



Punjab Urban Development Projects (PUDP) DREAMS-I, Bahawalpur

Environmental Impact Assessment (EIA)

Project:	Integrated Solid Waste Management System (ISWM), Bahawalpur (DREAMS-I)
Client:	Local Government & Community Development Department (LG&CDD) through the Program Management Unit (PMU)
Consultant:	Engineering Design and Construction Management (EDCM)

20023

Prepared By:	Project Management Unit - Punjab Urban Development Projects
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Abbreviations

ADB	Asian Development Bank
ADC	Alternate Daily Cover
AD	Anaerobic Digestion
AIP	Access to Information Policy
AMSL	Above Mean Sea Level
BDA	Bahawalpur Development Authority
BC	Before Construction
BOQ	Bill of Quantities
BWMC	Bahawalpur Waste Management Company
CIU	City Implementation Unit
CORDEX	Coordinated Regional Downscaling Experiment
CSC	Construction Supervision Consultant
DC	During Construction
DO	During Operation
EA	Executing Agency
EDCM	Engineering Design Construction Management
EGL	Existing Ground Level
EHS	Environmental, Health, and Safety
EIA	Environment Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
GFI	Ground Fault Interrupter
GoP	Government of Pakistan
GRM	Grievance Redress Mechanism
HDPE	High Density Polyethylene
IA	Implementing Agency
IBAT	Integrated Biodiversity Assessment Tool
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
LAA	Land Acquisition Act (of 1984)
LARP	Land Acquisition and Resettlement Plan
Leq	Equivalent continuous sound pressure level
LG&CDD	Local Government and Community Development Department
LHW	Lady Health Worker
LULC	Land use/Land cover
MBT	Mechanical & Biological treatment
MGD	Million Gallons per Day

MRF	Material Recovery Facility
MSF	Material Sorting Facility
MSWLF	Municipal Solid Waste Landfill
NCS	National Conservation Strategy
NEP	National Environmental Policy
NEQS	National Environmental Quality Standards
OHS	Occupational Health and Safety
O&M	Operation & Maintenance
PAP	Project Affected Persons
PC	Public consultation
PCC	Plain Cement Concrete
PCOs	Public Call Offices
PDD	Planning & Development Department
PEPAct	Pakistan Environment Protection Act 1997
PEPC	Pakistan Environmental Protection Council
PEQS	Punjab Environmental Quality Standards
PGA	Peak Ground Acceleration
PMU	Project Management Unit
PPE	Personal Protective Equipment
PEPD	Punjab Environmental Protection Department
RCC	Reinforced Cement Concrete
RDF	Refuse Derived Fuel
REA	Rapid Environmental Assessment
RFP	Request for Proposal
RO	Reverse Osmosis
RP	Resettlement Plan
SOPs	Standard Operating Procedures
SS	Suspended Solids
SPS	Safeguard Policy Statement
SSEMP	Site Specific Environmental Management Plan
SWMS	Solid Waste Management System
TPD	Tonnes per day
TMA	Tehsil Municipal Administration
TMP	Traffic Management Plan
UC	Union Council
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

CURRENCY EQUIVALENTS

As of 15th Feb, 2023

Currency Unit – Pak Rupees (Pak Rs.)

Pak Rs 1.00 = \$ 0.0037

US\$1.00 = Pak Rs. 270.16

CONVERSIONS

1 meter = 3.28 feet

1 hectare = 2.47 acre

1 kanal = 0.125 acre

Definition of Terms

“Carbon Monoxide” (also CO): A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

“Carbon Dioxide” (also CO₂): A colorless, odorless, incombustible gas, CO₂, formed during respiration, combustion, and organic decomposition and used in food refrigeration, carbonated beverages, inert atmospheres, fire extinguishers, and aerosols. Also called carbonic acid gas.

“Ground Water”: The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

“Laws”: means state and local laws and all regulations, rules, orders, decrees, decisions, instructions, requirements, policies and guidance which are issued or made by any Relevant Authority and which are legally binding, as any of them may be amended from time to time.

“Leachate” Contaminated water that seeps out of landfills. Often contains high amounts of organic matter and toxic chemicals.

“Liner system” The technical term for the layers of materials (such as clay and geosynthetics) that protect landfills from erosion, and keep trash and leachate from escaping from landfills.

“Methane” (also CH₄): A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds. A major component of natural gas used in the home.

“Municipal Solid Waste” (MSW) is a waste type that includes predominantly household waste (domestic waste) with sometimes the addition of commercial wastes collected by a municipality within a given area. The term residual waste relates to waste left from household sources containing materials that have not been separated out or sent for reprocessing.

“Operator” means the SLF operator employed or contracted by the EA to operate, maintain and manage the facility.

“Particulates” (also PM₁₀): 1. Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. 2. Very small solids suspended in water; they can vary in size, shape, density and electrical charge and can be gathered together by coagulation and flocculation.

“Personal Protective Equipment” (also PPE): Clothing and equipment worn by pesticide mixers, loaders and applicators and re-entry workers, hazmat emergency responders, which is worn to reduce their exposure to potentially hazardous chemicals and other pollutants.

“Peak Ground Acceleration” (PGA) is a measure of earthquake acceleration on the ground and an important input parameter for earthquake engineering.

“Recyclables” Any materials that will be used or reused, or prepared for use or reuse, as an ingredient in an industrial process to make a product, or as an effective substitute for a commercial product. This includes, but is not limited to, paper, glass, plastic and metal.

“Recycling” means the process by which recovered materials are transformed into new products or feedstock for new products.

“Residual Waste” means all municipal solid wastes that are not processed and/or recycled.

“Risk Assessment”: Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

“Solid Waste Management” means any activity involving the handling, treatment and disposal of Solid Waste. Also means any supervised handling of waste materials from their source through recovery processes to final disposal.

“Solid Waste Management System” The entire process of storage, collection, transportation, processing, and disposal of solid wastes by any entity engaging in such process as a business, or by any state agency, city, authority, county or any combination thereof.

“Sulfur Dioxide” (also SO₂): A pungent, colorless, gas formed primarily by the combustion of fossil fuels; becomes a pollutant when present in large amounts.

“Transfer Station” means the facility where solid wastes are temporarily stored and consolidated before being transported elsewhere for further treatment or disposal.

“Waste” means any movable articles or material for which their owner wishes to relinquish responsibility by Disposal or which must be removed from their holding place as waste to safeguard the common welfare and to protect the environment.

EXECUTIVE SUMMARY

Project Overview

Government of the Punjab is implementing Punjab Intermediate Cities Improvement Investment Project (PICIIP) in intermediate districts with financial assistance of the Asian Development Bank (ADB). PICIIP targets investments in urban management infrastructure and services across clusters of cities in Punjab. This Program represents seven cities in Punjab province, namely Sargodha, Rahim Yar Khan, Muzaffargarh, Bahawalpur, Dera Ghazi Khan, Multan, and Rawalpindi.

Developing Resilient Environments and Advancing Municipal Services (DREAMS) is part of multiyear PICIP portfolio which will be built upon the achievements and lessons learned from previous urban sector projects supported by the ADB and other partners in Pakistan including the Punjab Intermediate Cities Improvement Investment Project with the intention of improving urban services in cities of Punjab. This EIA Report covers the intermediate city of Bahawalpur.

The project will enhance climate-resilience and urban living standards for about 2.8 million people in four cities (Bahawalpur, Dera Ghazi Khan, Rawalpindi, and Sargodha) of Punjab Province, one of Pakistan's most urbanized regions and vulnerable to climate change. It will expand and modernize water supply and solid waste management systems to improve quality, coverage, efficiency, and reliability of basic urban services for residents and businesses, while contributing to decarbonization and improved resilience of social and environmental systems.

ADB has approved Project Readiness Finance (PRF) loan to enhance readiness for project implementation, thereby facilitating the timely and cost-effective achievement of project outcomes. Activities to be conducted under the PRF include spatial planning, feasibility studies, engineering design and construction management (EDCM) during the Design and Construction Phases, and operational design and business models (ODBM) during the Operation Phase.

DREAM will equip the cities of Bahawalpur and Dera Ghazi Khan (SWM pilot cities) with: (i) collection equipment, parking, transfer, and sorting facilities; (ii) establish segregation and composting centers, with a minimum 10% of women workers; and (iii) construct sanitary landfills and biogas recovery to reduce greenhouse gas emissions.

Due to the open dumping of waste in the cities, the leachate and odor of waste is disturbing the people and polluting the environment. Bahawalpur Waste Management Company (BWMC) aims to counter these practices but the existing solid waste management system and (BWMC) is not fully equipped with modern technologies, essential equipment's, landfill, and manpower.

The integrated waste management system for Bahawalpur will be upgraded to a modern door to door collection system and disposal at an engineered Bioreactor landfill by implementing Punjab intermediate cities improvement investment program and ADB funding. The system is comprised of primary and secondary waste collection and construction of Bioreactor landfill site. A compost plant and MRF is also included in the project design which is proposed to be established at existing dumping site.

Bahawalpur landfill is designed as an integrated facility. It comprises of 4 cells 150m x 200m which will be developed sequentially. In year 2024 cell one will be developed and will be ready to receive waste by January 2025. The bioreactor is integrated with landfill gas recovery system, landfill gas flaring and conversion of methane component into CNG. The closure and post closure utilization of site conceptual design is included which may have to be modified as closure of cells progresses over the years. Further in order to dispose of treated medical waste a portion of cell is under consideration at Landfill site.

A new bioreactor landfill will be set up at Mari Sheikh Shijra while the compost plant and MRF will be set up at a separate location at Khanuwali, the existing dump site. Development of ISWMS of Bahawalpur will comprise of the following activities.

