperator is required for air preheater and deaerator to reduce the

temperature and pressure of main steam to required parameters to supplement the shortage of extraction steam. In particular, during maintenance of steam turbine with incinerator still in operation, it is important to supply steam necessary for air preheater and deaerator by attemperator of air preheater and deaerator.

Table 5-8: Calculation Sheet for Boiler Operating Conditions and Steam Turbine Admission

Steam balance	Description	Maximum continuous operating condition (t/h)
Steam production	Steam production of waste heat boiler	192.6
Steam consumption	Admission steam quantity of steam turbine	186.8
	Steam and water loss	5.8
	Subtotal	192.6

(2) Main steam system (including bypass steam condensing system)

Main steam pipeline includes steam main pipe from outlet of superheated steam collecting header of waste heat boiler to inlet of steam turbine, and steam branch pipes from steam main pipe to each auxiliary equipment. Main steam system is adopted with single main pipe system. Main steam main pipe of 3 waste heat boilers is connected to steam turbine room from incinerator room, to main valve of steam turbine through shut-off valve and enters steam turbine for working and power generation. Shut-off valve is provided on pipeline from main steam main pipe to bypass attemperator and to first-stage and second-stage attemperators. All main steam main pipes are of 20G material.

When steam turbine generator unit is under maintenance, incinerator is required to continue waste incineration, and waste heat boiler will continue producing steam. As a result, bypass steam condensing system is provided, which is adopted with two-stage attemperators. Attemperating water of first-stage attemperator, air preheater attemperator and deaerator attemperator is led from water supply main pipe. The attemperating water of second-stage attemperator is led from condensate main pipe. First-stage attemperator is arranged at 7.0m pipeline level, while second-stage attemperator is installed at the throat of condenser. During normal operation, first-stage and second-stage attemperators are in hot standby status. In case of sudden load shedding or emergency shutdown of steam turbine, the main valve of steam turbine will be automatically closed, and first-stage and second-stage attemperators will be quickly put into operation. The superheated steam is cooled into condensate through bypass steam condensing system, and sent by condensate pump to deaerator. If the failure can be eliminated in a short period, the main valve of steam turbine will be opened again, with bypass steam condensing system, and resume to normal operation.

Main technical parameters of first-stage attemperator are as follows:

Steam outlet flow

120t/h

Inlet pressure of attemperator

4.1MPa(a)

• Inlet temperature of attemperator 400°C

- Outlet pressure of attemperator 0.7MPa(a)
- Outlet temperature of attemperator 160°C

Main technical parameters of second-stage attemperator are as follows:

Steam outlet flow

150t/h

- Outlet steam pressure of attemperator 0.7MPa(a)
- Inlet steam temperature of temperature and pressure reduce 170°C
- Outlet steam pressure of attemperator 0.02MPa(a)
- Outlet steam temperature of attemperator 75°C

(3) Main water supply system

The scope of main water supply system is from water outlet of deaerator to water inlet of feed water collecting tank of waste heat boiler economizer in incinerator room. The whole plant is provided with 2 sets of rotational film-type MP deaerators and 4 feed pumps (3 for operation and 1 standby). Both LP and HP feed water main pipes are adopted with single main pipe system. LP feed water pipe at deaerator outlet is connected to LP feed water main pipe which is connected to water inlet of 4 feed pumps respectively. HP feed water outlet pipe of 4 feed pumps are directly connected to feed water main pipe and sent to incinerator room to connect with waste heat boiler.

(4) Steam turbine extraction steam system

Steam turbine is set with 3-stage non-adjustable extraction steam.

First-stage extraction steam is supplied to air preheater of incinerator for heating primary air.

Second-stage extraction steam is supplied to deaerator for heating feed water of boiler.

Third-stage extraction steam is supplied to LP heater.

The heated steam of air preheater and deaerator, except extraction steam of steam turbine, is provided with attemperator with corresponding pressure as standby steam source.

Third-stage extraction steam pipe is connected to heated steam inlet of LP heater from steam turbine. First-stage, second-stage and third-stage extraction steam pipes are provided with shut-off valve. Electric control valve is installed on heated steam inlet pipe of deaerator to regulate the operating pressure of deaerator.

(5) Main condensate system

The circulating water cooled by cooling tower is sent by circulating water pump to condenser as cold source which cools the steam discharged into condenser to condensate. Main condensate system will send the condensate in hot well of condenser by condensate pump to deaerator after the condensate is preheated by steam seal heater and LP heater. The system is provided with 2 condensate pumps, 1 for operation and 1 standby. The capacity of each condensate pump is selected as per 120% of maximum condensate quantity of

steam turbine.

(6) Vacuum pumping system

The vacuum pumping system of each steam turbine is composed of 2 sets of water jet air ejectors, 2 sets of water jet pump, 1 water jet basin and other equipment and pipes. In normal operation, 1 water jet air ejector and 1 water jet pump can maintain the vacuum of main condenser. In case of steam turbine shutdown with boiler in operation, 1 steam turbine is shut down, but the water jet air ejector and water jet pump of this steam turbine still operate for vacuum pumping of condenser. When steam turbine shut down, and main steam enters condenser for condensation through bypass attemperator, the vacuum pumping system of steam turbine helps the pressure in condenser maintain vacuum. Water jet air ejector is provided by steam turbine plant.

(7) Chemical make-up water system

Chemical make-up water from water treatment room is distributed to 3 lines: first line enters deaerator through flow control valve to supply as system make-up water and boiler make-up water; the second line directly enters drain tank. The water level of drain tank is under interlock control with drain pump, while the water level of deaerator water tank is automatically regulated by flow control valve of chemical make-up water. The third line of chemical make-up water enters the hot well of condenser as filling water of hot well when starting.

(8) Drain and blowdown system

The whole plant is provided with one drain tank and one drain flash tank. The condensate or drained water and chemical make-up water from LP equipment and pipeline directly enters drain tank. The drained water of HP equipment and pipeline enters drain flash tank and then to drain tank. The deaerator is provided with overflow blowdown main pipe. When the water level of deaerator water tank is too high due to malfunction of automatic water level regulation, the blowdown electric valve will open to discharge the water in deaerator water tank to drain tank.

(9) Circulating water system

Condenser, generator air cooler and oil cooler are cooled by circulating water which is led from circulating water supply and return main pipe outside the power plant. The diameter of circulating water pipe in plant is DN600. Two DN200 pipes with isolating valve are used as cooling water supply and return pipe for oil cooler and generator air cooler, which are connected to circulating water supply and return pipes of main condenser respectively.

(10) Process water system

The process water system in steam turbine room is supplied with water by process water system of the whole plant. Process water is mainly used for cooling a small number of equipment, and when the temperature of circulating water is too high in summer, the process water will be added to the circulating water of oil cooler and generator air cooler for reducing temperature. The process water pipe of water consuming equipment is led from process water supply and return main pipe. Process water drainage is adopted with pressurized drainage, and the drained water enters the process water return main pipe.

(11) Demi water makeup station

The quality of saturated steam and superheated steam of drum boiler with pressure of 3.8 to 5.8MPa are as follows:

Silicon dioxíde content: SiO₂≤20µg/kg;

Sodion content:

Na≤15µg/kg.

Through treatment of above process, effluent quality of system is as follows:

Hardness Approximately 0

* /

Silicon dioxide ≤10µg/L

Conductivity <0.1us/cm

Design of the station meets the water use requirements of the boiler, with consideration to replenishment of other demi water consumption. Capacity of the demi water makeup system is determined to be 2x15t/h.

Steam and water loss in the plant are as follows:

Steam evaporation capacity 64.2t/h (3 sets)

Normal steam and water circulation loss in the plant: 5.778t/h

Startup and emergency loss of generator set: 6,42t/h

Boiler blowdown loss: 1.926t/h

Steam loss of leachate treatment: 1.98t/h

Steam loss of primary air heater: 0.99t/h

Steam loss of secondary air heater: 0.21t/h

Steam loss of demi water makeup station: 1.008t/h

Water consumption of SNCR: 2t/h

Domestic and other water consumptions: 1.0t/h

Total: 21,312t/h

5.2.8 Underground Water Treatment Station (WBS-011)

The scope of water supply and drainage: Water Pump House and Pond (WBS-010), Underground Water Treatment Station Pond (WBS-010) and fire-fighting equipment etc.

Water source of the plant is phreatic water. The well water will be conveyed to underground water treatment station, in which 1 set of multi-media filter and water desalinated device. 4 tanks and complete equipment with Q=360m³/h are provided.

The well water will flow into the production and fire water storage tank after being treated in filter and desalinated device, and will be used for production and firefighting after pressurization.

The processing details are displayed in related drawings in Volume II:

GA: DF930-0-011-PR-GA-01

5.2.9 Water Pump House and Pond (WBS-010)

The outdoor water tank for fire-fighting and production is 21m long, 20m wide and 5m deep, with semi-underground RC structure. It is divided into two parts, with total effective volume of 1,800m³, including an amount of 648m³ for fire water.

Four outdoor reverse-flow FRP cooling towers of RC frame will be constructed, under which the circulating water tank and suction tank with effective volume of 4,900m³ are provided.

The Water Pump House is semi-underground, with 72m long and 10.5m wide. It is provided with production booster water pump, emergency make-up water pump, domestic water tank, domestic water supply unit, fire monitor feed pump, fire hydrant feed pump, fire-fighting pressure stabilization unit, circulating water pump for steam turbine, circulating water pump for equipment, recycle water Supply unit and dosing device.

Water Balance Schematic Diagram of the WTE Project refers to DF930-0-000-PR-SCD-02 in Volume Π (leachate treatment station excluded).

The processing details are displayed in related drawings in Volume II:

GA: DF930-0-010-PR-GA-01

5.2.10 Leachate Treatment Station (WBS-012)

Leachate collecting tank is set at the bottom of waste pit and two lift pumps are installed in the tank. The leachate from waste pit and the floor flushing water from unloading hall will automatically flow to the collecting tank and will be pumped to the adjusting tank of leachate treatment station. The volume of floor flushing water from unloading hall is 5m³/d, and it will be merged with the leachate. The maximum collection volume of leachate is 500m³/d.

Settling pit is set near the slag pit, in which one lift pump is installed. Under emergency condition, the supernatant will be pumped to the adjusting tank of leachate treatment station.

The concentrated liquid generated from reverse osmosis system will be used for flue gas cleaning system, and the rest concentrated liquid will flow back to the incinerator. The maximum volume of reuse concentrated liquid is $78 \text{m}^3 \text{/d}$, which can replace the reuse water. Due to the large difference in leachate generation in different seasons, it is difficult to determine the quantity of reuse concentrated liquid, which, therefore, will not be included in the water balance table.

The qualified wastewater after leachate treatment will join the treated production wastewater and domestic sewage, which will be discharged to inland water.

The processing details are displayed in related drawings in Volume II:

PFD: DF930-0-012-PR-PFD-01

P&IDs: DF930-0-012-PR-P&ID-01/02/03/04/05

GA: DF930-0-012-PR-GA-01

Leachate treatment process flow

The waste leachate treatment (capacity: 500m³/d) process flow of the WTE Project is shown in Figure 5-6 below.

-Figure 5-6: Waste Leachate Treatment Process Flow

Vertical flow settling tank → Adjusting tank → Anaerobic system → Anaerobic effluent settling tank → A (anoxia) / 0 (aerobic) → Secondary hitrification → Secondary denitrification → Membrane bioreactor (MBR) → Nano-filtration (NF) membrane treatment system

Expected efficiency of leachate treatment

Removal efficiency of leachate treatment is listed in Table 5-9.

Table 5-9: Removal Rate of Leachate Treatment

	Description	COD	BOD	NH ₃ -N	TP	SS
		(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Vertical	Influent quality	60,000	35,000	2,000	23	10,000
flow settling	Expected effluent quality	60,000	35,000	2,000	23	9,000
tank	Removal rate (%)	0		0 9 1 2	0.55	10%
	Influent quality	60,000	35,000	2,000	23	9,000
UASB reaction system	Expected effluent quality	7,000	3,500	2,200	26	2,000
	Removal rate (%)	88.33	90			77.78
	Influent quality	7,000	3,500	2,200	26	2,000
MBR System	Expected effluent quality	480	150	20	0	20
	Removal rate (%)	93.2	95.7	99	100	99
	Influent quality	480	150	20	0	20
NF system	Expected effluent quality	72	22,5	20	0	0
	Removal rate (%)	85	85	0	0	100
Dis	charge limit	150	80	40		200

5.3 Electrical

The engineering scope of electrical discipline includes access system interfaces, power generation, auxiliary power, indoor and outdoor lighting, lightning and grounding, etc. within the red line of the plant site. The 132kV on-grid lines, 11kV external emergency power lines and scheduling communication lines that are beyond the red line shall be entrusted by the Owner separately.

The WTE Project will be installed with 2 sets of 20MW condensing steam turbines and 2 sets of 20MW generators, which will be connected to the system by single-circuit 132kV line (LGJ-240) after stepping-up by main transformer. One step-up substation will be set in the power plant.

The processing details are displayed in related drawings in Volume II:

Single line diagram: DF930-0-000-EL-SLD-01/02/03/04/05/06/07/08

GA: DF930-0-007-EL-GA-01/02

DF930-0-008-EL-GA-01

5.3.1 Main electrical wiring

Two sets of double-winding transformers (rated capacity of 31,500kVA) will be adopted as main transformers; two sets of generators will be connected to the two LV windings of the main transformers respectively. 11kV bus will be provided and connected as single-bus section. One generator and two boilers will be connected to the same section respectively, and two generators are not allowed to operate in parallel. Standby section will be reserved between 11kV bus bars. 11kV standby/startup power supply will be put into operation only when both 132kV line main switch and generator outlet switch are open. Auxiliary transformer will be directly powered from 11kV bus.

The 2 sets in the incinerator plant will be connected to the system through one-circuit 132kV line, and in-plant 11kV bus will be single line. Generator will be connected to 11kV bus through circuit breaker.

5.3.2 Auxiliary power

(1) Auxiliary power voltage

The voltage of HV auxiliary power system will be the same as that of the generator, i.e., 11kV, and the system will be neutral ungrounded. ID fan (800kW) and primary fan (370kW) will be operated at adjustable speed, with HV power frequency control. Except for the circulating water pump (315kVV), which will be served by 10kV power supply, all auxiliary motors will be served by LV 220/380V power supply.

For LV auxiliary power distribution, solidly earthed neutral TN-S system will be used.

(2) Table 5-10 presents the load calculation for auxiliary power.

Table 5-10: Load Calculation for Auxiliary Power

	17.037kW
Plant installed capacity	
Plant operating capacity	14,338kW
Calculated load of auxiliary power	11.875kW
	Cv≅16% I
Auxiliary power consumption rate	

(3) Auxiliary power wiring

In the power distribution room of main control building, 6 dry-type transformers will be installed, and 6 will be operating in total. Transformers for boiler will be allocated by boiler section, each transformer having a rated capacity of 1,600kVA. The rated capacity of 2 sets of shared transformers is 1,600kVA. 1 set of 0# transformer (1,600kVA) will be set additionally, and standby transformer will not be operating, hence cold standby. For leachate a treatment, 11kV power supply will be connected separately, and the rated capacity of transformer is 1600kVA.

In normal operation, the power plant will be connected to the grid by one 132kV line. The power plant will be in island operation in case of abnormality or failure of the interconnection line. In this case, the 11kV standby/startup power supply will serve as the second power supply, so that the power need of emergency and security load can be satisfied.

(4) Plant motor control

Plant motors will be DCS automatically controlled and manually controlled according to the production process; the site will be provided with maintenance and emergency stop switches; and major auxiliary machines will be provided with emergency shutdown buttons. Motors that are not necessary to be operated in control room will be controlled locally.

(5) Emergency security power supply

Since the power plant is provided with one circuit of 132kV outgoing line, in case the 132kV line becomes faulty and the plant power fails, the 11kV standby/startup power supply will serve as the second power supply, so that the power need of emergency and security load can be satisfied.

In case of emergency, waste incinerator cannot be stopped immediately; the residual waste will need to be incinerated on for about 1h. During this time power supply for the following load shall be maintained:

- (1) Electric water feed pump must continue to supply water to the incinerator to ensure safety of the waste heat boiler.
- (2) In case of power failure of the whole plant, as the rotary atomizer remains in hot flue gas, power supply for its cooling water pump and cooling fan should continue; the rotary atomizer will be hoisted out by electric hoist on the top of semi-dry absorber within 15min to ensure the safety of the equipment.
- (3) UPS: UPS system of the power plant can only supply power for half an hour, so bypass power supply (namely security power supply) is required.

(4) Motor for barring, thermal system automatic valves, charging device, lift, emergency lighting, aviation obstacle lights, DCS power supply and fire pump.

Auxiliary DC power supply is used to provide electricity for some control equipment, emergency oil pump, emergency lighting and some thermal control equipment.

5.3.3 Short-circuit current calculation

At present, only short-circuit current is estimated. It is tentatively estimated that the three-phase short-circuit current of the power plant 132kV bus I "≤31.5kA; and that of generator-voltage main bus I " ≤31.5kA. And, for the time being, 10kV three-phase symmetrical short-circuit current ≤31.5kA will be the basis for selecting 10kV electrical equipment. Detailed calculation and verification will be conducted after generator Xd " and main transformer Ud% equipment data and system parameters are acquired.

5.3.4 Synchronizing point setting

Synchronizing points will be placed at the generator outlet circuit breaker, 132kV line side circuit breaker and the high/low voltage side of main transformer.

Splitting point is 132kV line side circuit breaker, and the switch will be equipped with low frequency LV splitting device, and LV splitting protection.

5.3.5 DC system

The 220V DC system in the main control building will have a single bus wired in sections, with one group of accumulators. The DC system consists of fully enclosed maintenance-free lead-acid accumulator battery, accumulator charger and DC distribution panel.

Normally, the accumulator will be operated in float charging mode. It is provided with two groups of chargers, one in operation and one on standby. Modules will be backed up N+1, current 100A. The accumulator is of valve-controlled lead-acid type, in 108 pieces, the float charging voltage 2.03V, and capacity 600Ah.

Table 5-11: DC System Load Calculation

No	Load	Calculated capacity	Calculated current	Regular current	/ y	current A)	Time of discharge in	Capacity of discharge in
	The second secon	(kW)	(A)	(A)	Initial	Final	emergency(h)	emergency (Ah)
	Regular load	- 4	18.2	18.2	18.2	The second secon	The second secon	18.2
2	Emergency lighting	10	45.4	Para la companya da l	45.4		1	45.4
3	DC oil pump	2×5.5×0.9	45	The second secon	113.0		0.5	22.5
4	Thermal control power supply	4.5	20.5	20.5	20.5		1	20.5
5	Switch opening and closing inrush current		10			10		

No Load	Calculated capacity	Calculated current	Regular current	Inrush current (A)	Time of discharge in	Capacity of discharge in
	(kW)	(A)	(A)	Initial Final	emergency(h)	emergency (Ah)
6 UPS power supply		150		150	0.5	75
Total		289		346 10	. . 	182.6

Emergency discharge capacity is determined such that full power failure is provided for:

CC≥1.25×182.6/0.43=530.8(Ah)

Thus, the capacity has been set at 600Ah.

5.3.6 Generator excitation system

Generator excitation system will be supplied along with the generator. Excitation will be regulated by microcomputer. The voltage of the control power will be DC220V and AC380/220V. Each generator will be provided with one excitation system. The system will be provided with a control cabinet, in which automatic excitation regulator (AVR) will be installed.

5.3.7 Secondary line

The power plant will be equipped with a set of comprehensive automatic control and microcomputer protection system.

The comprehensive automation system will be distributed at three levels to monitor, protect and manage digital operation of the power plant.

To ensure safety operation, the protection device of the step-up station should be made relatively independent, and therefore separate. Advanced network communication will be adopted between each function unit of the entire system to guarantee a reliable communication. The measurement, control, and protection units of the main transformer and the protection device of 132kV line will be arranged in the main control room; the measurement and control and protection units of 11kV feeder will be installed in switch cabinet.

Control and signaling

HV, strong current installations will be controlled respectively in the main control room, so that through microcomputer, the generator, 132kV and 10kV transformation and distribution systems and equipment can be monitored and controlled, and their operating status and parameters can be displayed; for equipment with local control, locking devices will be provided to prevent fault operation.

Measurement and metering

Of all circuits under microcomputer monitoring, the current, voltage, active and reactive power, frequency, power factor and electric quantity can be displayed real-time on monitor as needed, and daily and monthly power consumption or maximum, minimum and average value can also be calculated or printed.

Two-way main and auxiliary active and reactive power meters will be installed on the 132kV side of the line.

5.3.8 Relay protection and automation device

Table 5-12: Relay Protection and Automation Device

	Generator differential protection (with main transformer and auxiliary branch bus); Compound voltage over-current protection;
Generator protection	Overload protection; Stator grounding protection;
	Rotor grounding protection; Excitation loss protection.
	The electricity protection includes: Differential protection (with generator and plant branch bus).
Main Transformer protection (As main transformer may operate under reversed	The following protection is provided on both sides of transformer: Compound voltage over-current protection; Overload protection; Single-phase grounding protection.
power transmission, there are electricity protection and non-electricity protection of the main transformer.)	Non-electricity protection includes: Heavy gas protection; Light gas protection; Temperature protection; Abnormal oil level protection; Pressure relief protection.
Protection for 11kV auxiliary backup power supply	Short-time delayed quick break protection; Over-current protection; Overload protection; Single-phase grounding protection.
Auxiliary LV transformer protection	Electricity protection includes: Quick break protection; Over-current protection; Overload protection; Zero sequence current (grounding) protection.
	Non-electricity protection includes: Temperature protection.
Automatic device	Automatically regulated excitation device of generator and automatic excitation cut-off device; Automatic quasi-synchronizing device of generator; 11kV and 0.38kV standby auxiliary power supply auto-switch-in device; Emergency lighting auto-switch-in device.

5.3.9 Selection of main electrical equipment

For 132kV power distribution, SF6 gas insulated switchgear (GIS) will be adopted.

Step-up transformer will be SFZ11-31500/132 145±8×1.25%/10.5 YNd11 oil-immersed energy-saving type, with air cooling and temperature control system.

11kV switchgear will be KYN28A-12 armored withdrawable type, with 11kV vacuum circuit breaker and spring operating mechanism.

Auxiliary power step-down transformer will be SCB11-1600/10/ casted dry-type power transformer.

LV switchgear will be MNS type LV withdrawable switchgear.

5.3.10 Electrical equipment arrangement

Step-up station will be arranged on one side of the main control building, and 132kV GIS and 2 sets of main transformers will be arranged indoors.

For 132kV power distribution, power cable will be used as incoming and outgoing lines, and power cable for grid-interconnection (132kV line) will be led from distribution room to terminal tower outside the red line. The step-up substation will be built all at once.

The main control building is composed of 11kV distribution room, auxiliary power transformation and distribution room, control room and electronic equipment room.

5.3.11 Overvoltage protection and grounding

Generator neutral point will be installed with zinc oxide lightning arrester;

10.5kV bus will be installed with zinc oxide lightning arrester and harmonics reduction device;

Stack and oil tank area will be provided with separate lightning rods.

Zinc oxide lightning arrester will be installed to circuits of vacuum circuit breakers in 11kV and 132kV distribution devices to prevent overvoltage-caused damage.

The whole plant's grounding grid forms an interconnected whole. Power frequency grounding resistance R \leq 2000/ I (Ω), where: "I" is the short-circuit current (A) flowing through grounding device into the ground.

Main plant house and auxiliary buildings will be provided with rooftop lightning protection belt and grounding according to norms and regulations.

5.3.12 Cable laying and lighting

According to different needs, step-up station and main control building will be provided with cable channel and vault. Cable tray is adopted to facilitate installation and maintenance.

Cables of the whole plant will be flame-retardant types. The activated carbon area will be a dust explosion-proof zone, where the laying and grounding of cables shall conform to corresponding explosion protection regulations. All the cables connected to frequency control devices will be shielded; both ends of the shield layer of three-phase motive power

cable will be grounded.

The step-up substation and main control room will be provided with grate-covered fluorescent lighting; 132kV indoor distribution device and main transformer room will be lighted by wall-mounted lamp and metal halide lamp for lighting. All the lamps are of energy-saving type. High efficiency gas discharge lamp will be installed inside plant buildings.

In case of power failure in the whole plant, passage accessible to personnel will be provided with 220V DC emergency lighting. In normal condition emergency lighting will use AC power, whereas in blackout lighting will switch automatically to DC system.

5.3.13 Electrical energy conservation

ID fan, primary and secondary fans and water feed pump will be powered by frequency-controlled drives to save energy.

Auxiliary transformer will be low loss dry-type transformer.

Energy consumption of each operating section in the plant will be metered.

The road lightning within the plant area will be controlled automatically by optical sensing switches, and lamps and lanterns in buildings will be controlled in groups according to production requirements and natural light conditions. The lighting shall be of high-efficiency and energy-saving types. Fluorescent lamps shall be provided with electronic ballast to improve the power factor.

5.3.14 Electrical maintenance

Only routine maintenance, inspection and spare parts replacement are arranged in the WTE Project, and tools for routine maintenance will be provided accordingly. Other maintenance and tests will be entrusted to local sources.

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5.4 Control & Instrument (C&I), Telecommunication

5.4.1 Control & Instrument

Process control of the WTE Project is in a central control method. Distributed control system (DCS) in the central control room is to achieve a central, uniform and coordinated control of the whole plant, and ensure high production efficiency, energy conservation, safety and environment protection.

Plant telecommunication system and control system are designed in a coordinated and uniform manner, with advanced technology, economic rationality and strong capability.

(1) Control mode

Central control room is in main control building, including central control room, electronic equipment room and engineer room. The control room is provided with one set of central Distributed Control System (DCS) to centrally monitor operation of each facility. Some process equipment is provided with Programmable Logic Controller (PLC), which shall be centrally monitored by central control room as well.

To better monitor waste incineration process in an all-round way, large screen display system is set in central control room.

CCTV is provided at the positions and places of key manufacturing equipment which need frequent monitoring. The actual conditions of such positions and places are directly visible through television monitor or large screen in the central control room.

In addition, real-time display bulletin board of flue gas emission online monitoring (CEMS) is set, which will showcase flue gas emission data for inspection and supervision by the public.

(2) Composition of control system

The DCS man-machine interface equipment is provided in the central control room. The central control room is also provided with large color screen display system to improve operating conditions and management level.

DCS also enables unified and centralized motoring or control by interconnecting with the following systems via communication interfaces:

Table 5-13: Interconnected Equipment System by DCS

No.	Monitoring systems fitted by the equipment manufacturers
1	Incinerator combustion (ACC) control system
2	Ignition and auxiliary burner control system
3	Semi-dry reactor control system (including rotary atomizer)
4	Bag filter control system
5	Rotary atomizer control system
6	Steam turbine rotation and electro-hydraulic control system
7	Chemical water treatment control system
8	Air compressor station control system
9	Control system of other equipment

DCS is a network of control station, operation station, engineer station, communication network and instruments on site.

Control station

Control station is composed of controller, input and output module (I/O), communication network and other units.

Operation station

The task of operation station is to centrally display relevant operation information on standard screen and user configuration screen for operators.

The hardware of operation station is composed of industrial controller and man-machine interface (LCD screen, keyboard, mouse, etc.), operation platform and printer.

Communication network

The communication network system is a three-layer network, namely site-level communication network, industrial control network and plant management network interface (SIS and MIS).

Table 5-14: SIS and MIS of the Plant Management Network Interface.

	Plant-level supervision information system (SIS)	Plant-level management information system (MIS)
Description	A complete set of solutions integrated with real-time data acquisition, processing, display and storage based on different control, monitoring, metering and other systems involved in during production process of power plant.	Used for managing plant operation and production activities with support of computer network and database.
	 (1) Achieve plant production process monitoring and management; (2) Provide reference to economic load distribution; (3) Process information related to production cost in production site in real time manner; 	 (1) Real-time tariff calculation; (2) Operation management; (3) Maintenance management; (4) Fuel management; (5) Comprehensive indicator
Functions	 (4) Plant-level performance calculation and analysis function: SIS can complete plant-level performance calculation, to provide basis to power generation cost accounting in commercial operation of power plant; (5) Equipment status (leakage, wear, etc.) detection; (6) Establishment and maintenance of mathematical model. 	management; (6) Production technology management; (7) Finance management; (8) Human resources management; (9) Office automation.

(3) Functions of control system

DCS conducts data acquisition (DAS), modulating control (MCS), sequence control (SCS), interlock protection of main equipment and other functions.

- Data acquisition system (DAS) comprehensively and timely monitors variables of all detection objects of the entire plant.
- Modulating control system (MCS) shall guarantee safe, reliable, stable and efficient operation of incinerator, boiler, steam turbine and their auxiliary systems. In case of system failure, the control system will automatically switch the system without disturbance from "automatic mode" to "manual mode".

Table 5-15: Composition and Function of MCS (by stages, left to right)

			(1) Boiler steam flow control;						
			(2) Waste thickness control;						
			(3) Waste combustion position control;						
		Incinerator automatic combustion control	(4) Loss of ignition minimization control (ast grate upper temperature control);						
	Incinerator, boller and flue gas treatment control system		(5) Furnace temperature control;						
, and the part of			(6) Flue gas oxygen concentration control;						
			(7) Hearth negative pressure adjustment.						
			(1) Three-impulse cascade adjustment of boiler steam drum water level;						
MCS		Boiler control system	(2) Cascade adjustment of superheated steam temperature;						
			(3) Boiler outlet main steam pressure adjustment.						
		Flue gas treatment control system							
		(1) Steam turbine rotating speed regulating system.							
	Steam turbine and deaerator control system	(2) Condenser hot well water level adjustment;							
		(3) Deaerator level adjustment;							
		(4) Deaerator pressure adjustment;							
		(5) Attemperator temperature and pressure adjustment.							

◆ Procedure control, sequence control, interlocking control and manual control

According to production and operation requirements, the startup and stop process of relevant main equipment will be divided into several functional subgroups for different interlocking or sequence control.

The control system can automatically or manually start/stop subsystems including relevant auxiliary equipment.

Those control systems can display the status of each equipment subsystem together with relevant equipment on display screen of operation station by equipment color change, and display startup allowing conditions, operating sequence, operation mode and sequence control progress.

Protection system

- Steam turbine generator set protection

In case of severe failure of steam turbine generator system, according to shutdown conditions provided by steam turbine plant, when emergency shutdown is required, the

protection system can promptly cut off the inlet air valve and extraction valve of steam turbine, and turning will start to protect the steam turbine.

- Boiler protection

In case that the conditions for trip of boiler section occur (designed according to requirements provided by boiler supplier), the protection system is capable of automatically cutting off the waste and other fuels feeding into the combustion system (i.e., the feeder stops working), and shutting down all burners and fans;

(4) Instrument selection

- ◆ Temperature measurement: electric thermocouple and platinum thermistor are selected respectively according to different measurement range; bimetal thermometer is selected for local measurement; temperature switch or electric contact bimetal thermometer is selected for interlock protection; wearable thermal resistance (thermocouple) is selected for occasion with wear-resisting requirement.
- Pressure measurement: smart pressure transmitter and differential pressure transmitter are selected; bourdon tube pressure gauge, bellows-type pressure gauge and diaphragm pressure gauge are selected for local measurement; pressure switch and pressure controller are selected for interlock protection.
- ♦ Flow measurement: constant power heat mass flowmeter is selected according to different operating conditions respectively for measuring gas flow; balance flowmeter and electromagnetic flowmeter are selected respectively for measuring flow of water, steam and other conductive liquid; Corilis force mass flowmeter and metallic rotor flowmeter are selected for measuring flow of non-conductive liquid.
- Liquid level measurement: in general, ultrasonic liquid level meter, differential pressure liquid level transmitter, static pressure type liquid level transmitter, magnetic rolling board liquid level transmitter with signal distant transfer and RF admittance continuous material level meter are selected respectively; double-room equilibrium vessel + differential pressure transmitter or capacitive liquid level meter specific to steam drum are adopted for measuring water level of steam drum and deaerator.
- Solid material measurement: ultrasonic level meter is selected; RF admittance level switch is adopted for material level signal for interlock protection.
- Zirconia oxide analyzer is selected as oxygen content analyzer for flue gas at boiler outlet.
- Liquid analyzer: industrial PH meter, conductivity analyzer and water quality online analyzer are selected according to measurement objects.
- Valve: according to requirements and conditions, electric control valve, self-regulating control valve and solenoid valve are selected; actuator: electric actuator is selected; switch type electric valve is required to provide with smart integrated electric actuator; complete set of valve and actuator shall be used as far as possible.

(5) Central control room

The control room is provided with DCS equipment and relevant instrument panel, industrial television monitor, large screen monitor, etc.

(6) Power supply of control system and instrument

To guarantee power supply of control system, uninterrupted power supply (UPS) is provided in control room to supply power to DCS, instrument and other control systems. UPS shall guarantee the power supply duration of 30min.

- (7) Instrument air supply
- Instrument air supply is mainly used for some pneumatic instrument provided.
- Instrument air must be removed with oil, water, dust, dried and subject to other air purification treatment, and the air supply quality must conform to the following requirements:
- Dew point: the air supply dew point at operating pressure is at least 10°C lower than the lower limit of ambient temperature:
- Dust content: the size of dust particles in air shall not be greater than 3um;
- Oil content: the oil content in air shall not be greater than 10mg/m³ (8ppm);
- Pollutants: air supply shall be free of obvious hazardous gas or steam;
- Air supply pressure shall be automatically maintained within 0.7MPa to 0.8MPa, and the instrument air supply shall be provided with alarm protection functions;

2.3

- -Special air storage tank is provided.
- (8) Industrial television monitoring system (CCTV)

CCTV system visually monitors key positions and equipment.

Monitoring objects includes:

- Incinerator flame status
- Boiler steam drum water level
- Waste transport vehicle at waste unloading platform
- Current condition of waste accumulation of waste bunker
- Waste accumulation of boiler-front waste hopper
- Slag stockpiling in slag pit
- Material level in slag truck hopper
- Conditions of steam turbine generation platform
- Flue gas emission of stack
- (9) Poisonous and combustible gas monitoring system

To guarantee personal health and prevent fire, leachate collecting tank, waste bunker, SNCR

room, waste leachate ditch and adjacent staircase are monitored by poisonous and combustible gas detectors.

The processing details are displayed in related drawings in Volume II:

Schematic diagram: DF930-0-000-IN-SCD-04

5.4.2 Telecommunication

The telecommunication system includes voice communication and public-address system, enterprise information management network system, automatic fire alarm system, safety protection video monitoring system and cable television system.

As for fire alarm system design, it is proposed to set centralized fire alarm controller, graphic display device, fire protection broadcasting and fire-fighting telephone switchboard in central control room of Main Processing Building of waste incinerator. Each fire alarm controller in plant area is connected to network through optical fiber, and fire alarm information is displayed and controlled in central control room of Main Processing Building of waste incinerator. The central control room is also used as fire control room and dispatching center of the entire plant area.

The processing details are displayed in related drawings in Volume II:

Schematic diagram: DF930-0-000-IN-SCD-01

(1) Voice communication and public-address system

The plant is provided with 1 set of 100-line digital SPG exchange for production management communication and production dispatching communication. The SPC exchange is provided in electronic equipment room.

Floor-type outdoor telephone cross-connecting box is provided outside the Main Processing Building, with capacity of 200-circuit lines.

Wireless interphone is provided as needed to facilitate communication of production management personnel and meet the need of frequent contact between on-post team of some sections and equipment maintenance and commissioning.

Public address system is set along road in the plant area, which can be used as background music and other public address at ordinary times. In case of emergency, it can be used as emergency broadcasting and fire protection broadcasting.

(2) Enterprise information management network system

Computer information management network system enables all data, pictures, reports and tables of production management, personnel, financial management, attendance, supply and storehouse management and office automation system to be summarized, transmitted and managed in this system.

Plant core network equipment is placed in electronic equipment room, which is provided with industrial-level network switch, enterprise server, router, fire wall and anti-virus wall.

Table 5-16: Detailed Description of Network Arrangement

Location	ltems	Provided with
Main Processing Building	Crane control room, ±0.00m power pipe well, electronic equipment room, guard room, purification and booster pump chamber control room, truck scale duty room, leachate treatment station, oil depot oil pump house, circulating water pump house control room and complex building are provided with access-level switches. Crane control room of Main Processing Building, central control room, engineer station, flue gas monitoring room, dispatching room, office, conference room and demi water makeup station control room, leachate treatment station control room, truck scale duty room and guard room.	Internet access
Complex	Complex building office, conference room, duty room and dormitory management room, dormitory and activity room are provided with telephone/internet double-port socket	One telephone/internet double-port socket every 8m²
Building, Administration Building	Dormitory	One telephone/internet double-port socket each room
	Canteen and dormitory	Wi-Fi network

The local area network of the plant area is connected to Internet through broadband optical fiber.

(3) Video monitoring system for security

Network monitoring system is adopted for security video monitoring and security monitoring center is set in the security office of complex building. The monitoring system is incorporated into the LAN system and shares a network switch with office network.

2

Table 5-17: Description of Security Monitoring Points in the Main Processing Building

Items	Camera Type
Ground logistics lane, elevator lobby, transformer room, 35kV power distribution room and switching room	PTZ dome network cameras or fixed dome network cameras
Fence of Main Processing Building	PTZ dome cameras
Elevator lobby of each floor, aisle for visitors and exhibition hall	PTZ dome network cameras or fixed dome network cameras
Elevator	Fixed dome network cameras
Gateway	PTZ dome cameras
Entrances and exits of the complex building	PTZ dome cameras

The secondary display terminal of security video monitoring system is set in the security room and central control room of the complex building. The security video monitoring signal

of main plant also can be displayed on the large screen of central control room.

(4) Cable television system

A set of cable television access front-end equipment is provided in the dormitory management room of the complex building. The video signal is provided by the local cable television operator. The front-end equipment includes broadband amplifier and transmission network for branch distribution. It is planned to provide TV socket in the conference room of complex building, activity room of dormitory building, the hall and rooms of canteen.

5.5 Civil & structure

Detailed information on meteorological data, wind pressure, and seismology etc. are specified in VOLUME V.

The processing details are displayed in related drawings in Volume II:

GA: DF930-0-001-AR-GA-01

DF930-0-014-AR-GA-01/02/03/04

DF930-0-015-AR-GA-01/02/03

5.5.1 Architectural design

(1) Design concept

Chinese culture will be blended in design of Administration Building, complex building and landscape. The external wall of the buildings is in gray and white. In consideration of the eating and living habits of personnel from China and Pakistan, canteens and dormitories for both Chinese and Pakistanis will be arranged in the complex building. Landscape, pavilions and plants in Chinese style will be taken into consideration of landscape design.

To highlight environmental protection, bright and spacious exhibiting hall and passageway are designed for visitors and social groups.

(2) Architectural concept

There are two options for architectural design, Modern Building, and Building with Local Tradition & Muslim Features.

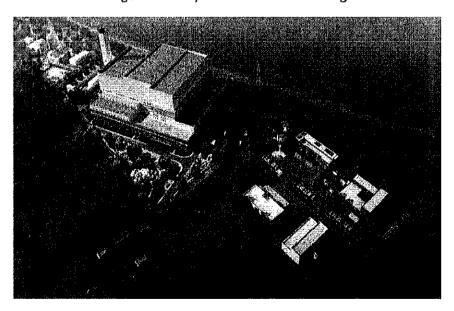
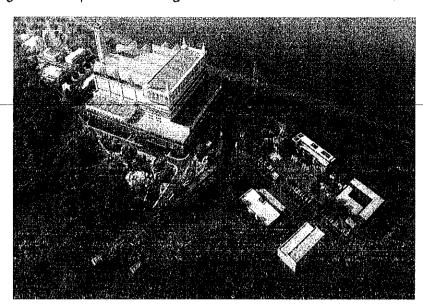


Figure 5-7: Option A Modern Building

Figure 5-8: Option B Building with Local Tradition & Muslim Features



The following is principles and features of design:

- All buildings organically blend in the surroundings
- Ensure people's space and ergonomic corridor in the plant
- A brand-new architectural design with local and Muslim feature

5.5.2 Design of main processing buildings

(1) Main Processing Building

Roof of incineration building, turbo generator building, unloading hall and waste bunker adopts large-space steel frame and steel roof truss, and the roof sheathing adopts corrugated aluminum-magnesium plate and light plate. Visiting corridor, deaerator room and main control building adopt cast-in-place RC roof.

VIP visiting route is in the Main Processing Building. Visitors can easily enter the central control room through the entrance hallway, stairway and elevators. Visiting corridor is arranged among the incineration building, flue gas cleaning building, the turbine generation building and central control room.

Building color: the main color of the exterior wall of main plant is lunar white and the bottom is of stones in agate red. The upper exterior wall of incineration plant and flue gas cleaning room is made of metal plates, forming changes to material and texture.

Entrance treatment: the main entrance faces the landscape green belt of the plant area. The outdoor landscape is reflected by large canopy and panoptic doors and windows. Full-length glass curtain wall is provided on the main wall to achieve virtual-real and bright-dark variation of light shadows, which highlights the main entrance and makes the whole building changeful in simplicity.

The main control building is adjacent to the Turbo Generator Building, and the main part of the two buildings are of 2-layer frame structure. Cable interlayer is set at the elevation of 4.500m. Layer 1: station power distribution room and battery room; layer 2: central control room, electronic equipment room and office.

The plant is equipped with 2 elevators and 7 emergency staircases, 2 of which lead to the underground leachate channel and the rest 5 are on the ground. The elevators are used as guest elevator, service elevator and fire evacuation.

Materials for wall: The frame and bent adopt solid brick wall, and the steel structure is of double-layer composite thermal-insulating wall with core material.

(2) Design of other buildings

Bricks of walls are 240mm thick.

Refer Table 5-18 of buildings and structures for details.

Table 5-18; List of Buildings and Structures

F

	Remarks	Including sub-items 02-07	Waste storage tank: 51x24x30.7 (4m underground) Crude waste tank: 8.95x21.25x30.7 (4m underground)						3.6m underground	Semi-underground/underground concrete water tank
	K	lincluoling	Waste storage I und und Crude waste ta						3.6m	Semi-undergi concre
The state of the s	Structural style		RC frame	Steel structure	Steel structure	RC frame	RC frame		RC frame	
	Indicator Building volume (m³)								8,529	
	Building indicator Building area Building	33,766		7,277	4,275	4005	4, 800	EMA COMMENT	806	
	Sketch or overall dimension		33.6x88x53+28x96x21	42.4x87x53	46x87x48.5	64x18x21+64x8x25.5	64.2x26x14+2.1x18x12	08×6×6	12x10.5x5.6+60x10.5x11.6	56.5x16x5+56.5x4x7
Description		Main Processing Building	Waste Receiving, Storage, Feeding System and Auxiliary System	Incinerator and Boiler Building	Flue Gas Cleaning Building (including fly ash stabilization room)	Turbo Generator Building	Main control building (including Step-up Substation)	Stack	Water Pump House and Pond	Circulating water tank
	2	δ	0.5	8	0.4	SO	90	07	Š.	8

		Remarks	Semi-underground/underground concrete water tank	Semi-underground concrete water tank	Semi-underground concrete water tank	Semi-underground concrete water tank					Underground concrete basin			
		Structural style					RC frame	RC frame	RC frame	RC frame		RC frame	RC frame	RC frame
) .	ndicator	Building volume (m³)					720	7 <u>2</u> 6	2673			167.2	11,668.5	7,955
	Building Indicator	∵Building area (m²):					214	162	272.5	50		4	2,655	1,700
)	Sketch or byersell dimension	LxWxH	21x20x5	(27x14x9) x2	16x12x9	20x20x12	9x6.5x12.3	27x6x6	18x13.5x7+16x13.5x4.5	6×3×4.1	10x3x3.5	9x4,5x3,5	37.5x9.9x11.7 +30x10.5x8.1+30x27x5.4	55.2x16x8.8
		Description	Production and fire water tank	Biochemical tank	Sludge and concentrated solution tank	Adjusting tank and emergency tank	Sludge treatment equipment room	Equipment room	Membrane treatment plant	Sewage treatment station	Adjusting tank, etc.	Oil Pump House	Complex building	Administration building
		2	A CONTROL OF THE CONTROL OF T	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2		8		Marine II		· • • • • • • • • • • • • • • • • • • •		5	2	13

		Skatch or overell dimension	Building	Building indicator			
Ś	Description	Maria in the second of the	Building area (m²)	Building volume (m³)	Structural style	Remarks	
A 200	Weighbridge and Gate Control House	53x14.6x3.6	S	355.4	RC frame		
P	Fence, Gate House and Guard House	5x4x4+6x3.6x4	ZZ	291			
12	Deep phreatic water treatment station	36×9×7.2	347	2,499	RC frame		
Š	Fly ash stabilization temporary storeroom	30×10×6	300	008'1	Steel structure		

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5.5.3 Structural design

Building classification

Building structure is of safety class II;

Foundation design is of class C;

Seismic fortification category of building structure is "C";

The environment classification of the concrete structure is as follows:

Underground structure: category "II b",

The waste bunker and slag bin are of category "V";

Structures above ground: category "I",

The waste bunker and slag bin are of category "V".

Values of main loads

Table 5-19: Values of Main Live Loads (kN/m²) (roof)

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Design of structure

Table 5-20: Selection of Structural Forms.

Buildings and Structures	Structure Selection	Remarks
Plant of frame-bent structure	Cast-in-situ RC column	
Particularly high, large and open single-layer plant	Steel pipe lattice column	
Roof of light-weight steel structure	Light-weight steel skeleton or profiled steel sheet	
Multi-layer plant, Administration Building and complex building	RC frame and cast-in-situ RC beams or slabs	
Small auxiliary buildings	RC frame	The second section of the second section section of the second section
Stack	Multi-flue stack; RC structure for load-bearing outer cylinder steel internal cylinder	Special structures
Waste pit, slag bin, water tank and pit	Waterproof cast-in-situ RC structure	Special structures

Buildings and Structures	Structure Selection Remarks
Pipe support	Steel structure or cast-in-situ RC Special structure structures
Trestle	Cast-in⊩situ.RC frame Special structures

- Design of main plant buildings

The Main Processing Building includes Waste Receiving, Storage, Feeding System and Auxiliary System (unloading hall, waste bunker, demi water makeup station, air compressor station), Incinerator and Boiler Building, Flue Gas Cleaning Building (including fly ash stabilization room), main control building (including Step-up Substation) and Turbo Generator Building. The waste feeding and auxiliary facilities (including main control building and Step-up Substation), Incinerator and Boiler Building (including flue gas cleaning plant building and fly ash stabilization room) and Turbo Generator Building are independent of each other with gaps between.

The overall height of the stack is 80m. Multi-flue stack is adopted. The load-bearing outer cylinder is of RC structure and the inner barrel for flue gas evacuation is made of steel.

The waste transportation ramp is the main channel for waste transportation. It is planned to adopt cast-in-situ RC frame structure to ensure harmonization and unification with the main plant and to save construction cost.

Other plants and buildings are small, so normal structure will be adopted. Details are illustrated in Table 5-18 List of Buildings (Structures).

Foundation design

Geological and hydrological conditions

According to Lakhodair landfill EIA report, this area is dominated by silt, fine sand and gravel, with small terrain fluctuation. No vein has been found. The groundwater level is high.

The site can be divided into 3 layers from top to bottom within the control range of hole location and depth: ① silt, ② silty clay, ③ fine sand.

The description of geotechnical layering from top to bottom is as follows:

- (1) Silt: brown gray, average thickness: 11m, average buried depth: 0.00m.
- ② Silty clay: brown, average thickness: 9m, average buried depth: 11m.
- ③ Fine sand: gray, average thickness: 10m, average buried depth: 20m.

Figure 5-9: Lakhodair Landfill Soil

Leterterretressenterressenterresser	CT:Sorilary Landill &	A DESCRIPTION OF THE PROPERTY		LOCATION: Lakhtr Dec, Mahmood Booti, Laktore.		
CLIEN	Letsore Waster Ma	inagement Com	yany. Panya	WATER TABL	E: 10 m	
Depth (m)	Streta Encombered	Legend		Description	Remarks	
		12111		и мерения менения менения по	camanana constanti	
			Brownish Silly Sand	Grey / Sandy Silt		
5 8 7 8 8 W M 12 10 4 5 16 17 18 19			Brownish Silty Ciay	/ Clayey Silt		
20 21 22 23 24 25 26 27 28 28 28		The control of the co	Grey Fine-Sand	/ Silly Sand		
Sand		Sand: Passin (0.075 nm	, g No 4 slevi 1)	y & Retained No.	200 sleve	
Clay	The state of the s	1,5-0,000 mm) Clay: Pagaing No 200 slave (0.005-0.001 mm)				
Sift		Silt: Passing No 200 sleve (0.075-0.005 mm)				
Gravel		Grayel: More than half of coarse fraction is larger than No 4 sleve size				

- Foundation design

According to borehole data in Lakhodair landfill EIA report, soil in the site mainly includes silt, silty clay and fine sand.

3

The important buildings and structures with large load, including Main Processing Building, waste transportation trestle and stack will adopt piling foundation.

Other auxiliary buildings and structures with small load, including water pump house, circulating water pump house and waste water treatment station, will adopt natural foundation.

- Seepage proofing and anti-floating technical measures and seamless design for extralong structure for waste bunker
- Seepage proofing measures for waste bunker:

The corrosion prevention of waste bunker shall make use of multi-protection of buildings

and structures. The impermeability grade of waste bunker is of P8. In order to strengthen the anti-penetrability performance of the waste bunker, a certain amount of concrete admixture and anti-crack fiber shall be mixed into the concrete.

Anti-floating measures for waste bunker

The underground anti-floating water level of the WTE Project has not been determined in the stage of preliminary survey. The following anti-floating measures can be adopted: anti-floating through the structure weight. If this cannot be satisfied, a certain thickness of plain concrete can be paved on the bottom of waste bunker; if the first scheme cannot satisfy the anti-floating requirements, a certain number of anti-floating piles can be provided below the waste bunker.

Seamless design for extra-long structure:

Since the length and width of unloading platform and waste bunker exceed the maximum spacing of expansion joint between the RC frame structure, permanent expansion joint will not be set to maintain the integrity of buildings, better play its functions and ensure its aesthetics. In order to avoid problems such as structure cracking caused by over-length of buildings, there are mainly four structural and construction measures that will be adopted:

- Provide two post-pouring belts in the middle of the building.
- Add expanding agent and anti-crack fiber to post-pouring belt.
- Increase reinforcement ratio wherever is greatly affected by temperature variation.
- Enhance the thermal insulation measures.
- Building materials and construction conditions

Ordinary building materials: Ordinary concrete and reinforcement can be purchased in local market; special steel, H-shape steel and channel steel above 300 can be purchased in China market according to the engineering demands.

Since the WTE Project is complicated, it shall be constructed by competent construction unit with the technical level of construction personnel, construction machinery, prefabrication and lifting capacity as well as the capacity for manufacturing and installing steel members satisfying the needs of the WTE Project.

5.6 Heating, ventilation and air conditioning (HVAC)

Due to tropical climate in the WTE project, ventilation, air conditioning and deodorization are applicable and described in this chapter.

The processing details are displayed in related drawings in Volume II:

Schematic diagram: DF930-0-001-HVAC-SCD-01

GA: DF930-0-001-HVAC-GA-01/02/03/04/05/06/07/08

5.6.1 Meteorological data and design data

Baseline meteorological data are elaborated in following:

- Annex 1: Report of site selection
- VOLUME V: INITICAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

Table 5-21: Design Parameters for Indoor Air

Room	Tempera	ature °C	Relative humidity %		Fresh air volume	Ventilation rate	Noise criteria
	Summer	Winter	Summer	Winter	(30m³ / h · person)	(time/h)	dB(A)
Central control room	26	18	≤65		30		45-50
Electronic equipment room	26		<65				
Office and conference room	26		<65		-30		
Slag pit crane control room	26		<65		30		
Waste pit crane control room	26		<65		30		
Air compressor station	40						
Demi water makeup station						3 to 4	
Machine maintenance and rivet welding room						6 to 8	
Lime slurry preparation room/fly ash stabilization room/activated carbon and dry powder transmission room						6 to 8	
Turbo Generator Building	40						
Water Pump House						3 to 4	
Complex building	26		<65		- 30		.

5.6.2 Ventilation

(1) Ventilation of incineration building

The heat release capacity of the incinerators and waste heat boilers is about 5,850kW.

Since the incineration plant building is of high temperature, the ventilation mode of natural air intake through low-level side window and mechanical air exhaust through axial flow fan on the roof is adopted to remove the indoor waste heat.

The exhaust air temperature is 50°C. The ventilation quantity required to remove the indoor waste heat is 1,589,775m³/h in summer. The net area of natural air inlet at the low-level side

window shall not be smaller than 250m².

(2) Ventilation of flue gas cleaning building

Table 5-22: Ventilation for Flue Gas Cleaning Building

Plant building	Ventilation form	Net area of natural air inlet at the low-level side window
Flue gas cleaning plant	The heat release of process equipment in flue gas cleaning plant building is about 1,950kW. The ventilation mode of natural air intake through low-level side window and mechanical air exhaust through axial flow fan on the roof is adopted to remove the indoor waste heat. The exhaust air temperature is 45°C. The ventilation quantity required to remove the indoor waste heat is 894,530m³/h in summer.	No smaller than 130m²
Fly ash stabilization room	Natural air intake and mechanical air exhaust is adopted. The mechanical ventilation rate shall be 6 to 8 times/h.	No smaller than 20m²
Lime slurry preparation room	Natural air intake and mechanical air exhaust is adopted. The mechanical ventilation rate shall be 6 to 8 times/h.	No smaller than 8m²
Activated carbon transmission room	Natural air intake and mechanical air exhaust is adopted. The mechanical ventilation rate shall be 6 to 8 times/h.	No smaller than 3m²
Lime dry powder transmission room	Natural air intake and mechanical air exhaust is adopted. The mechanical ventilation rate shall be 6 to 8 times/h.	No smaller than 3m²

(3) Ventilation for waste heat Turbo Generator Building

Steam turbine room

The heat release of equipment and pipelines is about 450kW. The ventilation mode of natural air intake through low-level side window and mechanical air exhaust through roof window is adopted to remove the waste heat. The exhaust air temperature is 50°C. The natural air intake volume required to remove the waste heat is 117,991m³/h in summer, and the net area of natural air inlet at the low-level side window shall not be smaller than 40m². The natural air exhaust rate of roof window is 122,492m³/h, and the net area of air exhaust outlet of roof window shall not be smaller than 35m². The roof window shall be designed by architecture discipline.

Deaerator room

The heat release of process equipment and pipeline is about 150kW. The ventilation mode of natural air intake through low-level side window and mechanical air exhaust through axial flow fan on the roof is adopted to remove the waste heat. The exhaust air temperature is

45°C. The ventilation quantity required to remove the waste heat is 68,810m³/h in summer. The net area of natural air inlet at the low-level side window of deaerator room shall not be smaller than 10m².

Power generation chamber

The power generation chamber is equipped with mechanical ventilation facility. The ventilation rate shall be 10 times/h. The net area of natural air inlet of power generation chamber shall not be smaller than 0.5m².

(4) Ventilation of waste leachate collecting house

The waste leachate collecting house is composed of waste leachate tank, leachate pump room and channel chamber. Since the waste leachate will produce a large amount of odor in these areas, mechanical air supply and exhaust system shall be provided to remove the ammonia gas, hydrogen sulfide produced in waste leachate collecting chamber. The exhaust air from waste leachate collecting chamber will be discharged to the waste bunker and then drawn into the incinerator for combustion and decomposition by the primary air fan of process discipline.

The air blower and exhaust fan shall be of FRP centrifugal type (explosion proof). The air volume of the exhaust fan shall satisfy the ventilation requirements of 12 times/h. In order to maintain the negative pressure of leachate collecting chamber, the supply air volume shall be 80% of the exhaust air volume.

The air supply and exhaust system of leachate collecting chamber shall be subject to 24-hour continuous operation. The air blower and exhaust fan shall be interlocked with the combustible and harmful gas alarm signal of instrument discipline.

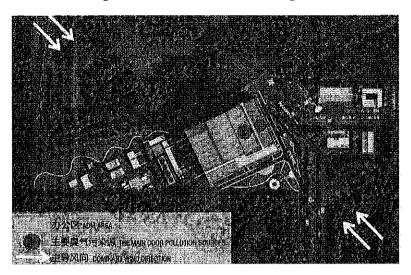
(5) Ventilation of other rooms

Ventilation facilities shall be provided for slag pit, air compressor station, demi water makeup station, the machine maintenance room, rivet welding room, steam and water sampling room, SNCR room, and drug storehouse, battery room and oil pump room, GIS room of Step-up Substation, power distribution room of flue gas cleaning plant and the high and low voltage distribution room of main control building, cable interlayer, water pump room of Water Pump House and deep well water treatment station, ground pump house of sewage treatment station, and leachate treatment station.

5.6.3 Deodorization of waste bunker

Deodorization is defined with various function areas shown in Figure 5-10.

Figure 5-10: Deodorization Diagram



Deodorization under normal operation of incinerator

Main pollution factors in the waste bunker are H₂S, NH₃ and etc.

The waste bunker shall be of totally enclosed to prevent odor from leakage. Odorous substance will be extracted by the primary air fan of the incinerator through the exhaust inlet on the upper part of waste bunker, and will be fed into the incinerator as combustion air. The odor pollutants will be burned and decomposed in the high-temperature atmosphere.

Deodorization during shutdown of the incinerators

Pressure in the waste bunker becomes positive when the incinerator is shut down for maintenance. The H₂S, NH₃ and etc. produced in waste bunker will be discharged to activated carbon adsorption deodorization unit by the air hose located on the upper part of waste bunker. Then the gas will be adsorbed and purified by the activated carbon.

Deodorization device by atomization of plant extract is provided in the unloading hall to decompose the odorous gas through biological degradation. Meanwhile, air curtain will be installed at entrance of the unloading hall to cut off indoor and outdoor air flow, thus prevent contaminated air from leaking out.

5.6.4 Air conditioning

Air conditioning facilities are provided in Main Control Building, Complex Building, Administration Building, and other rooms.

Air conditioning cooling load 1,425kW

Total air volume of ventilation 3,938,320m³/h

Electric power consumption 1,058kW

Chapter 6 Environmental Protection and Social Impact

6.1 Background information

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According to the Pakistan Environmental Protection Act, 1997 amended 2012, "an Initial Environmental Examination (IEE) or, where the project is likely to cause an adverse environmental effect, an Environmental Impact Assessment (EIA)" shall be filed to the Federal Agency prior to the construction or operation of a project, and shall "obtain from the FEDERAL Agency approval in respect thereof".

With a view to evaluate likely impacts/ risks associated with the WTE project on environment, and to achieve certain environmental objectives besides the existing local legal requirement, ENFI has invited Environmental Consultancies and Options (ECO) to carry out the an IEE study of the WTE Project.

6.2 Main pollutants and treatment measures

Table 6-1: Main Pollutants and Mitigation Measures

Sources	Pollutants	Mitigation Measures	Remarks
MGF	Particulate, SO _X , HCl, NO _X , etc. contained in Flue gas	SO _x , HCl, HF in flue gas is neutralized by lime slurry and thus become CaSO ₄ , CaCl ₂ , CaF ₂	Vent to atmosphere
Demi water makeup station	Wastewater with high Cl content		
Blowdown cooling tank Wastewater Water source Back flushing T purification system water			To inland water;
		Treatment station	High concentrated solution back to the incineration process
Circulating water tank	Wastewater		system
Waste pit	Leachate	en en en arabien en e	Carlotte Commission of Commiss
Lime bin, activated carbon bin, fly ash bin and cement bin and fly ash conveyor	Dust	Bag filler	Storage bin
Flue gas cleaning system	Fly ash	Stabilization system	Nearby landfill
MGE	Slag	WHB.	Transported to the outside of the plant for comprehensive utilization
Bag filter	Broken bags	A temporary warehouse	To be disposed by a qualified hazardous wastes disposal unit
Leachate treatment station	Filter cakes	Back to MGF	/ / / / / / / / / / / / / / / / / / /
Equipment operation, steam venting and blowing, drain pipe, etc.	Noise	Muffler; flexible coupling and spring damper; sound insulation with wall; soundproof windows and doors; sound insulation and thermal insulation layer; green plants	
Waste pit, leachate storage tank	Odor	Enclosed type; negative pressure air exhaust; air curtain	/

Afforestation is also taken as an effective way to isolate and absorb the dust, purify the air, achieve noise attenuation, and thus creating a good environment.

6.3 Emission standards for flue gas

The emission of flue gas will be subject to the emission values in PEQS and China standard GB18485-2014 and thus meet the requirements of environmental protection. Table 6-2 and

6-3 shows the detailed information.

Table 6-2: GB18485-2014 Emission Values of Pollutants in Incineration Flue Gas

No.	Pollutants	Unit	Design value
1	Dust	mg/Nm³	≤ 20
2	HCI	mg/Nm³	≤50
3	SOx	mg/Nm³	≤80
4	NOx	mg/Nm³	≤250
5	CO	mg/Nm³	≨80
6	HF	mg/Nm³	≤ 1
7	Hg and its compounds (take the concentration of Hg)	mg/Nm³	≤0.05
8	Cd, Ti and their compounds (take the concentration of cd+Ti)	mg/Nm³	≤0.1
9	Sb, As, Pb, Cr, Co, Cu, Mn, Ni and their compounds (take the concentration of Sb+As+Pb+Cr+Co+Cu+Mn+Ni)	mg/Nm³	≤1.0
10	Dioxins	ng/Nm³	≤0.1
11	Smoke	Ringlemann Scale	1

Table 6-3: PEQS Emission Values of Pollutants in Incineration Flue Gas

Parameter	PEQS
Smoke Opacity	-2
Particulate Matter (mg/Nm³)	Oil fired: 300 Coal fired: 500 Cement Kilns: 300 Metallurgical processes, grinding, crushing, etc.: 500
SOx (mg/Nm³)	Sulfuric acid plants: 5000 Plants other than power plant operating on oil and coal: 1700
NOx (mg/Nm³)	Plants other than power plant operating on oil or coal Oil fired: 600 Gas fired: 400 Coal fired: 1200
HCI (mg/Nm³)	400
HF (mg/Nm³)	150
CO (mg/Nm³)	800
Hg (mg/Nm³)	10
Cd (mg/Nm³)	20
Pb (mg/Nm³)	50
As (mg/Nm³)	20
Cu (mg/Nm³)	50
Sb (mg/Nm³)	20
Dioxins	

Chapter 7 Fire Protection

7.1 Plot plan and traffic

The general layout takes full account of the requirements of fire safety design. The distance between buildings and structures meet relevant fire protection design codes. At the same time, the 6-7m wide annular driveways are provided around such main buildings as Main Processing Building, Administration Building and complex building, with the minimum inner turning radius of 12m. Around other auxiliary production facilities are 6m or larger open spaces and turnarounds, meeting the requirements for fire truck passage and firefighting operation. The safety enclosure is provided around the oil tank area, and no tall arbor tree or oily hedge is permitted to grow within or around the plant area to reduce fire hazards. The plant access roads shall be designed to separate the pedestrians and vehicles, and gates are provided at different orientations, beneficial to emergency evacuation in case of fire, so as to ensure the fire safety of the plant.

- 7.2 Fire protection of buildings and facilities
- 7.2.1 Determination of fire risk during production in each building
- (1) Main Processing Building

The Main Processing Building is a large space plant building.

- (2) Water Pump House, membrane treatment plant, underground water treatment station and fly ash stabilization temporary storeroom
- (3) Oil pump house
- 7.2.2 Determination of fire resistance ratings of buildings
- 7.2.3 Fire zoning of buildings
- (1) Main Processing Building

The Main Processing Building is divided into 6 fire zones according to the process arrangement, namely, waste unloading room, waste bunker, flue gas cleaning room of incineration plant, rooms at the lower floor of the unloading room, turbine generation plant and main control building, each as a separate fire zone. Fire zones are separated by firewalls and fire doors & windows. The piping passing through the fire zone shall be provided with enclosed system.

(2) Other buildings

If the building area is less than 2,500m², the fire zoning will not be required.

- 7.2.4 Safety evacuation design
- (1) Main Processing Building

In the Main Processing Building, the platforms at different floors within the fire zone where the incinerator building is located shall be provided with evacuation stairs at south and north sides for daily vertical evacuation of inspectors, and there are fewer than 10 workers in this zone, which means the Main Processing Building meets the personnel evacuation

requirements. Other fire zones shall be provided with two exits; and all fire doors shall be opened towards the evacuation direction. Thus the requirements for evacuation exits and distance are met.

The Main Processing Building is RC frame + steel lattice column structure, with steel roof. As the Main Processing Building is listed into Type D according to the fire risk classification, the steel lattice columns are coated with thick fire-proof materials; while the steel grids and beams are coated with thin fire-proof materials.

(2) Other buildings

The frame is RC column, while the roof and floor are cast-in-place RC roof and floor slabs.

(3) Office and living buildings within the plant area

Office and living buildings constructed during Phase I within the plant area are complex building and Administration Building

The Administration Building has 2 floors, a building area of 1,700 m², RC frame structure, a building height of 8.8m.

7.3 Firefighting system

7.3.1 Fire water consumption

The WTE Project is provided with a separate fire water supply system.

The processing details are displayed in related drawings in Volume II:

Schematic diagram: DF930-0-000-PR-SCD-01

The design assumes that only 1 fire occurs at a time. The severest fire conditions shall be: indoor/outdoor fire lasting for 2h or more, or the waste bunker fire lasting for 1h or more. This design is based on the sum of water consumptions of indoor & outdoor fire hydrants and fire monitors, i.e., the one-time firefighting water consumption is taken as 648m³, and the fire water is stored in a 1,800m³ storage pool for production and fire protection purposes. The pool is provided with continuous level signals remotely transmitted to the Fire Services Communication Center, and measures are also taken to avoid the use for purposes other than fire protection. The fire water utilizes purified water from deep well.

7.3.2 Firefighting facilities

Outdoor & indoor fire hydrants, waste bunker fire monitor, waste bunker feed hopper fire water, domestic fire extinguishing system and other firefighting facilities shall be provided.

(1) Outdoor firefighting facilities

The looped fire water supply pipeline consisted of DN200 welded steel pipe and ground-type fire hydrant shall be provided outdoors along the main roads in the incineration area and living area. The temporary HP firefighting system shall be used for water supply to the fire network through fire pump in the event of fire. The fire hoses and pipe network shall be shared by the outdoor and indoor fire hydrants.

(2) Indoor firefighting facilities.

The temporary HP firefighting system shall be used indoors for water supply to the fire network through fire pump in the event of fire. The Main Processing Building is provided with fire hydrant water supply system, with two water inlet pipes led from outdoors, and the indoor fire pipes in ringed arrangement. The Main Processing Building is provided with indoor fire hydrants and 2 sets of water pump adapters.

The main incineration plant is provided with fire monitors for firefighting. The fire monitors have a unit design flow of 30L/s, an injection range not less than 60m and the required water pressure of 1.1MPa. The comprehensive water pump house is provided with 2 special pumps for fire monitors, 1 operating, 1 standby.

7.3.3 Fire water pressurization facilities

These shall be provided within the comprehensive water pump house. The fire monitor extinguishing system shall consist of 2 XBD-type vertical multi-stage firefighting centrifugal pumps, 1 in service and 1 standby, with Q=60L/s and H=130m.

The fire hydrant extinguishing system shall consist of 2 XBD-type vertical multi-stage firefighting centrifugal pumps, 1 in service and 1 standby, with Q=60L/s and H=75m.

The operating status of fire water pump and pressure stabilization unit shall be transmitted to the Fire Service Communication Center which can remotely control the start-up and shutdown of the firefighting equipment.

7.3.4 Special fire extinguishing facilities

The domestic ammonium phosphate dry chemical fire extinguishers shall be provided at each plant and in the complex building; while the domestic foam fire extinguishers shall be provided for the oil tank in the steam turbine room.

Different fire extinguishing modes of different buildings are shown in table 7-1.

Table 7-1: Fire Extinguishing Modes of Different Buildings

Buildings, structures and equipment rooms	Fire extinguishing system	Start-up mode
I. Main Processing Building		
Waste receiving and storage plants	Fire hydrant and dry powder fire extinguisher	Manual
Incineration plant	Fire hydrant, fire monitor and dry powder fire extinguisher	Manual and automatic
Flue gas cleaning plant	Fire hydrant and dry powder fire extinguisher	Manual
Main control building	Fire hydrant and dry powder fire extinguisher	Manual
Waste heat powerhouse	Fire hydrant, dry powder fire extinguisher, foam fire extinguisher	Manual
II. Stack	lime dry powder fire extinguisher	Manual
III. phreatic water treatment station	lime dry powder fire extinguisher	Manual
IV. Comprehensive water pump house	lime dry powder fire extinguisher	Manual
V. Leachate treatment station	lime dry powder fire extinguisher	Manual
VI. Domestic sewage treatment station	lime dry powder fire extinguisher	Manual
VII. Oil depot and oil pump house	lime dry powder fire extinguisher, foam fire extinguisher, fire blanket, and sand box	Manual
VII. Motor truck scale	lime dry powder fire extinguisher	Manual
VIII, Guard	lime dry powder fire extinguisher	Manual
IX. Complex building and Administration Building	lime dry powder fire extinguisher	Manual

7.4 Automatic fire alarm and interlocking system

(1) Functions and equipment descriptions of fire alarm system

A 256-point centralized fire alarm controller is provided in the CCR at 7.00m level in the Main Processing Building, as the fire alarm control center of the entire plant.

A 256-point centralized fire alarm control system is provided in the CCR, consisting of the power supply for firefighting linkage, the alarm controller, the straight wire linked control board, the emergency PA and the firefighting telephone switchboard, all integrated into a standard 19" cabinet.

The oil pump house, purification and booster pump houses, complex building and other places shall be provided with local fire alarm controllers, in connection with the centralized fire alarm controller of the CCR, sharing cables with telecommunication system, laid in same cable but different cores.

(2) Fire alarm power supply and grounding

The fire control room is provided with UPS, battery and power distribution cabinet. The fire alarm system uses double-circuit fire incoming power lines to be switched at ends. UPS is on-line power supply. Battery enables 3h power supply.

The fire alarm system is jointly grounded, with the grounding resistance not greater than 1Ω .

(3) Provision of detectors and alarm equipment

The integrated Main Processing Building is divided into 4 fire zones in total, and based on such zoning, the detectors and alarm equipment are provided at the following locations:

The smoke detectors shall be provided at 35kV distribution room, transformer room, distribution room, ventilation equipment room, CCR, electronic equipment room, exhibition hall, office rooms, engineer's station, meeting room, warehouse, crane control room, flue gas on-line analysis room, elevator equipment room, etc.:

The flame detectors shall be provided at waste bunker and steam turbine generator plant;

The heat sensitive cable detector shall be provided at the cable channel of power distribution room;

The manual alarm buttons and audible & visual alarms shall be provided at main passages, exists & entrances and elevator doorway of each floor;

The fire telephone extensions shall be provided at each distribution room, CCR, ventilation equipment room, air conditioning room and fire control room.

The smoke detectors shall be provided at complex building offices, canteen and dormitories; the manual alarm buttons and audible & visual alarms shall be provided at the corridors and main exits & entrances.

(4) Provision of firefighting emergency PA

The fire control room inside is provided with a set of firefighting emergency PA system, consisting of control panel, broadcasting power amplifiers and some other equipment within the broadcasting area. In the event of fire, the fire control room will send emergency broadcast to the entire plant to direct the evacuation.

(5) Fire alarm linkage

When the plant catch on fire, push the fire hydrant alarm button manually, and the fire control room may automatically or manually start up the fire pump for fire extinguishing. When the waste bunker catch on fire, start up the fire monitor control box for fire extinguishing, and pressurize the fire monitor pump for water supply at the same time.

The mechanical smoke exhaust system shall be arranged within the waste bunker by the ventilation discipline. The smoke control and exhaust system is subject to automatic and manual control.