- Construction of Compost Plant and MRF at existing dumpsite in Khanu Wali including construction and improvement of 5 Km access road
- Construction of New Engineered Bioreactor Landfill site at Mari Sheikh Shijra mouza Nouabad including new construction of 2.5 Km access road and improvement of 10 Km main road. This landfill site is located at a distance of 20.2 km from the existing dumpsite at Khanu Wali.
- Upgradation of existing transfer station located at Band Road at a distance of 18.3 km from the proposed landfill and 6.5 km from the existing Khanuwali dumpsite.
- Construction and Demolition (C&D) waste recycling through dedicated C&D waste contractor is also proposed in the project feasibility.
- Construction of BWMC office building at Hasilpur Road.

An extensive environmental awareness and community interface program will be designed and implemented as part of IWMS of Bahawalpur. The public awareness program will start from primary schools and spread over the school system up to high schools. The environmental awareness program for higher education, universities will be custom design for all students and faculty members. The special programs will be developed for students undertaking environmental and engineering studies. Beside internal BWMC environmental awareness organization, education department and local government designated representatives will become part of permanent environmental awareness organization for the city.

Rapid Environmental Analysis (REA) for the project categorization from environmental safeguards perspective for the proposed Solid Waste Management System (SWMS) in district Bahawalpur, Punjab, Pakistan has been prepared. REA findings concludes that proposed project falls under Category A project as per ADB SPS, 2009 and EIA has to be prepared, approved and disclosed on ADB website. A map of the project area is provided as **Figure ES-1**.

Project Need

Solid waste disposal is one of the basic indicators of environmental health. There is a deep relation between improper disposal of solid waste and incidence of vector borne diseases. Hence, efficient system of solid waste disposal is a crucial requirement of the community to minimize the health risks caused by such kind of waste. Current situation of solid waste disposal in Bahawalpur city is more alarming compared to other indicators of environmental health risk.

Currently no scientifically and engineered Landfill site is available in Bahawalpur. Eighty percent of the waste is collected and being deposited in an area of 15 acres since 2016- and 10-Acres area is available for installation of compost plant and material recovery facility (MRF). Almost 74% of households dump their waste in open fields which is a threat to local environment in terms of health as it encourages fly breeding; attract rodents and

vermin, cause water and soil pollution, and continually troubles the people from bad odours.

Based on the waste characterization data, a Compost Plant and a Material Recovery Facility is suggested in project feasibility to be developed as part of Integrated Solid Waste Management System ISWMS. With the establishment of MRF and Compost Plant at existing dump site, a major portion of the solid waste generated will be diverted and, in turn, will prolong the lifespan of bioreactor landfill that will be developed at Mari Sheikh Shijra, mouza Nouabad.

The proposed Bahawalpur ISWMS will assist Bahawalpur Waste Management Company (BWMC) and Punjab LG&CDD, to fully transform the SWM system in the city. The project also includes the installation of primary and secondary municipal solid waste (MSW) collection systems and development of International standard bioreactor landfill including MRF and composting plant to store municipal solid waste from Bahawalpur for at least 20 years.

Current disposal practice is the open dumping of waste at Khanu Wali existing dumpsite. This dumpsite is characterized as an area where garbage is simply transported, unloaded, and at times levelled by a bulldozer. The site operates with no protection against soil and groundwater contamination. There is no liner system, Leachate collection system and landfill gas recovery system. The dumpsite is in the middle of the agriculture zone and the leachate is contaminating underground water and surface water. The harmful air emissions are impacting the health of residents around the dumpsite. The estimated quantity of deposited waste is about 800 thousand tons. The dumpsite is in the middle of active farming area. The contamination situation will worsen from continued migration of leachate and this contamination will continue for next 60 years or more.

Khanuwali dumpsite is located at a distance of 20.2 km from the new proposed landfill. The site mitigation, remediation and rehabilitation will be done by capping the site with final cover and install LFG system. About 0.8 million tons of waste need to be baled and depositing in the new lined landfill. It is estimated that this waste can be baled in about one year utilizing two baling units of 65-70 tons per hour baling capacity and operating for 16hrs/day.

Study Methodology

Both secondary and primary data analysis on ambient noise levels and air quality, water resources, flora, fauna and information from the detailed design conducted for this and other projects of similar nature were collected, reviewed, and analysed. Extensive field visits to the project area were undertaken and key receptors and stakeholders within the project area were identified and consulted.

The significance of impacts from the proposed project were then assessed and for those impacts requiring mitigation, suitable measures were proposed to reduce impacts to within acceptable limits as per local and international applicable regulations. A detailed environmental management and monitoring plan was developed to ensure compliance to the proposed measures during the project development.

Integrated Biodiversity Assessment Tool (IBAT) proximity analysis has been carried out in order to mark any protected areas, key biodiversity area and habitat of key species in close proximity of landfill site.

Leachate leaking effect on ground water quality has been carried out and findings are discussed. Air pollutant dispersion modelling has been carried out using Lakes Environmental Software AERMOD and results are used for impact assessment of gas flaring in the EIA report.

Public Consultation Process

Two rounds of comprehensive stakeholders' consultations were organized with a total of over 160 different stakeholders consulted. The first round of public consultations was conducted in the month of first week of November, 2022, while the second round of public consultation was completed in the month of December, 2022. Information on positive and negative impacts associated with its construction and operational stage and proper mitigation of adverse impacts were shared at these consultations.

Analysis of Alternatives

The current waste disposal system has been through un-controlled dumpsites. These dumpsites often characterized by an area where garbage is simply transported, unloaded, and at times leveled by a bulldozer. Nearly all these sites operate with no protection against soil and groundwater contamination.

The situation is further exacerbated by operators' seldom attempt to control pungent smoke, objectionable odor and vermin. Sorting is only achieved through scavenging, which at times tolerated, with no checks in place for the health and safety. Such dumpsites are inexpensive to operate, but pose serious damage to the land, water, air, aesthetics, and the health of the surrounding population. These dumpsites are also difficult to rehabilitate after they are filled and abandoned. Failure to implement the project or a "No-Action alternative" will result to allocation of land only to be subjected to the existing practice.

Alternatives in this context will mean the establishment of the Bioreactor Landfill (BLF) at alternative sites or the project not realizing. However, such alternatives will not negate the disadvantages of allocating land for disposal purposes only under the current practice of dumping.

On the other hand, if the project is implemented, it will result in improved SWM system services and improved urban environment quality. Furthermore, project implementation will also create job opportunities during construction, thereby improving the socioeconomic condition of the local people and help in improving their quality of life. Thus, the 'no project' option is not a viable option.

Three different sites for the development of land fill considered were as follows:

- **Yazman** - located at Marot Yazman Road Bahawalpur next to the Malot Machinery Store
- **Khanu Wali** –The site is located at 0.5 km from the Sutlej River and the nearest human settlement is located within 350-400 metres radius from the project site. The proposed site area is adequate for 25 years of useable life.
- **Mari Sheikh Shijra Mouza Nouabad** - located near Basti Yar Muhammad, Bahawalpur. Total area of the site is 110 acres. Proposed site is mostly surrounded by agricultural fields and located at a safe distance from the nearby human settlements.

Yazman site was rejected on the basis of some technical points related to the nearby locations of Bahawalpur airport in term of high chance of bird's strike with the flying aircrafts. The site area of 56 Acres is not adequate for the waste treatment till 25 years and more land acquisition will be required which will create financial burden to the project. Another reason of rejection was a clear more than three times distance of the alternative site which will entail comparatively huge cost of fuel and vehicles maintenance.

The site at Khanu Wali was immediately eliminated primarily due to its proximity to the city. The location lies very much within the urban built-up area. One option which this site

provides is the setting up of a transfer station, a point of convergence for waste originating from various parts of the city, possibly coupled with a Material Recovery Facility (MRF) and/or a composting facility. Establishing facilities in such proximity to the city will separate the waste not meant to be disposed in the landfill, thereby making more efficient use of the heavy equipment, compactors and large arm-roll trucks, which will travel to the landfill site.

The site at Mari Sheikh Shijra mouza Nouabad fulfilled most of the criteria required for landfill site selection. It is far enough away from the city. The population is sparse and although there are a few sensitive receptors, proper environmental assessments are being carried and resettlement plans are being prepared to minimize both environmental and socioeconomic impacts. Most of the surrounding area is barren and agricultural. Given the locations of other alternative sites, all were either agricultural or semi-urban areas, which at least places this site as the most ideal as compared to the other sites.

No additional land acquisition is required as land area of 110 acres is already owned by BWMC and cell locations meet the buffer zone requirements which ensures that potential effects of the landfilling operation may not cause any unacceptable impact outside the site. The social acceptability of the project is enhanced by educating the nearby population on the merits of a bioreactor landfill. There is no private land acquisition involved in the project.

Different types of Landfills were also considered as part of EIA process such as Sanitary landfill, Bioreactor landfill and Secured landfill. Based on the comparison conducted, the project design consultant suggested to construct a Bioreactor landfill for Bahawalpur in order to maximize and control the landfill gas extraction and harvesting the Methane component together with converting the methane gas into CNG for beneficial utilization.

Different landfill construction alternatives were also considered such as Lining, Leachate collection and treatment and Gas collection and treatment with flaring proposed for landfill gas management. After few years of landfill operation Gas recovery will be carried out and methane gas will be converted into CNG for further dispensing.

Other types of alternatives that were considered were technological alternatives for Anaerobic Digestion System, technological alternatives for Material Recovery Facility, Waste Disposal Alternatives along with a comparison of possible treatment options as well as an Economic Aspect Analysis of the different types of landfilling technologies.

Baseline Conditions

Physical Environment: The project area has irregular topography. The sand dunes are deposited all over the project area which comprises of mostly flat terrain with scattered vegetation consisting of bushes, grasses and some trees. In general, no fill Material is present at top. Silty Sand dominates upto 3-5 m depth and afterwards, Lean Clay and Sandy Strata is observed. Probabilistic seismic hazard assessment shows that the project area falls in Zone-2A with peak horizontal ground acceleration of 0.08g-0.16g i.e. negligible damage. As far as the project area is concerned, there are no water bodies lying in close proximity of the project. Ground water is found at depth of about 15-20 feet As part of EIA baseline, one ground water sample was collected from Basti Chachran and analysed from EPA certified lab. The results of the tests are attached as **Appendix A.4**, which indicates that all parameters including pH, turbidity, alkalinity, etc. are within the applicable PEQS and WHO standards with no exceedances observed. Ambient noise levels being within the most stringent guidelines during the daytime, however, exceedances were observed at the night time at two locations in the project area.

Air Quality Monitoring was conducted for 24 hours at six locations near the project site. Results showed that all ambient air quality parameters of PM₁₀, PM_{2.5}, CO, NO, NO₂, SO₂

were in compliance with the PEQS. Air dispersion modelling was also carried out and results showed compliance with the stringent standards.

Major Land use of the project area is barren land followed by cropped area.

Biological Environment: Project is falling outside environmental sensitive areas (Wildlife park, Wildlife sanctuary, Game Reserve or Protected/Reserved Forests) and critical habitats. Floral species belonging to 18 families including 63 plant species from project site and adjacent areas were reported (Sadia et al, 2021, Ahmad et al, 2012). Similarly, faunal species were also observed during the survey. Among them 16 tree species, 09 shrubs, 20 herbs and 18 grass species found. Also 17 bird's species, 11 mammals' species, 5 reptiles, 2 amphibians, 4 fish and 3 grazing mammals' species were observed. Species of special concern found in the vicinity of the project area are Hog Deer (Endangered) and Houbara Bustard (Vulnerable). These species do not exist near the landfill site as site is not a habitat of such species due to urbanization. IBAT proximity report shows that there are no key biodiversity area and protected areas falling with 5 Km radius of the site. NOC from Punjab wildlife department has been obtained for the project. Consultation with Punjab wildlife department has been carried out and NOC for the project execution has been obtained and attached as **Appendix A.17**.

Social Environment: The study area falls in Bahawalpur City and Saddar Tehsil. According to DCR Bahawalpur 2017, it has a population of 1,256,646 persons of which 681,696 population is of City Tehsil while 574,950 population is of Saddar Tehsil. Project area is primarily rural sub-urbs. The names of the major settlements falling in the project area are village Mari Sheikh Shujra, Sangal Wali Pull Village, Khanu wala, Noabad and Dera Ramazan Village and Band road. The average family size in project area is 5. No archaeological and cultural site was observed in close proximity of Bahawalpur landfill site. The population of the district is predominantly Muslims i.e. 98.1 percent. The next higher percentage is of Hindu with 0.9 points followed by Christian 0.6 percent. While other minorities like Ahmadis, Schedule Castes etc. are very small in number. The main castes and groups of the Bahawalpur district are Arain, Jatt, Rajput, Pathan, Gujar, Baloch, Qureshi and Syed. These casts have been further sub-divided in various sub-caste and sub-tribes. Major occupations in the project area are small businesses, shop keeping, government service, farming and manual labor. It was noted that facilities such as Electricity, Sui Gas, Water Supply, Telephone, Sewerage Drainage, school are available in the settlement or in its vicinity.

Potential Major Impacts

The screening matrices for the pre-construction, construction and operation phases of the Landfill are provided below as **Tables ES.1, ES.2 and ES.3**.

Mitigation Measures

Mitigation measures associated with pre-construction, design, operation, closure and post closure phases are detailed in the EIA report. Necessary design considerations have been included for leachate collection and treatment, landfill gas management, odour and vector controls. Mitigations associated with construction phase are detailed in the EIA report to avoid soil and ground/surface water contamination, OHS issues, social conflicts, vegetation loss and communicable diseases.

Mitigations for operation phase are provided to ensure that leachate and landfill gas is managed properly, there would be no waste hauling impacts, traffic issues, wind-blown litter, vector spread and air quality problems. Daily cover will be applied to avoid odour and litter issues. Buffer zone through necessary plantation will be developed to improve aesthetic appeal of the area. Project will result in improved waste management services, improved public health and improved aesthetic appeal of the area.

Climate Change Sensitivity of Landfill Site

Bahawalpur lies on elevation of 117m above mean sea level. The climate here is dry. During the year, there is virtually no rainfall in Bahawalpur. According to Köppen and Geiger, this climate is classified as BWP. The city witnesses some of the extreme temperatures in the country. The summer season starts from the month of April and continues till October, while the weather is pleasant and cold from November to February. Besides, dust storms are also common in the area.

Due to less average annual rainfall (143 mm) the city features an arid climate with sweltering summers and cold winters. The wettest year observed was 2021; with an annual total rainfall of 166.2 mm. Minimum annual rainfall was 119 mm recorded in 2017

Based on the past decade data, the month with the maximum precipitation on average is July with 27.67 mm of precipitation. The month with the least precipitation on average is October with an average of 2.33 mm.

The average temperature for the past decade in Bahawalpur is 89.6°F (32°C). The warmest month, on average, is July with mean temperature of 104.36°F (40.2°C). The coolest month on average is January, with mean temperature of 66.56°F (19.2°C).

The wind experienced at any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Wind speed usually blows from the north to south after the wind has arrived strongly and steadily from those quarters for a day or more. In fall season, the rain clouds come mostly from west due to western depression/ disturbance.

Based on the past decade data, the maximum average wind speed of 16.70 kmph is recorded in the month of July while average minimum wind speed of 7.71 kmph was observed in November.

Likelihood of climate change related hazards including floods, flash rains and temperature variations are included in sensitivity assessment that could negatively affect the functioning of the landfill site including direct impacts (accessibility, physical damage, water damage) and indirect impacts (accidental fire, explosion or ecosystem damage). These direct and indirect impacts can affect the landfill site in terms of damage to liner or cover materials, washout of contaminated contents, leachate collection and removal, landfill gas management etc.

Cumulative Impacts

No other infrastructure works are planned to be conducted in the landfill project area while these project works shall be conducted till 2025. Thus, no cumulative impacts are expected.

Indirect and Induced Impacts

The potential effects of every stage of the proposed Bahawalpur SWM facility have been identified and evaluated using field data, secondary data, expert opinion, and research into earlier, comparable projects in Pakistan. These include effects on physical, biological and socio-economic environment. Impacts on the environment from air emissions, traffic and community noise have also been assessed and have found to be acceptable and within the carrying capacities of the environmental media.

Thus, negative indirect and induced impacts from the proposed landfill works are not expected.

Institutional Arrangements for EMP Implementation

During the construction phase, the overall responsibility for the implementation and monitoring of the EMP rests with the Project Director (PD), Project Management Unit (PMU), Punjab Intermediate Cities Investment Program (PICIIP). The PD through assistance from the Supervision Consultant's Environmental staff and the Environment team of PMU, will supervise the implementation of the proposed mitigation measures and monitor the implementation progress in the field. Monthly environmental monitoring data/reports will be incorporated in the project implementation progress reports to be shared with ADB and such monthly reports will be consolidated into bi-annual monitoring reports and submitted to ADB for review and clearance. Upon clearance, all such reports will be uploaded on the PMU and ADB websites.

Conclusion & Recommendations

An action plan with clear roles and responsibilities of stakeholders has been provided in the report. The PMU, Contractors and the Construction Supervision Consultant are the major stakeholders responsible for the action plan. The action plan must be implemented prior to commencement of construction work.

Mitigation measures will be assured by a program of environmental monitoring conducted during construction and operation to ensure that all measures in the EMP are implemented and to determine whether the environment is protected as intended. This will include observations on and off-site, document checks, and interviews with workers and beneficiaries, and any requirements for remedial action will be reported.

The majority of the environmental impacts are associated with the operation phase of the project since these will be long term, such as generation of objectionable odor and impact on air quality, attraction of vermin and disease vector generation, Leachate generation, Possible contamination of soil and groundwater and Generation of Landfill Gas. These shall be mitigated through necessary measures provided in EMP.

The potential adverse impacts that are associated with design, construction, and operation can be mitigated to standard levels without difficulty through proper engineering design and the incorporation or application of recommended mitigation measures and procedures. It is concluded that the proposed project should proceed, with appropriate mitigation measures and monitoring programs identified in the EIA study.

Punjab EPA has issued NOC for same site back in 2018 which is attached as **Appendix A.14** which shows that project can be established at proposed site and EPA has already carried out site assessment and accorded approval following legal requirements. PMU PICIIP will maintain close coordination with Punjab EPA on the status of already issued NOC and upon direction of EPA will file application for its renewal or submit updated EIA along with review fee to obtain new NOC .

Urdu Version of Executive Summary

Urdu version of Executive Summary is attached as **Appendix A 16** of the report.