The smoke control and exhaust measures shall be provided for the centralized air-conditioning system at CCR and electronic equipment room. When the outdoor air-conditioning duct system passes through the air feeder room, 70°C fire valve shall be provided and will be closed automatically in case of fire. The air-conditioner of this system is interlocked with such valve.

In the event of fire, the elevators will be forced landing to the first floor, and the power supply of the non-fire elevators will be cut off.

The alarm signal on flammable gas in leachate system is transmitted to fire alarm system.

Besides the fire alarm system controls the modules to automatically start up the fire pump, fire monitor pump and smoke exhaust fan; the fire control room is also set with pulling multi-core fire-rated control cable connected to the electric control boxes of the above equipment, directly interlock the equipment and receive the feedback signals.

- 7.5 Firefighting smoke exhaust system
- 7.5.1 Smoke control and exhaust system in main control room

As the waste pool is closed and cannot meet the natural smoke exhaust requirements, the smoke exhaust facilities shall be provided in case of any accident. The smoke exhaust rate shall be taken as $60\text{m}^3/(\text{h}\cdot\text{m}^2)$ and the total smoke exhaust volume is $106,445\text{m}^3/\text{h}$. The smoke exhaust duct shall also serve as the air duct for deodorization of waste bunker. When the waste pool catches on fire, waste crane control room gives orders to close the electric control valve in front of the deodorization device, and start up smoke exhaust fan and 280°C smoke exhaust fire valve. When the flue gas temperature reaches 280°C within the pipe, the exhaust fire valve on the pipe will be closed automatically to stop smoke exhaust.

- 7.5.2 Waste pit is provided with emergency smoke exhaust device.
- 7.5.3 Pressurized air feeding is provided at staircases between leachate channels
- 7.5.4 Smoke control at doorway of smoke-proof staircase and fire elevator in the incineration plant

One set of mechanically pressurized air feeding facilities shall be provided at doorway. The pressurized air feeder is set within the special fan room.

- 7.5.5 Main Control building
- (1) The ±0.00m flat corridor is provided with one set of mechanical smoke exhaust facilities.

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- (2) The 7.00m flat view corridor is provided with one set of mechanical smoke exhaust facilities.
- (3) In the event of fire, use the manual alarm signal in the corridor and the electric signal in CCR to open the smoke exhaust fire valve and start up the smoke exhaust fan. When the flue gas temperature reaches 280°C within the exhaust duct, the exhaust fire valve will be closed automatically and the smoke exhaust fan will be stopped.
- 7.6 Power supply for fire fighting

The fire pump and other firefighting consumers are connected to the security section to ensure reliable power supply.

The emergency evacuation indicator lights shall be provided at staircases, public channels and important exits & entrances.

NH-YJV22-1kV fire resistant cables shall be provided for firefighting equipment in the Main Processing Building. The cable tray shall be fire resistant.

The oil-free vacuum circuit breaker shall be used for HV cabinet, and the auxiliary transformer shall be dry type.

The automatic fire alarm system shall be provided with UPS to ensure the reliability of power supply.

7.7 Fire prevention measures

7.7.1 Lubricating oil system

The domestic foam fire extinguishers shall be provided nearby the indoor oil storage tank to effectively put out the sprinkling fire caused by leakage of lubricating oil.

7.7.2 Oil storage tank

The wheeled foam fire extinguishers as well as sand box and fire blanket shall be provided in the underground oil tank area; and the domestic foam fire extinguishers shall be provided at oil pump house, to timely put out the fire.

7.7.3 Waste bunker

The fire monitor fight extinguishing system shall be provided at the upper platform of the waste bunker. The system is subject to automatic control, remote control and field control from the fire control center.

With these methods, the fire can be put out within the shortest time, and the safe operation of waste storage system can be ensured effectively.

7.7.4 Protective measures of electrical facilities

The electrical facilities shall be protected against fire, explosion and electric shock.

(1) Protection against fire and explosion on electric facilities

The main transformer room shall be provided with oil storage pool laid with pebbles. The emergency oil storage pit shall be separately set outdoors. All other auxiliary electric facilities shall be designed oil-free.

The flame-retardant cable shall be used at inflammable places, high temperature-resistant cable used under high temperature services; and the fire blocking materials or fire package shall be applied to block the cable inlet/outlet or shaft, and openings at the bottom of panels/cabinets.

(2) Protection against electric shock on electric facilities

In lightning protection grounding, working grounding and protective grounding works, the composite artificial grounding devices are respectively used as the lead wires connected to the electric equipment, and the foundation works shall be used as far as possible for grounding to reduce the electric resistance and the investment of grounding works.

All electric equipment enclosures and non-rotary metal enclosures shall be provided with protective grounding, and the step voltage at the intersections between grounding grid and channels shall be reduced.

Acoustic and light signals shall be provided for auxiliary power and distribution unit failure.

As per the technical requirements for process production, the process equipment shall be provided with safety interlocking control, and the electric equipment with remote and local control shall be provided with selector switch.

For lightning of boiler body, except the electric leakage protection, the high temperature resistant cable shall be also provided for routing; and the domestic working lights for maintenance purpose shall be provided with AC12V power supply.

Chapter 8 Project Schedule

8.1 Project Objectives

- ◆To build a modern WTE plant and meet LWMC strategy of MSW disposal in Lahore and supplement power output to local grid;
- ◆The WTE Project shall be a demonstrative plant with advanced technology, which is environment-friendly and compatible with local culture and history in a harmless, reductive and regenerative way;
- ◆ Pollutants during construction and operation shall meet local environmental protection requirements and international standards;
 - ◆The plant will be operated at a high automation and ergonomic level.

8.2 Project schedule

Milestones of the project are listed in Table 8-1.

Table 8-1: Project Milestones

Milestone	Date		
Project commencement (Issuance of LOI)	2016-10-19		
Completion of feasibility study	2017-7-20		
Completion of basic engineering	2018-5-20		
Commencement of construction	2018-5-1		
Completion of detailed engineering	2019-6-29		
Mechanical completion	2020-9-15		
Commissioning period	2020-9-16 to 2021-4-29		
Commencement of commercial operation	2021-4-30		
Operation period	2021-5-1 to 2046-4-30		
Project transfer	2046-5-1		

The project will be implemented with following stages:

- (1) Preliminary works: including signing of project agreements, acquisition of land, site surveys, environmental impact assessment, geotechnical studies, and other associated preparations
- (2) Engineering & design: including feasibility study, basic engineering, detail design, procurement support, as-built drawings, etc.

- (3) Procurement: including procurement of equipment and materials, manufacturing, transportation, etc.
- (4) Construction: including earthworks, civil and structure works, installation and erection of all facilities onsite, etc.
- (5) Commissioning: including linkage commissioning, commissioning with loads, and handover
- (6) Commercial operation
- (7) Project transfer

Schedule from preliminary works to commercial operation is displayed in Figure 8-1 Project Schedule.

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Fourth Botch of Equipment Logistics 30 d Main Process Building Detailed Engineering 45 d Construction of main structure of Main Process O.d. Completion Of Linkage test run of all systems Procurement Of Waste Crane, Blower, The Other Civil Engineering Drawing Procurement Of Incinerator, Waste Heat Stack Detailed Engineering Drawings All Detailed Engineering Drawings Boiler, Turbo Generator, Flue Gas Oreanir Completion Of Test Run Of Each System Second Satch of Equipment Logistics Cooling Tower, Water Feed Pump, GIS installation of main process equipment quipment Manufacturing & Logistics Third Batch of Equipment Logistics First Batch of Equipment Logistics Piles Drawing of Civil Design Procument Of Electric, DCS, I&C Commencement Of Construction Completion of Basic Engineering Civil Engineering Design Equipment Procurement Mechanical Completion Feasibility Study Report Installation Design Procurement. Of Aux Commercial Operation Detailed Engineering building completed Submission Completion of FS Construction Site Preparation completed IN PAKESTAN Activities ත් වේ 1.9 1.9 1.1 6) 6) ତ - ୧୪ ପ ବା ବା ଜ ଟ ପ

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Figure 8-1: Project Schedule

Activities No-load Commissioning
Partial-load Commissioning
Full-load Commissioning
Test run of the whole plant
Commercial Operation Test Run Ancillary Works

Girculating Water Pump House. Cooling Tow 90 d
Ancillary Works Installation 50 d
Integrated Pipe Retwork Construction 90 d
Roads, Dirch, Ground Paving 287 d
Pest Run

Test Run Of Each System 90 d
Mechancial Pre-commissioning 50 d
Subsystem Pre-commissioning 50 d
Linhage test run of all systems 70 d
Inhage test run of all systems 70 d
Partial-load Commissioning 50 Linkage test run of all systems Test Run Of Each System
Mechancial Pre-commissioning
Subsystem Pre-commissioning Stack Shell Installation Ancillary Works 1204 Dur. 2020/5/10 2019/12/12 2019/12/12 2020/5/11 2019/12/12 2020/3/11 2020/7/18 2020/7/18 2020/7/18 2020/10/10 2020/10/16 2020/12/16 2021/1/14 2021/1/31 Start Base 2000/9/s
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Chapter 9 Capital Cost Estimate

9.1 Basis for cost estimate

9.1.1 Scope

Scope of capital estimate includes:

- Direct capital cost
- Indirect capital cost
- Owner's cost
- Contingency

9.1,2 Basis

Total capital cost and breakdown are estimated and calibrated by:

- ENFI Estimating System (in Excel Software) and database;
- The equipment list, material take-offs and bill of quantities;
- Price quotations from local and China vendors;
- Investigative data of labor, material and machine prices, logistics, and tax during preparation of FS.

9.1.3 Reference Documents

The following documents are referenced:

- Process Design Criteria
- PFD & Mass Balance
- Equipment list and specifications
- General plot plan and FS drawings
- Topography map
- Material Take-off
- ENFI's Database
- Local & foreign labor rates
- Project schedule

9.1.4 Estimate Allowances

Three types of cost allowances are taken into account as the following:

Variation of Bill of Quantities (BOQ)

Allowances are made for cost fluctuations due to:

- Engineering and design optimization
- Losses, damages, repairs and modifications at construction stage
- Allowance of net quantity at engineering stage
- Increase outside of material take-offs

Allowance is to cover elements such as gussets, fasteners, steel touch up paint, cable terminations, etc., which is addressed by a factor applied to the net quantity of MTOs.

Other Items:

Specific items may be undefined or ignored at the preliminary level of engineering level.

9.1.5 Estimating Methodology

- Quantities of work are based on scope definition, engineering, plant layout and general arrangement of each facility.
- Cost estimation for ground levelling, earthworks, concrete, steel and platework, etc. is based on work quantity list and prices.
- Cost of main package is estimated by equipment list, vendors' quotation and ENFI's database.
- Cost of other equipment is estimated by referring ENFI's database.
- Cost of electrical and C&I equipment is estimated by referring ENFI's database of similar WTE projects.
- Pipework price is made up of materials, labor and installation costs. valves and local instrument costs come from quotations of vendors, while installation fee is evaluated by referring ENFI's database.

All equipment of the WTE Project is assumed to be imported and transported to Lahore from China.

9.1.6 Indirect cost

The costs for EPCM, temporary facilities, catering & lodging, precommissioning and commissioning, insurance, third-party services and training are determined per referenced data of similar WTE projects and ENFI's database.

Freight & miscellaneous expense are determined by freight weight and volume, and verified by quotations of logistics vendors.

Customs duty and sales tax, etc. are based on tax study by ENFI. Major processing equipment is considered to be exempted from customs duty and sales tax, with only 5% of other import tax (VAT) and miscellaneous expense.

Customs duty of 15% and sales tax of 17% are levied for electrical and instrumental equipment.

9.1.7 Owner's cost

Owner's cost is estimated with a certain percentage of direct cost.

9.1.8 Contingency

Contingency is a provision of funds for unforeseen costs, which is mainly due to level and accuracy of engineering. The contingency is meant to deal with events or incidents that occur during building of the WTE Project, which cannot be covered by allowance for project risk.

In China, such project is a technically mature project with complete and sound process. This FS is a fairly in-depth design based on a fairly wide availability of data. Based on the depth and accuracy of design, and the possession of information on equipment, materials and sub-contraction price level, etc., the contingency is taken at 5% on a comprehensive basis, the calculation bases of which include direct cost, indirect cost and the Owner's cost.

The followings are excluded in contingency analysis:

- Change of Scope of Work (SOW)
- Substantial change of processing of the plant
- Force majeure

- Welfare
- Interest conflict between labor and capital
- Change in Project Implementation Plan (PIP)
- Deductible costs of insurance
- Unpredictable delay of construction schedule

9.2 Currency Exchange Rates

Costs is presented in US Dollars (USD).

USD 1.00 = CNY 6.95

USD 1.00 = PKR 105

9.3 Exclusions

Following items are excluded from capital cost:

- Force majeure
- Working capital
- Inflation of currency
- Changes of exchange rates
- Interests during construction period

9.4 Preliminary capital estimate result

Unit of figures in following tables is USD. Capital cost is summarized in Table 9-1.



INITIAL ENVIRONMENTAL EXAMINATION (IEE) REPORT

2000 T/D WASTE TO ENERGY PROJECT LAHORE

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LIST OF ABBREVIATIONS

CDGL Environmental Impact Assessment

DCR District Census Report

ECO Environmental Consultancies and Options

EIA City District Government Lahore

EPA Environmental Protection Agency

EPC Engineering, Procurement and Construction

EMP Environmental Management Plan

GEL Global Eco Laboratories

GHGs Green House Gases

GT Global Technologies

GWM Global Waste Management

HV High VoltageHV High Voltage

IEE Initial Environmental Examination

IEE Initial Environmental Examination

kV Kilo Volt

km Kilometer

KV Kilo Volt

LHV Lower Heating Value

LWMC Lahore Waste Management Company

M³ Cubic Meter

MBR Membrane Process

MCR Mechanical Continuous Rating

MGF Moving Grate Furnace
MSW Municipal Solid Waste

MSW Municipal Solid Waste

NF Nano Filtration

NGOs Non-Governmental Organizations

NOC No Objection Certificate

O & M Operation and Maintenance

PEPA Pakistan Environmental Protection Act

PHA Parks and Horticulture Authority

PPDB Punjab Power Development Board

SIA Social Impact Assessment

SPV Special Purpose Vehicle

t/d Tons/day

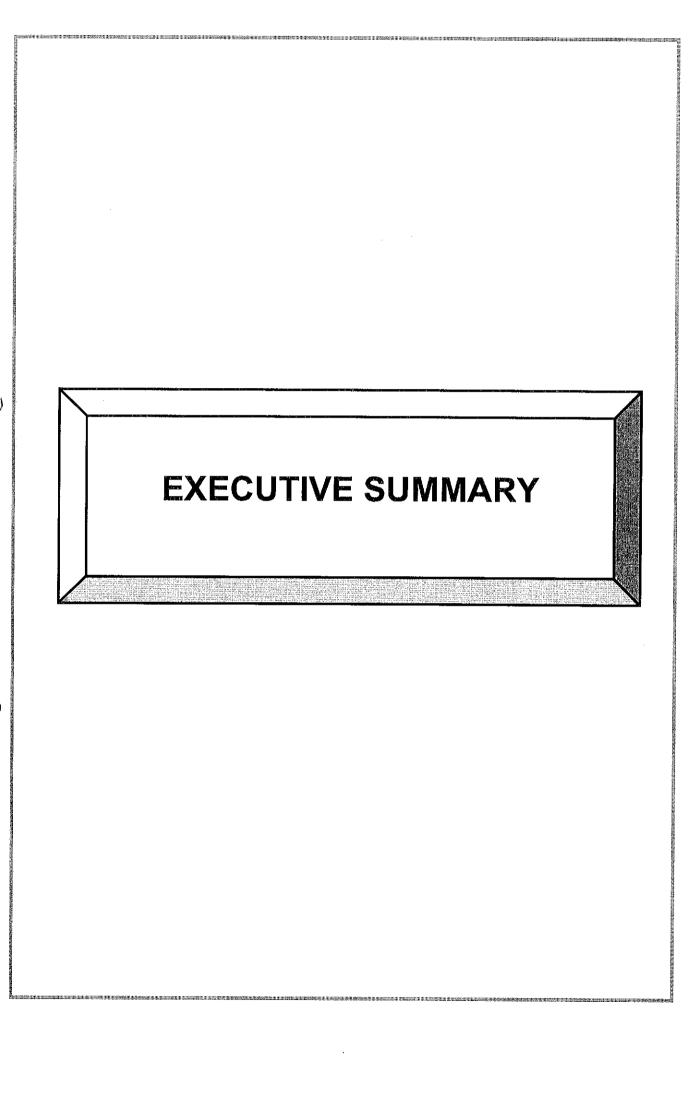
TDS Total Dissolved Solids

USD United States Dollar

WHO World Health Organization

WTE Waste to Energy

wwrp Waste water Treatment Plant





Executive Summary

i. Proposed Project

The proposed project is the construction of Waste to Energy Facility at Lakhodair Landfill site, Lahore. The daily capacity of the project is to incinerate and dispose off 2000 tons of municipal solid waste. Three sets of 670 t/d moving grate furnaces and two sets of condensing steam turbine generator sets with the rated capacity of 20 MW shall be installed to achieve the annual domestic waste treatment capacity of 667,000 t.

ii. Punjab Power Development Board (PPDB) Government of Punjab

The Punjab Power Development Board (PPDB) has been established by the Punjab Government to facilitate development of power generation projects based on renewable and non-renewable sources through private sector investments.

Currently, Pakistan has been facing substantial shortages in the power sector and the province of Punjab is no exception. In Punjab, at present, there is a demand-supply gap of about 4000 MW which is increasing at a rate of 6% per annum.

In the light of existing energy needs Government of Punjab is vigorously exploring all-the possible options to meet the growing energy challenges. One feasible option identified by Government of the Punjab is to produce energy from the municipal solid waste. In this context, PPDB has hired three Chinese companies: China ENFI Engineering Corporation, MCC Tongsin Resources Co., Ltd and Chengdu Xingrong Environment Co., Ltd.

These three companies have established a new SPV Company named Lahore Xingzhong Renewable Energy Company (Private) Limited, jointly to undertake the proposed project of Punjab Government i-e 2000 t/d Waste to Energy Project Lahore. The SPV Company shall be responsible for investment, construction, operation and transfer of WtE Project.

iii. Project Company Details

The section below provides a brief introduction of the Project Company.

- China ENFI Engineering Corporation
- Chengdu Xingrong Environment Co., Ltd
- MCC Tongsin Resources Co. Ltd





Lahore Xingzhong Renewable Energy Company (Private) Limited

• China ENFI Engineering Corporation

China ENFI Engineering Corporation was formerly known as China Nonferrous Engineering and Research Institute and changed its name to China ENFI Engineering Corp. in 2006. The company was founded in 1953 and is based in Beijing, China. China ENFI Engineering Corp. operates as a subsidiary of China Metallurgical Group Corporation.

China ENFI Engineering Corp. engages in the project integration, energy industry, and resource development businesses. The company specializes in metallurgical and mining engineering, environmental protection, chemical engineering, ropeway engineering, architecture and construction, and rare metals and light metals engineering design services. Its project integration business provides various services, such as Engineering, Procurement and Construction (EPC), engineering consulting, engineering design, scientific research, engineering supervision, equipment development and supply, and information and automatic-control system, as well as integration services for construction in the fields of mine engineering, nonferrous metallurgical engineering, municipal engineering, air quality control engineering, civil architectural engineering, etc. The company's energy industry business includes photovoltaic material and photovoltaic power generation based on poly silicon production; and power generation by waste incineration based on projects of municipal domestic waste treatment. It also provides water and mineral resource development services.

Chengdu Xingrong Environment Co., Ltd

Chengdu Xingrong Environment Co., Ltd., formerly Chengdu Xingrong Investment Co., Ltd., is a China-based company principally engaged in the supplying and distribution of tap water. The business scope of the company includes water supply and drainage as well as environmental protection. Company has also made great achievements in the fields of sewage and sludge treatment, waste leachate treatment, waste incineration power generation and reclaimed water use etc.

MCC Tongsin Resources Co., Ltd.

MCC Tongsin Resources Co., Ltd. is a Level I subsidiary company of China Metallurgical Group Corporation as a large mixed type company integrating; development, investment, construction, production, operation and management of





mineral resources like copper and gold as well as lead and zinc as the main development objects. Its main business is the overseas mineral resources, and it has three subsidiaries with the main business of non-ferrous metal resources development and one subsidiary with the main business of import and export of goods.

Lahore Xingzhong Renewable Energy Company (Private) Limited

Lahore Xingzhong Renewable Energy Company (Private) Limited (hereinafter referred as "Xingzhong") was registered on 1st February 2017 as a SPV Company. The SPV Company shall be responsible for investment, construction, operation and transfer of WtE Project. The company was jointly established by China ENFI Engineering Corporation (hereinafter referred as China ENFI), MCC Tongsin Resources Co., Ltd (hereinafter referred as MCCT) and Chengdu Xingrong Environment Co., Ltd (hereinafter referred as Xingrong Environment) as per the three Side Cooperation Framework Agreement of Lahore Waste to Energy Project signed on 30th May 2016 in Pakistan.

iv. Lahore Waste Management Company (LWMC) - The Waste Contractor Lahore Waste Management Company (LWMC) has been entrusted by the City

District Government Lahore (CDGL) to perform Solid Waste Management (SWM)functions in Lahore. Company is mandated for recycling and re-use of waste with
private sector partnership.

LWMC has outsourced SWM to two Turkish Waste Management companies i-e M/S Albayrak and M/S Ozpak. Both companies are responsible for waste collection, Transportation, Mechanical Sweeping and Washing in their respective zones.

For this project, LWMC shall transport 6000 t/day urban domestic waste in service area among which 2000t/d is for waste to energy project, 1000 t/d for waste recovery and utilization, 500t/d for compost and rest 2500t/d is for landfill.

v. Environmental Consultancies and Options- The Consultant

The ECO is a professionally run environmental management & engineering firm with strong backup of highly qualified and experienced personnel. The company is specialized in diversified fields and continuously identifies the current and future demands related to environment and engineering. ECO services include: environmental assessments, audits, risk assessments, environmental monitoring, trainings, water, wastewater treatment and alternate energy. The ECO is serving market niche with a broad range of high technology products and services to a wide





spectrum of industries in Pakistan. ECO is a member of groups of companies. The other members are:

- ☐ Global Waste Management (GWM)
- ☐ Global Eco Laboratories (GEL) [ISO 9001:2000 Certified: ISO 17025:2005]
- ☐ Global Technologies (GT)

vi. Environmental Settings

Lahore is the second largest city of Pakistan covering a total administrative region area of 1,770km² with the population of over 9,000,000. It is located on the east bank of the smallest Indus River tributary, Ravi River in Punjab Province with India on the east and Kasur on the south. It has s flat territory with height above sea level of 200m, temperature of -2°C~45°C, rainy season from July ~ September and annual rainfall of 629mm.

Lahore is the culture and art center of Pakistan with over 2,000 years of history. It once was the capital of Mughal Empire known as "Garden City". After the independence of Pakistan in 1947, Lahore became the richest capital of Punjab Province with economy in rapid development.

The topography of the project area is an irregular trapezoid strip with relatively flat territory. The average altitude of Lakhoder Landfill is 208m and the slope is 0.05~0.5%. The district Lahore is divided into two parts. The low lying alluvial soil is along the Ravi River, and the upland in the east. Upland is a plain slope from northeast to south-west. The lowlands are generally inundated during the monsoon season by Ravi River, flowing in the west of district along its boundary with district Sheikhupura. Project area is dominated by silt, sine sand and gravel, with small terrain fluctuation. The groundwater level is high.

The proposed project site is located at moderate earthquake zone with the value range of 4~4.9 in WHO damage category. The region is not in the active earthquake zone.

Seasonal climatic conditions must be considered for the design and execution of Project. The climate including air, temperature, precipitation, cloud & humidity and wind speed is an influencing factor, affecting the construction of plant. However, to determine the overall effect of the climatic stresses, daily and seasonal temperature changes and precipitation must be considered. The Project Area has extreme climate: it has hot summer and cold winters. The summer starts from May and lasts





till September. May, June, and July are the hottest months. The mean maximum and minimum temperature ranges from 47 °C and 25 °C respectively for these months.

The winter seasons lasts from November to February. December and January are the coldest months. The mean maximum and mean minimum temperature ranges from 24°C to 9°C in January. Temperatures in the Project Area vary from 47 °C to 9°C. The project area receives rains in all the seasons but monsoon rain is pronounced and constitutes a definite rainy season between the month of July and September. The average rainfall is about 629 millimeters per year.

vii. Impact Assessment and Mitigation

During the present IEE, the project's potential social and environmental impacts were identified. Each identified impact was then characterized with respect to its nature, reversibility, geo-extent, consequence-severity and likelihood. Based upon this characterization, the impacts were then assessed to be of high, medium or low significance.

IEE study revealed that most of the impacts of the proposed project were confined to the construction phase and temporary in nature. Appropriate control and housekeeping measures recommended in the IEE, would address these issues adequately. The environmental monitoring would ensure compliance to and effectiveness of these control measures.

The project activities may result in localized and temporary disturbances due to construction activities at the project site. There is no land acquisition involved in the proposed project, therefore no demolition of buildings and/or resettlement of residents will be carried out. The principle environmental impacts will be the noise, dust, odor and traffic delays that construction phase of development projects always entails.

To minimize these impacts, mitigation measures will be imposed on the Contractor. Working hours will be limited to reduce noise, dust, and odor and traffic delays on rest days and public holidays. Strict limits will be placed on the noise generated by construction equipment and on exhaust emissions from vehicles and stand-by generators.

The Contractor shall abide by all relevant laws, regulations and standards. Prior to commencing work, the Contractor will prepare a Traffic Management Plan which will give details of how traffic delays, the occasional need for temporary road closure and the use of diversionary routes will be managed. Vehicular access to service such as





medical centers, police and fire stations shall be maintained at all times. The public will receive prior notification of temporary disruptions.

Necessary health and safety rules shall be enforced by the management to minimize occupational hazards and to ensure that all staff members adhere to these standards. Biological resources include flora and fauna. No endangered species are reported to exist within the study area. All the necessary precautions will be taken to ensure the minimum disturbance to the local flora and fauna.

No displacement of population is envisaged. Employment opportunities generated by the project include construction labor at the site in the initial stages of setting up of the proposed facility, skilled and unskilled labor.

viii. Environmental Management Plan

In order to provide an implementation mechanism for the mitigation measures discussed above, a comprehensive environmental management plan (EMP) has been developed. The EMP provides the organization structure for the environmental management system during the project, and defines the roles and responsibilities of various players. The EMP includes a mitigation plan, a monitoring plan, the communication and documentation requirements and training needs, in the context of the environmental and social management of the project. The EMP also includes a grievance redressal mechanism.

ix. Proposed Monitoring

Environmental monitoring is one of the keys for effective management of environmental quality. Monitoring support is essential in almost all stages of pollution control and abatement programs. The decisions based upon monitoring results are far reaching, and require an accurate, reliable and comprehensive database.

Following environmental parameters were monitored for the proposed project:

- Drinking Water (Chemical and Physical Analysis)
- Surface Water (Chemical and Physical Analysis)
- Waste Water (Chemical and Physical Analysis)
- Soil Quality Analysis
- Ambient Air Quality and Noise Levels

The mitigation measures to be adopted to minimize potentially negative impacts, their success can only be determined by a program to:

→ Monitor any changes in the biophysical and social characteristics of the environment:





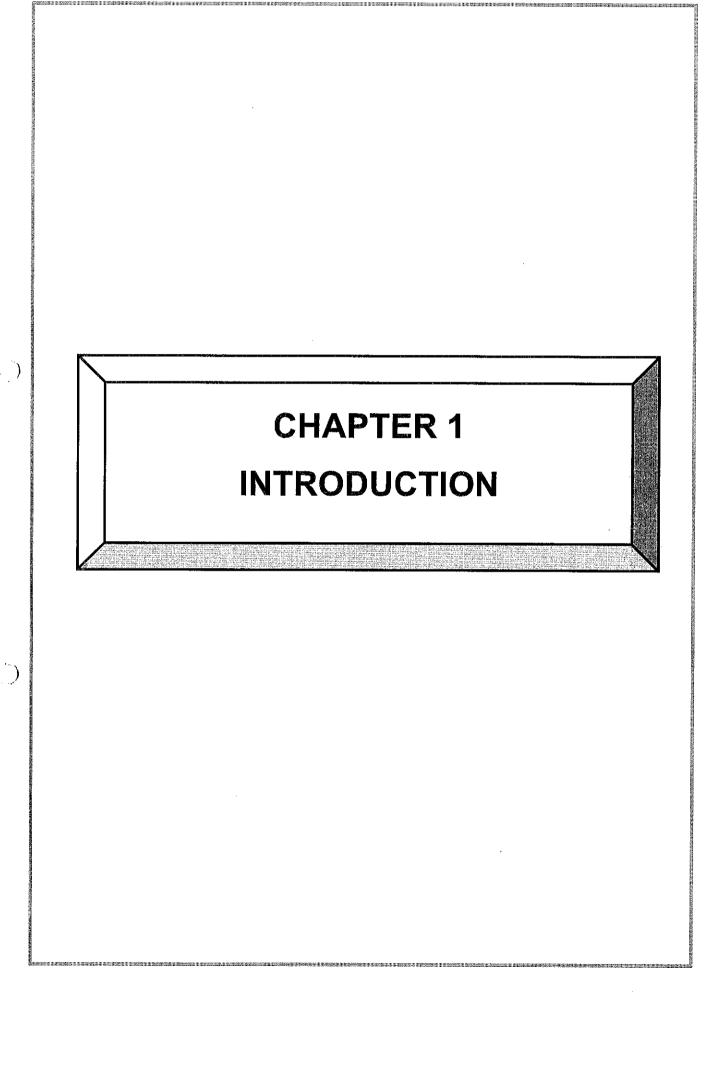
- Determine if these changes result from project or non-project causes;
- Identify and determine the impact of non-compliance with the EMP by the Contractor with particular regard to emissions and discharges that contravene adopted standards;
- Assess the effectiveness of impact mitigation; and
- Highlight any concerns unforeseen in the EMP and recommend additional mitigation.

In conjunction with the Contractor, the Construction Manager will monitor air quality, noise level, monthly consumption of materials including aggregates, hazardous materials, fuel, water and electricity, the disposal of surplus earth materials and other solid and liquid wastes. The monitoring of Health and Safety shall, include but not be limited to H&S signage, the availability and use of protective headgear, footwear and other clothing, the occurrence of accidents and the potential for accidents in relation to general site condition.

x. Conclusion

After assessing the significance of potential impacts, the environmental consultants, ECO have concluded that:

"All environmental and social issues involved during the project activities are manageable, therefore it is concluded that the project is environmentally friendly, financially viable, economically sustainable, generally neutral and pro-poverty elevation"







CHAPTER1 INTRODUCTION

1.1 Purpose of the Report

With a view to evaluate likely impacts/ risks associated with the proposed project on various components of the environment and to achieve certain environmental objectives besides the existing local legal requirements, the Lahore Xingzhong Renewable Energy Company (Private) Limited has hired Environmental Consultancies and Options (ECO) to carry out Initial Environmental Examination (IEE) study of the proposed 2000 t/d Waste to Energy Project of Lahore.

Therefore, ECO has carried out detailed impact assessment study covering all the features of the environment i-e physical, ecological and socioeconomic. The outcome of the study is this IEE report which will be submitted to Punjab EPA in order to obtain Environmental Approval/NOC for the construction phase of the project.

1.2 Punjab Power Development Board (PPDB) Government of Punjab

The Punjab Power Development-Board (PPDB) has been established by the Punjab Government to facilitate development of power generation projects based on renewable and non-renewable sources through private sector investments.

Currently, Pakistan has been facing substantial shortages in the power sector and the province of Punjab is no exception. In Punjab, at present, there is a demand-supply gap of about 4000 MW which is increasing at a rate of 6% per annum.

In the light of existing energy needs Government of Punjab is vigorously exploring all the possible options to meet the growing energy challenges. One feasible option identified by Government of the Punjab is to produce energy from the municipal solid waste. In this context, PPDB has hired three Chinese companies: China ENFI Engineering Corporation, MCC Tongsin Resources Co., Ltd and Chengdu Xingrong Environment Co., Ltd.

These three companies have established a new SPV Company named Lahore Xingzhong Renewable Energy Company (Private) Limited, jointly to undertake the proposed project of Punjab Government i-e 2000t/d Waste to Energy Project Lahore. The SPV Company shall be responsible for investment, construction, operation and transfer of WtE Project.



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1.3 Project Company Details

The section below provides a brief introduction of the Project Company.

- China ENFI Engineering Corporation
- · Chengdu Xingrong Environment Co., Ltd
- MCC Tongsin Resources Co. Ltd
- Lahore Xingzhong Renewable Energy Company (Private) Limited

• China ENFI Engineering Corporation

China ENFI Engineering Corporation was formerly known as China Nonferrous Engineering and Research Institute and changed its name to China ENFI Engineering Corp. in 2006. The company was founded in 1953 and is based in Beijing, China. China ENFI Engineering Corp. operates as a subsidiary of China Metallurgical Group Corporation.

China ENFI Engineering Corp. engages in the project integration, energy industry, and resource development businesses. The company specializes in metallurgical and mining engineering, environmental protection, chemical engineering, ropeway engineering, architecture and construction, and rare metals and light metals engineering design services. Its project integration business provides various services, such as Engineering, Procurement and Construction (EPC), engineering consulting, engineering design, scientific research, engineering supervision, equipment development and supply, and information and automatic-control system, as well as integration services for construction in the fields of mine engineering, nonferrous metallurgical engineering, municipal engineering, air quality control engineering, civil architectural engineering, etc. The company's energy industry business includes photovoltaic material and photovoltaic power generation based on poly silicon production; and power generation by waste incineration based on projects of municipal domestic waste treatment. It also provides water and mineral resource development services.

Chengdu Xingrong Environment Co., Ltd

Chengdu Xingrong Environment Co., Ltd., formerly Chengdu Xingrong Investment Co., Ltd., is a China-based company principally engaged in the supplying and distribution of tap water. The business scope of the company includes water supply and drainage as well as environmental protection. Company has also made great





achievements in the fields of sewage and sludge treatment, waste leachate treatment, waste incineration power generation and reclaimed water use etc.

MCC Tongsin Resources Co., Ltd

MCC Tongsin Resources Co., Ltd. is a Level I subsidiary company of China Metallurgical Group Corporation as a large mixed type company integrating; development, investment, construction, production, operation and management of mineral resources like copper and gold as well as lead and zinc as the main development objects. Its main business is the overseas mineral resources, and it has three subsidiaries with the main business of non-ferrous metal resources development and one subsidiary with the main business of import and export of goods.

Lahore Xingzhong Renewable Energy Company (Private) Limited

Lahore Xingzhong Renewable Energy Company (Pvt) Limited (hereinafter referred as "Xingzhong") was registered on 1st February 2017 as a SPV Company. The SPV Company shall be responsible for investment, construction, operation and transfer of WtE Project. The company was jointly established by China ENFI Engineering Corporation (hereinafter referred as China ENFI), MCC Tongsin Resources Co., Ltd (hereinafter referred as MCCT) and Chengdu Xingrong Environment Co., Ltd (hereinafter referred as Xingrong Environment) as per the three Side Cooperation Framework Agreement of Lahore Waste to Energy Project signed on 30th May 2016 in Pakistan.

1.4 Lahore Waste Management Company (LWMC) - The Waste Contractor

Lahore Waste Management Company (LWMC) has been entrusted by the City District Government Lahore (CDGL) to perform Solid Waste Management functions in Lahore. Company is mandated for recycling and re-use of waste with private sector partnership.

LWMC has outsourced SWM to two Turkish Waste Management companies i-e M/S Albayrak and M/S Ozpak. Both companies are responsible for waste collection, Transportation, Mechanical Sweeping and Washing in their respective zones.

For this project, LWMC shall transport 6000 t/day urban domestic waste in service area among which 2000t/d is for waste to energy project, 1000t/d for waste recovery and utilization, 500t/d for compost and rest 2500t/d is for landfill.