Table ES.1: Screening of possible Impacts during Design/Pre-Construction phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Landfill Site Selection	Likely	Moderate	Medium	Long Term
2	Integration of EIA/EMP requirements in construction bid documents	Likely	Moderate	Medium	Short Term
3	EMP implementation	Likely	Moderate	Medium	Short Term
4	Land acquisition and resettlement impacts	Likely	Moderate	Medium	Short Term
5	Impacts due to natural hazards	Likely	Moderate	Medium	Long Term

 Critical Risk Level

 Significant Risk Level

 Medium Risk Level

 Low Risk Level

Table ES.2: Screening of Possible Impacts during Construction Phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Soil and Water Contamination	Likely	Major	Medium	Long Term
2	Air Quality Degradation	Likely	Moderate	Medium	Short Term
3	Loss of Vegetation	Likely	Moderate	Medium	Short Term
4	Damage to Wildlife	Likely	Moderate	Medium	Short Term
5	Health and Safety Hazard	Likely	Moderate	Medium	Short Term
6	Noise and Vibration	Likely	Moderate	Medium	

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
					Short Term
7	Hazardous and Non Hazardous Waste Disposal	Likely	Moderate	Medium	Short Term
8	Waste Effluent Disposal	Likely	Moderate	Medium	Short Term
9	Soil Erosion and Sedimentation	Likely	Moderate	Medium	Short Term
10	Soil Contamination	Likely	Moderate	Medium	Short Term
11	Employment Conflicts	Likely	Moderate	Medium	Short Term
12	Communicable diseases	Likely	Moderate	Medium	Short Term
13	Historical/Archaeological Sites	Unlikely	Moderate	Low	No Residual Impact
14	Impacts associated with Construction of Administration and BWMC office Buildings and Other Infrastructure	Likely	Moderate	Medium	Short Term
15	Impacts associated with Construction/Widening of Access Road	Likely	Moderate	Medium	Short Term

 Critical Risk Level

 Significant Risk Level

 Medium Risk Level

 Low Risk Level

Table ES.3: Screening of Possible Impacts during Operation Phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Leachate Generation	Likely	Major	Medium	Long Term
2	Soil and Groundwater Contamination	Likely	Major	Medium	Long Term
3	Landfill Gas Generation	Likely	Major	Medium	Long Term

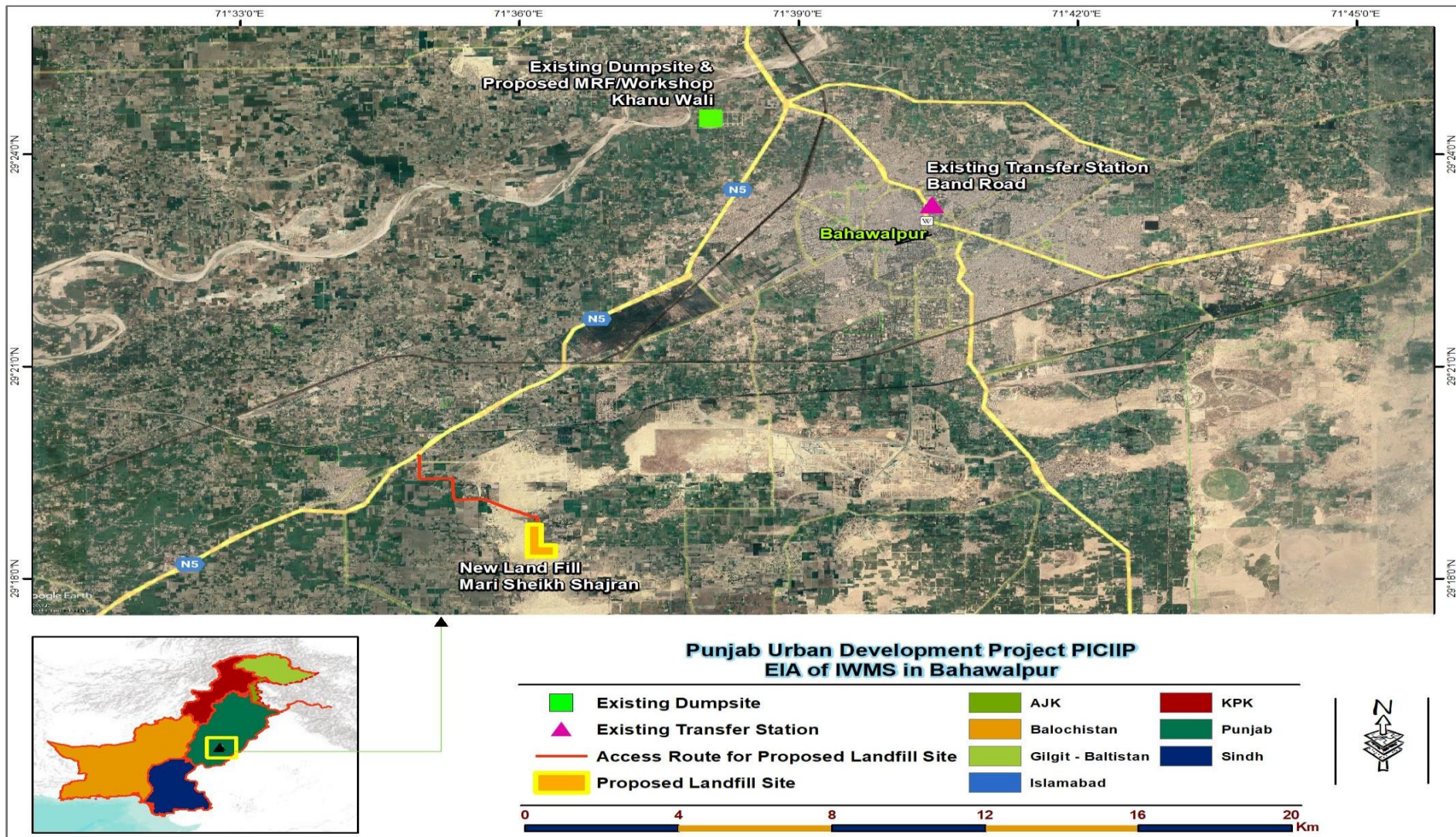
S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
4	Air Quality Deterioration	Likely	Major	Medium	Long Term
5	Disease Vector Generation and Vermin Attraction	Likely	Major	Medium	Long Term
6	Occupational Health and Safety	Likely	Major	Medium	Long Term
7	Waste Collection and Hauling Impacts	Likely	Major	Medium	Long Term
8	Wind Blown Litter	Likely	Major	Medium	Long Term
9	Medical Waste Management	Likely	Major	Medium	Long Term
9	Solid waste & health and sanitation	Positive impacts expected			Long Term positive residual impact
10	Public Health	Positive impacts expected			Long Term positive residual impact
11	Aesthetic aspects	Positive impacts expected			Long Term positive residual impact
12	Construction and Demolition Waste Disposal	Positive impacts expected			Long Term positive residual impact
13	Medical Waste Disposal	Positive impacts expected			Long Term positive residual impact

 Critical Risk Level

 Significant Risk Level

 Medium Risk Level

 Low Risk Level



1. INTRODUCTION

1.1 OVERVIEW

Government of the Punjab is implementing Punjab Intermediate Cities Improvement Project (PICIP) in intermediate districts with financial assistance of The Asian Development Bank (ADB). PICIP targets investments in urban management infrastructure and services across clusters of cities in Punjab. This Program represents seven cities in Punjab province, namely Sargodha, Rahim Yar Khan, Muzaffargarh, Bahawalpur, Dera Ghazi Khan, Multan, and Rawalpindi.

Developing Resilient Environments and Advancing Municipal Services (DREAMS) is part of multiyear PICIP portfolio which will be built upon the achievements and lessons learned from previous urban sector projects supported by the ADB and other partners in Pakistan including the Punjab Intermediate Cities Improvement Investment Project with the intention of improving urban services in cities of Punjab. This EIA Report covers the intermediate city of Bahawalpur.

The consultancy services for DREAMS have been awarded to the Engineering Design and Construction Management (EDCM) Consultant by the PMU to achieve the objectives of the project.

The project will enhance climate-resilience and urban living standards for about 2.8 million people in four cities (Bahawalpur, Dera Ghazi Khan, Rawalpindi, and Sargodha) of Punjab Province, one of Pakistan's most urbanized regions and vulnerable to climate change. It will expand and modernize water supply and solid waste management systems to improve quality, coverage, efficiency, and reliability of basic urban services for residents and businesses, while contributing to decarbonization and improved resilience of social and environmental systems.

ADB has approved Project Readiness Finance (PRF) loan to enhance readiness for project implementation, thereby facilitating the timely and cost-effective achievement of project outcomes. Activities to be conducted under the PRF include spatial planning, feasibility studies, engineering design and construction management (EDCM) during the Design and Construction Phases, and operational design and business models (ODBM) during the Operation Phase.

DREAM will equip the cities of Bahawalpur and Dera Ghazi Khan (SWM pilot cities) with: (i) collection equipment, parking, transfer, and sorting facilities; (ii) establish segregation and composting centers, with a minimum 10% of women workers; and (iii) construct sanitary landfills and biogas recovery to reduce greenhouse gas emissions.

Due to a lack of systematic management, solid waste is also listed as a priority sector in all cities. While greater tools and abilities could improve collection, it's vital to establish bioreactor landfills to reduce health hazards and enhance environmental conditions. Heaps of garbage is one of the greatest challenges that caused poor state of cleanliness in all cities. Furthermore, improved sanitation operations will also provide solid waste management services include collection, segregation, transportation and safe disposal of solid wastes of the cities. Collected garbage will be dumped in Landfills and later these sites will be transformed into parks.

The Local Government and Community Development Department (LG&CDD) of the Government of Punjab will be the executing agency (EA) of the project and the Bahawalpur Waste Management Company will be the implementing agencies. The LG&CDD has established a Project Management Unit (PMU) and city implementation units (CIUs), which will support LG&CDD, with the implementation and capacity development component of the project.

Due to the open dumping of waste in the cities, the leachate and odor of waste is disturbing the people and polluting the environment. Bahawalpur Waste Management

Company (BWMC) aims to counter these practices but the existing solid waste management system and (BWMC) is not fully equipped with modern technologies, essential equipment's, landfill and manpower.

This Environmental Impact Assessment (EIA) document focuses solely on the scope of works of the development of the landfill and assesses any potentially significant impacts and proposes required mitigation measures, which shall be implemented by the Contractor and monitored by the PMU/CIU, Local Government and Community Development Department (LG&CDD), Punjab and ADB using the Environmental Management Plan (EMP).

1.2 PROJECT LOCATION

The proposed landfill site will be developed at Mari Sheikh Shijra, mouza Nouabad located approximately 13km away from Bahawalpur city centre at an elevation of 392 ft (119 m) above mean sea level (AMSL). The site is accessible through Basti Yar Muhammad road, however the road leading to LFS (about 2.5 Km length) is not constructed yet and its construction is included in project feasibility design.

A small compost plant, Material recovery facility (MRF) is located at existing dump site in Khanu wali which will be accessible through 10 KM road which will also be constructed as part IWMS. Compost plant and MRF will be constructed on 10 Acres land adjacent to existing dumping. This dumping is being carried out by Bahawalpur Waste Management Company (BWMC) until the commencement of operation of the MRF.