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Initial Environmental Examination (IEE) Waste to Energy Project Lahore



1.5 Environmental Consultancies and Options- The Consultant

The ECO is a professionally run environmental management & engineering firm with strong backup of highly qualified and experienced personnel. The company is specialized in diversified fields and continuously identifies the current and future demands related to environment and engineering. ECO services include: environmental assessments, audits, risk assessments, environmental monitoring, trainings, water, wastewater treatment and alternate energy. The ECO is serving market niche with a broad range of high technology products and services to a wide spectrum of industries in Pakistan. ECO is a member of groups of companies. The other members are:

- ☐ Global Waste Management (GWM)
- ☐ Global ECO Laboratories (GEL) [ISO 9001:2000 Certified: ISO 17025:2005]
- ☐ Global Technologies (GT)

1.6 Project Nature, Size and Location

The proposed project is the establishment of waste to energy facility at Lakhodair landfill site. The treatment capacity of the project shall be 2000 t/day waste. In order to achieve annual domestic waste treatment capacity of 667,000 tons, 3 sets of 670t/d moving grate furnaces (MGF) and 2 sets of condensing steam turbine generator sets with the rated capacity of 20MW shall be arranged. Figure 1.1 shows location map of the proposed project site. However, table 1.1 shows geographic coordinates of the site.

Table 1.1 Geographic Coordinates of Proposed Project Site

Sr No.	Proposed Sites	Latitude	Longitude
1	Lakhodair Landfill Site	31°37'35.10"N	74°25′7.77"E
2	WtE Plant Site	31°37'24.16"N	74°25'8.52"E
3	Office Area WtE Plant	31°37'28.39"N	74°25'15.79"E



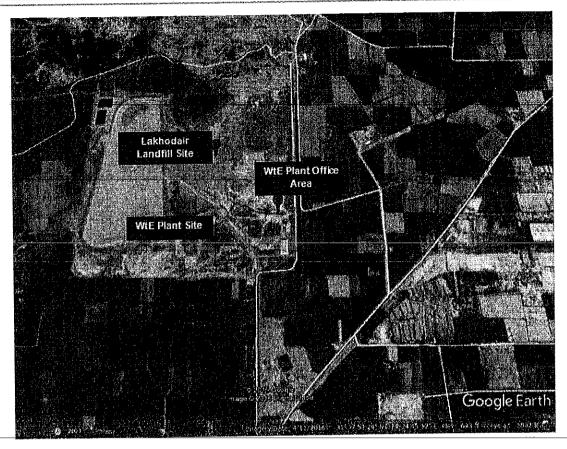


Figure 1.1 Location Map of Proposed Project Site

CHAPTER 2 SCOPE AND METHODOLOGY





CHAPTER 2 SCOPE AND METHODOLOGY

2.1 Initial Environmental Examination (IEE)

Initial Environmental Examination (IEE) is a systematic identification and evaluation of potential impacts of proposed projects, plans, programs or legislative actions relative to the physical, chemical, biological, cultural and socio economic components of the total environment.

2.2 Objectives of IEE

The objectives of the IEE are to:

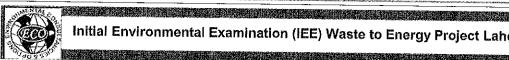
- * Assess and establish the existing environmental and socio economic conditions in the project area.
- * Assess the potential environmental or socio economic impacts of project activities and identify issues of concern.
- Implement and execute environmental safe guards.
- * Propose mitigation and monitoring measures that can be incorporated into the design of the project to remove or reduce any damaging effects as far as possible and to control and monitor residual impacts.
- Facilitate the environmental decision making.
- Facilitate an appropriate follow up process with requirements for monitoring, management, audit, and evaluation.
- Assess the proposed activities to ensure that they comply with the relevant environmental and social regulations and standards,
- Prepare an IEE report as per the relevant guidelines for submitting it to the concerned Environmental Protection Agency (EPA).

2.3 Approach & Methodology

Detailed methodology is described as follows:

2.3.1 Step - 1: Scoping / Data Collection

In this step, information relating to the physical, technical and environmental parameters was collected from the Client and other relevant agencies. Local inhabitants were interviewed in detail to understand the socio-economic status,





culture and customs of the area. An extensive literature review was also carried out in this step.

Following information was collected from the Technical departments:

- Details of project activities
- Legislative obligations
- Environmental data through physical survey (Monitoring of Effluent, Air Quality and Drinking Water Quality) was obtained.

2.3.2 Step - 2: Data Analysis

The data collected in step-1 was analyzed in the framework of Pakistan Environmental Protection Act, 1997, (Amended, 2012).

2.3.3 Step - 3: Initial Environmental Examination

The data collected in previous phases was used to investigate existing environmental conditions and assess the potential impacts of the proposed activities. Although the major emphasis remained on the compliance of the client's operations with the national legislation available, International guidelines were also reviewed and mitigations measures were developed to ensure environmentally safe practices.

2.3.4 Step - 4: Initial Environmental Examination (IEE) Report

The findings of the study were communicated to the client in the form of a Draft Initial Environmental Examination (IEE) Report. The report has been prepared in accordance with the relevant guidelines of the Pakistan Environmental Protection Agency. The discussion and comments of the client regarding the recommendations by the consultants were considered and appropriate modifications were incorporated in the Draft Report to be presented as a final report.

2.4 Salient Features of The Report

The Initial Environmental Examination (IEE) Report has been organized into eight (8) chapters. Chapter-1 describes the proponent, overview of the proposed project activities and location of the proposed project Chapter-2 is the definition of Initial Environmental Examination (IEE) and its study, objectives and methodology. Chapter-3 is an overview of national and international legislation and guidelines relevant to project activities and the Initial Environmental Examination (IEE) process. Chapter-4 describes the project activities in detail. The environmental settings of the project area including the physical and socio-economic conditions are discussed in Chapter-5. Chapter-6 describes the project impacts, mitigation and alternatives.





Chapter-7 describes the detailed Environmental Management Plan (EMP) and Chapter-8 pertains to the conclusion.

CHAPTER 3 STATUTORY REQUIREMENTS & STANDARDS





CHAPTER 3 STATUTORY REQUIREMENTS & STANDARDS

A number of laws exist in Pakistan, containing range of clauses concerning protection of the environment. However, the first legislation on environmental protection was issued in 1983. The Pakistan Environmental Protection Ordinance, 1983 was the first legislation promulgated for the protection of environment.

Pakistan Environment Protection Agency was established in 1984. No significant environmental policy, guidelines and regulations were carried out till early 1990's. The National Conservation Strategy was developed and approved by the federal cabinet in 1992. Provincial Environmental Protection Agencies were also established in 1992-1993. Punjab Environmental Quality Standards (PEQS) were established in 2016. Detailed environmental guidelines started in 1996. The National Assembly and the Senate conferred National Environmental Protection Act in 1997.

3.1 Policy Guidelines

The National Conservation Strategy (NCS) is the primary document addressing environmental issues of the country. NCS is duly recognized as the National Environmental Action Plan by various international donor agencies including the World Bank. The document identifies 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural environment.

- Biodiversity conservation.
- 2. Restoration of rangelands,
- 3. Pollution prevention and abatement
- 4. Preservation of cultural heritage.

The Pakistan Environmental Protection Act, 1997 is the key legislation empowering the government to frame regulations for the protection of the environment. Detailed rules, regulations and guidelines required to enforce the Environmental Protection Act are still in various stages of development.

Pakistan is a signatory to the Convention on Biological Diversity and is thereby obligated to develop a national strategy for the conservation of biodiversity. A Biodiversity Working group has been constituted under the Ministry of Environment, Local Government and Rural Development to develop a Biodiversity Action Plan for the country. The Biodiversity Action Plan has been developed after an extensive





consultative process and compliments the NCS and the proposed provincial conservation strategies. It identifies the causes of biodiversity loss in Pakistan and suggests a series of proposals for action to conserve in the country. The Pakistan Environmental Protection Council (PEPC) has approved the plan and while the provincial steering committees are in the process of being formed, a federal steering committee is already in place.

3.2 Environmental Institutions and Administration

The Constitution of Pakistan distributes the legislative powers between the federal and the provincial governments through "Federal and Concurrent Lists" attached to the Constitution as appendices. The Federal list depicts the areas and subjects on which the Federal government has exclusive powers. The second, concurrent list contains areas and subjects on which both Federal and Provincial governments can enact laws.

The Ministry of Climate Change is responsible for environmental issues at federal level. The NCS unit within the Ministry ensures implementation of the National Conservation Strategy.

The Pakistan Environmental Protection Agency (PEPA) at the federal level is responsible for administering the provisions of the Environmental Protection Act. It is responsible to ensure compliance with the Punjab Environmental Quality Standards (PEQS), develop monitoring and evaluation systems and initiate legislation when necessary.

The Provincial Environmental Protection Agencies (Environmental Protection Directorate in Punjab) are responsible for environmental planning and development, approval of Initial Environmental Examination (IEE) and Environmental Impact Assessments (EIA) of new projects at provincial level.

Wildlife conservation and management is also a provincial subject. Provincial Wildlife and forestry departments are responsible for implementation of provisions of provincial Wildlife Protection Ordinances, Acts and Regulations.

3.3 Laws, Regulations and Guidelines

Pakistan Environmental Protection Act, 1997 amended 2012 is the basic law that empowers the Government of Pakistan to develop policies and guidelines for the protection of natural environment. Details of the laws applicable are described below:





3.3.1 The Constitution (Eighteenth Amendment) Act 2010

It gives provincial governments exclusive powers to legislate on the subject of "environmental pollution and ecology". When the Pakistan Environmental Protection Act (PEPA) 1997 operated as a federal law, any contradictory provisions in other laws, whether federal or provincial, were nullified because PEPA 1997 had overriding effect. But this is no longer the case. Environmental Consultancies and Options (ECO) Statutory Requirement & Standards with environmental protection legislation operating at the provincial level, all federal laws now override it. Prior to the enactment of the Eighteenth Amendment, PEPA 1997 governed all operations and activities that have the potential to cause environmental damage. This included subjects such as nuclear power for which only the federal government may legislate. This too is no longer the case. The federal government retains exclusive authority over a number of subjects that should be regulated by environmental law but the ambit of that law will now no longer extend to them.

3.3.2 National Environmental Policy 2005

Government of Pakistan has notified National Environmental Policy 2005, for different projects/aspects in which guidelines/priorities have been given to undertake/commence the projects having significant environmental impacts. The National Environmental Policy (2005) provides a framework for addressing the environmental issues (particularly pollution of fresh water bodies and coastal waters, air pollution, lack of proper waste management, deforestation, loss of biodiversity, desertification etc.) confronting Pakistan. It recognizes the goals and objectives of the Pakistan National Conservation Strategy (PNCS, 1992), National Environmental Action Plans, and other existing environment related national policies, strategies, and action plans. It also provides broad guidelines to the Federal Government, Provincial Governments, federally administrated territories and local governments to address their environmental concerns and to ensure effective management of their environmental resources.

3.3.3 Pakistan Environmental Protection Ordinance (PEPO) 1983

In 1983, the Government of Pakistan issued an Environmental Protection Ordinance (EPO). It was the first legislation promulgated for the protection of environment. According to PEPO, 1983, it was necessary to carry out IEE / EIA for all development projects, but there were no IEE / EIA regulations under that ordinance.



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3.3.4 Pakistan Environmental Protection Act, 1997 amended 2012

The Act is applicable to a broad range of issues and extends to air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. Some portions from the Act are reproduced below for reference purposes.

- * Section-11 (1): "Subject to the provisions of this Act and the rules and regulations made there under no person shall discharge or emit or allow the discharge or emission of any effluent or waste or air pollution or noise in an amount, concentration or level which is in excess of the National Environmental Quality Standards."
- * Section-12 (1): "No proponent of a project shall commence construction or operation unless he has filed with the Federal Agency an Initial Environmental Examination (IEE) or, where the project is likely to cause an adverse environmental effect, an Environmental Impact Assessment (EIA), and has obtained from the Federal Agency approval in respect thereof".
- * Section-14: "Subject to the provisions of this Act, no person shall generate, collect, consign, transport, treat, dispose of, store, handle or import any hazardous substance except (a) under a license issued by the Federal Agency and in such manner as may be prescribed; or (b) in accordance with the provisions of any other law for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Pakistan is a party"

3.3.5 Pakistan Environmental Protection Agency Review of IEE and EIA Regulation, 2000

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulations provide the necessary details on preparation, submission and review of the IEE and EIA.

Categorization of projects for IEE and EIA is one of the main components of the Regulations. Projects have been classified on the basis of expected degree of adverse environmental impacts. Project types listed in Schedule-II are designated as potentially less adverse effects. Schedule-I projects require an IEE to be conducted, rather than a full-fledged EIA, provided they are not located in environmentally sensitive areas.

Salient features of the regulations relevant to the proposed project are listed below:





- * Categories of projects requiring IEE and EIA are issued through two schedules attached with the Regulations. Oil and gas extraction projects including exploration, production, gathering systems, separation, and storage are included in an IEE category.
- * The IEE/ EIA must be prepared, to the extent practicable, in accordance with the Pak-EPA environmental Guidelines discussed in the sections to follow.
- * A fee, depending on the cost of the project has been imposed for review of the IEE and EIA.
- * The submittal is to be accompanied by an application in prescribed format included as Schedule-IV of the Regulations.
- * The EPA is bound to conduct a scrutiny and reply within 10-days of submittal of report (a) confirming completeness (b) asking for additional information, or (c) requiring additional studies.
- * The EPA is required to make every effort to complete the review process for the IEE within 45-days, and of the EIA within 90-days, of issue of confirmation of completeness.
- * When EPA accords their approval subject to certain conditions, the following procedure will be followed:
 - Before commencing construction of the project, the proponent is required to submit an undertaking accepting the conditions.
 - Before commencing operation of the project, the proponent is required to obtain from the EPA a written confirmation of compliance with the approval conditions and requirements of the IEE/ EIA.
- * There is a requirement for an EMP to be submitted with the request for obtaining confirmation of compliance.
- * The EPA is required to issue confirmation of compliance within 15-days of receipt of request and complete documentation.
- * The IEE/ EIA approval will be valid for three years from date of accord.
- * The regulations of monitoring report are required to be submitted to the EPA after the completion of construction followed by annual monitoring reports during operations.

3.3.5 Punjab Environmental Quality Standards (PEQS)

EPA sustains qualitative and quantitative standards for the discharge of effluents, wastes, air emissions or noise either for general applicability or for a particular area





or from a particular source in the form of Punjab Environmental Quality Standards (PEQS). Pakistan Environmental Protection Act 1997 establishes the following discharge concentration standards:

- * Maximum allowable concentration of the Pollutants, (32 parameters) in emission and liquid industrial effluents discharged to inland waters, sewerage treatment and the sea
- * Maximum allowable concentration of pollutants (16 parameters) in gaseous emission
- * Maximum allowable exhaust emissions and noise emission from vehicles.
- * Maximum allowable noise level from vehicles
- * Maximum allowable limits for Drinking Water
- * Maximum allowable limits for Ambient Air Quality
- * The Punjab Environmental Quality Standards (PEQS) are given in Exhibit 3.1 to Exhibit 3.6.

Exhibit- 3.1: Effluent Discharge Standards (PEQS 2016)

Sr. No.	Determinant	Into Inland Waters	Into Sewage Treatment
1	Temperature	≤3 °C	≤3 ⁰ C
2	рН	6 – 9	6-9
3	BOD5	80 mg/l	250
4	Chemical Oxygen Demand (COD)	150 mg/l	400
5	Total Suspended Solid (TSS)	200 mg/l	400
6	Total Dissolved Solids	3500 mg/l	3500 mg/l
7	Grease and Oil	10 mg/l	10 mg/l
8	Phenolic compounds (as phenol)	0.1 mg/l	0.3 mg/l
9	Ammonia	40 mg/l	40 mg/l
10	Chlorine	1.0 mg/l	1.0 mg/l
11	Chloride	1000.0 mg/l	1000.0 mg/l
12	Sulphate	600 mg/l	1000 mg/l
13	Manganese	1.5 mg/l	1.5 mg/l
14	Fluoride	10 mg/l	10 mg/l

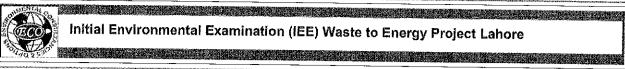




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15	Cyanide (as CN') total	1.0 mg/l	1.0 mg/l
16	An-ionic detergents (as MB As)	20 mg/l	20 mg/l
17	Sulphide (S-2)	1.0 mg/l	1.0 mg/l
18	Pesficides	0.15 mg/l	0.15 mg/l
19	Cadmium	0.1 mg/l	0.1 mg/l
20	Chromium trivalent and hexavalent	1.0 mg/l	1.0 mg/l
21	Copper	1.0 mg/l	1.0 mg/l
22	Lead	0.5 mg/l	0.5 mg/l
23	Mercury	0.01 mg/l	0.01 mg/l
24	Selenium	0.5 mg/l	0.5 mg/l
25	Nickel	1.0 mg/l	1.0 mg/l
26	Silver	1.0 mg/l	1.0 mg/l
27	Total Toxic metals	2.0 mg/l	2.0 mg/l
28	Zinc	5.0 mg/l	5.0 mg/l
29	Arsenic	1.0 mg/l	1.0 mg/l
30	Barium	1.5 mg/l	1.5 mg/l
31	Iron	8.0 mg/l	8.0 mg/l
32	Boron	6.0 mg/l	6.0 mg/l

Exhibit – 3.2: Punjab Environmental Quality Standards (PEQS) for Gaseous Emission (mg/Nm³, Unless Otherwise Defined)

Sr. No.	Parameter	Source of Emission	Existing Standards
1.	Smoke	Smoke Opacity not to exceed	40% or 2 Ringlemann Scale
2.	Particulate Matter	(a) Boilers and Furnaces (i) Oil fired	300





	770		
	(I)	(ii) Coal fired	500
		(iii) Cement Kilns	300
		(b) Grinding, crushing, clinker coolers and Related processes, Metallurgical Processes, converter, blast furnaces and cupolas.	500
3.	Hydrogen Chloride	Any	400
4.	Chlorine	Any	150
5.	Hydrogen Fluoride	Any	150
6.	Hydrogen Sulphide	Any	10
	Sulphur Oxide	Sulfuric acid/ Sulphonic acid plants	5000
7.		Other plants except power plants operating on oil and coal	1700
8.	Carbon Monoxide	Any	800
9.	Lead	Any	50
10.	Mercury	Any	10
11.	Cadmium	Any	20
12.	Arsenic	Any	20
13.	Copper	Any	50
14.	Antimony	Any	20
15.	Zinc	Any	200





	age commenced in the date of t	Nitric acid manufacturing unit.	3000
16.	Oxides of Nitrogen	Other plants except power plants operating on oil or coal:	
	(3)	Gas fired	400
		Oil fired	600
		Coal fired	1200

Explanation

- 1. Based on the assumption that the size of the particulate is 10 micron or more.
- Based on 1 percent sulphur content in fuel. Higher content of Sulphur will case standards to be pro-rated.
- In respect of emissions of sulphur dioxide Nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to Punjab Environmental Quality Standards (PEQS) specified above, comply with the following standards.

Exhibit - 3.3: Punjab Environmental Quality Standards (PEQS) for Vehicular Emission

Sr. No.	Paramet er	Standard (Maximum permissible Limit)	Measuring Method	Applicabili ty
1	Smoke	40% or 2 on the Ringlemann Scale during engine acceleration mode.	To be compared with Ringlemann Chart at a distance of 6 meters or more	Immediate effect
2	Carbon Monoxid e (CO)	6%	Under idling condition: Non-dispersive infrared detection through gas analyzer.	
3	Noise	85 dB(A)	Sound Meter at 7.5 meters from the source	•





Exhibit - 3.4: Punjab Environmental Quality Standards (PEQS) for Noise

Sr. No.	Category of Area / Zone	Effectiv	e from 1 st July, 2010		tive from 1 st ıly, 2013	
		Limit in dB (A) Leq*				
		Daytim e	Night-time	Daytim e	Night-time	
1	Residential Area (A)	65	50	55	45	
2	Commercial Area (B)	70	60	65	55	
3	Industrial Area (C)	80	75	75	65	
4	Silence Zone (D)	55	45	50	45	

Note

- 1. Daytime hours: 6:00 a.m. to 10:00 p.m.
- 2. Night-time hours: 10:00 p.m. to 6:00 a.m.
- 3. Silence Zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters round hospitals, educational institutions and courts.
- 4. Mixed categories of areas may be decided as one of the four above mentioned categories by the competent authority.

*dB (A) Leq: Time weighted average of the level of sound in scale "A" which is relatable to human hearing.

Exhibit – 3.5: Punjab Environmental Quality Standards (PEQS) for Drinking Water

Sr. No.	Properties/Parameters	Standard Values for Pakistan	WHO Standards	Remarks
Bac	terial			<u> </u>
1	All water is intended for drinking (E.Coli or Thermotolerant	Must not be detectable in any 100ml	Must not be detectable in any 100ml	Most Asian Countries also follow WHO





***************************************	Coliform bacteria)	sample	sample	Standards
				Most Asian
2	Treated water entering the distribution system (E.Coli or Thermotolerant Coliform and total Coliform bacteria)	Must not be detectable in any 100ml sample	Must not be detectable in any 100ml sample	Countries also follow WHO Standards
3	Treated water entering the distribution system (E.Coli or Thermotolerant Coliform and total Coliform bacteria)	Must not be detectable in any 100ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period.	examined, must not be present in 95% of the samples taken	Standards
PI	nysical		145 701	
7	Colour	≤15 TCU	≤15 TCU	
E	Taste	Non Objectionable/ Acceptable	Non Objectionable/ Acceptable	
	6 Odour	Non Objectionable/ Acceptable	Non Objectionable/ Acceptable	
-	7 Turbidity	<5 NTU	<5 NTU	
	8 Total hardness a CaCO ₃	s <500mg/l		
	9 TDS	<1000	<1000	





10	рН	6.5-8.5	6.5-8.5	
Rad	ioactive			
11	Alpha Emitters bq/L or pCi	0.1	0.1	
12	Beta Emitters	01	01	
Che	mical			
Esse	ential Inorganics	mg/litre	mg/litre	
13	Aluminum (AI) mg/l	≤0.2	0.02	
14	Antimony (Sb)	≤0.005	0.02	
15	Arsenic (As)	≤0.05	0.01	Standard for Pakistan similar to most Asian developing Countries
16	Barium (Ba)	0.7	0.7	n. a.
17	Boron (B)	0.3	0.3	
18	Cadmium (Cd)	0.01	0.003	Standard for Pakistan similar to most Asian developing Countries
19	Chloride (CI)	<250	250	
20	Chromium (Cr)	≤0.05	0.05	
21	Copper (Cu)	2	2	
Toxi	ic Inorganics	mg/litre	mg/litre	
22	Cyanide (CN)	≤0.05	0.07	Standard for Pakistan similar to most Asian developing Countries
23	Fluoride (F)	≤1.5	1.5	





	24	Lead (Pb)	≤0.05	0.01	Standard for Pakistan similar to most Asian developing Countries
-	25	Manganese (Mn)	≤0.5	0.5	pan pag
	26	Mercury (Hg)	≤0.001	0.001	
	27	Nickel (Ni)	≤0.02	0.02	
	28	Nitrate (NO ₃)	≤50	50	
	29	Nitrite (NO ₂)	<u>≤</u> 3	3	
	30	Selenium (Se)	0.01	0.01	
	31	Residual Chlorine	0.2-0.5 at consumer end 0.5-1.5 at source		
3	32	Zinc (Zn)	5.0	3	Standard for Pakistan similar to most Asian developing Countries
-	Orga	janics			Oddinios
	33	Pesticides mg/L		PSQCA No. 4629-2004, Page No.4, Table No. 3, Serial No. 20-58 may be consulted	Annex-II
	34	Phenolic Compounds (as Phenols) mg/L		≤0.002	
	35	Poly nuclear aromatic hydrocarbons (as PAH) g/L SQCA: Pakistan Standard		0.01 (By GC/MS method)	





Exhibit – 3.6: Punjab Environmental Quality Standards (PEQS) for Ambient Air

Pollutants	Time-weighted	Concentration	Method of Measurement	
	average	in Ambient Air		
Sulphur Dioxide	Annual Average*	80µg/m ³	Ultraviolet Fluorescence Method	
(SO ₂)	24 hours**	120µg/m³		
Oxides of Nitrogen	Annual Average*	40µg/m ³	Gas Phase	
as (NO)	24 hours**	40μg/m ³	Chemiluminescence	
Oxides of Nitrogen	Annual Average*	40μg/m ³	Gas Phase Chemiluminescence	
as (NO ₂)	24 hours**	80μg/m ³		
Ozone (O ₃)	1 hour	130µg/m ³	Non disperse UV absorption method	
Suspended	Annual Average*	360μg/m ³	High Volume Sampling,	
Particulate Matter (SPM)	24 hours**	550μg/m ³	(Average flow rate not less than 1.1m³/minute)	
Respire	Annual Average*	120µg/m³	ß-Ray Absorption Method	
able Particulate Matter (PM ₁₀)	24 hours**	150μg/m ³		
Respire	Annual Average*	15μg/m ³	ß-Ray Absorption Method	
able Particulate	24 hours**	35μg/m ³		
Matter (PM _{2.5})	1 hour	15µg/m3		





Lead (Pb)	Annual Average*	15µg/m³	AAS Method after sampling using EPM 2000
	24 hours**	1µg/m³	or equivalent Filter paper
Carbon Monoxide	8 hours**	5µg/m³	Non Dispersive Infrared (NDIR) method
(CO)	1 hour	10μg/m ³	

3.3.7 The Punjab Local Government Ordinance, 2001

Schedules 4 and 8 of this Ordinance pertain to environmental pollution. There are not withstanding any specific provisions; every local government may perform functions conferred by or under the Punjab Local Government Ordinance, 2001, and in performance of such functions may exercise such powers as may be necessary and appropriate. Under the ordinance, the local councils are authorized to restrict projects causing pollution to air, water or land. They may also initiate schemes for improving the environment.

3.3.8 Pakistan Penal Code (Act XLV), 1860

This defines the penalties for violations concerning pollution of air, water bodies and land. Sections 272 and 273 of this Act deal with the adulteration of food or drink. Noise pollution has been covered in section 268, which defines and recognizes noise as a public nuisance. "A person is guilty of a public nuisance who does any act or is guilty of an illegal omission which causes any common injury, danger of annoyance to the public or the people in general who dwell or occupy property in the vicinity, or which must necessarily cause injury, obstruction, danger or annoyance to persons who may have occasion to use any public right".

^{*}Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform intervals.

^{**24} hourly/8 hourly values should be met 98% in a year. 2% of the time, it may exceed but not on two consecutive days.





3.3.8 The Land Acquisition Act, 1894

The Land Acquisition Act (1894) deals with the acquisition of private properties for public purposes. There are 55 sections in this Act mainly dealing with area notification, surveys, acquisition, compensation, apportionment awards, disputes resolution, penalties and exemptions. Although quite old, this act laid out the legal basis for any property affected by a project and for compensating the effected owners of the land.

3.3.9 Labor Laws

Construction and operational activities during the course of the project may affect occupational health and safety of workers. Employers are required to abide by labor laws in respect of their own employees and also to ensure that contractors follow the relevant labor laws and rules relating to safety of the workforce and creating a healthy working environment, and provide their employees at all scales and levels with their due rights. The proponents shall ensure that the labor force engaged at the project site is not exposed to any danger by monitoring the contractor's work frequently.

3.3.10 Safety Regulations

Following laws and regulations directly or indirectly govern the occupational health and safety issues during the currently studied production activities:

- Factories Act, 1934
- PEPA Laws, 2000
- Labor Laws
- Electricity Rules, 1937
- Nuclear Safety & Radiation Act, 1990

3.3.11 Other Regulations

- * The Forest Act, 1927
- * Rules for Prohibition and Regulation of Fishing Burboster, *Labeo Rohita*, *Catlcatla*, *Cirrhina*, and *Mirgala* less than 10 inches in length (No. 2989/54-6541-D (f), 1954.
- West Pakistan Land Reform Rules, 1959
- West Pakistan Land Reforms Regulation, 1959, MLR No. 64.
- West Pakistan Wildlife Protection Ordinance, 1959





- Wildlife Protection Rules, 1960
- The Land Acquisition Act, 1984
- Wild Birds and Animals Protection Act, 1992

3.4 Environmental Guidelines of the Pakistan EPA

Sets of environmental guidelines to facilitate environmental assessment studies have been developed under the statutory cover of the Pakistan Environmental Protection Act, 1997. The following guidelines have been developed through a consultative process:

- Guidelines for the preparation and review of environmental reports
- * Guidelines for Public Consultations
- * Guidelines for sensitive and critical areas
- * Sectoral Guidelines

3.5 Environmental Guidelines of UNEP and the World Bank

- Some of the environmental guidelines of UNEP and the World Bank are as follows:
- * Environmental Impact Assessment Training Resource Manual, Draft 1996,
 UNEP
- * Pollution Prevention and Abatement Handbook 1998: Towards Cleaner Production (WB/UNIDO/UNEP, 1999)
- Environmental Assessment Sourcebook, Volume-I: Policies, Procedures and Cross-Sectoral Issues (WB, 1991a)
- * Environmental Assessment of Energy and Industry Projects (WB, 1991a)
 Exhibit 3.7 and 3.8 depicts the maximum discharge limits of pollutants proposed by the World Bank for liquid effluents and gaseous emissions.
 Ambient air quality standards are provided as Exhibit 3.9.

3.6 International Treaties and Obligations

Pakistan is a signatory to various international treaties and conventions on the conservation of the environment and wildlife protection. Some of these treaties and conventions are as follows:

- * UN Convention on Biological Diversity, Rio-de-Janeiro (1992)
- Convention of the Conservation of Migratory Species of Wildlife Animals (1979)



International Plant Protection Convention (1952)

3.7 Environmental Assessment Process

The environmental assessment process is governed by the following documents:

- * The Pakistan Environmental Protection Act, 1997
- * Pakistan Environmental Protection Agency Review of IEE and EIA Regulations, 2000.

* Pakistan Environmental Protection Agency Guidelines for the preparation and review of environmental reports.

Submission of environmental assessment study report to obtain No-Objection-Certificate (NOC) was made mandatory by the Pakistan Environmental Protection ordinance (1983) and the Pakistan Environmental Protection Act (1997). Section 12(1) of the Pakistan Environmental Protection Act (1997) stipulates that no project involving construction or any change in the physical environment can be undertaken unless an IEE or an EIA is conducted, and approval (NOC) is received from the relevant provincial Environmental Protection Agency.

The Pakistan Environmental Protection Agency Review of IEE and EIA Regulation (2000) categorizes projects into various schedules based on the anticipated environmental hazards. Projects with fewer environmental hazards are listed in Schedule-I and are required to carry out an Initial Environmental Examination (IEE). Projects with significant environmental hazards are grouped as Schedule-II. Projects listed in Schedule-II require that a detailed Environmental Impact Assessment (EIA) is carried out. Projects listed under Schedule-I will require a detailed EIA if the project is to be located in a sensitive area.

Exhibit - 3.7: World Bank Liquid Effluent Discharge Limits

Parameter	Oil and Gas Production (Onshore)	Other Industry
PH	6-9	6-9
BOD5	50 mg/l	30 mg/l
COD	-	150 mg/l
Total Suspended Solids	50 mg/l	30 mg/l





Oil and Grease	20 mg/l	10 mg/l
Chromium (Hexavalent)	-	0.1 mg/l
Chromium (total)	-	0.5 mg/l
Lead	-	0.1 mg/l
Phenol	1 mg/l	0,5 mg/l
Benzene	-	0.05 mg/l
Benzo(a)pyrene		0.05 mg/l
Sulfide	1 mg/l	1 mg/l
Nitrogen (total)	-	10 mg/l
Cyanide (total)	0.2 mg/l	-
Total Toxic Metals	5 mg/l	-
Temperature Increase	<3°C	<3°C

Exhibit - 3.8: World Bank Emissions Discharge Limits

Parameter	Oil and Gas Production (Onshore)	Other Industry
Volatile Organic Compounds (including benzene)	20 mg/Nm ³	-
Hydrogen Sulfide	30 mg/Nm ³	152 mg/Nm ³
Sulfur Oxides (for oil production)	1,000 mg/Nm ³	-
Sulfur Oxides (for sulfur recovery units)	-	150 mg/Nm ³
Sulfur Oxides (for combustion units)	-	500 mg/Nm ³





Nitrogen oxides (gas fired)	320 mg/Nm ³	-
Nitrogen oxides (oil fired)	460 mg/Nm ³	-
Nitrogen oxides (excluding catalytic units)	-	460 mg/Nm ³
Particulate matter	-	50 mg/Nm ³
Odor at the receptor end	Not offensive	
Nickel And vanadium (combined)	-	2 mg/Nm ³
Nickel And vanadium (combined)	-	2 mg/Nm ³

Exhibit - 3.9: Standards and Guidelines for Ambient Levels of Nitrogen Oxides, Sulfur Dioxide and Particulate Matter ($\mu g/Nm^3$, unless otherwise defined)

Pollutant	Agency	Annual	24-hr	1-hr
		Average	Average	Average
Nitrogen	EU (1985)	200	н	-
Oxides				
	USEPA (1992)	100	-	-
	WHO (1977)	-	-	190-230
	WHO for Europe (1987)	-	150	400
Sulfur Oxides	EU (1985)	80-120	250-350	-
	USEPA (1992)	80	365	-
	WHO (1977)	40-60	100-150	
	WHO for Europe (1987)	50	125	350
Particulates	EU (1985)	80 (BS)	250 (BS)	-
		150 (TSP)	300 (TSP)	

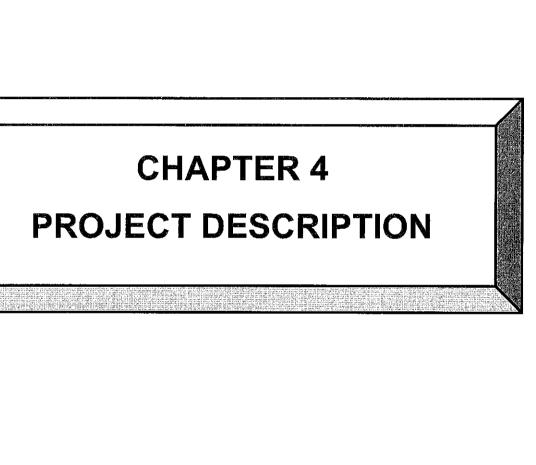




USEPA (1992)	50 (PM ₁₀)	150 (PM ₁₀)	
WHO (1977)	40-60 (BS)	100-150 (BS)	_
	60-90 (TSP)	150-230 (TSP)	
WHO for Europe (1987)	50 (BS)	70 (PM ₁₀) 125 (BS) 120 (TSP)	-

Legal Requirement

Pakistan Environment Protection Agency (Review of IEE & EIA) Regulation 2000, Schedule-I clearly states the list of projects requiring IEE. The proposed project of Waste to Energy Lahore Project falls under the Schedule-I (IEE) Category B-6.







CHAPTER 4 PROJECT DESCRIPTION

4.1 Type and Category of the Proposed Project

According to the Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulation 2000, the proposed waste to energy project of Lähöre Xingzhong Renewable Energy Company (Private) Limited falls in Schedule-I (IEE) under the Category B (6).

4.2 Project Need

The rapid increase in the human population and improvements in the living standards during recent years has resulted in an increased demand for land, energy and resources. It has also caused the increased quantities of waste to be generated, which has resulted in an increased amount of the pollutants to be disposed off in land, air and water bodies. This rapid urbanization has changed the overall environmental conditions of many ecosystems and has affected the natural habitats of most of the floral and faunal species.

Lahore is a capital city of the province of Punjab and second largest city of Pakistan. The population of Lahore is about 11 million and more than 6000 tons of waste is generated on daily basis. Currently, Lahore Waste Management Company (LWMC) is performing municipal solid waste management role in Lahore. At present only one sanitary landfill site has been established in Lahore named as Lakhodair Sanitary landfill; managing 2000-2500 tons of waste on daily basis.

There is an urgent need to manage the growing rate of municipal and domestic waste. Moreover, the residents of Lahore city are also facing persistent electricity load-shedding. Therefore, the proposed project of waste to energy has been planned with the purpose to manage basic needs of residents of Lahore city.

A waste-to-energy plant is a valuable local source of secure, stable and climate-friendly energy. It does not require extensive land; it basically involves the utilization of solid waste to recover energy that can be in the form of electricity, fuel or any other byproducts. The technology reduces the volume of the solid waste and hence conserves a huge chunk of landfill spaces. Also, it allows the recovery of many





useful products from waste material; which may otherwise be lost when directly dumped by landfill methods.

4.3 Project Objectives

Proposed project objectives can be summarized as:

- To solve domestic waste problems of Lahore
- To treat urban domestic waste in a reasonable and effective manner
- To improve urban environment and to turn Lahore into a green and sustainable city as well as one of the cleanest cities of Pakistan
- To fulfill the energy demands of residents of Lahore
- To reduce the Municipal Solid Waste (MSW) burden on landfill
- To create new employment opportunities

4.4 Salient Features of the Project

Salient features of the project are as follows

4.4.1 Project Location

The proposed project site is located approximately 15 km center of the city towards north.

4.4.2 Project Cost

The total cost of the project is USD \$ 219,813,117.

4.4.3 Duration

The construction period of this Project shall be 3 years and the duration of franchise right shall be 30 years.

4.4.4 Capacity of the Project

The daily capacity of the project is to incinerate and dispose off 2000 tons of municipal solid waste. Three sets of 670 t/d moving grate furnaces (MGF) and two sets of condensing steam turbine generator sets with the rated capacity of 20MW shall be arranged to achieve the annual domestic waste treatment capacity of 667,000t.

4.4.5 Project Area

The Lakhodair Landfill Site covers an area of 52.9 ha and it is located on the outer edge on the northeast of Lahore. However, the total area allocated to the proposed project is about 10.64 ha. The main road of landfill site divides the land into two





parts- east and west and the east part of 3.49 ha will be used to construct office building and living land. The west part of 7.24 ha will be used to construct WtE plant building.

4.4.6 Manpower

The total labor required during construction phase would be 80 persons. While in operational phase there would also be 80 persons including 10 plant management personnel and 70 production personnel.

4.4.7 Water

Underground water will be used for production and domestic purpose. The water consumption during construction phase would be 5 m³/d and in operational phase it would be as follows

Process Water: 1585 m³/d

Potable Water Consumption: 21 m³/d

4.4.8 Power

The estimated power consumption during construction phase will be 540 kWh. Moreover, the proposed plant will produce 40 MW and its breakup will be as follows:

- Auxiliary Consumption: 4 MW-6 MW
- National Grid 34 MW-36 MW

4.4.9 Site Alternatives

Initially two sites were considered for the construction of waste to energy facility in Lahore. Site I: Lakhodair Landfill Site. Site II: Tibba Landfill Site. Both sites were studied in detail. Table 4.1 shows comparison of both sites in terms of plant construction and existing natural environmental condition





Table 4.1 Comparison of Plant Construction and Natural Environment Conditions

	Proposed Plant Sites		
Name	Plant Site I	Plant Site II	
	Lakhodair Waste Landfill Site	Tibba Waste Landfill Site	
Geographic Location	Northeast of Lahore, Lakhodair	Southwest of Lahore, near Tibba	
Geographic Coordinates	Latitude: N31°37'25" Longitude: E74°25'14"	Latitude: 31°24′1″ Longitude: E74°20′31″	
Site Elevation	217~228m, inclining from east to west, with a flat landscape. Highest level of the nearby Ravi River 20-year flood is 211.7m,	The land is open and flat with the elevation of about 192m. The site elevation is lower than the highest level (211.7m) of the nearby Ravi River 20-year flood, which is not good for flood control safety of the plant.	
Land Acquisition		Land acquisition formalities are being undertaken by LWMC now. The land cost is little higher than plant site I.	
Water Supply Conditions	available, and underground	Urban water supply is not available, and underground water intake facility shall be built. The site is about 20 km away from the Ravi River.	





	Proposed Plant Sites		
Name	Plant Site I	Plant Site II	
	Lakhodair Waste Landfill Site	Tibba Waste Landfill Site	
ļ	volume of the River in the dry season is not guaranteed; in		
	such consequence underground water shall be taken into		
		Waste is mainly from Zone II, and OzPak company is responsible for the collection	
Service Radius	responsible for the waste	and transportation. Complete collection	
of Waste	collection and transportation.	and transportation system within 30 km of	
Collection		the maximum service radius has been set	
	transportation system within 30 km of the maximum service radius has been set up.	up.	
Grid Connection	One 132 kV power grid is near the plant and connection point is at the booster station of the plant.	ingly tomage perior give is them are promisely	
Communication	coverage area, and main communication cable of fixed line telephone is available.	line telephone is available.	
External Road	from the Ring Road of Lahore. External connecting roads have been built by landfill project.	Plant site is about 800 m off the main Rohi Nala Road, and about 500 m connecting road shall be built (it is planned to be built by the planned landfill project). The urban road is covered with asphalt and concrete	





	Proposed Plant Sites			
Name	Plant Site I	Plant Site II		
	Lakhodair Waste Landfill Site	Tibba Waste Landfill Site		
	asphalt and concrete with the width of 8~30 m. The condition of the road is good for driving.			
Sensitive Receptors				

4.4.9.1 Conclusion

On the basis of the above comparison, Plant site No.1 was selected as the site is limited by its topographic condition; it is satisfying the construction demands of the project; and it is economical, safe and reliable. Therefore, Plant site No.1 was recommended for this project.

4.4.10 Waste and Auxiliary Fuel Supply

4.4.10.1 Waste Supply

Domestic waste shall be collected by Lahore Waste Management Company (LMWC) and transported to the incineration plant after compressed by transfer station. The annual supply of domestic waste shall be 667,000 t (daily average supply is about 2,000t). The incoming waste shall be led to the unloading hall along the approach bridge after weighed through the weighing balance, after that, the waste shall be dumped into the waste bin. The empty truck with waste unloaded shall be driven out of the plant area after being weighed.





4.4.10.2 Auxiliary Fuel Supply

Light diesel oil shall be adopted for ignition and auxiliary combustion, which shall be delivered into the plant through commercial tanker. The total light diesel oil consumption shall be 300t/a. In the 1st year of operation, the light diesel oil consumption is relatively large due to equipment commissioning and test runs, however, after 1 year of stable operation, the annual oil consumption for ignition and auxiliary combustion shall decrease year by year based on the quality of waste in the service area.

4.5 Salient Features of Project Site

Salient features of the project site are as follows:

4.5.1 Land Features

The land is in irregular trapezoid strip with relatively flat territory. The land is filled by silt, sand and gravel with small terrain fluctuation. The ground surface is consists of wasteland and the open-air landfill land and 132kV HV wire and iron tower passes through the edge on the north side of the site.

4.5.2 Vegetation Features

The site allocated for the construction of office building is covered with wild grass. However, the site for the construction of WtE Plant is filled by silt, sand, and gravels. Hence, no major vegetation cover is present at the project site.

4.5.3 Water Body

The proposed project site is about 4.5 km away from the Ravi River.

4.5.4 Sensitive Receptors

The plant site is about 630 m away from the nearest residential building and about 1.1 km off the populated area. It is located at the edge of the city and there is no major sensitive source near the plant site.

4.5.5 Access Road

The proposed plant site is easily accessible from Lahore, Ring Road which is approximately 1Km away from the project site.



4.6 Project Components

The proposed project components are as follows:

a) Production Facility:

Production facility mainly includes: Waste Receiving, Storage, Feeding System and Auxiliary System, Incinerator and Boiler Building, Flue Gas Cleaning Building, Fly Ash Stabilization Building, Turbo Generator Building, Step-up Substation and Stack etc.

b) Auxiliary Production Facility

Auxiliary production facility includes: Water Pump House and Pond, Underground, Water Treatment Station, Oil Pump House and Fly Ash Curing Quarter etc.

c) Administrative/ Complex Building and Amenities

Administrative/ Complex Building and Amenities include: Administration Complex, Complex Building, Trestle, Weighbridge and Gate Control House, Fence, Gate House and Guard House, etc. General Layout of the plant is attached as Annex C.

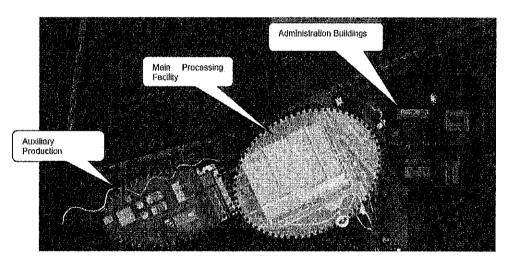


Figure 4.1 Main Project Components

4.7 Waste Incineration Process

The daily capacity of the Project is to treat 2,000t domestic waste with 3 sets of 670t/d moving grate furnace configured to achieve the annual domestic waste treatment capacity of 667,000t.





4.7.1 Waste Receiving and Storage

4.7.1.1 Waste Unloading

Domestic waste shall be delivered by Lahore Waste Management Company (LWMC) to the unloading hall of the main plant house. The waste shall be weighed at the gate before being transported to the unloading platform. The maximum load of waste truck shall be 40 tons.

4.7.1.2 Waste Storage

Waste bin is a sealed reinforced concrete structure with the functions of leakage and corrosion prevention. It shall be used to receive and store waste. Its effective volume shall be about 26,880m³, which may store the waste for 6~7 days.

The process of waste stockpiling shall results in smooth export of leachate and improved waste heat value. During stockpiling of waste, it is required to treat waste by stirring, mixing and dehydration so that the compositions of waste can be more even to be in favor of incineration. The underlying waste shall be subject to natural stockpiling compaction with the density improved by 50%~80% after compression, which may improve the actual stockpiling volume of the waste in the bin.

Primary air fan exhaust opening shall be set on the incinerator side at the upper part of the waste bin, to pull out the odor from the waste bin and to prevent the

accumulation and overflow of odor and methane gas.

In addition, ventilation and deodorization system shall be installed on the top of the waste bin to guarantee that the odor in the waste storage tank will not spread outward during the shutdown period of the incinerator.

4.7.1.3 Waste Feeding

Three sets of crab cranes shall be provided in the upper part of the waste pit. The system shall be equipped with weighing devices, as well as measuring devices, prewarning, over-load protection, swing-prevention, inclination prevention, self-positioning and collision functions. In addition, the cranes shall also record and summarize waste data. Manual and automatic operation can be chosen by the crane operators for feeding of incineration as well as waste mixing, handling and stirring, etc.





The operators in control room shall control the whole operation of the cranes. Waste shall be grabbed and lifted from the pit to feed hopper of MGF.

4.7.1.4 Auxiliary System: Leachate Collection and Transmission System

Waste leachate collection system shall be set in the waste bin, and discharge in layers shall be adopted for the drainage of leachate from the waste pit. 2-layer grizzly screens shall be set in the pit wall at the lower part of the waste unloading side, which may drain waste leachate in lower place and high place to the ditch of the underground channels, and ditches may lead the leachate to the collecting pool.

Leachate collecting tank shall be set in the underground of the unloading hall near the waste pit. After pumped out by the leachate pump, the waste leachate in the leachate tank shall be delivered to the leachate treatment station in the plant for treatment and recycle.

The collection and treatment capacity of waste leachate shall be designed as 25%-30% of waste volume. In view of high water content of waste in summer, the leachate treatment station capacity shall be designed as 500 t/d whereas, the daily treatment capacity of the Project is 2,000t.

4.8 Waste Incineration System

Three sets of moving grate furnaces (MGF) shall be configured for the WtE Project.

The waste incineration system of the Project includes waste feeding system; incinerator, ignition and auxiliary combustion system. The waste in the waste pit shall be grabbed by the crab crane and put into the feeding hopper, after that, the waste shall slide to the incinerator along the water cooling feeding chute. The feeding grates shall guarantee that controlled waste is fed into the incineration grates, which are driven by hydraulic system.

Primary air shall be sucked from the sidewall of the waste pit, which shall be heated by the air pre-heater indirectly, after that it shall be delivered to the lower part of the grate after converged with the cooling air of the side wall. Secondary air shall be sucked from the top of the incinerator room to the incinerator to strengthen the mixing of the combustible air and flue gas so as to achieve full combustion of air.

Figure 4.2 shows combustion features of the incinerator.

Where,



- The X-axis is the waste incineration volume and the Y-axis is the input heat of the waste.
- MCR point is the point of waste input heat (58.125MW).
- LHV of the waste is the rated value of 7,500kJ/kg
- The treatment volume is the rated capacity (27.9t/h).
- Continuous operation area is the area surrounded by points MCR-A-B-C (D) E-F-G.
- The overload operation area is the area surrounded by points H-I-A-MCR-G-F-J, and the area which needs combustion support is the area surrounded by points C (D) -E-F-G.

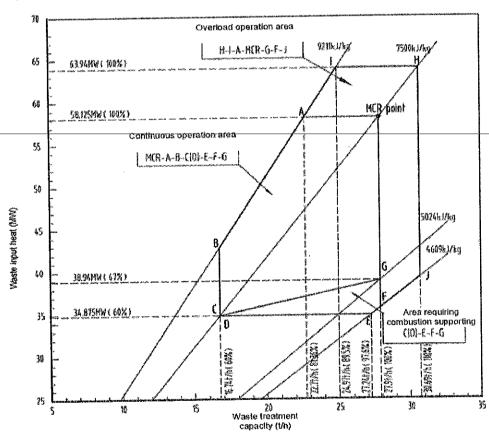


Figure 4.2 Incinerator Combustion Features

Moreover, natural circulation mode shall be adopted for waste heat boiler with the layout of heated surface including multiple back stroke horizontal layout and multiple



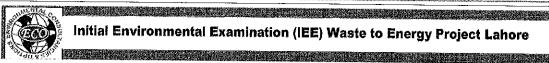


back stroke vertical layout. Waste heat boilers in the layout of the two kinds are applicable to the waste incinerator. However, since horizontal layout may occupy relatively large area, vertical layout of waste heat boilers shall be adopted for the Project.

Rotary spray semi-dry purification process flow shall be adopted for flue gas purification with mechanical rotating spray drying deacidification reaction tower, activated carbon adsorption and bag dust collector. Flue gas discharge shall be conformed to the local standards.

The slag left after combustion shall be delivered into the slag transmission system through slag remover. Small amount of ash leaked from grate shall be collected and delivered to the slag remover with the wet type chain scraper conveyor, and then sent to the slag transmission system. Flame monitor shall be set for the waste incinerator so that the operators may observe the combustion conditions in the hearth at any time in the central control room. The technical process flow diagram is attached as Annex D.

CHAPTER 5 DESCRIPTION OF ENVIRONMENT





CHAPTER 5 DESCRIPTION OF ENVIRONMENT

An environmental baseline study is envisioned to establish a database against which potential project impacts can be anticipated and accomplished later. The IEE of the proposed IEE of Waste to Energy Project, Lahore covers a comprehensive description of the project area, including environmental attributes which are expected to be affected by the project, as well as, those which are not expected to be directly affected by the construction and operation of the project. The existing environmental conditions around the proposed project have been considered with respect to physical, biological and socio-economic aspects.

5.1 Study Parameters

The information - data for use in the report has been secured from two main sources: published literature and field survey. Published literature was reviewed to collect available environmental information about Lahore including climate, ecological, biological, socioeconomic, cultural conditions and land use. A site visit was conducted to survey the field area and to collect environmental data on physical, biological and socio-economic parameters. Further, consultations were held with the general public and stakeholders of the project area in order to pursue the public opinion on the enactment of the proposed project.

5.2 City Profile of Lahore

Lahore is the second largest city of Pakistan covering a total administrative region area of 1,770km² with the population of over 9,000,000. It is located on the east bank of the smallest Indus River tributary, Ravi River in Punjab Province with India on the east and Kasur on the south. It has s flat territory with height above sea level of 200m, temperature of -2°C~45°C, rainy season from July ~ September and annual rainfall of 629mm.

Lahore is the culture and art center of Pakistan with over 2,000 years of history. It once was the capital of Mughal Empire known as "Garden City". After the independence of Pakistan in 1947, Lahore became the richest capital of Punjab Province with economy in rapid development.





5.3 Waste Management Situation in Lahore

Solid waste management situation in Pakistan is a matter of grave concern as more than 5 million people to die each year due to waste-related diseases. In Pakistan roughly 20 million tons of solid waste is generated annually, with annual growth rate of about 2.4 percent. Karachi, largest city in the country, generates more than 9,000 tons of municipal waste daily. All major cities, be it Islamabad, Lahore or Peshawar, are facing enormous challenges in tackling the problem of urban waste. The root factors for the worsening garbage problem in Pakistan are lack of urban planning, infrastructure, public awareness and endemic corruption. In Lahore, the capital of Punjab and the second largest city in Pakistan, there are currently no controlled waste disposal facilities, though roughly 27% of waste (by weight) is recycled through the informal sector, Lahore does not have very high performing governmental management in the waste management situation. Instead, the City District Government Lahore established the Lahore Waste Management Company and left the responsibility of the Solid Waste Management in Lahore to them. Beginning in 2011, Lahore Waste Management Company strives to develop a system of SWM that ensures productive collection, recovery, transportation, treatment and disposal of the waste in Lahore. Lahore Waste Management Company (LWMC) has over 10,000 field workers involved in waste collection and disposal. Though the LWMC is working in phases, 100% collection rates are not seen yet. Lahore currently only has three disposal sites which are no more than dumps, where illegal dumping and trash burning is common. However, there is some resource recovery taking place. It is estimated that 27% of dry recyclables are informally recycled within the city. Additionally a compost plant converts 8% of waste into compost. In general, the governance over the Waste Management in Lahore is hardly present. Though there are current projects and plans taking place, by the Lahore Waste Management Company for example, in order to achieve a productive and sustainable system in the city it is necessary for all service providers (formal, private, and informal) to take part in decisions and actions.

5.4 Conditions of the domestic waste collection and transportation system of Lahore

The current population of Lahore is about 9,000,000, and the total actual output of waste in 2016 was about 5,200t/d. With the constant increase of population, the waste quantity in also rising. In order to plan and treat urban domestic waste in a





reasonable and effective manner, improve urban environment and turn Lahore into a green and sustainable city as well as one of the cleanest cities in the world, the Punjab Province Waste Management Company prepared a strategic planning for urban waste treatment. The planned total waste treatment capacity is 6,000t/d including 2,000t/d for waste treatment capacity through waste incineration generation projects, 1,000t/d for waste recycling projects, 500t/d for refuse composting and 2,500t/d for landfill.

5.5 Overview of the Proposed Project Site

The Lakhoder Landfill covers a total area of 52.9ha. (hm²), and it is located on the outer edge on the northeast of Lahore (northern latitude 31°37′25″ and east longitude 74°25′14″). The Project land is located within the red line on the south of the landfill with the planned total land occupation area of 10.64 ha. (hm²). The land is in irregular trapezoid strip with relatively flat territory. The surface of the ground consists of wasteland and the open-air landfill land, and 132kV HV wire and iron tower passing through the edge on the north side of the site.

5.6 Environmental Profile of the Proposed Project Site

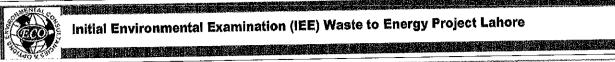
The Lahore Waste to Energy Project in Pakistan is located in the northeast of Lahore and is adjacent to the existing landfill. The project site is of good external conditions and is far away from downtown. There is no residential area near the project area and roads to the site are available. The external power grid passes through the plant area. The straight-line distance from the plant area to the nearest river is about 4km. The plant area is of flat terrain and abundant underground water.

5.6.1 Plant Environmental Conditions

The project area is located adjacent to Lakhodair Landfill Site, Lahore The plant site is about 630m away from the nearest residential building, and about 1.1km off the populated area. It is located at the edge of the city and there is no major sensitive source near the plant site.

Table 5.1: Plant Environmental Conditions

Name	Lakhodair waste landfill site	
Geographic location	Northeast of Lahore, Lakhoder, N31°37′25″, E74°25′14″	
Elevation of site	As per the general layout of landfill site, the site elevation is about 217~228m, inclining from east to west, with a flat landscape. Highest level of the nearby Ravi River 20-year flood is 211.7m, and the site elevation is	





Name	Lakhodair waste landfill site
	higher than that level.
	Total area of Lakhoder waste landfill site is 52.9 ha, and gross area for this plant use is 10.64 ha. Main road of landfill site divides the land into two parts— east and west, and the east part of 3.49 ha will be used as office building and living land.
Boundary line and topography of the land	The west part of 7.24 ha will be used as WtE plant building, with the longest point of 534m in the direction of east-to-west, and different widths of 73~230m from north to south, it is shaped in an irregular trapezoid as a whole. Moreover, 132kV high-voltage power line from the north of the site passes through the site in parallel in the direction of east-to-west. The site does not benefit to general layout planning design and plant expansion in the future.
Land acquisition status	The land has been acquired by waste landfill project of LWMC.
Engineering geology	There is natural discharge ditch of rain water and culvert across the north of the site, and the site is wasteland and borrow area. Within the site, there is landfill waste required to be cleaned and removed, and no undesirable geological phenomenon exists. It is suitable to build the plant.
Water supply conditions	Urban water supply is not available, and underground water intake facility shall be built by its own. The site is 4.5km away from the Ravi River, as the water volume of the River in the dry season is not guaranteed; in consequence underground water shall be taken into account as the water source. It shall be further demonstrated in accordance with hydrogeological report and local water resource use policy.
Grid connection conditions of the power generated	One 132kV power grid is near the plant and connection point is at the booster station of the plant.
Communicat ion conditions	It is the mobile network coverage area, and main communication cable of fixed line telephone is available.
External road of the plant	Plant site is about 1km away from the Ring Road of Lahore. External connecting roads have been built by landfill project. The road is covered with asphalt and concrete with the width of 8~30m. The condition of the road is good for driving.
Sewage discharge conditions	Urban sewage pipeline is about 4km away from the north of plant
Atmospherio diffusion	Plant site is in the plain with a good atmospheric diffusion condition.





Name	Lakhodair waste landfill site						
conditions							
Demolition of obstacles and numbers of residents	No demolition and relocation work within the plant site, and only the existing low-voltage power poles shall be removed.						
Surrounding sensitive points	The plant site is about 630m away from the nearest residential building, and about 1.1km off the populated area. It is located at the edge of the city and there is no major sensitive source near the plant site.						



Fig 5.1: Geological Location of the Proposed Project Area

5.7 Physical Environment

Physical environment consists of existing land form and land use of the project site, geology and geomorphology, soils, groundwater, surface water, meteorology and climate. The pre-project condition (i.e. baseline) of each these components of the physical environment are described here below.

The baseline environmental conditions on the basis of the said data sets have subsequently been used to identify the potential impacts on the physical, biological and socio-economic environment that are likely to arise from the project activities.

5.7.1 Topography

The topography of the project area is an irregular trapezoid strip with relatively flat territory. The average altitude of Lakhoder Landfill is 208m and the slope is 0.05~0.5%. The district Lahore is divided into two parts. The low lying alluvial soil is along the Ravi River, and the upland in the east. Upland is a plain slope from north-



east to south-west. The lowlands are generally inundated during the monsoon season by Ravi River, flowing in the west of district along its boundary with district Sheikhupura. **Figure 5.2** represents the topography of Lahore.

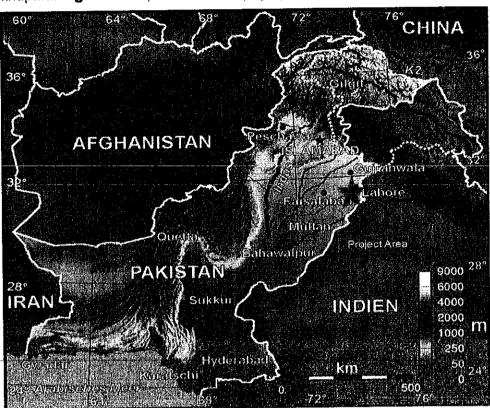


Figure 5.2: Topography of Lahore

5.7.2 Geology and Hydrology

The Lahore District derives itself naturally between the central uplands and alluvial lands of Ravi, having no hills or mountains of any kind. The alluvial land of Lahore can be sub-divided into the following two categories:

- (i) Uttar Land
- (ii) Hither land

Uttar lies in the north and constitutes about two thirds of the entire land. The low lands are known as Hither, which are generally inundated by the water of the Ravi River during monsoon floods. The Ravi flows in the West District along its boundary with Sheikhupura District. The general altitude of the area is 150 to 200 meters above sea level. The only minerals worth any value are Kallar and Kankar. They are used for manufacture of crude saltpeter also as manure for top dressing of young





cotton and tobacco plant. The soil is very different in character and generally inclined to be dry. However, it is rich in plant nutrients.

The Proposed Project Site is in Lahore in the area of Lakhoder which is 15 km away from Lahore. The average altitude of Lakhoder Landfill is 208m and the slope is 0.05~0.5%. The compositions of soil in the local area mainly include silt, cohesive soil, sand and gravel.

5.7.3 Physiography/Soil

Project area is dominated by silt, sine sand and gravel, with small terrain fluctuation. The groundwater level is high. The site can be divided into 3 layers from top to bottom within the control range of hole location and depth:

- * silt,
- * silty clay,
- * fine sand.

The description of geotechnical layering from top to bottom is as follows:

Silt: brown gray, average thickness: 11m, average buried depth: 0.00m.

Silty clay: brown, average thickness: 9m, average buried depth: 11m.

Fine sand: gray, average thickness: 10m, average buried depth: 20m.

Soil

The compositions of soil of the Project area mainly include silt, cohesive soil, sand and gravel.

Table 5.2: Results of Soil Survey

Parameters	Units	PEQS	Concentration		
рН	444	NS	7.97		
Sulphate	mg/kg	NS	410		
Chloride	mg/kg	NS	480		
Sodium	mg/kg	NS	154		
Potassium	mg/kg	NS	74		
Calcium	mg/kg	NS	1154.0		
Phosphorous	mg/kg	NS	0.12		





PROJE	CT;Sanitary Landfill Sit	er og enemalere for der state, sterke speriore frederichte er die	DEFECTOR SESSENCE AND ADDRESS OF THE SESSENCE AND ADDRESS	LOCATION:	Lakho Der, Mahmood Booti, Lahore.			
CLIENT	Lahore Waster Mac	agement Com	pany.	WATER TABLE: 1.0 m				
Depth (m)	Strata Encountered	Legend		Description	Remarks			
	L		Moderness management		e-12 1/L-021 100000000000			
2 3 4 5 6 7 8			Brownish Silty Sand	Grey / Sandy Silt				
12 13 14 15 16 17 18		1	Brownish Silty Clay	/ Clayey Silt				
20 21 22 23 24 25 26 27 28			Grey Fine San	d / Silty Sand				
29 30			-					
Send		Sand: Passk (0.075 mi	ng No 4 siev m)	re & Retained No	200 sieve			
Clay	***		g No 200 sl	eve (0.005-0.001	mm)			
Sh	*** ** ** ** ** ** ** ** ** ** ** ** **			ve (0.075-0.005 r	nm)			
Gravel		Gravel: Mon than No 4 si	s than half c ove size	f coarse fraction	is larger			

Figure 5.3: Soil of Lakhoder Landfill Site

5.7.4 Seismology

Due to the continental plate drift of the Indian Plate and Asian Plate, Pakistan has suffered from devastating earthquakes in past. The whole country is divided into the following 5 zones:



Table 5.3 Seismic Zones of Pakistan

Seismic Zone	Peak Horizontal Ground Acceleration
1	0.05 to 0.08g
2A	0.08 to 0.16g
28	0.16 to 0.24g
3	0.24 to 0.32g
4	>0,32g

"g" is the acceleration due to gravity

Source: Geological Survey of Pakistan

The area of Lahore falls within zone 2A according to the zoning developed by the Government of Pakistan (GoP). This zone represents the area of negligible damage from a potential earthquake

The proposed project site is located at moderate earthquake zone with the value range of 4~4.9 in WHO damage category. The region is not in the active earthquake zone.

5.7.5 Climate and Meteorology

Seasonal climatic conditions must be considered for the design and execution of Project. The climate including air, temperature, precipitation, cloud & humidity and wind speed is an influencing factor, affecting the construction of plant. However, to determine the overall effect of the climatic stresses, daily and seasonal temperature changes and precipitation must be considered. The Project Area has extreme climate: it has hot summer and cold winters. The summer starts from May and lasts till September. May, June, and July are the hottest months. The mean maximum and minimum temperature ranges from 47 °C and 25 °C respectively for these months.

The winter seasons lasts from November to February. December and January are the coldest months. The mean maximum and mean minimum temperature ranges from 24°C to 9°C in January. Temperatures in the Project Area vary from 47 °C to 9°C.





The project area receives rains in all the seasons but monsoon rain is pronounced and constitutes a definite rainy season between the month of July and September. The average rainfall is about 629 millimeters per year. **Table 5.2, Table 5.3, Table 5.4 and Table 5.5** summarizes month-wise temperature, precipitation, Wind Speed, Cloud and humidity in the study area.

Lahore belongs to sub-tropical continental climate with sufficient rainwater. The winter begins from November to the February of the next year, and the summer covers May, June, July, August and September. Monsoon rains are concentrated during July ~ September, and the weather during the period is hot and dry in the day and night. Except the months mentioned above, other months have relatively mild temperature. Extreme maximum temperature: 48.0°C

Based on climatic elements, five seasons are recognized in the project area:

i) Pre-monsoon Season

Pre-monsoon refers to the period from May to June prior to the setting in of the monsoon. These are the hottest and the driest season, with persistent dry and hot winds. Day time temperature rises to 47 °C. The flows in the river begin to rise simultaneously due to snow-melt water in the high mountains. The water table falls to the maximum depth.

ii) Monsoon Season

Monsoon is the main rainy period, which starts at the beginning of July, reaches its climax in August and gradually, subsides in September. High intensity Rainfall causes soil erosion which is a function of erosivity and erodibility. The cool monsoon winds followed by heavy showers lower the temperature to great extent. The part of rain percolates into the soil and is conserved in the subsoil and part adds to the groundwater. The conserved moisture in the soils is generally sufficient to rejuvenate the vegetation. All plants grow rapidly and mature towards the end of the season. With the start of monsoon season, the rivers flow at their peak level. The groundwater level is improved toward the end of the season in September and October.

iii) Post-monsoon Season

Post monsoon season refers to autumn (October-November). The temperature starts falling but the extreme aridity prevents plants to flower early and set seed toward mid-seasons. Groundwater level rises as a result of infiltration from rainfall.



iv) Winter Season

Winter refers to the period from December to January. The lowest temperatures (9 °C) and cold winds characterize this season. The plants become dormant and most of them dry out. Most of the trees shed their leaves and few remain green or partly green. Sometimes this season becomes severe due to cold Siberian winds. Groundwater level declines in this season due to low flows in the rivers and no or little rains which usually fall in light showers causing little soil erosion.

v) Spring Season

Spring refers to the period from March to April. Temperatures become pleasant. The mean maximum temperature is 39 °C with the highest precipitation of 185.5 mm and relative humidity of 40 percent. Some light showers of rain may also fall without generating run off. The vegetation sprouts again because of conserved moisture from winter and spring rains, if any. The water table starts falling.

Data about wind speed, cloud and Humidity for the year 2009-2016 is available on the format of average monthly basis.

5.7.5.1 Temperature

In general, the Project corridor is subject to pronounced variations in temperature, directly and indirectly influencing the environment. The frequent dust storms associated with such weather increase suspended particulate concentration in the air leading to reduced visibility.

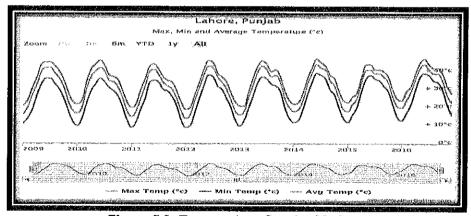


Figure 5.3: Temperature Graph of Lahore





			18	bie 3.4	: remp	erature	Vala v	Land				
			<u></u>		iem	perature 2009	(6)					
								<u> </u>				
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Max.	21	24	31	37	44	45	45	43	40	35	28	23
Min.	16	14	19	27	33	36	36	33	30	25	18	18
Avg.	11	20	27	33	40_	42	42	39_	36	31	23_	12
						2010						
Max.	22	24	34	41	44	46	43	38	37	35	29	23
Min.	10	14	22	29	33	36	34_	31	29	26	20	13
Avg.	17	20	30	37	40	42	40	35_	34	31	25	18
	l		<u></u>		<u> </u>	2011	•					
Мах.	20	22	30	36	43	44	41	37	35	34	29	23
Min.	9	12	19	25	34	35	34	30	29	26	21	13
Avg.	15	18	25	32	40	41	38	34	32	30	25	18
Avg.	10	10		UZ.		2012	J	<u> </u>				
				Ţ	 .	· · · · ·		1 00	1 07	24	1 20	23
Max.	19	20	27	34	41	46	45	39	37	34 25	28	13
Min.	9	10	17	25	32_	38	37	32_	30 34	30	24	18
Avg.	14	16	24	31	38	43	42	37	34	30	24	10
						2013						
Мах.	21	21	29	37	43	46	44	40	41	37	29	24
Min.	10	13	20	27	34	37	36	33	32	29	20	14
Avg.	16	18	26	33	40	43	41	37	38	34	25	20
	· 					2014						
Max.	22	23	28	36	42	47	45	43	38	36	29	2/
Min.	12	13	19	27	34	39	38	36	30	2.7	20	14
Avg.	18	19	24	33	39	44	42	41	35	32	25	19
		!				2015						
Мах.	23	26	28	37	44	44	41	41	40	37	30	25
Min.	12	16	20	29	36	38	36	35	32	29	22	18
Avg.	18	22	25	34	41	41	39	39	37	34	26	21
was A.	1 10		1 20			2016	. 			•		
W.M	1 04	29	32	39	45	47	44	42	42	39	32	28
Max.	24	17	22	30	37	39	38	35	34	30	22	16
Min.	13	24	29	36	42	44	41	39	39	35	27	23
Avg.	20	24		30	"T.Z.	77		1 00		· Morld		

Source: World Weather Online



5.7.5.2 Rainfall

The Rainy season starts in July and ends in September. Annual rainfall is 629mm. More rain occurs in July and August than any other months. Most of the winter rains are received in the months of December and January.