This part of the proposed site, where the dumping is being conducted, will be properly remediated through processing of the existing waste lying on site using latest technological methods with machinery to be brought to site that will process the waste and turn it into an organic form with the possibility to combine it with the other organic waste to be disposed of at the cells of the proposed landfill.

Existing transfer station that will be up-graded is located at Band Road while proposed BWMC office building that will be constructed on 1.125 acres land is located at Hasilpur road

Site closure plan for existing dumping including trenching, gas well network and necessary compactions will be developed and implemented once dumping will be stopped.

The key map for the proposed landfill is provided in **Figure 1.1**.

1.3 ENVIRONMENTAL CATEGORY OF PROJECT

According to ADB's Safeguard Policy Statement (SPS) 2009, a Rapid Environmental Assessment (REA) Checklist was prepared for the proposed landfill works (**Appendix A.1**).

As per Punjab Environmental Protection Act, 1997 (Amended 2017) and Review of IEE and EIA Regulations, 2022; the project is falling in Schedule II, Category G-Waste Storage and Disposal (Rule 1) and requires that an EIA shall be prepared and submitted to Punjab EPA for review and necessary approval.

Based on the initial findings, it was ascertained that certain adverse environmental impacts are expected due to development of the proposed landfill, MRF and compost plant and thus the subject project is considered environmentally "A" category as per ADB SPS, 2009. Therefore, an EIA has been conducted.

1.4 OBJECTIVES OF THE EIA

Following are the objectives of this EIA study:

- Assess the existing environmental conditions of Bahawalpur landfill area and MRF area including the identification of environmental sensitive receptors and develop a baseline of its prevalent environmental and socioeconomic conditions;
- Identify and investigate all impacts of the proposed landfill pre-construction/design, construction, operation, closure and post closure on the physical, biological and socioeconomic environment of the project area;
- To propose mitigation measures that would help PMU PICIIP, LG&CDD, Punjab and supervision consultant in conducting the proposed project activities in an environmentally sustainable manner;
- To uncover the planning and operational phase impacts up to microenvironment levels in which project is proposed to be sited; and
- To develop an Environmental Management Plan (EMP) that would assist PMU PICIIP LG&CDD, Punjab and EDCM in the effective implementation of the recommendations of the EIA.

1.5 EIA TEAM

The team participated in the EIA study comprised of following experts:

Sr. No.	Name of Expert	Designation
Project Management Unit (PMU) PICCIP		
1	Saad Malik	ADB's Environmental Consultant Review of first draft of EIA study.
2	Aziz Karim	Individual Consultant (Environmental Consultant) of first draft of EIA study.
3	Waqas Afzal	Deputy Director (Environment and Social Safeguards) Project Management Unit (PMU) Review of first draft of EIA study.
4	Usama Faheem	Assistant Director (Environmental Safeguards) Project Management Unit (PMU) Review of first draft of EIA study.
3	Shahnaz Aslam	Assistant Director (Environmental Safeguards) Project Management Unit (PMU) She participated in review of the EIA.
EDCM Team (Environment Component)		
4	Engr. Ihtasham ul Haq	Landfill Design Engineer EDCM
5	Dr. Abdul Qayyum Aslam	Environment Expert (EDCM) Lead Environment Expert
6	Dr. Gulnaz	Environment Specialist (EDCM)
7	Ehtasham Raza	Environment Specialist (EDCM)
8	Adnan Sharif	Environmentalism (EDCM)
9	Mehmood Amjad	Environmentalism (EDCM)
10	Ihsan Nadir	Social Expert-Environment Component (EDCM)

1.6 METHODOLOGY OF EIA STUDY

The following methodology was employed for this EIA study:

1.6.1.1 Understanding of the Proposed Operation

This involved collecting information from the ADB, PMU Punjab, LG&CDD and Engineering Design and Construction Management technical team on the proposed project activities and understanding the activities to identify potential impacts of implementing them.

1.6.1.2 Review of Legislation and Guidelines

National legislation, international agreements, environmental guidelines both of Punjab EPD, and ADB, and best industry practices have been reviewed to set environmental standards that Punjab LG&CDD as the executing Agency will adhere to during implementation and operation phase of the project.

1.6.1.3 Secondary Data Collection

Available published and unpublished information pertaining to the background environment has been obtained and reviewed. All data sources have been carefully reviewed to collect the following information:

- Physical environment – topography, geology, seismology, geomorphology, soils, surface and groundwater resources and climate;
- Biological environment – habitat types, flora and fauna (particularly rare or endangered species), critical habitats, vegetation and communities within the area;
- Physical cultural resources – sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance; and,
- Socio-economic environment – settlements, socio-economic conditions, infrastructure and land use.

1.6.1.4 Field Data Collection (Baseline Survey)

Field visits were undertaken in the month of October and November, 2022 consisting of preliminary scoping through survey and assessment activities to establish the potential impacts and categorization of activities and the Rapid Environmental Assessment (REA) Checklist was completed. The key receptors and stakeholders within the project area were identified.

Baseline surveys required to identify and establish physical and biological conditions and ecosystems in the project area has been carried out by EIA team and results has been incorporated in this report. The socio-economic environment in the project areas has been obtained through the socio-economic profiles and social impact assessment carried out by social safeguard team. Climate risk and vulnerability assessment findings have also been presented and discussed.

Primary data collection in a two kilometer area of influence, such as ambient noise levels, ambient air quality and ground water quality at the key receptor locations in the project area and particularly in close proximity to the project site was conducted.

Review of secondary information on the physical, biological and ecological aspects, physical cultural resources and infrastructure utilities in the Bahawalpur Landfill area was conducted.

1.6.1.5 Public Consultations

Public consultations (PC) were carried out with all key stakeholders, particularly local communities residing in the project area, local businesses and government and local government bodies in line with ADB's "Safeguard Policy Statement (SPS) – June 2009"/ Environmental Assessment Guidelines. Under ADB requirements, the environmental assessment process must also include meaningful public consultations during the completion of the study. In this EIA study, the public consultation process was carried out including verbal disclosure regarding the project development with stakeholders to brief them about project and to seek their response/recommendation.

1.6.1.6 Impacts Identification and Assessment

Potential impacts arising from each phase of the proposed project have been identified and assessed on the basis of field data, secondary data, expert opinions and examining previous similar projects in Pakistan. These include effects on physical, biological and socio-economic environment.

1.6.1.7 Recommendations for Mitigation Measures

Mitigation measures to minimize, eliminate or compensate for the potential environmental impacts has been recommended. The mitigation measures have been recommended on the basis of past experiences, best industry practices, legislative requirements and professional judgement.

1.6.1.8 Development of Environmental Management Plan (EMP)

An Environmental Management Plan (EMP) has been developed for effective implementation of the recommended mitigation measures. The EMP includes controls to minimize the identified impacts and monitoring program to monitor effect of mitigation measures implemented and residual impacts, if any, during implementation. The EMP has identified roles and responsibilities of all concerned parties during the implementation of the project.

1.7 PROPONENT OF PROJECT

The LG&CDD, Govt. of Punjab is the Executing Agency (EA) for the Integrated Solid Waste Management System (ISWMS) of Bahawalpur while the project will be implemented through BWMC with support from PMU. Contact details of the EA are provided as **Table 1.1** below.

Table 1.1: Executing Agency Contact Details

Executing Agency Details	Information
Name of EA	Project Management Unit (PMU), Local Government and Community Development Department (LG&CDD), Govt of Punjab
Address	40-B-I, Gulberg-III, Lahore
Telephone	+92-42- 99268484
E-mail	info@piciip.gov.pk
Web	piciip.gov.pk

1.8 STRUCTURE OF THE REPORT

The EIA report contains eleven chapters as follows:

Section 1: Introduction

Contains general information about the project and process of carrying out the EIA study.

Section 2: Policy and Legal Framework

Briefly discusses the environmental policy of ADB, existing national policy and resulting legislation for sustainable development and environmental protection, and then presents the legislative requirements of Punjab Pakhtunkhwa Environmental Protection Act (amended act).

Section 3: Description of the Project

Provides the description of the proposed project, its layout plans and associated activities, utility requirement, technology used, current and proposed waste disposal practices, project layout plans, etc.

Section 4: Description of Environment

Describes the project area's existing physical, biological, and socioeconomic conditions, including geomorphology and soils, water resources, water and air quality, flora and fauna, demography, etc.

Section 5: Analysis of Alternatives

Presents the project alternatives (site and technology alternatives, landfill types and construction alternative, waste disposal alternatives) that were considered, and the reasons for their acceptance or rejection.

Section 6: Assessment of Environmental Impacts and Mitigation Measures

Presents an assessment of the project's impact and their required mitigation measures to the physical, biological, and socioeconomic environment.

Section 7: Institutional Requirements Environmental Management Plan

Contains comprehensive prescriptions regarding environmental impacts and their mitigation measures. This also includes institutional arrangements and Environmental Management & Monitoring Plan.

Section 8: Public Consultation

Record of consultation meetings, for obtaining the views of the affected people, local non-governmental organizations and regulatory agencies.

Section 9: Grievance Redressal Mechanism

This section provides GRM stages and its process of receive and facilitate resolution of the Displaced/Affected Persons concerns and grievances regarding the project's social and environment performance.

Section 10: Public Disclosure and Information

This section provides the EIA disclosure mechanism and details.

Section 11: Findings, Recommendations and Conclusions

Concludes the EIA report with some practical recommendations.

Section 12: References

Provides all reference made in the EIA report.

1.9 FURTHER ADDITIONS & UPDATING OF EIA STUDY

This version of the report will be further updated once the detailed design is completed and any other details of the proposed landfill become available over the coming weeks and months. These revisions shall be incorporated into any subsequent updated versions of this EIA report.

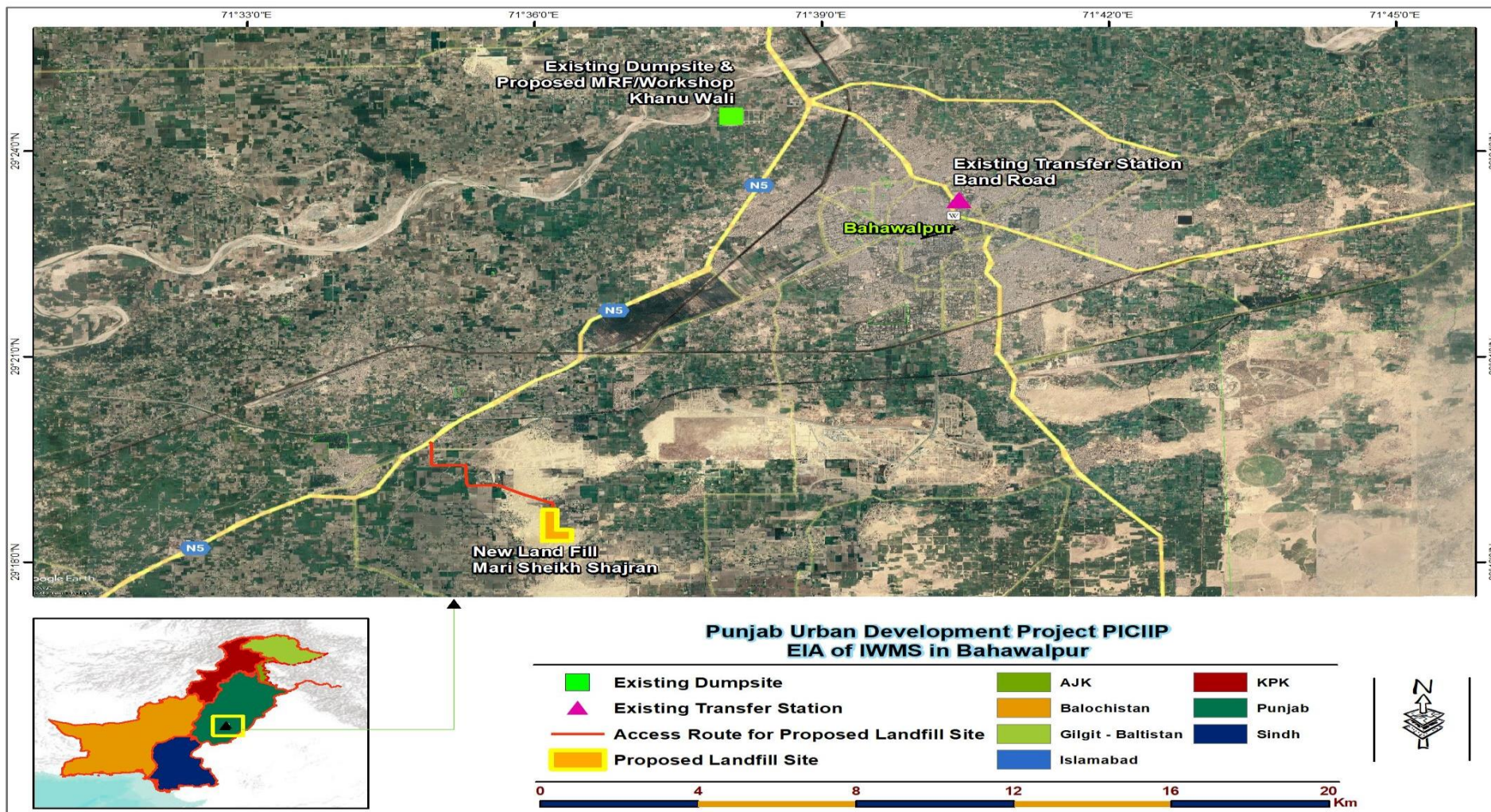


Figure Showing the Location of the Project

2. POLICY AND LEGAL FRAMEWORK

2.1 GENERAL

This section provides an overview of the policy framework and national legislation that applies to the proposed Landfill development at Mari Sheikh Shijra mouza Nouabad and MRF development at Khanu Wali in the outskirts of Bahawalpur city, Punjab, Pakistan. The project will comply with all national legislation relating to the environment in Punjab and Pakistan and will obtain all the regulatory clearances required from the financing agency, ADB in compliance to ADB SPS, 2009.

2.2 NATIONAL POLICY AND LEGAL FRAMEWORK

The Pakistan National Conservation Strategy (NCS) that was approved by the federal cabinet in March 1992 is the principal policy document on environmental issues in the country (EUAD/IUCN, 1992). The NCS outlines the country's primary approach towards encouraging sustainable development, conserving natural resources, and improving efficiency in the use and management of resources. The NCS has 68 specific programs in 14 core areas in which policy intervention is considered crucial for the preservation of Pakistan's natural and physical environment. The core areas that are relevant in the context of the proposed landfill development are pollution prevention and abatement and increasing energy efficiency while conserving biodiversity.

Prior to the adoption of the 18th Constitutional Amendment, the Pakistan Environmental Protection Act (PEPA) 1997 was the governing law for environmental conservation in the country. Under PEPA 1997, the Pakistan Environmental Protection Council (PEPC) and Pak EPA were primarily responsible for administering PEPA 1997. Post the adoption of the 18th Constitutional Amendment in 2011, the subject of environment was devolved, and the provinces have been empowered for environmental protection and conservation.

Before the passage of 18th constitutional amendment by the parliament, Punjab Government had enforced The Punjab Environmental Protection Act, 1997 in the province which was originated and derived from the Pakistan Environmental Protection Act, 1997. After the passage of 18th amendment Punjab provincial assembly passed an amendment in the act 'The Punjab Environmental Protection (Amendment) Act 2012'. About 22 amendments were made in the original act.

2.3 PUNJAB ENVIRONMENTAL PROTECTION ACT, 1997 AND AMENDMENTS

According to the Section 12 of the Act 'Initial Environmental Examination and Environmental Impact Assessment' no proponent of a project shall commence construction or operation unless; has filed with the Provincial Agency an Initial Environmental Examination or where the project is likely to cause an adverse environmental effect, an Environmental Impact Assessment, and has obtained from the Provincial Agency approval in respect thereof.

The Act is quite comprehensive to provide for the protection, conservation, rehabilitation and improvement of the environment, for the prevention and control of pollution, and promotion of sustainable development in the province of Punjab. Punjab Environmental Quality Standards (PEQS) have also been promulgated in 2016 under PEPA 1997 (Amended 2017).

2.4 REVIEW OF IEE AND EIA REGULATIONS, 2022

The Punjab Environmental Protection Agency Review of IEE and EIA Regulations, 2022 (the 'Regulations'), prepared by the Pak-EPA under the powers conferred upon it by the PEPA, provide the necessary details on the preparation, submission and review of the initial environmental examination (IEE) and the environmental impact assessment (EIA).

The Regulation classifies projects on the basis of expected degree of adverse environmental impacts and lists them in two separate schedules. 'Schedule-I' lists projects that may not have significant environmental impacts and therefore require an IEE. Schedule-II lists projects of potentially significant environmental impacts requiring preparation of an EIA. The Regulations also require that all projects located in environmentally sensitive areas require preparation of an EIA.

As per Punjab Environmental Protection Act, 1997 (Amended 2017) and Review of IEE and EIA Regulations, 2022; the IEE and EIA review fee has to be submitted to Punjab-EPA. Moreover, review period for IEE and EIA has been also predefined which is from 45-90 days.

2.5 REGULATORY CLEARANCES, PUNJAB EPA

In accordance with provincial regulatory requirements, an IEE/EIA satisfying the requirements of the Punjab Environmental Protection Act (Amended 2017) is to be submitted to Punjab environmental protection agency (Punjab-EPA) for review and approval, and subsequent issuance of NOC before the commencement of construction.

As per Punjab Environmental Protection Act, 1997 (Amended 2017) and Review of IEE and EIA Regulations, 2022; the project is falling in Schedule II, Category G-Waste Storage and Disposal (Rule 1) and requires that an EIA shall be prepared and submitted to Punjab EPA for review and necessary approval.

Punjab EPA has issued NOC for same site back in 2018 which is attached as **Appendix A.14** which shows that project can be established at proposed site and EPA has already carried out site assessment and accorded approval following legal requirements. PMU PICIIP will maintain close coordination with Punjab EPA on the status of already issued NOC and upon direction of EPA will file application for its renewal or submit updated EIA along with review fee to obtain new NOC.

2.6 PUNJAB ENVIRONMENTAL QUALITY STANDARDS (PEQS), 2016

PEQS were promulgated in 2016 under the Punjab Environmental Protection Act, 2012 (Amendment 2017) by Punjab Environmental Protection Agency and approved by Punjab Environment Protection Council. PEQS are mainly adopted from NEQS after the enactment of Punjab Environmental Protection Act, 2012 as result of 18th amendment. The act specifies the imposition of a pollution charge in case of non-compliance with the PEQS. The project will strictly comply with environmental quality standards of both provincial domains.

Under Section 6 (I) (c) of PEPA Act 1997, the National Environmental Quality Standards (NEQS), now called the Punjab Environmental Quality Standards (PEQS) post-devolution, have also been set for liquid effluents, gaseous emissions, noise levels and drinking water quality such as;

The PEQS (2016) specifies the following standards for:

2.6.1 Liquid Effluents and Gaseous Emissions

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea (three separate sets).
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources.
- Maximum allowable concentration of pollutants (2 parameters) in gaseous emissions from vehicle exhaust.

- Maximum allowable noise levels from vehicles.