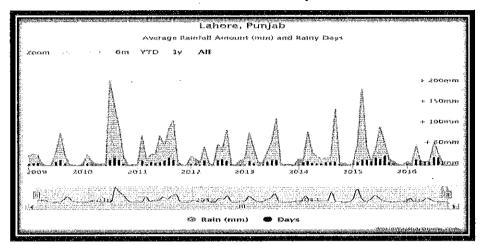


Figure 5.4: Rainfall Graph of Lahore

Table 5.5: Rainfall Data of Lahore

			Ra	ainfall (mn	n)							
	Years											
Months	2009	2010	2011	2012	2013	2014	2015	2016				
Jan	23.02	3.3	1.4	21.52	14.61	15.79	4.2	8.3				
Feb	28.53	26.21	72.17	15.72	79.09	12.8	49.8	2.5				
Mar	25.59	9.57	12.88	6.39	40.91	81.51	185.59	47.94				
Apr	3.4	3.54	27.32	44.68	7.08	30.42	45.48	10.69				
May	0.0	3.87	27.57	4.41	5.0	22.49	8.2	7.49				
June	0.0	3.09	72.56	1.79	31.51	15.2	39.05	11.11				
July	31.76	206.1	46.29	51.31	59.24	18.59	93.67	56.18				
Aug	77.94	141.8	88.81	39.31	113.83	17.81	54.72	28.49				
Sep	23.94	92.09	109.6	86.22	2.69	136.93	15.16	3.6				
Oct	2.49	19.81	8.2	2.78	1.9	4.81	7.91	0.0				
Nov	0.6	0.0	0.3	0.1	1.9	6.0	1.0	0.0				
Dec	0.0	2.1	0.0	10.88	0.2	0.3	0.2	1.0				

Source: World Weather Online



5.7.5.3 Wind

Wind speed and direction, are important parameters for the dispersion of gases and odors generated at the waste management facilities. Wind blows calmly in Lahore from NW direction

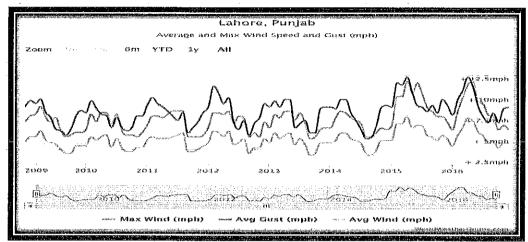


Figure 5.5: Wind Speed Graph of Lahore

Table 5.6: Wind Data of Lahore

	Wind Speed (mph)												
	<u>Years</u>												
Months	2009	2010	2011	2012	2013	2014	2015	2016	Wind Direction				
Jan	5.1	4.7	5.4	5.1	5.1	5.1	5.4	4.7	NW				
Feb	5.8	5.8	5.8	6.5	6.3	5.4	7.4	6.0	NW				
Mar	5.8	5.4	5.6	6.3	5.6	6.3	7.4	6.9	NW				
Apr	6.5	5.8	5.6	5.8	6.0	6.3	8.3	8.1	NW				
May	15.4	6.0	5.6	6.5	6.3	5.6	6.9	7.8	NW				
June	5.1	4.5	5.8	4.9	4.9	5.4	7.2	6.5	SE				
Jul	4.9	5.6	6.0	5.1	5.6	5.1	7.2	6.0	SE				
Aug	4.3	4.5	6.3	5.6	4.9	3.8	6.0	5.1	SE				
Sep	3.8	4.0	4.0	3.8	3.6	3.6	5.8	5.4	SE				
Oct	3.8	4.0	4.0	4.5	3.8	4.3	5.4	4.5	NW				
Nov	4.7	4.5	4.3	4.5	5.1	5.4	6.0	5.1	NW				
Dec	4.7	4.5	4.7	5.6	5.1	5.4	5.6	5.1	NW				

Source: World Weather Online

5.7.5.4 Cloud and Humidity

Average data of Cloud is shown in **Table 5.5.** July, August and September are the most humid months in the area, whereas May and June are the least humid months. Annual average humidity at the proposed project site is 62.3%.



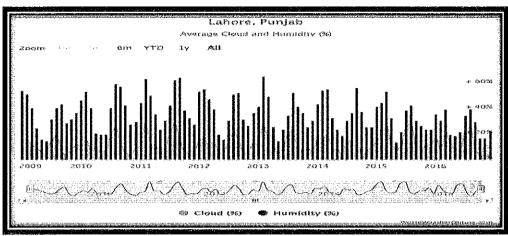


Figure 5.6: Average Cloud and Humidity Graph of Lahore

Table 5.7: Average Cloud Data of Lahore

	table on Average Globa Data of Earlore											
			Cle	oud (%)								
	Years											
Months	2009	2010	2011	2012	2013	2014	2015	2016				
Jan	16	10	11	15	11	17	14	18				
Feb	15	16	30	17	30	17	25	7				
Mar	12	7	12	10	14	20	30	23				
Apr	9	8	12	15	11	9	13	13				
May	6	6	5	5	4	8	8	8				
June	7	7	9	6	91	4	10	7				
Jul	15	20	21	14	21	16	27	24				
Aug	20	26	29	23	24	14	30	26				
Sep	6	13	17	16	8	14	10	7				
Oct	29	5	4	4	7	4	6	2				
Nov	8	3	7	6	9	6	12	12				
Dec	12	9	6	14	6	11	12	10				

Source: World Weather Online

Table 5.8: Average Humidity Data of Lahore

	Humidity (%)											
Years												
Months	2009	2010	2011	2012	2013	2014	2015	2016				
Jan	55	47	45	54	42	44	42	36				
Feb	52	54	64	56	66	55	45	31				
Mar	41	41	51	48	50	56	54	40				
Apr	25	21	36	40	26	33	33	20				
May	16	20	24	20	15	24	14	19				
June	15	20	31	16	24	19	22	22				
Jul	32	41	43	31	35	31	39	35				
Aug	41	60	63	52	53	37	43	40				
Sep	44	58	65	53	42	57	31	30				
Oct	3	43	39	32	37	38	27	17				
Nov	32	28	33	27	26	26	24	17				
Dec	37	30	28	37	31	26	24	23				

Source: World Weather Online



5.8 Ambient Air Quality

Atmospheric pollution, particularly in urban areas like Lahore, has a strong impact on daily life. The primary source of air pollution at the proposed project site, is the vehicular emissions and the key pollutants likely to be found include carbon monoxide (CO), Oxides of Nitrogen (NO_x), Sulfur Dioxide (SO₂) and Particulate matter (PM₁₀). Other source of air pollution is dust arising from construction activities.

Table 5.9: Summary of Ambient Air Quality Analysis

Sources	0.0		NO	53.2
Units	co	SO ₂	NO ₂	PM ₁₀
	ррт	μg/m³	μg/m³	μg/m³
PEQS	10	120	80	150
Mid-Point of the Plant Site	0.6	7.8	58.0	56
Entrance to the Plant Site	1.2	8.3	66.0	76
Mid-Point of the Office Site	0.4	8.1	60.0	70
Entrance to the Office Site	0.9	9.5	62.0	94

5.9 Noise

Noise from vehicles and other powered mechanical equipment is intermittent. However the construction from the proposed waste to energy project will use powered mechanical equipment. Subjective observations were made of background noise and also of individual vehicle pass by events.

Studies show that due to the nature of the decibel scale, a doubling of traffic will result in a three-decibel increase in noise levels, which in and of itself would not normally be a perceivable noise increase. Studies also show that changes in noise levels of three decibels or less are not typically detectable by the average human ear. (Minnesota Department of Transportation)





Table 5.10: Results Analysis of Noise Monitoring

Sources	Noise Level	PEQS
Mid-Point of the Plant Site	63.5	
Entrance to the Plant Site	66.4	
Mid-Point of the Office Site	65.2	75dB
Entrance to the Office Site	68.8	

5.10 Water Resources

5.10.1 Water Source and Drainage in Project Area

There is no large area of surface water in the landfill area, only a Ravi River located at 5km away from the landfill on the northwest. The surrounding underground water level is 1~3m, pH value and chloride content are conformed to drinking water standard, however, the total dissolved solids (TDS) is slightly out of limit.

5.10.2 Water Resources

The production water source of the plant area is deep phreatic water. Water meter will be installed at the entrance of the plant. The water will flow into the 1,800m³ production and fire water storage tank after being treated in multi-media filter and water softening device, and will be used for production and fire-fighting after pressurization.

The domestic water source is municipal tap water, which will flow into the domestic water storage tank in the pump house and will be supplied to the toilets of each building, bathrooms and dining room after being pressurized by domestic water supply unit.

5.10.3 Water supply system

The plant area is equipped with production water supply system, domestic water supply system, circulating water system, reuse water and fire water supply system. The production water for the plant area is from the deep-well pump house. The domestic water for the plant area is from the municipal tap water.

5.10.4 Water drainage

All of the Lahore districts drain ultimately to River Ravi which is the major natural surface water resource located in the northern part of the district. River Ravi receives huge amount of wastewater from the city of Lahore and other industrial discharges





from different sources especially Hudyara Drain, a natural drain which carries pollution loads from both Pakistan and India. Most wastewater discharge reaches to Ravi in the 60km stretch between Bulloki and Lahore. These wastewater discharges, along with reduction in available water in River Ravi for dilution, has greatly deteriorated the quality of river water. River Ravi runs merely as a sullage carrier near Lahore during low flow season.

Besides, there are 76 minor drains which finally fall in eight (8) major drains namely Satto Kattle drain, Lakshimi Drain, Suk Neher Drain, Upper Chota Ravi Drain, Siddique Pura Drain and Shahdara Drain. Nowadays, all these drains collect wastewater from different areas of Lahore and finally fall into River Ravi.

5.10.5 Surface Water

There is no such large surface water body passing within the boundary of the study area. Ravi River is passing at a distance of about 5km from the project site. The agricultural land around the project site is being irrigated with tube well source.

5.10.6 Groundwater

There is no existing tube well in the Project Area. The ground water table varies between less than 1m to 3 meters. The ground water quality of the study area is quite good which is determined by the laboratory analysis. The groundwater quality of the project area is quite good and according to WHO guidelines it is suitable for drinking purpose. Laboratory team also executed three bore holes at different depths within the study area for ground water quality analysis. The results are presented in Table 5.6. pH of all the samples lie within the allowable range for drinking water (i.e., 6.5-8.5). There is no existing sewerage water drain in the study area.

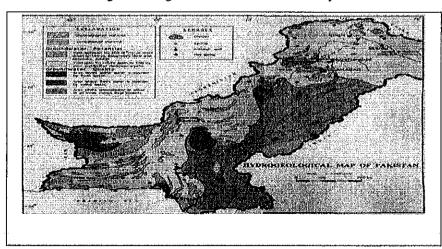


Figure: 5.6 Ground Water in Pakistan

Source: Geology Survey of Pakistan



5.10.7 Flooding

The proposed project site is located at about 5 km away from the River Ravi. The area cannot be considered completely safe from floods.

Table 5.11: Summary of parameters for Ground Water

Parameters	Unit	PEQS	Concentration
pH Value		6.5-8.5	7.20
TDS	mg/l	<1000	780.0
Chloride	mg/l	< 250	28.0
Turbidity	NTU	< 5	2.14
Sodium	mg/l		129.9
Potassium	mg/l		6.6

5.11 Ecological Environment

The climate of Lahore is semi-arid and subtropical, the vegetation of the area falls under scrub, dry, tropical thorn forest type as per Phyto-geographical classification of the area. The study area was once covered with thick vegetation consisting of trees like Karir (Capparisdeciduas), Wan (SalvadoraOleoides), and Jand (Prosopis Spicigera). With passage of time, rapid urbanization and development this vegetation was cleared earlier for agriculture purpose and then for housing and commercial activities. These agricultural lands were then converted into business centers, small industries, multistory plazas and housing colonies.

5.11.1 Aquatic Flora and Fauna

There is no aquatic ecosystem (i.e., stream, canal or pond) observed within or around the study area, which omits the possibility of any kind of aquatic species.

5.11.2 Terrestrial Flora and Fauna

Practically the site does not possess extensive terrestrial flora and has vegetation cover and some trees. However, following flora and fauna were observed during the baseline survey.

5.11.3 Flora

As observed on the Project area presents a diverse variety of vegetation and tree cover. There are 25 big trees present; their species are mentioned in table 5.8 below. The dominant tree species are Eucalyptus, Poplar, Jaman, Neem, berri and





Mango. The trees are of varying heights in the Project area. The project and study area has a variety of trees along the roadsides from Babu Sabu to Project Site, consisting of the following major species as shown in the **Table 5.10**.

Table 5.12: List of identified trees in the Project Area

No.	Common Names	Botanical Names
1	Arjun	Terminalia arjuna
2	Dhak	Butea frondosa
3	Mahwa	Bassia latifolia
4	Bahara	Terminalia bellerica
5	Amaltas	Cassia fistula
6	Gul-e-nishter	Erytrina subrosa
7	Barringtonia	Barringtonia acutengula
8	Nim	Melia indica
9	Gab	Diospyores embryopteris
10	Berna	Crateva religiosa
11	Khark	Celtus australis
12	Putajan	Putranjiva roxburgi
13	Fiddle wood/Kashmir Lagotis	Eithrxyllum ruberratum
14	Gul-e-mast	Dalinia Indica
15	Gul-e-mohr	Poinciana regia
16	Alstonia	Alstonia scholaris
17	Ashoke	Saraca indica
18	Sheesham	Dalbergia sisso
19	Alata	Stercolia colorata
20	Kenair	Nerium grandiflora
21	Weeping Willow	Salix babylonica
22	Keekar	Parkinsonia aculeata
23	Nilem	Jacaranda mimosfolia
24	Kachnar	Bauhinia purpurea
25	Molsary	Mimosop elengi
26	Bel	Aegle marmelos
27	Siris	Albizia lebbek
28	Tun	Cedrela toona
29	Jamin	Eugenia jambolana
30	Moor pankh	Thuja orientalis





Silkoak	Grevillea robusta
Sufeda	Eucalyptus citriodora
Peepal	Ficus relegiosa
Simbal	Hyacinthus orientalis
Berri	Diospyros melanoxylon
Suk chain	Pongamia glabra
Poplar	Populus alba
Aam	Mangifera indica
Shehtoot	Morus alba
	Sufeda Peepal Simbal Berri Suk chain Poplar Aam

Source: PHA, Lahore

Table 5.13: List of identified trees in the Study Area

Sr. #	Local Name	English Name	Scientific Name
1	Amaltas	Puddingpipetree	Cassiafistula
2	Neem	Ash-leavedbedtree	Azadirachtaindica
3	Jamin	Blackbery	Eugeniajambolana
4	Sheesham	Sosoo tree	Dalbergiasisoo
5	Berri	Indian-cigar	Diospyrosmelanoxylon
6	Sukchain	Smoothlevelpongama	Pongamiaglabra
7	Poplar	Poplar	Populusalba
8	Aam	Mango	Mangiferaindica
9	Shehtoot	Mulbury	Morusalba
10	Safeda	Indian willow	Salixtetarsperma
11	Keekar	Parkinsonia	Parkinsoniaaculeate

Lahore is very important due to its ecological conditions. Several types of floral species are present in Lahore, whereas principal trees, shrubs, and herbs are given in the table with their nomenclature including local, English and botanical names. These trees data is acquired from PHA (Parks and Horticulture Authority).

Table: 5.14: Inventory of Shrubs Present in Study Area

No.	Common Names	Botanical Names
1	Marwa	Murraya exotica
2	Gul-e-fanoos	Lagerstromia indica
3	Golden durant	Duranta plumier
4		Exocaria bicolor
5	Jasmin	Gardenia jasmonoidis
6	Firebush	Hamelia patens
7	Jasmine	Jasminum grandiflora
8		Lantana alba
9	Henna	Lawsonia inermis
***************************************	Haar Singhaar	Nyctanthes arbotrists





10		
11	<u>Nila Chitrak</u>	Plumbago capensis
12	Tecoma	Tecoma stans
13	Queen of night	Cestrum nocturnum
14	-	Buddlia hybrid
15	Motia	Jasminum Sambac

Source: PHA, Lahore

Table 5.15 Inventory of Herbs Present in Lahore District

N	Botanical Names
0. 1	Disable floribused
	Russelia floribunda
2	Alternentha red
3	Alternantha white
4	Aurecaria
5	Asparages
6	Plumosis
7	Riben grass
8	American dasi
9	Stanotefferum
10	Hemerocallis
11	Oxalis
12	Amaryllis
13	Cineraria maritime
14	Euphorbia splendens
15	Iris barbette
16	Ruscus

Source: PHA, Lahore

There are few floral species which are at the risk of extinction. **Table 5.16** shows the list of endangered and prohibited floral species.





Table 5.16: List of Endangered and Prohibited Species in Lahore District

Endangered Species	Prohibited Species
Dalbergia sissoo	Eucalyptus species
Salvedora persica	Broussonetia papyrifera
Ficus bengalensis	Salmalia malabarica
Ficus religiosa	Populus nigra/Alba
Ficus enfectoria	Nerium odorum
Ficus glomerata	Thevetia nerifolia
Albbizia procera	
Albizzia lebbek	
Anogeissus acuminit	
Artocarpus integrifolia	
Artocarpus lakoocha	
Azadirachta indica	
Bischofia javanica	

Source: Forest Department, Lahore

There were no species reported by Forest and Wildlife Departments to be threatened, which are included in the IUCN Red Data Book. There is no endanger or threatened species would be affected as it is the rehabilitation of existing road network and located in high density residential and commercial area.

The plants being grown in project area are mostly bushy, with thick leafy composition, hardy, drought resistant, which can withstand with all the weather vagaries and heavily polluted road environment due to traffic flow on these sections of road. The project area has a variety of trees, along the roadsides, consisting of the following major species as shown in **Table 5.17**.

Table 5.17: List of identified trees in the Project area

Sr #	Local Name	English Name	Scientific Name
1	Amaltas	Pudding pipe tree	Cassia fistula
2	Golarra	Coccinia	Coccinia cardifolia
3	Alstonia	Devil tree	Alstonia scholans
4	Neem	Ash-leaved bed tree	Azadirachta indica
5	Gul-e-nishter	Coral tree	Erythrina variegata





Torono Maria	**************************************	processor community of the contract of the con	of many commencement of the first of the fir
6	Jamin	Black bery	Eugenia jambolana
7	Peepal	Ficus	Ficus relegiosa
8	Simbal	Hyacinth	Hyacinthus orientalis
9	Sheesham	Sosoo tree	Dalbergia sisoo
10	Berri	Indian-cigar	Diospyros melanoxylon
11	Chanar	Platanus	Platanus orientalis
12	Suk chain	Smooth level pongama	Pongamia glabra
13	Poplar	Poplar	Populus alba
14	Aam	Mango	Mangifera indica
15	Bakain	Persian lilac	Melia azedarach
16	Molsary	Mimusaps	Memusops elangi
17	Shehtoot	Mulbury	Morus alba
18	Arjun	Terminalia	Terminalia arjuna
19	Anar	Pomegranate	Punica granatum
20	Safeda	Indian willow	Salix tetarsperma
21	Keekar	Parkinsonia	Parkinsonia aculeate
22	Kawar gandal	Aloe	Aloe vera
23	Araucaria	Araucaria	Araucaria cumminighamli
24	Bans	Bamboo	Bambusa stricta
25	Khajor	Date palm	Phoenix sylvestris
26	Banana	Bannana	Musa sapientum
27	Kenair	Oleandar	Nerium grandiflora
28	Gulab	Rose	Rosa Indica
29	Ashook	Saraca	Saraca indica
30	Bougainvillia	Bougainvillia	Bougainvillea spectabilis
31	Dronta	Duranta	Duranta repens

5.11.4 Fauna

5.11.4.1 Mammals

Commonly found mammals in the area include dogs, cats, horses, houserats and bats. However Small Indian Mongoose and Indian Palm Squirrel are also found in the area.

5.11.4.2 Reptiles

Snakes such as cobra, kraits etc. were once common in the tract, but now cases of snake bites are very rare, as these reptiles have been either killed by expanding





urbanization or they have moved away. Lizards such as Spiny tailed lizard (Uromastix hardwickii) and fringed toed lizard (Acanthodactylus cantoris) are also reported by the residents of the area.

5.11.4.3 Amphibians

Amphibians frequently seen in and around the project area, especially during rainy season, include common Frog (Rana tigrina) and Indus valley toad.

5.11.4.4 Birds

House sparrow (Passerdomesticus), house crow (Corvus Splenders), and Vultures are commonly found in the area. Along with these, some of other birds were also found such as:

Table 5.18: Birds in the Study Area

Sr. No.	Common Name	Scientific Name	
1	Pigeon	Columba liviadomestica	
2	Bulbul	Pycnonotidae	
3	Teetar	Francolinusfrancolinus	
4	Parrot	Psittaciformes	
5	Titodi	Vanellusindicus	
6	Dove	Zenaida macroura	
7	Owl	Strigiformes	
8	Kites	Milvus migrans	

5.11.5 Endangered Species

No endangered species was found at the site. The area also has not been identified as ecologically sensitive area by the wildlife department.

5.11.6 Protected Areas, Wildlife, and Archeological Sites

There are a number of national parks and protected areas throughout Pakistan that are under the control of provincial forest departments. National parks in the country are shown in **Figure 5.7**.



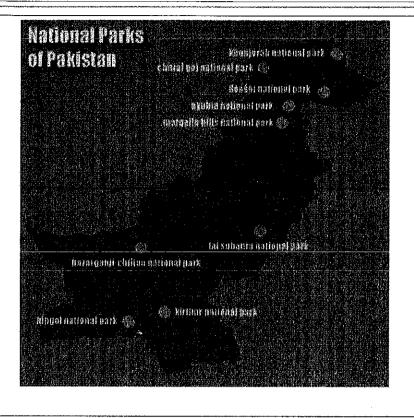


Figure: 5.7 National Parks in Pakistan

Source: Wildlife of Pakistan

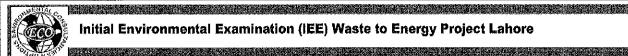
5.11.7 Critical Habitats

No wild life sanctuary or game reserve (Critical Habitats), exists near the project area or the study area and therefore it can be stated that, this project does not affect any critical habitat as, no critical habitat is located close to the project area.

Besides all these, as Lahore does not contain any of the wildlife species. If it was containing a time ago but it has become extinct now. The reason for extinction and the rising number of endangered species, according to the wildlife authorities are steady conversion of the forests into agricultural lands and urban areas to meet the food and housing requirements of the increasing population, reduction in the wetland areas due to the water shortage in rivers and canals, cutting of trees in forest areas and of course, unauthorized killing of birds and animals.

5.11.8 Environmental Hotspots

In view of the greatly modified nature of the habitats, as, there do not exist any environmental hotspots at or around any of the proposed project components.





5.12 Economic Development

5.12.1 Agriculture

The main crops in the subproject area during winter are tobacco; Mutter (peas) wheat and sesamum comprise 531, 489, 51 and 32 thousand hectares respectively. Mung, Barley, Masoor and Rape-seed seem to be less cultivated as compared to the other crops.

5.12.2 Horticulture

Potato, carrot, lady finger, chillies, onion and cauliflowers are grown on 4131, 601, 259, 250 and 220 hectares respectively ar per 2008 data. The production of coriander is very prominent in Lahore. Bitter gourd, turmeric and garlic are grown to meet the public demand. Other vegetables i.e Radish, Tinda, Bringal is also grown. Major fruits grown are; citrus, guava, mango watermelons, banana and peach.

5.12.3 Industry

Lahore is the biggest trade centre in Punjab which exports and imports a sizable quantity of different types of goods. Its major industrial items of trade include electrical fans, motors, transformers and electrical goods, rubber and its products, bicycles and auto cycles, food products, beverages, body buildings, handicrafts, leather shoes, printing and publishing chemicals, photo goods and cinema films. Besides, it trades in agriculture production and dry fruits.. There are many large industrial units in the district. These units manufacture cotton, woolen and silk cloths, carpets and rugs, textile products, leather and rubber footwear's, wearing apparel, pharmaceutical goods, soap, iron and steel products, heating, pluming and lighting equipment, hardware, miscellaneous fabricated products, agriculture machinery, engines and turbines, textile machinery, printing machinery, metal working machinery, pumps and compressors, household machinery, water generators, motor generators, transformers, electric fans, communication equipment, cycles and rickshaws. There are also a good number of printing and publishing units and workshops of vehicle body building. Besides, there are units of canning and preservation of food, edible oils, beverages, metal and wood furniture, rubber products, chemicals, glass products, repair of railway equipment, toys, stationery etc.

5.12.4 Transportation

Lahore is linked with the rest of the country by air, rail and road. It lies on the Ground Trunk road or the Shahrah-e-Azam, which connects Kabul with Calcutta. The road was originally built by the Afghan ruler Sher Shah Suri in the 16th century whereas





Okara District is linked with rest of the country by rail and road. It lies on Multan Road which connects the Lahore and Multan city.

There is a complete network of roads in the district. All major villages are connected with the district headquarters through metal led roads. In the history of Pakistan first four lanes Motorway has been constructed from Lahore to Islamabad keeping in view high traffic pressure on G.T. road. It also provides modern facilities to the passengers at International standards.

The main Karachi-Peshawar railway line passes through the district. It enters from the south near Raiwind and passing through Shahdara in the north leaves for Gujranwala. From Lahore Railway Station, a railway line goes upto Wahga at Pakistan-India border and then across the border to Amritsar in India. From Shahdra Railway Junction, two railway lines take off; one goes to Sheikhupura and the other to Narowal.

For air traffic, there is a beautiful modern International airport at Lahore. PIA and other air companies operate regular flights from Lahore other parts of the country as well as on international routes. Air traffic between India and Pakistan also operates from this airport.

5.12.5 Tourism

There are many places of interest those attract tourists and promote tourisms e.g. Royal Fort Lahore, Shalimar Garden, Minar-e-Pakistan, Lahore Zoo, Badshahi Mosque, Wazeer Khan Mosque, Golden Mosque, Shrine of Data Bakhsh, Shrine of Miran Shah, Anarkali Bazar, Walled city, Jallo Park, Alhamra Art Council, Shakir Ali Museum, Tombs of Allama Iqbal, Town Hall, Chouburji and the Zamzama in Lahore whereas Pipli Pahar, Old Mosque, Feroze Shah Tughlaq Palace, Hujra Shah Muqem, Shrine of Hazrat Muhammad Ghous, Gogera Sadar and Shergarh in Okara District.

5.12.6 Energy Sources

The transmission lines for electrical power run to a main grid substation at. The existing 132 kV Grid Station owned by LESCO, transmits power to the load centers. Reserves of fossil fuels the main sources of energy in Pakistan others are derived from hydropower. In the study area there is no source of hydropower and other energy sources are progressively more common further away from the major towns. The biomass sourcing is concentrated on home garden production of fuel wood, the extraction of wood from forests, woodland, crop plantations and agricultural residues.





The other significant energy sources in the area are kerosene and LPG. There are numerous petrol stations and LPG dealers in the district.

5.13 Social and Cultural Resources

5.13.1 Population Communities and Employment

The total population of Lahore district was 6,318,745 and Okara District was 2232992 as enumerated in March1998. As emerged from 1998 Census the population of district is predominantly Muslim, i.e. 93.9 per cent. The next higher percentage is of Christians with 5.8 points, followed by Ahmadis 0.2 per cent. While other minorities like Hindu (Jati), Scheduled Castes etc. are very small in number. The proportion of population of Muslims in rural and urban areas is 90.9 and 94.5 percent respectively. Christians are mostly living in rural areas representing 8.9 per cent as compared to 5.2 per cent in rural areas. Ahmadis in urban areas are 0.3 per cent and rural areas 0.1 per cent. The Hindu (Jati) is very small number in rural area. Also scheduled castes and others are in very small numbers. Punjabi is the predominant languages being spoken in the district, representing 86.2 per cent of the population, followed by Urdu, Pushto and Siraiki spoken by 10.2, 1.9 and 0.4 percent. Sindhi is spoken by 0.1 per cent.

Of the total economically active population 98.9 per cent were registered as employed in 1998. Nearly 52.6 per cent were self employed, 27.1 per cent private employees and 14.4 per cent government employees. Un-paid family helpers were recorded as 1.1 per cent. In 1998 of the total employed persons, 44.7 per cent had elementary occupations, followed by service workers and shop and market sales workers, 17.5 per cent, and professional, 9.2 per cent. In rural areas people having elementary occupations were again in majority, followed by skilled agricultural and fishery works and service workers and shop and market sales workers, represented 52.5, 23.7 and 8.4 per cent respectively.

The main occupation of women in rural areas of Lahore & Okara districts is house-keeping which includes attending to the cattle, extracting butter and Ghee from milk, weaving and sewing of family clothes. In addition they generally help their men-folk on farms with the lighter duties like transplanting of seedlings, threshing and winnowing of grains and sometimes they also help in harvesting. In city women are house-wives or work as professional's doctors, nurses, teaching and in offices.





5.13.2 Education and Literacy

The literacy ratio in the district has increased from 47.7 per cent in 1981 to 48.4 per cent in 1998. The literacy ratio for males is 69.1 per cent as against 59.7 per cent for females.

Lahore is an old first class seat of learning in Pakistan. The world famous and the oldest university of Pakistan i.e. University of the Punjab is located in this city. The pioneering University of Engineering and Technology is also in Lahore. There has been a significant development in the educational sector of this district. University of the Punjab has been extended and its new campus is constructed along the Lahore branch of Upper Bari Doab canal, This provides an ideal environment for teachers and taught in the green lush area surrounding by New Muslim Town. Wahdat Colony, PCSIR Colony, Faisal Town and Garden Town. There are also a number of government and private schools, colleges and technical institutes. Lahore is, therefore, rightly been called, by Pitras Bukhari an eminent scholar, the city of colleges and schools. Most of the colleges have boarding houses for their students who hail from interior Punjab and other parts of the country. Moreover the study of Business Management Commerce and Computer Technology is becoming very popular for the decade. Main medical colleges are the King Edward Medical College, the Allama Igbal Medical College and the Fatima Jinnah Medical College. The King Edward Medical College is the oldest medical college. These are producing doctors and other paramedical staff Schools. There is a middle school for girls and high school for boys across the road in front of DGS at 100m. Besides there are many Government and private schools and colleges located in Harbanspura and Shalimar at 1 and 2 km from the substation.

Number of educational institutions and their enrolment 1997-98 is given in the table below:-



Table: 5.19 Educational Institutions by Level of Education, 1997-98 (Lahore)

TANCO MATAKAKAN MENGANGAN PENGANGKAN PROPERTURAN PENGANGKAN PENGANGKAN PENGANGKAN PENGANGKAN PENGANGKAN PENGAN

Name of	Institute		Enrolment		Teaching Staff	
Institute	Male	Female	Male	Female	Male	Female
Primary	447	496	56,103	59,417	2,422	2,422
Middle	54	91	15,639	25,729	798	1,262
High/Secondary	119	114	82,521	90,551	3.194	3,363
Higher Secondary (Class XI-XII)	20	9	2,676	2,101	378	164
Intermediate and Degree Colleges	18	27	32.563	43,275	1,634	1,798
Intermediate Colleges	4	5	1,030	2,010	84	93
Degree Colleges	14	22	31,533	41,265	1,550	1,705
Mosque Schools	190	-	6,745	<u>.</u>	199	_
Total 866	764		228,310	255,348	10,259	10,807

Source: Punjab Development Statistics, Bureau of Statistics Punjab, 1999.

5.13.3 Health Facilities

Ample medical and health facilities are available in the Lahore Metropolitan Corporation area and its suburbs. Shaukat Khanum Hospital is the latest addition in the medical care facilities in Lahore for the most dangerous disease in the country i.e. cancer. There are also other hospitals of voluntary organizations which provide health cover to the general public. King Zaid Bin Sultan Hospital is also a very advanced addition in the medical care for Lahore. Among the prominent hospitals are General Hospital, Lady Aitcheson Hospital, Lady Wilingdon Hospital, Mayo Hospital, Fatima Jinnah Hospital, Services Hospital, Gulab Devi Hospital, Ganga Ram Hospital, Shalimar Hospital, Combined Military Hospital and Itefaq Hospital Fatima Memorial Hospital. Besides, a number of private medical practitioners, Hakims and Homeopathic doctors are also practicing in the city. Medical facilities i.e





Ghurki and Shalimar Hospitals located at10-15 km from the substation. There are many private clinics in Harbanspura at one km from DGS.

Table: 5.20: Number of Health Institutions with Bed Capacity, 1998 (Lahore)

Institution	Number	Beds
Hospital	42	11,529
Dispensary	140	68
Rural Health Centre	6	120
Basic Health Centre	37	74
T.B. Clinic	6	-
Sub-Health Centres	11	-
M.C.H. Centres	117	-
Total	359	11,791

5.14 Social Environment

This section deals with the social conditions of the Project Area. During the desk/ office study, available reports/ documents were comprehensively studied. During the field survey interviews with the residents, shopkeepers, students, pedestrians, drivers, and hospital employees were held and observations were taken after giving due consideration to the desk/ office study results.

5.14.1 Political and Administrative Setup

The project area falls in Lahore City of the Lahore District. District Co-ordination Officer is the highest ranked administrator of the district. For the collection of revenue and administration, the districts are subdivided into Tehsils. Local governments also administer the area through Union Councils and Tehsils. The total area of the district Lahore is 2,300 square kilometers.

5.14.2 Demographic Characteristics

The total population of Lahore District was 6,318,745 as enumerated in March 1998 with an intercensal percentage increase of 78.3 since March 1981 when it was 3,544,942 souls. The average annual growth rate of population in the district during intercensal period 1981-1998 was 3.5 percent. The total area of the district is 1772 square kilometers, which gives population density of 3,566 persons per square kilometer as against 2000 persons observed in 1981 indicating a fast growth rate of





the district. **Table 5.21** gives population, its intercensal increase and average annual growth rate since 1951 of Lahore district.

Table 5.21: Population and Intercensal Increase and Growth Rates

Description	1951	1961	1972	1981	1998
Population (in 000's)	1,135	1,626	2,588	3,545	6,319
Intercensal Increase (%)	43.3	59.2	37.0	78.3	_
Average Annual Growth Rate (%)	3.7	4.1	3.8	3.5	-

Source: DCR of Lahore District, 1998

5.14.3 Rural and Urban Distributions

The urban population was 5,209,088 or 82.4 percent of the total population of the Lahore district, which grew at an average rate of 3.3 percent during 1981-98. The growth decreased from 3.7 percent, which was observed during 1972-81. There are one Metropolitan Corporation, two Town Committees and one Cantonment in the District.

There were 261 Mauzas (a smallest revenue unit) in 1998. Of these 61 had population over 5 thousand, another 61 had 2 to 5 thousand, 64 had one to two thousand, and 74 had under one thousand persons while one was un-inhibited.

5.14.4 Religion

The population of the district is predominantly Muslims i.e. 93.9 percent. The next higher percentage is of Christians with 5.8 points followed by Ahmadis 0.2 percent. While other minorities like Hindu etc. are very small in number as shown in the **Table 5.22** given below:

Table 5.22: Percentage of Population by Religion and Rural/ Urban Areas

	Lahore District			
Religion	All Areas	Rural	Urban	
Muslims	93.9	90.9	94.5	
Christians	5.8	8.9	5.2	
Hindu	0	-	0	
Ahmadis	0.2	0.1	0.3	
Others	-		-	

Refers to a very small number

Source: DCR Lahore District, 1998





5.14.5 Ethnic Structure

The main castes and groups of the Lahore district are Arain, Jat, Rajput, Malik, Pathan, Mughal, Sheikh, Komboh and Gujjar. Besides, there are also village artisans, which include Lohars (blacksmiths), Tarkhan (carpenter), Kumhars (potters), Mochis (cobblers), Machhis (water-carries), barbers and weavers etc.

5.14.6 Language

The mother tongue refers to the language used for communication between parents and their children in any household. Punjabi is the predominant language being spoken by majority (86.2 percent) of the population of the district followed by Urdu, Pushto and Siraiki being spoken by 10.2, 1.9, and 0.4 percent. Sindhi is spoken by 0.1 percent.

5.14.7 Sex Ratio

Number of males for every 100 females was 111 percent recorded in 1998 Census in the district, which had decreased from 115 in 1981. The ratio was 112 percent in rural areas and it was 111 in urban areas.

5.14.8 Marital Status

The population above 15 years was classified into never married, married, widowed and divorced. 36.2 percent of the total population was never married, 58.6 percent married, 4.9 percent widowed and 0.3 percent divorced. The percentage share of never married male was higher than that of females, being 41.3 percent and 30.3 percent respectively. The percentage of never married females was higher in urban than in rural areas.

5.15 Socio-Economic Environment of the Proposed Project Site

For the social and cultural impacts of nomadic, semi-nomadic and settled inhabitants near the proposed project, the consultants undertook the selective questionnaires and interviews supplemented by personal observations. Profiles of the social organization and cultural patterns of the major nomadic, seminomadic and other settled social groups and their spatial distribution in the project area were done that are given below:

5.15.1 Cultivated Crops

The main crops which are being cultivated in project area i.e.; Wheat, potato, bitter gourd, ladyfinger, radish and pumpkin are some of the famous crops cultivated in this area.



5.15.2 Livestock

Buffalo, cow, sheep, goat and hen are common part of domestic livestock in the study area. However, no large cattle farm or poultry farm was observed near the site.

5.15.3 Social and Public Amenities Available

The social and public amenities present in the area are given below:

5.15.3.1 Physical Structures

This section elaborates the overall physical structures of proposed area is as follows:

5,15,3,2 Structures

There is no population found in the Project Area but the study area is semi populated. People in this area have no basic facilities like health, public transport etc. There are few educational institutes in the study area.

5.15.3.3 Industries

The Project Area is 10 kms away from industrial area.