2.6.2 Drinking Water Quality

The PEQS notified documents provide standard values for following 37 parameters:

- Biological (6 parameters)
- Physical (7 parameters)
- Chemical (19 parameters)
 - Essential inorganic (9 parameters)
 - Toxic inorganic (10 parameters)
- Organic (3 parameters)
- Radioactive (2 parameters)

2.6.3 Motor Vehicle Exhaust and Noise

Under the PEQS (2016), different areas/zones have been categorized to specify PEQS (2016) limiting values depending on land use and exposure level of sensitive receptors in different environmental conditions. Four types of areas have been mentioned with specific values for the noise level during day and night times in this regard. These are:

- Residential area
- Commercial area
- Industrial area
- Silence Zone

2.6.4 Ambient Air Quality

Ambient Quality parameters in the standard are provided below;

- Five ambient gaseous parameters of SO₂, NO₂, NO, O₃, and CO.
- Three numbers ambient particulates parameters of SPM, PM, and PM 2.5
- One parameter of Pb (Lead)

2.7 NATIONAL ENVIRONMENTAL QUALITY STANDARDS (NEQS) 2000

The National Environmental Quality Standards (NEQS), 2000, specify the following standards:

- Maximum allowable concentration of pollutants (32 parameters) in municipal and liquid industrial effluents discharged to inland waters, sewage treatment facilities, and the sea (three separate sets of numbers);
- Maximum allowable concentration of pollutants (16 parameters) in gaseous emissions from industrial sources;
- Maximum allowable concentration of pollutants (two parameters) in gaseous emissions from vehicle exhaust and noise emission from vehicles;

- Maximum allowable noise levels from vehicles;
- Maximum allowable concentration of parameters in drinking water

PEQS guidelines are provided as **Appendix A.12** of this EIA report.

2.8 OTHER ENVIRONMENT RELATED LEGISLATIONS

The national laws and regulations are provided in **Table 2.1** below.

Table 2.1: Environmental Guidelines and Regulations

Legislation/Guideline	Description
National Environmental Policy (2005) (NEP)	NEP is the primary policy of Government of Pakistan addressing environmental issues. The broad Goal of NEP is, “to protect, conserve and restore Pakistan’s environment in order to improve the quality of life of the citizens through sustainable development”. The NEP identifies a set of sectorial and cross-sectorial guidelines to achieve its goal of sustainable development. It also suggests various policy instruments to overcome the environmental problems throughout the country.
The Forest Act (1927)	The Forest Act 1927, was amended in 2016, promulgated after the approval of the Governor of Punjab on January 26, 2016. This act is applicable to all regions of Punjab. It includes procedures for constituting and managing various types of forests, such as reserved forests and protected forests. The act empowers the provincial forest departments to declare any forest area as reserved or protected and also prohibit the breaking up or clearing of forest for cultivation, grazing, hunting, removing forest produce, quarrying and felling, lopping and topping of trees, branches in reserved and protected forests. The latest amendment bill grants provisions for the use of reserved or protected forest land, where inevitable, for national projects of strategic importance.
The Punjab Wildlife (Protection, Preservation, Conservation and Management) Act, 1974	This Act provides for the protection, preservation, conservation and management of wildlife by the formation and management of protected areas and prohibition of hunting of wildlife species declared protected under this Act. The Act also specifies three broad classifications of the protected areas; national parks, wildlife sanctuaries and game reserves. Activities such as hunting and breaking of land for mining are prohibited in national parks, as are removing vegetation or polluting water flowing through the park. Wildlife sanctuaries are areas that have been set aside as undisturbed breeding grounds and cultivation and grazing is prohibited in the demarcated areas. Nobody is allowed to reside in a wildlife sanctuary and entrance for the general public is by special dispensation. However, these restrictions may be relaxed for scientific purpose or betterment of the respective area on the discretion of the governing authority in exceptional circumstances. Game reserves are designated as areas where hunting or shooting is not allowed except under special permits. On the basis of available/published material, SOP maps and the list issued by the concerned authorities the project area for EIA is located outside of any Wildlife Sanctuary, National Park or Game

Legislation/Guideline	Description
	Reserves and therefore the project will not contravene with any provisions of the Act.
The Canal and Drainage Act, 1873	The Canal and Drainage Act, 1873 prohibits corruption or fouling of water in canals (defined to include channels, tube wells, reservoirs and watercourses), or obstruction of drainage. This act has relevance to the study due to the presence of canals and irrigation network in the project area. All project activities near the irrigation network will have to be implemented in a way that no physical damage to the canal or alteration in water quality occurs. Any discharge of waste into the canal shall also be prohibited. Any abstraction of water from the canal or associated watercourses shall be subject to approval from the concerned irrigation department.
The Antiquities Act (1975)	The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. Antiquities have been defined in the Act as ancient products of human activity, historical sites or sites of anthropological or cultural interest, national monuments etc. The act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area which may contain articles of archaeological significance. Under the Act, the project proponents are obligated to: ■ Ensure that no activity is undertaken in the proximity of a protected antiquity; and ■ If during the course of the project an archaeological discovery is made, it should be reported to the Department of Archaeology, Government of Pakistan.
Pakistan Penal Code (1860)	It authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use.
NATIONAL ENVIRONMENTAL AND CONSERVATION STRATEGIES	
National Conservation Strategy	Before the approval of NEP, the National Conservation Strategy (NCS) was considered as the Government's primary policy document on national environmental issues. At the moment, this strategy just exists as a national conservation program. The NCS identifies 14 core areas including conservation of biodiversity, pollution prevention and abatement, soil and water conservation and preservation of cultural heritage and recommends immediate attention to these core areas.
Biodiversity Action Plan	The plan recognizes IEE/EIA as an effective tool for identifying and assessing the effects of a proposed operation on biodiversity.
INTERNATIONAL CONVENTIONS	

Legislation/Guideline	Description
The Convention on Conservation of Migratory Species of Wild Animals (1981.21)	The Convention requires countries to take action to avoid endangering migratory species. The term "migratory species" refers to the species of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries. The parties are also required to promote or cooperate with other countries in matters of research on migratory species. There are no endangered species of plant life or animal life in the vicinity of the proposed project areas for the landfill works.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)	The convention requires Pakistan to impose strict regulation (including penalization, confiscation of the specimen) regarding trade of all species threatened with extinction or that may become so, in order not to endanger their survival further.
International Union for Conservation of Nature and Natural Resources Red List (2000)	Lists wildlife species experiencing various levels of threats internationally. Some of the species indicated in the IUCN red list are also present in the wetlands of Pakistan.
Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention) (1971)	The Ramsar Convention deals with the protection of water bodies of international importance and their associated biodiversity, as well as promoting wise use of allied resources. The Convention was adopted in 1971 at Ramsar, Iran and entered into force in 1975. Pakistan signed the Ramsar Convention in 1971, and ratified it in July 1976. There are 19 Ramsar sites in Pakistan.
Basel Convention on the Control of Trans-Boundary Movements of Hazardous Wastes and their Disposal (1992)	The Basel Convention deals with the controlled trans-boundary movement of hazardous wastes and their disposal. The Convention was adopted on March 22, 1989, and entered into force on May 5, 1992; Pakistan signed the Convention in May 1992 and ratified it in October 1994.
United Nations Framework Convention on Climate Change (UNFCCC) (1994)	This convention highlights broad guidelines for protecting the climate of the planet. It was adopted in 1992 and came into force in 1994. Pakistan signed the UNFCCC in 1992 and ratified it in June 1994.
Kyoto Protocol to UNFCCC (2005)	The Kyoto Protocol seeks to mitigate climate change and to reverse the pace of climate change through the use of carbon sequestration and carbon credits known as Certified Emission Reduction trading. The Protocol was adopted in 1997 and came into force in 2005; Pakistan signed the Protocol in December 1997 and ratified it in January 2005.

2.9 IMPLICATIONS OF NATIONAL POLICIES AND REGULATIONS ON PROPOSED PROJECT

According to the Punjab-EPA 'Review of IEE and EIA Rules and Regulations, 2022', development projects are categorized under two Schedules- I and II. Projects are classified on the basis of expected degree and magnitude of environmental impacts and the level of environmental assessment required is determined from the schedule under which the project is categorized.

The projects listed in Schedule-I include those where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis. Schedule-I projects require an IEE to be conducted, rather than a full-fledged EIA, provided that the project is not located in an environmentally sensitive area.

The projects listed in Schedule-II are generally major projects and have the potential to affect a large number of people in addition to significant adverse environmental impacts. The impacts of projects included in Schedule-II may be irreversible and could lead to significant changes in land use and the social, physical and biological environments. The proposed Landfill development project has been categorized as Schedule II (G) and requires an EIA.

The PMU PICIIP LG&CDD, Govt. of Punjab, being the Executing Agency for the Project is responsible for management of project impacts, and have to undertake the commitments and mitigation measures proposed in this environmental report and in the subsequent review and approval conditions.

According to the regulations, no construction, preliminary or otherwise, relating to the project shall be undertaken until and unless approval of the EIA report has been issued by the Punjab EPA.

The PMU LG& CDD will submit the EIA Report on a prescribed application along with the processing fee to Punjab EPA. After submission of the EIA report, a thirty (30) day period for public comments will be provided. The assessment will be completed within a period of ninety (90) days from receipt of the complete documents, and earlier than this wherever practicable. Following the completion of public hearing, if required, and the provision of any further data from the proponent, the decision shall be made and conveyed after thirty days thereafter.

2.10 ADB'S SAFEGUARD POLICY STATEMENT (SPS), 2009

The ADB's SPS 2009 requires that environmental considerations be incorporated into ADB funded projects to ensure that the project will have minimal environmental impacts and be environmentally sound. Occupational health & safety of the local population should also be addressed as well as the project workers as stated in SPS. A Grievance Redress Mechanism (GRM) to receive application and facilitate resolution of affected peoples' concerns, complaints, and grievances about the project's environmental performance is also established.

All loans and investments are subject to categorization to determine environmental assessment requirements. Categorization is to be undertaken using Rapid Environmental Assessment (REA) checklists, consisting of questions relating to (i) the sensitivity and vulnerability of environmental resources in project area, and (ii) the potential for the project to cause significant adverse environmental impacts. Projects are classified into one of the following environmental categories:

Category A: A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment (EIA) is required.