5.15.3.4 Religious Structures

There is no religious structure near the proposed project area.

5.15.3.5 Protected Structures

According to the survey team, no historical, architectural or archaeological sites were found in the study area.

5.16 Stakeholder Consultation

General Social Impact Assessment (SIA) mainly involves the processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. These assessments can enable the project implementing authorities to not only identify social and environmental impacts, but also to put in place suitable institutional, organizational and project-specific mechanisms to mitigate the adverse effects. They can also aid in bringing about greater social inclusion and participation in the design and implementation stages of the project. The main types of social impacts that occur as a result of this project related changes can be grouped into five overlapping categories:

Lifestyle impacts

On the way people behave and relate to family, friends and cohorts on a day-to-day basis

Cultural impacts





On shared customs, obligations, values, language, religious belief and other elements which make a social or ethnic group distinct

Community impacts

On infrastructure, services, voluntary organizations, activity networks and cohesion

Quality of life impacts

On sense of place, aesthetics and heritage, perception of belonging, security and livability, and aspirations for the future.

Health impacts

On mental, physical and social wellbeing, although these aspects are also the subject of health impact assessment

5.16.1 Objectives of Stakeholder Consultation

The aims and objectives of public involvement and consultation of this project include:

- * To provide information related to proposed Project activities to stakeholders.
- * Allowing the public to express their views on the scope and content of an IEE (and the proposed development action).
- * Obtaining local and traditional knowledge (corrective and creative) before decision-making.
- * To seek for the participation of all interested parties and to identify stakeholders' interests and issues.
- * Ensuring that important impacts are not overlooked.
- Reducing conflict through the early identification of contentious issues.
- * Influencing project design in a positive manner (thereby creating a sense of ownership of the proposal).
- Identify all potential significant adverse environmental and social impacts of the project and recommend measures for mitigation;
- * Verify compliance with the environmental regulations and relevant standards;
- Identify problems (non-conformity) and recommend measures to improve the environmental management system;
- * Generate baseline data that will be used to monitor and evaluate the mitigation measures implemented during the project cycle.





Identify and quantify different categories of project affected people (PAPs)
 who would require some form of assistance, compensation, rehabilitation or relocation.

 Provide guidelines to stakeholders participating in the mitigation of adverse social impacts of the project.

5.16.2 Methodology

The methodology adopted for the purpose of socio-economic and heath assessment was based on general observation, interviews, questionnaires and recording of various parameters for the baseline information. Stakeholders were selected randomly for this process. Secondary data includes mode of transportation, education level and facilities, health facilities, water and sanitation facilities etc. Views of the people about the proposed project were collected by interviewing them using a semi structured questionnaire.

5.16.3 Classification of Stakeholders

One of the most common divisions is between primary and secondary stakeholders. The former consists of those whose interests can be affected directly by a decision on a proposed initiative (examples are local communities living in the Project Area). Secondary stakeholders consist of those who are not directly affected but may be indirectly affected and/or have an ability to influence the decision (examples might be international conservation NGOs or local/national media). Another classification divides stakeholders into internal and external groups. The former are those who are involved in the decision-making and the latter are those having interests that may be directly or indirectly affected.

5.17 Quality of Life Values

This section covers the social structure of this area. Consultants carried out a detailed survey in the project area and collected the desired information. Socioeconomic questionnaire was used as survey tool by the survey team to collect desired information. Graphical representation of results of socio economic survey is given below;

5.17.1 Occupation of Respondents

Majority of the respondents i.e. 45% were involved in agriculture and cattle rearing, 21% were job holders, 15% belonged to various industries, 14% with business and 5% with other occupations. During survey, efforts were made to interact with people





representing all walks of life. The detailed graphic representation of occupational status is given below:

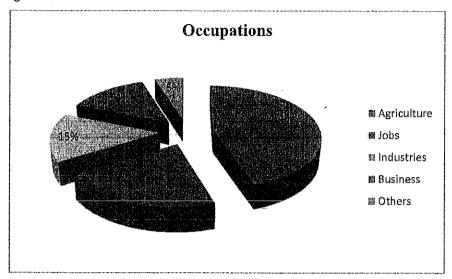


Figure 5.8 Graph Showing the Occupations of the people of Project Area 5.17.2 Income Level

5% respondents fall within the income range of 1,000-5,000, 45% respondents earn 5,000 - 10,000 while 15% are those who earn between 10,000-20,000, 21% of the respondents earn between 20,000-30,000 and 14% are those respondents who earn more than 30,000.

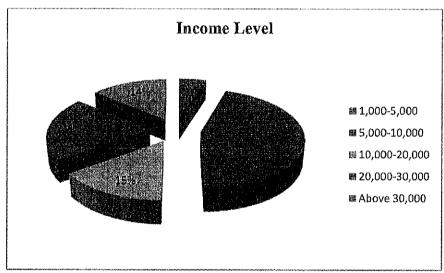
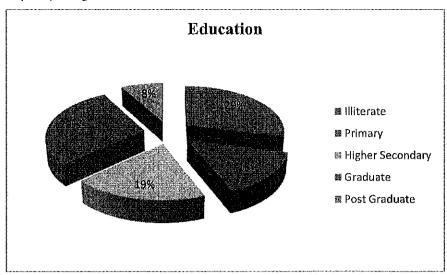


Figure 5.9: Graph showing the Income Levels of the people of Project Area 5.17.3 Education

From survey results, it was found that 29% population were illiterate, 15% were up to primary level, 19% were up to higher secondary level, 29% were graduate level and



8% were up to post graduate level.



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Figure 5.10: Graph showing the Education Level of the people of Project Area

5.17.4Health Facilities

There is no proper medical facility is available in or near the project area. Commonly, residents used to go to Lahore City for treatment.

5.17.4 Common Diseases

According to the survey the common diseases recorded in the project area were as, 7% Asthma, 18% Tuberculosis, 7% Skin infection, 18% Malaria, 11% Scabies and 18% Hepatitis.

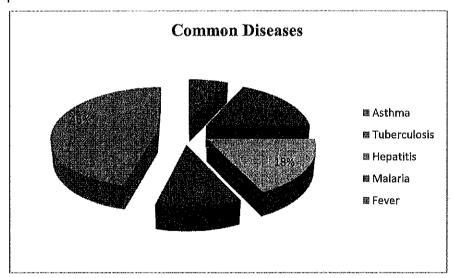


Figure 5.11: Graph showing the common diseases of the Project Area



5.17.5 Road Access

Plant site is about 1km away from the Lahore Ring Road.

5.18 Project Response

The majority people of the nearby communities are strongly in favor of the proposed project. They have the perspective of healthy future which will bring prosperity to their young ones. They also gave comments that these projects will pave the path of development. On the other hand, 8% of people seemed not satisfied with the projects. As they said that these project will bring disturbance to them. They were afraid that these tasks will never be done hence will create a lot of pollution and waste water. According to them, if mitigation measures would be provided and monitored then they would have no objection.

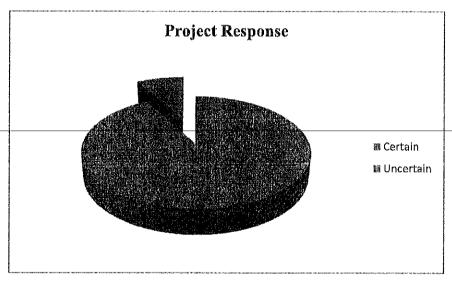


Figure 5.12 :Graph showing the percentage of people against and in favor of the proposed project

So we can conclude that if this project is not harming the natural environment, then this project is environment friendly and without any hesitation and deterioration under risk we can commence the project. This will enhance the development of the people and they will get desirable result.



PICTORIAL PROFILE OF PUBLIC CONSULTATION



Figure (a): Consultation with the gardener



Figure (b): Consultation with the school worker



Figure (c): Consultation with the local resident



Figure (d): Consultation with the school worker







Figure (e): Consultation with the Gurad



Figure (f): Consultation with the Guard



Figure (g): Consultation with the local resident

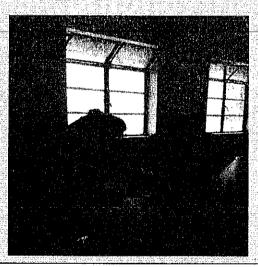


Figure (h): Consultation with a school worker







Figure (i): Consultation with the landfill worker



Figure (j): Consultation with the local resident

CHAPTER 6 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES





CHAPTER 6 POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The potential impacts of the proposed project on the area's geomorphology, surface and groundwater resources, air quality, biological resources, and socio-cultural environment have been discussed in this chapter. Where appropriate, mitigation measures have also been included to reduce the obnoxious impacts. Likely impacts that trigger the Environmental Management Plan (EMP), and accompanied mitigation measures have been identified in this IEE report. The proposed project activities would impact on the environment in three distinct phases:

- Design phase
- Construction phase
- Operational phase

6.1 Project Location

The proposed project site for Heat Incineration Waste to Energy Project is located adjacent to Lakhodair landfill site in the northeast of Lahore, Pakistan. The project site is of good external conditions and is far away from downtown. Access roads to the site are available.

6.2 Impacts during Design Phase

Some of the concerns to be considered during this phase are described below:

a. Layout and Design

Layout and design of the proposed project can have impacts on the environment if it is not prepared accordingly. It is necessary to consider a sustainable project approach. Detailed feasibility report has been prepared for the instigation of the proposed project. Proposed project conforms to national and international standards and guidelines.

Standards adopted for Design phase

Design phase has been analyzed on the basis of technical standards. Main technical standards and specifications adopted for the design are as follows:





Sr#	Design Standards	Code of Standards	
i.	Standard for Pollution Control on the Municipal Solid Waste Incineration	GB18485-2014	
ii.	Technical Code for Projects of Municipal Waste Incineration	CJJ90-2009	
iii.	Construction Standard for MSW Incineration Project	JB142-2010	
iv.	Code for Design of Small-size Power Plant	GB50049-2011	
V.	Technical Code for Municipal Solid Waste Sanitary Landfill	GB50869-2013	
vi.	Standard for Pollution Control on the Landfill Site of Municipal Solid Waste	GB16889-2008	
vii.	Land Use Indicator of Municipal Solid Waste Treatment, Water Supply and Sewage Treatment Projects	JB [2005] No.157	
viii.	Integrated Wastewater Discharge Standard	GB8978-1996	
ix.	Identification Standard for Hazardous Wastes-	GB5085.3-2007	
	identification for Extraction Toxicity		
Χ.	Solid Waste-Extraction Procedure for Leaching Toxicity- Acetic Acid Buffer Solution Method	HJ/T300-2007	
xi.	Standards for Pollution Control on the Storage and Disposal Site for General Industrial Solid Wastes	GB18599- 2001 (Revised in 2013)	
xii.	Standard for Pollution Control on Hazardous Waste Storage	GB18597-2001 (Revised in 2013)	
xiii.	Emission Standards for Odor Pollutants	GB14554-1993	
xiv.	Emission Standard for Industrial Enterprise Noise at Boundary	GB12348-2008	
XV.	Technical Rule for Designing Thermodynamic Control System for Fossil Fuel Power Plant	DL/T5175-2003	
xvi.	Various technical standards and specifications of other disciplines		





Environmental Mitigation Measures

- The design process should be carried out in recognition of identified hazards and risks assessment. Accepted design solutions should focus on maximum possible opportunity for risks reduction.
- Carry out engineering surveys including environmental surveys depending on the level of complexity and potential hazards of the planned facilities in the area of construction.
- Structural design specifications of proposed Waste to Energy plant are attached as Annexure M of IEE report.

b. Site Inspection

Site inspection is vital to commission any project. It is done to ensure the site is feasible to construct/install. Site investigation will be done for hydrological properties, geology, physical hazards for site development.

Environmental Mitigation Measures

- Care shall be taken if the site is present in any seismic zone or it is vulnerable to flooding and earthquake.
- According to the structure stability data of the proposed site, currently, no accurate earthquake parameters are available. According to the Pakistan local code *Building Code of Pakistan*, the project is located in Zone 2A of seismic zoning, and the peak acceleration is 0.08~0.16g; according to the parameters of Chinese earthquake resistance specification, earthquake fortification shall be carried out for 8 degree (0.2g) temporarily.
- Site-selection decisions shall take into account the risk of exposing human populations and vulnerable habitats to the hazards of toxic and flammable materials (if any).

c. Risk Assessment

The Project involves numerous risks affecting the project implementation. The project risks are summarized and generally can be divided into the following factors:

- 1. Risk factors in public resistance;
- 2. Risk factors of external and basic conditions of the Project;
- 3. Risk factors in market;





- 4. Risk factors in construction and organization;
- 5. Risk factors in safety and environmental protection;
- Risk factors in technical and design aspects.
 (Detail of Project Risks and their precautionary measures has been provided as *Annexure N* of IEE report.)

Environmental Mitigation Measures

- The project company shall make good works and get well with different parties, ensuring the project execution would not cause any conflict with local society or any risk after completion.
- Upon multi-aspect and multi-angle comprehensive analysis of the Project, it can be concluded that the risks are generally low within the controllable range and can be controlled within the affordable range through effective precautions and countermeasures.
- The risk identification and aversion shall be made as early as possible to solve any issue at the first time and eliminate hazards at the very beginning.
- The project company shall carry out systematic risk qualitative and quantitative analysis according to the construction progress.
- During analysis, it shall draw on the practice experience of foreign peer industry, invite relevant project stakeholders, and invite relevant industrial and specialized experts and scholars to participate in the key risk analysis.
- Once any safety or quality hazard occurs, it shall be reported to local government for coordination and solution as early as possible, to effectively reduce the social stability risk during project construction.

d. Cultural and Heritage Impact

No cultural attachment or heritage site exists near the proposed project areas. So there would be no impact on heritage and culture of that area due to project placement. 

1)



6.3 Impacts during Construction Phase

a. Dust

Major dust sources from construction activities include site clearance, excavation, loading and unloading activities at the stockpile areas, wind erosion and backfilling.

Environmental Mitigation Measures

- · Use of water sprays to decrease dust generation.
- Use of modern machinery, with adequate pollution control devices. Regular maintenance and inspection programs for all construction vehicles.
- Workers should be provided with Personal Protective Equipments (PPEs) such as face masks and goggles.
- The emissions will be regularly monitored by 3rd party.

b. Gaseous emissions

The potential sources of gaseous emission are exhaust gases from vehicles and machinery. These emissions can be oxides of sulfur, oxides of nitrogen, carbon monoxide, CO₂, and PM₁₀.

Environmental Mitigation Measures

- Monitoring of gaseous emission should be conducted on regular basis by 3rd party.
- Well maintained machinery should be used at site and its regular monitoring should be ensured.

c. Water Quality

Water quality (groundwater and surface water resources) can be disturbed during the construction activities i.e. by soil excavation, clearance, spillage of oils, lubricants, detergents and chemicals. There is no significant surface water resource on project site, however, River Ravi flows at an adequately far away distance from proposed site and there will be no impact on river water quality. However, to mitigate negative impacts on groundwater following improvement measures are suggested.

Environmental Mitigation Measures

 Protection of groundwater reserves from any source of contamination such as the construction and oily waste that will degrade its potable quality.





- Water required for construction is obtained in such a way that the water availability and supply to nearby communities remain unaffected.
- Regular water quality monitoring according to determined sampling schedule would be carried out.

d. Wastewater

Wastewater would be generated from construction activities and camp site.

Environmental Mitigation Measures

- The sewage system for wastewater shall be properly designed (pit latrines or, as required, sedimentation tanks) to receive all sanitary wastewaters prior to final disposal.
- Sanitary wastewater should be treated in sedimentation tank prior to final disposal.
- No hazardous untreated effluents shall be released to the environment.
- Wastewater sampling shall be conducted on monthly basis by 3rd party.

e. Soil Erosion

Soil erosion may occur due to excavation, clearing of vegetation and land leveling activities. Such activities can destabilize the surrounding land surface, particularly if the excavated area is left unfilled for long, which may lead to rainfall induced soil erosion.

Environmental Enhancement Measures

- Excavations would be kept confined to the specified spots as per the approved engineering drawings. Unnecessary excavations shall be avoided.
- All the unspent and left over materials shall be completely removed offsite upon completion of construction and the site should be restored to original or near to original condition.

f. Soil Contamination

 Leakages of oils, lubricants, chemicals, and other similar substances from their storage sites and from engines of the generators, machines and vehicles can spoil the soil and may undermine ability of the soil to support growth of vegetation and plants.





 Washing of the machinery and vehicles without proper drainage of the washout water can adversely affect the soil quality. This impact is, however, temporary and minor negative in nature.

 Onsite storage of the construction materials such as sand, aggregate, crushed stone, cement, bricks, lubricants, fuels and iron bars on the land without an intervening barrier, can degrade soil quality and may smear them with fine particulates of the dumped materials.

Environmental Mitigation Measures

- Wastes from construction activities shall be dumped in approved sites, in line with the legal prescriptions for dumpsites, and covered.
- Oils, lubricants, chemicals, and other listed hazardous materials shall be stored safely at their designated spots, enclosures or store rooms, which shall be safe from rainfall and away from any potential source of fire.
- Septic tanks of adequate capacities shall be constructed for receiving and treating wastewater from all temporary worksite toilets and at the temporary container offices, if any. The toilet wastewater shall not be discharged untreated onto the adjacent lands.

g. Noise

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Sources of noise during construction are heavy machinery such as bulldozers, excavators, stabilizers, concrete mixing plant, drills, stone crushers and other equipments. Noise generated by construction machinery is likely to affect sensitive receptors located within 50 meter of the proposed project area, however, there are no residential quarters near the proposed plant area, and the noise intensity will be attenuated as the distance increases. Therefore, the equipment noise will not affect the acoustic environmental quality. This impact is temporary and moderate negative in nature.

Environmental Mitigation Measures

- Selection of up-to-date and well maintained equipments with reduced noise levels ensured by suitable in-built damping techniques or appropriate muffling devices.
- Confining excessively noisy work to normal working hours in the day, as far as possible.





- Providing the construction workers with suitable hearing protection like earmuffs and training them in their use.
- Preferably, restricting construction vehicles movement during night time.
- Heavy machinery like percussion hammers and pneumatic drills shall not be used during the night without prior approval from the residents.
- Contractors shall comply with submitted work schedule, keeping noisy operations away from sensitive points, implement regular maintenance and repairs and employ strict implementation of operation procedures.

h. Solid Waste

Solid waste is generated during civil work. Solid inert waste found on construction site usually consists of building rubble, but may also include as demolition material, concrete, bricks, timber, plastic, glass and metals.

Environmental Mitigation Measures

- Solid waste generated during construction and camp sites shall be safely disposed in defined waste disposal sites and the contractor shall provide a proper waste management plan.
- The wastes which are reusable/recyclable (iron bars, aluminum) shall be sold to
 waste vendors and those which cannot be sold out (brick pieces) shall be used
 as a filling material for leveling the depressions, subject to technical feasibility.
- Training of working force in the storage, handling of materials and chemicals and transportation of hazardous material regarding emergency procedures.
- Construction workers and supervisory staff shall be encouraged and educated to practice waste minimization, reuse and recycling to reduce quantity of the waste for disposal.
- Open burning of solid waste shall be prohibited.

i. Biological Resources (Impacts on biodiversity)

Flora Fauna

The proposed Waste to Energy plant will be adjacent to already established wastelandfill site and no endangered species of fauna and flora are reported on or near this site. After rainfalls, wild growth of species of shrubs and herbs is observed.





Environmental Mitigation Measures

 All the necessary precautions will be taken to ensure the minimum disturbance to the local flora and fauna.

 Strict instructions given to all personnel working in project area to refrain from killing, capturing or disturbing any species of bird, reptile or mammal encountered during project activities, except in self-defense.

j. Socio Economic Impacts

The project would be beneficial from a socioeconomic viewpoint. Social impacts of the proposed project are as follows:

Displacement: No displacement of population is envisaged.

Employment: Primarily a positive impact, the project will create significant temporary employment for construction workers, equipment maintenance and support staff from surrounding areas. Reliance on local markets for provision of construction materials and other supplies will lead to a raise in income .Thus good amount of employment opportunities will be generated as well.

Health and Safety: There will be risk to the safety of workers and the public (if any) only if health and safety procedures are not properly adhered. The source of health nuisance during construction phase would be construction dust and noise, as these impacts are temporary. Safety management measures are attached as **Annexure O.**

Social Disputes: Social disputes, delays and disruptions are among the challenges faced in the course of executing projects. Interferences with the flow of work in the project are common disruptions. Some of the effects of delays are responsible for the time overrun, cost overrun, dispute, arbitration, total abandonment and litigation. However, no significant social dispute was observed at the project site.

Environmental Mitigation Measures

Following mitigations are recommended for the anticipated social impacts:

- Employment opportunities shall preferably be provided to the locals in case of new requirement, if any.
- Dust suppression methods such as wetting or slowing the work shall be employed as needed to avoid visible dust.





 Perform physical examination of the staff on a regular basis and establish the health records.

6.4 Impacts during Operational Phase

The open piling and landfill treatment of urban domestic waste occupies lots of land resources and more seriously, can produce bacteria, transmit disease, give off odor, pollute the environment and do damage to the human health. In order to protect the ecological environment, it is necessary to perform quantity reduction, harmless treatment and resourceful treatment to the urban domestic waste. Power generation by incineration of urban domestic waste is a way to solve the pollution of urban domestic waste and also a public welfare project to protect the environmental quality. The project can eliminate environmental pollution caused by domestic waste and generate electricity with the heat generated by incineration. However, the Project will also produce pollutants including flue gas, waste leachate, fly ash and slag. Impacts during operational phase and their mitigation measures are described below.

a. Air quality

During operational phase air quality can de deteriorated by the emissions of flue gas produced by domestic waste incineration and flue gas cleaning system. The main components of the flue gas produced during incineration are SO_X, HCl, NO_X and dust.

Sources of dust: The lime powder, activated carbon powder and ash required for incineration flue gas cleaning system may be raised or scattered, leading to dust pollution to the work environment; the fly ash emission of bag filter and transportation of materials in fly ash solidification station may cause harmful dust pollution to the workplace. The dust production points during the transportation of materials include fly ash stabilization plant: inlets of bins including lime bin, activated carbon bin, fly ash bin and cement bin and fly ash conveyor.

Sources of hazardous substances: The main hazardous substances of urban domestic waste incineration plant: include H_2S , ammonia, methyl mercaptan and marsh gas and dioxins.

Sources of marsh gas: Marsh gas will be produced during the fermentation of domestic waste. The main components of marsh gas are methane, carbon dioxide,





nitrogen, hydrogen, carbon monoxide and hydrogen sulfide. In addition, hydrogen sulfide will be produced during the treatment of leachate in waste bin.

Environmental Mitigation Measures

Measures to manage flue gas

- Flue gas would be managed by flue gas cleaning system. Flue gas cleaning process is determined to be "SNCR + Semidry Reaction Tower + Dry Powder Injection + Activated Carbon Adsorption + Bag Filter".
- In order to make sure that the pollution discharge standard can be satisfied under abnormal conditions, activated carbon shall be injected to the flue in front of the bag filter in flue gas cleaning system to achieve low temperature adsorption and remove the harmful factors including dioxins, which ensures the high purification efficiency of the whole system and makes the emission of dioxins be lower than 0.1ngTEQ/Nm³. Details of flue gas cleaning system are provided in *Annexure P*.

Measures to manage production of dioxins

• The economical and effective way to control the production of dioxins is "3T" technology, i.e. maintain the high temperature in incinerator (Temperature); extend the standing time of gas in high-temperature area (Time); strengthen the turbulence in incinerator to facilitate air diffusion and mixing (Turbulence). Under normal conditions, "3T" technology can make sure that the destruction and removal efficiency of dioxins is up to 99.99%. This is the internationally agreed technology to restrain dioxins ("3T" technology), which can effectively restrain the production of organic pollutants including dioxins.

The process parameters of urban domestic waste incineration adopted by the Project:

- ➤ The temperature inside the incinerator maintains at 850°C~950°C;
- ➤ The standing time of flue gas in high-temperature area (>850°C) of the chamber is longer than 2s;
- > The domestic waste in the combustion chamber is adequately mixed up.

Measures to manage Marsh Gas,

Since the waste bin, trench room and leachate collecting tank will produce marsh
gas and hydrogen sulfide, these places shall be airtight to prevent the leakage of





toxic and hazardous gas including marsh gas and hydrogen sulfide. The marsh gas produced during the treatment of leachate will be collected to the marsh gas storage tank and then led to the torch burner or incinerator.

• The waste bin, trench room and leachate collecting tank are provided with mechanical ventilation. Methane and hydrogen sulfide concentration detection and warning device shall be interlocked with the mechanical ventilation.

Measures to manage Dust

The equipment has its own dust collector of high efficiency of dust collection. The
collected dust will be discharged to the bins and scraper conveyor, and the filtered
air will be discharged to outdoor by the exhaust fan. The dust discharge
concentration shall be lower than 30mg/m³.

b. Wastewater

Sources of wastewater

Sources in the proposed project are mainly:

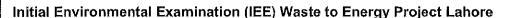
- 1. Production sewage mainly includes the waste water from flushing process equipment and ground of the main plant with sewage quantity of 7m3/d.
- 2. Domestic sewage includes wastewater discharged from toilets in complex building and main plant and the laboratory with sewage quantity of 19m³/d.
- Chemical water treatment station, the water for cooling boiler blow-off, the water for backwashing of deep phreatic water treatment station and the water for backwashing of non-valve filter of circulating water system.
- 4. Leachate

Environmental Mitigation Measures

ENFI has designed detailed drainage system for the treatment of wastewater. Some of the steps are described below:

Production sewage system

The collected sewage will flow to the domestic sewage pipe behind the septic-tank and will be discharged to the domestic sewage treatment station together with the domestic sewage. After being treated to grade II as specified in Integrated Wastewater Discharge Standard (GB8978-1996), the sewage will be merged with the





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water from leachate treatment station and will be discharged to the municipal sewage treatment plant.

Domestic sewage drainage system

The collected sewage will be discharged to the septic-tank in plant area and will be discharged to the sewage treatment station together with the production sewage after treatment. After being treated to grade I as specified in Integrated Wastewater Discharge Standard (GB8978-1996), the sewage will be merged with the water from leachate treatment station and will be discharged to the municipal sewage treatment plant. Details of Domestic Sewage Drainage System are attached as *Annexure Q*.

Clean water drainage system

The water is of high salt content and dust content and does not contain other contaminants, so it can be discharged directly to the rainwater pipe network of the plant area.

Rainwater drainage system

The initial rainwater from the garbage truck lane and approach viaduct will be discharged to the initial water collecting tank in the plant area after collection, and then will be discharged to the domestic sewage treatment station. The pipeline leading to the tank shall be equipped with changeover valve, which can be switched remotely after the effective volume of the tank is reached. The rainwater will be discharged to the municipal rainwater pipeline or flood-discharge trench outside the plant.

Leachate drainage system

Leachate collecting tank is set at the bottom of waste bin and 2 lift pumps are installed in the tank. The leachate from waste bin and the floor flushing water from unloading hall will automatically flow to the collecting tank and will be pumped to the adjusting tank of leachate treatment station. The volume of floor flushing water from unloading hall is 5m³/d, and it will be merged with the leachate. The maximum collection volume of leachate is 500m³/d.

Settling tank is set in the slag tank, in which 1 lift pump is installed. Under emergency condition, the hydrops will be pumped to the adjusting tank of leachate treatment station.





Details of leachate drainage system and engineering design are given as *Annexure R* of IEE report.

Odor

Since the urban domestic waste is of complicated composition and contains lots of organics, gas of various components along with stink after stacking for a certain period. The waste storage tank, waste crane, waste charging equipment and incinerator will produce odor due to storage of or contact with the waste; waste leachate will occur at the bottom of waste storage tank with odor and microorganism; even though the production is of enclosed and remote-controlled operation. Health of the personnel working here for a long time will be damaged if no proper preventive measures are taken. In addition, odor will also be produced during the anaerobic process and ammonia nitrogen stripping of waste leachate treatment.

Environmental Mitigation Measures

Deodorization

Generally, the deodorization can be achieved with the reasonable arrangement of function areas shown below:

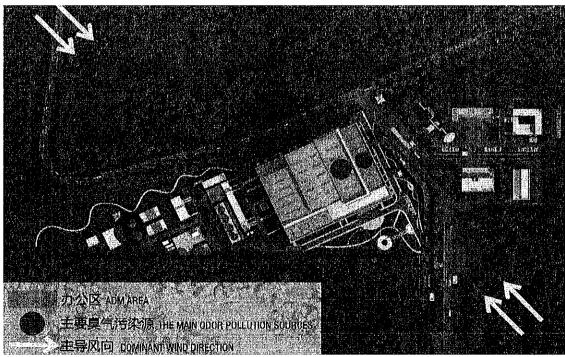


Figure 6.1: Deodorization diagram







Deodorization scheme under normal operation of incinerator

The main pollution factors in the waste bin are H₂S, NH₃ and methyl mercaptan, etc. The waste bin shall be of totally enclosed type to prevent odor from leakage. The air containing odorous substance will be extracted by the primary air fan of the incinerator through the exhaust inlet on the upper part of waste bin, and will be fed into the incinerator from the slag bucket at the bottom of the grate as combustion air. The odor pollutants will be burned and decomposed in the high-temperature incinerator.

Deodorization scheme during shutdown of the incinerator

The pressure in the waste bin is positive when the incinerator is shut down for maintenance. The H₂S, NH₃ and methyl mercaptan, etc. produced in waste bin will be discharged to activated carbon adsorption deodorization device by the air hose located on the upper part of waste bin. The exhaust gas will be adsorbed and purified by the activated carbon. Therefore, when the incinerator is shut down for maintenance, close the unloading door and start the deodorization device. A certain degree of negative pressure can be maintained in the waste bin. The odor pollutants will be adsorbed and purified by the activated carbon and then will be discharged to the atmosphere, so as to guarantee the air quality of the area where the incineration power plant is located.

It is difficult to collect the malodorous gas produced by the waste scattered by the waste transport vehicles in the unloading hall. Plant solution spray type deodorization device is provided above the unloading hall to decompose the malodorous gas through biological degradation. Meanwhile, air curtain will be provided above the entrance of unloading hall to cut off the indoor and outdoor air flow and prevent the contaminated air from escaping out.

In addition, the following measures will also be adopted to restrain the generation of odor such as closed waste transportation vehicle and frequently stirring of the waste to reduce the probability of anaerobic fermentation; cleaning the aged waste in the storage pit on a regular basis; providing by-pass pipe in the waste storage pit to exhaust air in case of accident and emergency and installing automatic unloading door to seal the waste storage pit.





Noise

Sources of strong noise in the main incineration plant are equipments such as blower, induced draft fan, secondary air fan, cooling fan, pumps, steam turbine. Secondary noise sources include hoist, water treatment equipment, flue gas cleaning equipment, slag conveyor and crane. In addition, steam discharging, steam blowing and pipe drainage will also produce noise.

Environmental Enhancement Measures

The following noise reduction measures are adopted for the Project:

- Noise index shall be indicated to the supplier when ordering mechanical equipment to reduce pollution source strength.
- Silencer shall be installed at the inlets of primary and secondary fans and the inlets of fans for start-up burner and auxiliary burner. Besides, exhaust steam silencer shall be installed on the exhaust steam pipe of waste heat boiler steam drum.
- Flexible coupling will be adopted for the connection between smoke flue, air flue and equipment and spring damper will be installed on the foundation of equipment including vibration slag conveyor to reduce vibration noise.
- Separate fan room shall be provided for the induced draft fan with high noise intensity for sound insulation with wall. It will make sure to arrange the air compressor station below the unloading platform and place the primary fan on the bottom layer in front of the incinerator.
- The central control room is equipped with double soundproof windows and double doors and acoustic material is adopted on the roof.
- The induced draft fan of incinerator has sound insulation and thermal insulation layer.
- Green plants will be used for sound absorption and noise reduction according to the function division.

After the noise reduction with the above measures, the noise level at 1m away from the sound source shall be < 85dB(A), and the noise at boundary shall satisfy the standard for category II (daytime: 60dB(A), nighttime: 50dB (A)) of *Emission Standard for Industrial Enterprises Noise at Boundary* (GB12348-2008).





High temperature

The surface temperature of waste heat boiler, steam turbine and boiler is high, which belongs to high-temperature operation place.

Environmental Enhancement Measures

- Being a high-temperature plant, the incineration plant adopts ventilation mode of natural air intake and mechanical air exhaust. The flue gas cleaning plant is equipped with general ventilation system. The ventilation mode of natural air intake and mechanical air exhaust will be adopted to discharge waste heat in summer; since the heat release of the condensing steam turbine generator in steam turbine room, deoxygenization room and heat distribution pipeline is of large amount, so the ventilation mode of natural air intake and mechanical air exhaust will be adopted.
- Safety isolation measures will be adopted for the arrangement of all equipment, which is convenient for maintenance and ensures personal safety. Thermal isolation will be adopted for the thermal component that the surface temperature is 25°C higher than the environment temperature (measured at 1m away from the measuring point) to make sure that the surface temperature after thermal insulation will not exceed 50°C and prevent the personnel from being scalded.
- Ventilation mode of natural air intake and mechanical air exhaust is discussed in depth in *Annexure S* covering following aspects:
 - ✓ Ventilation of incineration plant
 - ✓ Ventilation for waste heat Turbo Generator Building.
 - ✓ Ventilation of waste leachate collecting chamber
 - ✓ Ventilation of other rooms

Hazardous Solid Waste

During operational phase sources of hazardous solid waste include; slag, broken bags from the bag filter of incineration flue gas cleaning system, mud cake which is produced by leachate treatment and fly ash which is the residue collecting from flue gas cleaning system and mostly contains heavy metals, dioxin and other characteristic pollutants, so fly ash can be considered to hazardous waste.





Environmental Enhancement Measures

- As per law the waste has to be disposed of properly through certified vendor. All
 the ash from WtE would be dumped in landfill site.
- The slag left after combustion shall be delivered into the slag transmission system through slag remover. Details of slag removing system are attached as Annexure T.
- The slag produced by incineration of urban domestic waste can be used as building material. However, for this project, it will be sent to the nearby landfill site.
- Broken bags will be replaced annually.
- A temporary warehouse for hazardous wastes, with the area of 8~10m² and volume of 30~40 m³ shall be designed under the unloading platform according to Standard for Pollution Control on Hazardous Waste (GB18597-2001) to store the broken bags temporarily, which shall be disposed by a qualified hazardous wastes disposal unit.
- The mud cake will be conveyed back to the incinerator for disposal.
- Fly ash will be stabilized and sent directly by enclosed vehicle to landfill site nearby. Fly ash stabilization process is attached as *Annexure U*.

Worker's Health and Safety

Proposed project is intended to reduce environmental pollution at all levels by adopting latest air control technology, leachate treatment system, noise control measures etc. These measures are likely to reduce the health impacts on the workers. Other measures for labor hygiene are given below.

a. Hygiene of water supply

The domestic water is from city tap water and the water quality satisfies the requirements of *Punjab Environmental Quality Standards (PEQS)* for *Drinking Water Quality*.

b. Lighting

Normal task lighting and emergency lighting are design for the plant according to the requirements of specification for lighting design of power plant. High-efficiency energy-saving lamp is adopted for task lighting, high-efficiency gas discharge lamp is





adopted for the main plant and energy-saving fluorescent lamp is adopted for office to protect the eyesight of workers. The high and low voltage distribution rooms and main incineration plant are equipped with emergency lighting switching box to automatically switch the power supply to DC bus in case of accident to ensure the lighting of important places and channels. The duration of emergency lighting is 1h to ensure uninterrupted work or the safety of personnel evacuation when fault occurs to the normal lighting system. The auxiliary plants away from the main incineration plant shall adopt emergency lamps for emergency lighting; AC24V or 12V portable lighting transformer shall be provided for safety lighting for maintenance.

Metal halide lamp shall be adopted for tall and large plants including incineration plant, steam turbine room and waste bin. Fluorescent lamp is adopted for the main control building and complex building. Water and dust proof light is adopted for general plants. One-piece street lamp is adopted for roadway lighting.

c. Sunstroke prevention

If the ambient temperature is higher or lower than the given temperature for a certain range, this will cause harmful effects on human body. In order to prevent sunstroke, separate type air conditioner is used in all the control rooms and office facilities for comfortable air-conditioning. The purpose is to improve the work environment of the staff.

d. Periodic physical examination

Perform physical examination to the staff on a regular basis and establish the health records. Safety measures are elaborated in *Annexure O* attached with IEE report.

e. Fire Emergency Response

In *Annexure H* a detailed fire protection plan is discussed and it covers all different aspects including:

- Fire protection of buildings and facilities
- Firefighting system
- Automatic fire alarm and interlocking system
- Firefighting smoke exhaust system
- Power supply for fire-fighting
- Fire prevention measures





Table - 6.1: Impact Assessment for the Proposed Project

Factor	Impact
	Assessment
Any environmental impact on a community?	Detailed EMP has been developed for potential impacts.
Any transformation of a locality?	Yes - The tanks will physically transform the locality
Any environmental impact on the ecosystems of the	No
locality?	
Any reduction of the aesthetic, recreational, scientific or	No
other environmental quality or value of a locality?	
Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural,	No
cultural, historical, scientific or social significance or	
other special value for present or future generations?	
Any impact on the habitat of any protected fauna	-No-
(within the meaning of the National Parks and Wildlife	110
Act 1974)?	
Any endangering of any species of animal, plant or	No
other form of life, whether living on land, in water or in	
the air?	For potential
Any degradation of the quality of the environment?	environmental impacts EMP has been developed.
Any risk to the safety of the environment?	Detailed EMP has
Any reduction in the range of beneficial uses of the	been developed
environment?	No
Any environmental problems associated with the	No – The
disposal of waste?	management of waste is as per
	current operations
Any increased demands on resources (natural or	No





otherwise) which are, or are likely to become, in short	
supply?	
Any cumulative environmental effect with other existing	No
or likely future activities?	

Table 6.2: Impact Matrix

Activity	Positive	Impact	Negative	e Impact	No
	Short	Long	Short	Long	Impact
	Term	Term	Term	Term	
	Pre-	Project Ac	tivity		
Displacement and		<u> </u>			~
resettlement of local		:			
people					
Change in land use					V
Loss of	¥				
trees/vegetation					
Shifting of equipment,					~
machinery and					
material					
Employment for local		~			
people					
	Con	struction F	hase		l .
Pressure on			7	<u> </u>	
infrastructure and					
transportation system					
Impact on air quality			7		
including dust					
generation					
Noise Pollution			7		
Traffic					~





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Impact on the land/soil			¥		
environment					
Impact on			~		
groundwater	. .				
Stacking and disposal			4		
of construction					
material					
Impact on water		 	~		
quality					
Health and safety			✓		
conditions of people					
Social impact	V				
Economic impact	٧				
	Ope	ration Pha	se	J	L
Increase in air				V	
pollution and noise					
levels					
Disposal of solid					~
waste			3		
Infrastructure		¥			
development					
Quality of life		-	~		
Fly ash/ slag		 		~	





Table 6.3 Impact Significance

	Public	Health	ంర	Safety		-
RIANGE	Urban	Aesthetics				٢
SOCIAL IMPORTANCE	Urban	Congestion				7-
	Disturbance	to Other	Services			
ECOLOGICAL Mprotance	Destruction Disturbance Disturbance Urban	Hazards of Habitat / to local to Other Congestion Aesthetics Health	fauna			-2
ESOLO	Destruction	of Habitat /	Vegetation fauna			-2
	Fire	Hazards				1
	Smell	ళ	Smoke			۲
MINTER STANDARF	Noise Solid Smell	Waste &				₹***
	Noise					den.
	Air	Quality				 -
	Surface Air	and	Ground	Water	Quality	¢

1 = Moderate Negative Impacts are defined as Less significant adverse impacts that may be easily prevented or mitigated -1 = Major Negative Impacts are defined as significant, or adverse impacts -2 = This category serves no impacts from project 2 = Minor Negative Impacts are considered as likely to have minimal

CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN





CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN

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This chapter provides an overall approach for managing and monitoring environment and social issues and describes the institutional framework and resource allocations to implement the Environmental Management Plan (EMP) for the proposed project.

7.1 OBJECTIVE OF ENVIRONMENTAL MANAGEMENT PLAN

An Environmental Management Plan provides a mechanism to address the adverse environmental impact of a project during its construction and operational stage, enhance project benefits and to introduce standards of good practice for all project works.

The objectives of the EMP are to:

- Define the responsibilities of the project proponents, contractors, supervision consultants and environmental monitors.
- Facilitate the implementation of the mitigation measures identified in the IEE.
- Define a monitoring mechanism and identify monitoring parameters.
- Provide a procedure for timely action in the face of unanticipated environmental situation.
- Identify training, requirements at various levels.





7.2 COMPONENTS OF EMP

Components of a	n Environmental Management Plan (EMP)
Summary of impacts	The predicted adverse environmental and social impacts for which mitigation is required should be identified and briefly summarized.
Description of mitigation measures	Each mitigation measure should be briefly described with reference to the impact to which it relates and the conditions under which it is required (for example, continuously or in the event of contingencies). These should be accompanied by, or referenced to, project design and operating procedures which elaborate on the technical aspects of implementing the various measures.
Description of monitoring program	The monitoring program should clearly indicate the links between impacts—identified—in—the—IEE—report—and—their—monitoring—parameters to be measure where appropriate.
Institutional arrangements	Responsibilities for mitigation and monitoring should be clearly defined, including arrangements for co-ordination between the various actors responsible for mitigation.
Implementation schedule	The timing, frequency and duration of mitigation measure should be specified in an implementation schedule, showing links with overall project implementation.
Cost estimates (Environmental budget)	These should be specified for both the initial investment and recurring expenses for implementing all measures contained in the EMP, integrated into the total project costs.





7.2.1 Institutional Capacity

Implementation of EMP is the responsibility of Lahore Xingzhong Renewable Energy Company (Private) Limited, contractor and subcontractor personnel. This section provides institutional arrangements for environmental management during the proposed activity and defines the roles and responsibility of the various Organizations/departments. The responsibilities of different organizations/departments are summarized below:

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Lahore Xingzhong Renewable Energy Company (Private) Limited

Responsibility of Proponent includes the following:

- Must take ownership of the process to ensure that its responsibilities are met.
- Supervising construction works.
- Schedule preparation and resource forecasting for engineering and other technical activities relating to the project.

Contractor

The contractor of construction activities will be responsible for:

- Develop and review work instructions and procedures.
- Review and improve method statements for environmental aspects prior to work starting.
- Monitor construction activities to ensure that control measures are effective and ensure compliance with the EMP.
- Coordinate with construction teams to ensure that environmental risks are identified and appropriate controls are developed.
- Coordinate environmental training for site personnel and subcontractors.
- Liaison with the project's environmental manager, and project public liaison officer.
- Ensure correct procedures are followed in the event of an environmental incident.
- Maintain training register, identify training needs and provide training where required.

Sub-contractor

It is projected that a number of sub-contractors will be contracted to assist the main construction contractor in the main constructions activities and or supply equipment and materials. These sub-contractors will be required to:

Subscribe to the Goals and Objectives Environmental Management Plan.





- Comply with all of the negotiated Construction Contractor requirements.
- Comply with the contractor policies, procedures and systems.
- Report to the Contractor Environmental Health and Safety Team any-
- Incident/accident and the corrective action undertaken.
- Participate in training, induction programs and review programs as required.

EIA/IEE Expert

EIA/IEE Expert (Environmental Specialist) is the member of the supervising consultant's team. The responsibilities of EIA/IEE Expert include:

- Work with proponent to ensure all statutory environmental submissions under PEPA 1997 (Amended 2012) and other environmentally related legislation are thoroughly implemented.
- Work with proponent to ensure all environmental requirements and mitigation measures from the environmental assessment of the proposed project are included in the contract prequalification and bidding documents.
- Work with proponent to execute any additional IEE requirements needed due to fine tuning of the proposed project and that environmental performance targets are included in the contracts prior to project commencement.
- Work with contractors to manage and monitor the implementation of the project EMP.

7.2.2 Training Schedule

Lahore Xingzhong Renewable Energy Company (Private) Limited and contractor will be responsible for providing health and safety training, and briefing environmental requirement of the project o workers and its staff before the commencement of work. Training workshops should be conducted at every six months or twice each year to share the monitoring report on the implementation of the EMP, to share lessons learned in the implementation and to decide on remedial actions, if unexpected environmental impacts occur.

7.2.3 Summary of Impacts and Mitigation Measures

This section outlines the summary of potential impact on the physical, biological, and socioeconomic environment of the proposed scheme impacts and their mitigation measures. The summary is explained in Environmental Management Plan (EMP).





7.3 ENVIRONMENTAL MANAGEMENT PLAN

Guidelines for the implementation of Environmental Management Plan indicated in IEE of proposed project will cover:

- List of mitigation measures which will be directly covered by the environmental consultants under civil or mechanical work.
- The person(s) responsible for ensuring the implementation of the measures.
- The parameters to be monitored for the effective implementation of measures.
- A time scale for the implementation of measures to ensure that the objectives
 of mitigation plan are fully met.

The details of EMP are given in Table 7.1 in the form of a matrix. The impacts have been classified into those relevant to the design/preparation stage, construction stage and operation and maintenance stage. The matrix provides details of the mitigation measures recommended for each of the identified impacts, time span of the implementation of mitigation measures, monitoring program and the responsibility of the institution. Estimated cost for environmental monitoring is described in Table 7.2.

TABLE - 7:1 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

Monitoring	program		t						-				
Implementation	schedule (Time/frequency)		During preliminary	surveys and	investigations				During preliminary	surveys and	investigations		
Implementing	entity		Lahore	Xingzhong	Renewable	Energy	Company	(Private) Limited	Lahore	Xingzhong Renewable	Energy	Company	(Private) Limited
Mitigation measures			Design combined process of semi-dry	process + active carbon spraying + bag filter					Design of SNCR system (Selective non-	catalytic reduction method)			
Potential impact/or	issue :		Air pollution Design	brocess	system				NOx emission Design	catalyti			
Impact factor			Air quality						Air quality				
Tem		Design Stage	Design of flue gas	treatment system					Design of NOx	removal system			



ı	Monitoring
During preliminary surveys and investigations	Implementation schedule (Time/frequency) During preliminary surveys and investigations
Lahore Xingzhong Renewable Energy Company (Private) Limited	Implementing entity Lahore Xingzhong Renewable Energy Company (Private) Limited
Design of odor prevention system such as wind curtains at entrance and exit of MSW discharging hall, the MSW storage will be designed as entirely closed, and maintain at negative pressure state. The top is to be installed with extraction openings of primary wind and secondary wind with filter devices, and it is to suction odorous gases into the incinerator as combustion air for the incinerator, so as to prevent escape of odors.	Witigation measures Design of "vertical flow settling tank→adjusting tank→anaerobic system→anaerobic effluent settling tank→A(anoxia)/0(aerobic)→secondary mitrification→secondary denitrification→membrane bioreactor (MBR)→nanofiltration (NF) membrane treatment system (up-to-standard
Odor escape from various places	Potential impact for issue Wastewater discharge
Odor	Impact factor
Design of odor escape	Trem Design of leachate collection and treatment



F

			guarantee)".		:	
Design of fly ash	Solid waste	Solid waste impact	Slag will b	Slag will be entirely sold as raw material	Lahore	During preliminary
and slag collection			for brick plants;	ants;	Amgzhong Renewable	surveys and
and treatment			• According	According to the MSW incineration fly	Energy	investigations
			dust leachi	dust leaching toxicity identification	Company (Private) Limited	
			report in th	report in the actual production of the	,	
			proposed p	proposed project, solidified fly dusts will		
			be directly	be directly sent to LWMC MSW		
			Landfill for	Landfill for landfill or transported to		
			eligible dan	eligible dangerous wastes disposal		
			agency for	agency for final disposal		
Water quality	Water quality and	Pipe burst	Design of pipe	Design of pipe materials and connections	Lahore	During preliminary
	public health		must be adequa	must be adequate to prevent pipe burst.	Xingzhong Renewable	surveys &investigations
					Energy	
					Company (Private) Limited	
ltem.	Impact factor	Potential impact/or	W	Mitigation measures	Implementing	Implementation Monitoring
		issue			entity	schedule program
					No. 100	(Time/frequency)
Climate	Climate change	Air pollution, odor	Take into accou	Take into account energy efficiency, energy	Lahore	During preliminary
		emission and water	сопѕетуацоз	conservation and low GHG emissions in all	Xingzhong Renewable	surveys and
		pollution	building and sy	building and systems designs and equipment	Energy	investigations
			selection for the	selection for the wastewater pump stations.	Company (Private) Limited	
Pre-construction Stage	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6				200 (C)	
Institutional	1	Lack of environmental and social	• Appoint qua	Appoint qualified environment and social	LWMC	During staff induction -



	ion	ion -	n Monitoring program	site/ -
and ongoing	During staff induction and ongoing	During staff induction and ongoing	Implementation schedule (Time/frequency)	Prior moving onto site/ On site Feedback
	LWMC	LWMC	Implementing entity	LWMC
specialist on staff within Lahore Xingzhong Renewable Energy Company (Private) Limited and environmental and social unit Contract Environmental and social officer (E&S officer); Conduct environment management training.	Contract a 3 rd party Lab to conduct project impact monitoring during construction.	 Contract a 3rd party Lab to conduct project impact monitoring during the operational stage. 	Whigation measures	 Put into tender documents dust suppression measures: Water unpaved areas, backfill areas and haul roads 7-8 times each day; Erect hoarding around dusty activities;
management capacities within Lahore Xingzhong Renewable Energy Company (Private) Limited and environmental and social unit	Lack of environmental	and social monitoring capability and qualification	Potential impact/or issue	Dust impact to sensitive receptors
	1		Impact factor	a) Air quality
strengthening			Jem.	Tender documents



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ıle	និព្		tion			50		cks		thy			ach		931		sty	exits				thy		
Strengthen the management of stockpile	areas with frequent watering or covering	with tarpaulin;	Minimize the storage time of construction	and demolition wastes on site by	regularly removing them off site;	De not overload trucks for transporting	earth materials to avoid spilling dusty	materials onto public roads. Equip trucks	for transporting earth materials with	covers or tarpaulin to cover up the earthy	materials during transport;	Install wheel washing equipment or	conduct wheel washing manually at each	exit of the works area to prevent trucks	from carrying muddy or dusty substance	onto public roads;	Immediately cleanup all muddy or dusty	materials on public roads outside the exits	of the works areas;	Sensibly plan the transport routes and	time to avoid busy traffic and heavily	populated areas when transporting earthy	materials;	



construction to prevent dust and soil erosion. Odor impact to Put into tender documents that the transport of sensitive receptors MSW from the site of origin to the plant site must be in sealed containers. In Noise impact to Put into tender documents the following noise sensitive mitigation measures: receptors - Use quiet equipment; Adopt good O&M of machinery; Adopt good O&M of machinery; Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Wastewater impact on measures to treat wastewater and runoff from wastewater impact on measures to treat wastewater and runoff from wastewater impact on measures to treat wastewater and runoff from wastewater impact on measures to treat wastewater and runoff from wastewater impact on measures to treat wastewater and runoff from wastewater bodies construction sites: Provide portable toilets or small package WWWTPs for workers and canteens Provide portable toilets or small package WWTPs for workers and canteens Install sedimentation tanks on-site to treat			Immediately plant vegetation in all			
construction to prevent dust and soil erosion. Odor impact to RSW from the site of origin to the plant site must be in sealed containers. Noise impact to Put into tender documents that the transport of must be in sealed containers. Put into tender documents the following noise sensitive "Use quiet equipment, "Adopt good O&M of machinery, "Adopt good O&M of machinery, "Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; wastewater impact on measures to treat wastewater and runoff from water bodies "Provide portable toilets or small package WWTPs for "WWTPs for "Norses and canteens "Install sedimentation tanks on-site to treat			temporary land areas upon completion of			
Odor impact to Put into tender documents that the transport of sensitive receptors Noise Noise impact to Put into tender documents that the transport of must be in sealed containers. Put into tender documents the following noise sensitive mitigation measures: receptors • Use quiet equipment; • Use temporary hoardings or noise barriers to shield off noise sources; • Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; wastewater impact on measures to treat wastewater and runoff from construction sites: • Provide portable toilets or small package WWTPs for • Workers and canteens • Install sedimentation tanks on-site to treat			construction to prevent dust and soil			
Odor impact to RISW from the site of origin to the plant site must be in sealed containers. Noise impact to Put into tender documents that the transport of must be in sealed containers. Put into tender documents the following noise sensitive mitigation measures: • Use quiet equipment; • Use temporary hoardings or noise barriers to shield off noise sources; • Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; wastewater impact on water bodies • Provide portable toilets or small package WWTPs for • Wonkers and canteens • Install sedimentation tanks on-site to treat			erosion.			
Noise sensitive receptors Noise impact to Put into tender documents the following noise sensitive mitigation measures: receptors • Use quiet equipment; • Adopt good O&M of machinery; • Use temporary hoardings or noise barriers to shield off noise sources; • Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from construction sites: • Provide portable toilets or small package WWTPs for • Workers and canteens • Install sedimentation tanks on-site to treat		Odor impact to	Put into tender documents that the transport of	LWMC	Prior moving onto site/	ı
Noise impact to Put into tender documents the following noise sensitive mitigation measures: receptors • Use quiet equipment, • Adopt good O&M of machinery; • Use temporary hoardings or noise barriers to shield off noise sources; • Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; wastewater impact on measures to treat wastewater and runoff from construction sites water bodies construction sites: • Provide portable toilets or small package WWTPs for workers and canteens • Install sedimentation tanks on-site to treat		sensitive receptors	MSW from the site of origin to the plant site		On site Feedback	
Noise impact to Put into tender documents the following noise sensitive mitigation measures: receptors • Use quiet equipment; • Use temporary hoardings or noise barriers to shield off noise sources; • Winimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site Put into tender documents the following measures to treat wastewater and runoff from construction sites: • Provide portable toilets or small package WWTPs for • workers and canteens • Install sedimentation tanks on-site to treat			must be in sealed containers.			
receptors • Use quiet equipment, • Adopt good O&M of machinery; • Use temporary hoardings or noise barriers to shield off noise sources; • Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site Put into tender documents the following measures to treat wastewater and runoff from construction sites: • Provide portable toilets or small package WWTPs for • workers and canteens • Install sedimentation tanks on-site to treat		Noise impact to	Put into tender documents the following noise	LWMC	Prior moving onto site/	ı
 Descriptions Adopt good O&M of machinery; Use temporary hoardings or noise barriers to shield off noise sources; Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site Put into tender documents the following measures to treat wastewater and runoff from construction sites: Provide portable toilets or small package WWTPs for workers and canteens Install sedimentation tanks on-site to treat 		sensitive	mitigation measures:		On site Feedback	
Adopt good O&M of machinery; Use temporary hoardings or noise barriers to shield off noise sources; Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site wastewater impact on measures to treat wastewater and runoff from construction sites: Provide portable toilets or small package WWTPs for workers and canteens Install sedimentation tanks on-site to treat	-	receptors				
Use temporary hoardings or noise barriers to shield off noise sources; Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from construction sites: water bodies Provide portable toilets or small package WWTPs for workers and canteens workers and canteens Install sedimentation tanks on-site to treat						
Minimize night time construction. If night time construction is needed, consult and notify local communities beforehand; Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from construction sites: WWTPs for workers and canteens workers and canteens modese water and runoff.			Use temporary hoardings or noise barriers			
Water quality Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from construction sites: Put into tender documents the following water bodies construction sites: Put into tender documents the following water bodies construction sites: Provide portable toilets or small package WWTPs for workers and canteens Install sedimentation tanks on-site to treat			to shield off noise sources;			
Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from water bodies Onstruction sites: Put into tender documents the following water bodies Provide portable toilets or small package WWTPs for workers and canteens Install sedimentation tanks on-site to treat						
Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from vater bodies construction sites: • Provide portable toilets or small package WWTPs for • workers and canteens • workers and canteens			time construction is needed, consult and			
Water quality Construction site Put into tender documents the following wastewater impact on measures to treat wastewater and runoff from construction sites: • Provide portable toilets or small package WWTPs for • workers and canteens • workers and canteens			notify local communities beforehand;			
mea cons		Construction site	Put into tender documents the following	LWMC	Prior moving onto site/	1
COUR	····	wastewater impact on	measures to treat wastewater and runoff from		On site Feedback	
		water bodies	construction sites:			
						,
			WWTPs for			
thought and the state of the st						
דוחדתן נחזחון אווים דאומין אווים דווים דוו			process water and muddy runoff			



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	,	Menitoring program	Quarterly
Prior moving onto site/ On site Feedback	Prior moving onto site/ On site Feedback	Implementation schedule (Time/frequency)	Throughout Construction Phase
LWMC	LWMC	Diplementing	Contractor
Specify in tender documents the spoil disposal or storage sites and that only these sites could be used	Specify in tender documents the provision of personal safety and protective equipment such as safety hats and shoes, eye goggles, respiratory masks, . to all construction workers as well as responsibility of contractors to comply with national labor standards (minimum wages, insurance,) and core labor standards (prohibition of child labor, bonded labor, and non-discrimination)	Mitigation measures	Frequent watering of unpaved areas, backfill areas and haul roads; Erect hoarding around dusty activities;
Specify in t or storage s be used	Specify in the personal seal as safety has respiratory workers as contractors standards (to core labor standards bond)		Frequer backfill Brect hc
Disposal or storage of excavated spoil	Occupational health & safety of workers Compliance with labor standards (national and core labor standards)	Potential impact/or issue	Dust during construction
d) Solid waste	e) Labor, health &safety	Impact factor	a) Air quality
		Item Construction Stage	Construction site



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 Strengthen the management of stockpile 	areas with frequent watering or covering	with tarpaulin;	 Minimize the storage time of construction 	and demolition wastes on site by regularly	removing them off site;	 Do not overload trucks for transporting 	earth materials to avoid spilling dusty	materials onto public roads;	 Equip trucks for transporting earth 	materials with covers or tarpaulin to cover	up the earthy materials during transport;	 Install wheel washing equipment or 	conduct wheel washing manually at each	exit of the works area to prevent trucks	from carrying muddy or dusty substance	onto public roads;	 Immediately cleanup all muddy or dusty 	materials on public roads outside the exits	of the works areas;	 Sensibly plan the transport routes and time 	to avoid busy traffic and heavily populated	areas when transporting earthy materials;	• Immediately plan vegetation in all



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		temporary land take areas upon			
		completion of construction to prevent dust	prevent dust		
		and soil erosion.			
b) Noise	Noise from construction	· Sensibly schedule construction activities,	activities, Contractor	or During Construction	Quarterly
	machinery and vehicles	avoid noisy equipment working	ad	Phase	
		concurrently;			
		Select advanced quiet equipment and	ent and		
		construction method, and tightly control	ly control		
		the use of self-provided generators;	ttors;		
		Comply with local requirements in areas	ts in areas		
		with sensitive receptors very close by. If	lose by. If		
		night time work is needed, set up	ďn		
		temporary noise barrier, minimize use of	nize use of		
		noisy equipment, and consult and notify	and notify		
		local communities beforehand;			
		• Coutrol speed of bulldozer, excavator,	cavator,		
		crusher and other transport vehicles	iicles		
		travelling on site, adopt noise reduction	reduction		
		measures on equipment, strengthen	ythen		
		equipment repair and maintenance to keep	unce to keep		
		them in good working condition;	,m;		
		• Limit the speed of vehicles travelling (less	velling (less	·	
		than 20 km/hr), forbid the use of horns	of horns		
		unless absolutely necessary, minimize the	inimize the		



			use of whistles;			
	c) Water quality	Construction site	 Domestic and cafeteria wastewater will go 	Contractor	Throughout	Quarterly
		wastewater	to sedimentation tank before final		Construction Phase	
		discharge	disposal to sewage treatment facility			
			 Timely cleanup scattered materials on site, 			
			stockpiles must adopt measures to prevent			
			being washed into water bodies by rain			
			water;			
			Reuse equipment and wheel wash WW for			
			dust suppression;			
	d) Solid waste	Construction site refuse	Transport construction waste in enclosed	Contractor	During Construction	During routine
		and spoil	containers;		Phase	топтопт
		disposal	 Establish enclosed waste collection points 			
			on site, with separation of domestic waste			
	2000	· · · · · · · · · · · · · · · · · · ·	and construction waste;			
			 Set up centralized domestic waste 			
			collection point and transport offsite for			
	·		disposal regularly by sanitation			
			department;			
			 Dispose spoil at designated disposal site. 			
			Backfilled area if not being used must be			
•			planted with vegetation to prevent soil			
			erosion.			
Equipment	Air Quality	Gaseous emissions &	Prepare and keep the record of equipment	Contractor	During Construction	Regular Monitoring



Initial Environmental Examination (IEE) Waste to Energy Project Lahore

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During routine inspection During Construction Contractor the requirements of labor management and Remove standing water bodies and cover Provide public toilets in accordance with sanitation departments in the living areas Use fully tuned vehicles and machinery. Appoint designated staff responsible for Ensure personnel are aware of potential Prepare proper maintenance sheets for Effectively clean and disinfect the site. Enforce on-site hygiene regulations to Minimize the risk of fly- or mosquito-Disinfect toilets and refuse piles and drums and other containers to avoid borne diseases by maintaining welldrained and hygienic project sites; During site formation, spray with phenolated water for disinfection. formation of stagnant water; timely remove solid waste; on construction site, and maintenance log. prevent littler; disease risks; vebicles. i. Construction site sanitation Noise a) Occupational health and safety Health and Safety Maintenance



ii. Occupational safety construction workers and enforce their use by the workers; Provide ear plugs to workers working near noisy areas of plant iii. Food safety - Inspect and supervise food bygiene in Contractor During Construction cafeteria on site regularly. - Cafteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. - Disease prevention cannot before start working on site. If infectious disease it from spreading. - Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and medication and medication for simple treatment and medication and medication for simple treatment and and medication and medication and medication and and medication and and medication and and and and and and and and and an			cleaning and disinfection.			
construction workers and enforce their use by the workers; • Provide ear plugs to workers working near noisy areas of plant • Inspect and supervise food bygiene in cafeteria on site regularly. • Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent if from spreading. • Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. • Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.		ii. Occupational safety	Provide safety hats and shoes to all	Contractor	During Construction	During routine
by the workers; Provide ear plugs to workers working near noisy areas of plant Food safety Cafeteria on site regularly. Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. Disease prevention Contractor examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			construction workers and enforce their use			inspection
Provide ear plugs to workers working near noisy areas of plant Cafeteria and supervise food hygiene in cafeteria on site regularly. Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. Oisease prevention Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			by the workers;			
Food safety Inspect and supervise food hygiene in cafeteria on site regularly. Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. Contractor Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			Provide ear plugs to workers working near			
Food safety - Inspect and supervise food hygiene in cafeteria on site regularly. - Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. - Construction workers must have physical and safety awareness - Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			noisy areas of plant			
 cafeteria on site regularly. Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents. 			Inspect and supervise food hygiene in	Contractor	During Construction	During routine
 Cafeteria workers must have valid health permits. Once food poisoning is discovered, implement effective control measures immediately to prevent it from spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents. 			cafeteria on site regularly.			inspection
discovered, implement effective control measures immediately to prevent it from spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			 Cafeteria workers must have valid health 			
discovered, implement effective control measures immediately to prevent it from spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			permits. Once food poisoning is			
spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.	,		discovered, implement effective control			
 spreading. Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents. 			measures immediately to prevent it from			
 Construction workers must have physical examination before start working on site. If infectious disease is found, the patient must be isolated for treatment to prevent the disease from spreading. Establish health clinic at location where workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents. 			spreading.			
•		w. Disease prevention		Contractor	During Construction	During routine
		and safety awareness	examination before start working on site.			inspection
			If infectious disease is found, the patient			
			must be isolated for treatment to prevent			.,,
			the disease from spreading.			
workers are concentrated, which should be equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.						
equipped with common medical supplies and medication for simple treatment and emergency treatment for accidents.			workers are concentrated, which should be			
and medication for simple treatment and emergency treatment for accidents.			equipped with common medical supplies			
emergency treatment for accidents.			and medication for simple treatment and			
			emergency treatment for accidents.			
Specify the persons responsible for health			Specify the persons responsible for health			



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			and epidemic	and epidemic prevention, education on			
			food hygienc	food hygiene, and disease prevention, to			
			raise the awa	raise the awareness of workers.			
(q	b) Community	i. Temporary traffic	A traffic control	A traffic control and operation plan will be	Contractor	During Construction	Weekly
	health and	management	prepared togeth	prepared together with the local traffic		Phase	inspections
	safety		management au	management authority prior to any			
			construction. Th	construction. The plan shall include			
			previsions for d	provisions for diverting or scheduling			
			construction tra	construction traffic to avoid morning and			
			afternoon peak	afternoon peak traffic hours, regulating			
			traffic at road co	traffic at road crossings with an emphasis on			
			ensuring public	ensuring public safety through clear signs,			
			controls and pla	controls and planning in advance.			
		ii. Information	Residents and b	Residents and businesses will be informed in	Contractor		As needed
		disclosure	advance through	advance through media of the construction			
			activities, given	activities, given the dates and duration of			
			expected disruption.	tion.			
		iii. Access to	Clear signs will	Clear signs will be placed at construction	Contractor	During Construction	As needed/
		construction sites	sites in view of	sites in view of the public, warning people of		Phase	Monthly
			potential danger	potential dangers such as moving vehicles,			Updates
			hazardous mater	hazardous materials, excavations, and raising			
			awareness on sa	awareness on safety issues. All sites will be		S. 4.5. SEPS (1.5.	
			made secure, dis	made secure, discouraging access by			•
			members of the	members of the public through appropriate			



			fencing whenever appropriate.			
		iv. Utility services	 Assess construction locations in advance 	Contractor	During Construction	As needed/
		interruptions	for potential disruption to services and		Phase	Monthly
	.,,,		identify risks before starting construction.			Updates
			 If temporary disruption is unavoidable, 			
			develop a plan to minimize disruption			
			with relevant authorities e.g. power			
			company, water supply company,			
			communication company, and			
			communicate dates and duration in			
			advance to all affected people.			
	c) Compliance	Lack of compliance with	Contractors to comply with national labor	Contractor	During Construction	Ongoing
	with labor	national and core labor	standards on minimum wages, insurance;		Phase	
	standards	standards leading to	 Recruitment office to design and 			
		violation of rights of	implement measures to ensure that there is			
		workers	no discrimination during hiring and that			
			no child labor or bonded labor will be			
			engaged in the construction activities.			
Grievance	Social &	Handling and resolving	Establish a Grievance redress mechanism	Contractor	Throughout the project	All areas of
Redress mechanism	environmental	complaints on	(GRM), appoint a GRM coordinator			the scheme
		contractors	within environmental and social unit.			
			 Brief and provide training to GRM access 			
			points (environmental and social unit,			
			contractors).			



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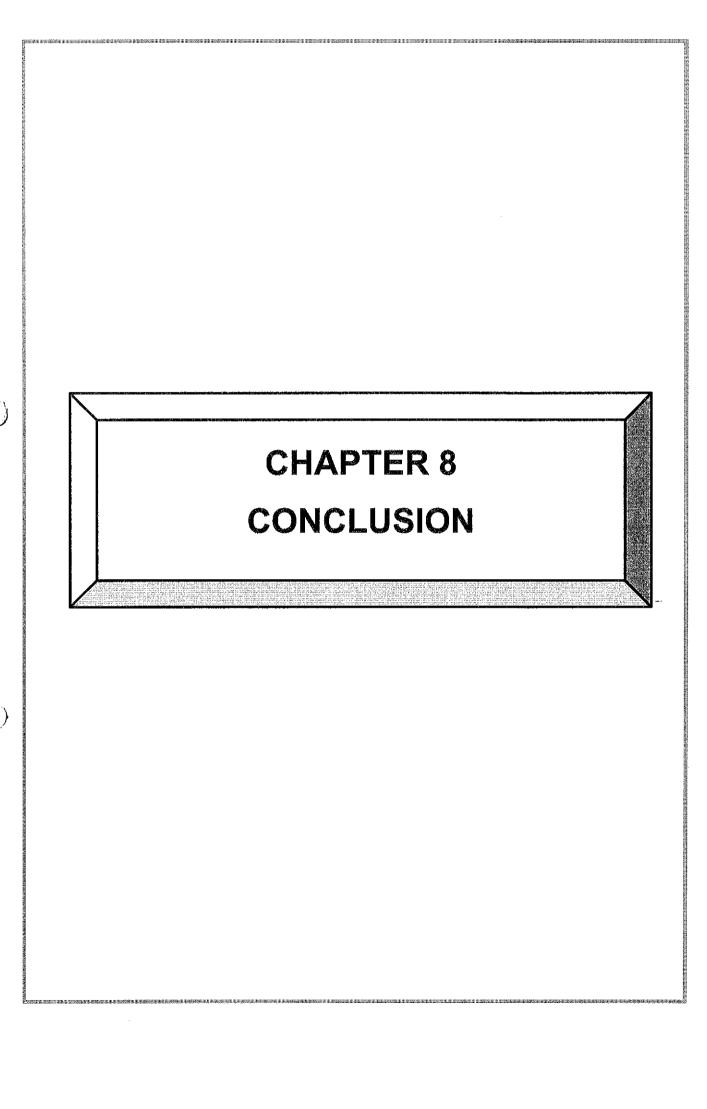
			e Discisse CRM to effected neonie before			
		,**				
			construction begins at the main entrance to			
			each construction site.			
			• Maintain and update a Complaint Register			
			to document all complaints.			
Kem	Impact factor	Potential impactfor issue	Witgation measures	Implementing entity	Implementation schedule	Monitoring program
Operational Stage						
a)]	a) Noise	Noise from steam engine	 In stall high efficiency micro-porous 	Lahore	Operational phase	Quarterly
		room, cooling tower,	silencer for instantaneous steam venting of	Xingzhong		
		incinerator room,	boilers.	Renewable		
		circulating water pump	 Keep the equipment in good working 	Energy		
		room	condition and with regular maintenance.	Company		
				(Private) Limited		
p) I	b) Flue gas	Air pollution	Regular check online monitoring system, and	Lahore	Operational phase	Quarterly
			alarm system to keep all facilities in good	Xingzhong Renewable		ALL
			operational condition	Energy		
				Company (Private) Limited		
(c) I	c) Leachate	wastewater	Regular check online monitoring system, and	Lahore	Operational phase	Quarterly
			alarm system to keep all facilities in good	Xingzhong Renewable		-,
			operational condition	Energy		
•				Company (Private) Limited		
(b)	d) Fly ash	Solid waste	• Regular check online monitoring system,	Lahore	Operational phase	Quarterly
				1 ************************************		





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Air conditioner should be used in all the control rooms and office facilities for comfortable air-conditioning. Perform physical examination of the staff on a regular basis and establish the health records. Safety measures are elaborated in Annexure C. In Annexure H a detailed fire protection	for office to protect the eyesight of workers.	saving rinorescent lamp should be adopted
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CHAPTER 8 CONCLUSION

The IEE of the proposed project has achieved the following goals:

- Identification of national environmental regulatory requirements that apply to the proposed development activities.
- Identification of the environmental features of the project area and the likely impacts of the project on the environment.
- Recommendation of appropriate mitigation measures that ENFI China will incorporate into the project design to eliminate or mitigate all adverse environmental impacts.

Baseline environmental and socioeconomic information was collected from a variety of sources including published literature and field surveys. The information collected was used to compose profiles of the natural and socioeconomic environments likely to be affected by the project

An assessment was then made of the potential impacts of the described project on the area's natural and socioeconomic environments.

The impacts of the planned activities in the project area will be insignificant, provided the generic mitigation measures proposed in this report are implemented. In areas where these activities may have a significant impact, additional mitigation measures are given to reduce impacts to as low as reasonably possible.

After assessing the proposed project activities and investigating the project area, the environmental consultants, Environmental Consultancies and Options (ECO) have concluded that:

"If the activities are undertaken as proposed and described in this report, and the recommended mitigation and environmental management measures are implemented/adopted, the project will not result in any long-term or significant impacts on the local community or the environment".