Category B: A proposed project is classified as category B if its potential adverse environmental impacts are less adverse than those of category A projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category A projects. An initial environmental examination (IEE) is required.

Category C: A proposed project is classified as category C if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed.

Category FI: A proposed project is classified as category FI if it involves investment of ADB funds to or through a financial intermediary (FI).

2.11 ADB'S ACCESS TO INFORMATION POLICY (AIP) 2018

ADB's new Access to Information Policy (AIP), reflects the ADB's ongoing commitment to transparency, accountability, and participation by stakeholders. The policy contains principles and exceptions to information sharing with external stakeholders, led by a new overarching principle of "clear, timely, and appropriate disclosure."

2.12 ADB'S ACCOUNTABILITY MECHANISM POLICY 2012

The objectives of the Accountability Mechanism are providing an independent and effective forum for people adversely affected by ADB-assisted projects to voice their concerns and seek solutions to their problems, and to request compliance review of the alleged noncompliance by ADB with its operational policies and procedures that may have caused, or is likely to cause, them direct and material harm. The Accountability Mechanism is a "last resort" mechanism.

2.13 IMPLICATIONS OF ADB'S SAFEGUARD POLICIES ON PROPOSED PROJECT

The objectives of ADB's safeguards are to:

- avoid adverse impacts of projects on the environment and affected people, where possible;
- minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and
- help borrowers/clients to strengthen their safeguard systems.

ADB's SPS sets out the policy objectives, scope and triggers, and principles for three key safeguard areas:

- environmental safeguards,
- involuntary resettlement safeguards, and
- Indigenous Peoples safeguards.

The objective of the environmental safeguards is to ensure the environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process. ADB's policy principles are summarized in **Table 2.2** below.

Table 2.2: ADB Policy Principles

No	Policy principle	Summary
1	Screening and categorization	Screening process initiated early to determine the appropriate extent and type of environmental assessment.

No	Policy principle	Summary
2	Environmental assessment	Conduct an environmental assessment to identify potential impacts and risks in the context of the project's area of influence.
3	Alternatives	Examine alternatives to the project's location, design, technology, and components and their potential environmental and social impacts, including no project alternative.
4	Impact mitigation	Avoid, and where avoidance is not possible, minimize, mitigate, and/or offset adverse impacts and enhance positive impacts. Prepare an environmental management plan (EMP).
5	Public consultations	Carry out meaningful consultation with affected people and facilitate their informed participation. Involve stakeholders early in the project preparation process and ensure that their views and concerns are made known to and understood by decision makers and taken into account. Continue consultations with stakeholders throughout project implementation. Establish a grievance redress mechanism.
6	Disclosure of environmental assessment	Disclose a draft environmental assessment in a timely manner, in an accessible place and in a form and language(s) understandable to stakeholders. Disclose the final environmental assessment to stakeholders.
7	Environmental management plan	Implement the EMP and monitor its effectiveness. Document monitoring results and disclose monitoring reports.
8	Biodiversity	Do not implement project activities in areas of critical habitats.
9	Pollution prevention	Apply pollution prevention and control technologies and practices consistent with international good practices. Adopt cleaner production processes and good energy efficiency practices. Avoid pollution, or, when avoidance is not possible, minimize or control the intensity or load of pollutant emissions and discharges. Avoid the use of hazardous materials subject to international bans or phase outs.
10	Occupational health and safety/Community safety.	Provide workers with safe and healthy working conditions and prevent accidents, injuries, and disease. Establish preventive and emergency preparedness and response measures to avoid, and where avoidance is not possible, to minimize, adverse impacts and risks to the health and safety of local communities
11	Physical cultural resources	Conserve physical cultural resources and avoid destroying or damaging them. Provide for the use of "chance find" procedures.

52. The basic environmental assessment requirements for Category 'A' projects are provided in **Table 2.3** below.

Table 2.3: ADB Environmental Assessment Requirements for Category ‘A’ projects

Aspect	Environmental Assessment & Management Requirements
Project processing	
Reporting	▪ Prepare full-scale environmental impact assessment (EIA)
Public consultations	▪ Conduct consultations at the early stage of EIA field work and when the draft EIA report is available during project preparation, and before project appraisal by ADB.
Disclosure of environmental assessment report	▪ Disclose draft environmental impact assessment reports at least 120 days before Board consideration.
Project implementation	
Reporting	▪ Submit semi-annual reports during project construction, and annual reports during project operation to ADB for disclosure. ▪ Conduct 3rd party monitoring and submit semi-annual external environmental monitoring reports to ADB for disclosure.

2.14 IFC SECTOR SPECIFIC GUIDELINES ON SOLID WASTE MANAGEMENT¹

The IFC guidelines provide guidance with regards to development and operation of SWM sites. In terms of site selection of the landfill site, these guidelines require the location of the landfill to take into account potential impacts associated with releases of polluting substances, including the following:

- **Proximity to residential, recreation, agricultural, natural protected areas, or wildlife habitat and areas prone to scavenging wildlife, as well as other potentially incompatible land uses:**
 - Residential development should be typically further than 250 meters from the perimeter of the proposed landfill cell development to minimize the potential for migration of underground gaseous emissions;
 - Visual impacts should be minimized by evaluating locational alternatives;
 - Siting should be further than 3 km of a turbojet airport and 1.6 km of a piston-type airport or as permitted by the aviation authority fully considering potential threats to air safety due to attraction and presence of birds;
- **Proximity and use of groundwater and surface water resources:**
 - Private or public drinking, irrigation, or livestock water supply wells located down gradient of the landfill boundaries should be further than 500 meters from the site perimeter, unless alternative water supply sources are readily and economically available and their development is acceptable to regulatory authorities and local communities;

¹<https://www.ifc.org/wps/wcm/connect/5b05bf0e-1726-42b1-b7c9-33c7b46ddda8/Final%2B-%2BWaste%2BManagement%2BFacilities.pdf?MOD=AJPERES&CVID=jqeDbH3>

- Areas within the landfill boundaries should be located outside of the 10-year groundwater recharge area for existing or pending water supply development;
- Perennial stream should not be located within 300 meters down gradient of the proposed landfill cell development, unless diversion, culverting or channelling is economically and environmentally feasible to protect the stream from potential contamination;
- **Site geology and hydrogeology:**
 - Landfills should be located in gently sloped topography, amenable to development using the cell (bund) method), with slopes which minimize the need for earthmoving to obtain the correct leachate drainage slope of about 2%;
 - Groundwater's seasonally high table level (i.e. 10 year high) should be at least 1.5 meters below the proposed base of any excavation or site preparation to enable landfill cell development;
 - Suitable soil cover material should be available on-site to meet the needs for intermediate (minimum of 30 cm depth) and final cover (minimum of 60 cm depth), as well as bund construction (for the cell method of landfill operation). Preferably, the site would have adequate soil to also meet required cover needs (usually a minimum of 15 cm depth of soil)²
- **Potential threats to landfill site integrity from natural hazards such as floods, landslides, and earthquakes:**
 - Landfills should be sited outside of a floodplain subject to 10-year floods and, if within areas subject to a 100- year flood, amenable to an economic design which would eliminate the potential for washout;
 - There should be no significant seismic risk within the region of the landfill which could cause destruction of berms, drains or other civil works, or require unnecessarily costly engineering measures; otherwise, side slopes should be adjusted accordingly to prevent failure in the event of seismic activity;
 - No fault lines or significantly fractured geologic structure should be present within 500 meters of the perimeter of the proposed landfill cell development which would allow unpredictable movement of gas or leachate;
 - There should be no underlying limestone, carbonate, fissured or other porous rock formations which would be incompetent as barriers to leachate and gas migration, where the formations are more than 1.5 meter in thickness and present as the uppermost geologic unit above sensitive groundwater.

All the guidelines mentioned above with regards to site selection for the landfill site have been taken into consideration while finalization of the site for the landfill development.

The IFC guidelines also provide guidance on the operational aspects of landfill sites, such as measures to prevent, minimize and control leachate generation, groundwater and leachate monitoring, measures for controlling of landfill gas emissions, controlling of dust and odor emissions from landfill site, measures for controlling dispersal of litter along with closure and post closure activities.

² Daily cover needs can be alternatively met by using removable tarps, other relatively inert materials (i.e., compost residuals), or by removing the previously laid daily soil cover at the start of each day for reuse at the end of the same day.

2.15 US EPA SUB TITLE 40 CFR

US EPA regulations subtitle 40 CFR provide a summary of the regulatory criteria for municipal solid waste landfills (MSWLFs). The regulations detail general requirements (Sub Part A) and local restrictions (Sub part B) that are applicable to landfill designer and operators. The regulations establish special siting restrictions and performance standards for six types of MSWLF site locations: airport surroundings, 100-year floodplains, wetlands, fault areas, seismic impact zones, and unstable areas (Part 258, Subpart B). These six types of locations are sensitive areas that warrant additional regulatory controls. While all six-location restrictions apply to new and laterally expanding MSWLF units, existing units are subject only to airport safety, floodplain, and unstable area controls.

53. Regulations sub part C details operating criteria are controls for the day-to-day management of a MSWLF. For example, owners and operators must have a program in place to exclude regulated quantities of hazardous waste and polychlorinated biphenyl (PCB) wastes. Additional requirements include daily cover material, controlling disease vector populations (such as rodents and mosquitoes), restricting public access, and maintaining appropriate records.

Regulations sub part D deals with design criteria which require a composite liner and leachate collection system to be installed. The lower component must be constructed of at least a 2-foot layer of compacted soil and must exhibit a hydraulic conductivity of no more than 1×10^{-7} cm/sec. EPA believes that the combination of an FML and a compacted soil layer ensures adequate protection by providing both a highly impermeable upper liner to maximize leachate collection and removal, and a lower soil layer to serve as a back-up in the event of FML failure (56 FR 51060; October 9, 1991). The leachate collection system must be designed and constructed to maintain less than a 30-cm depth of leachate over the liner (Section 258.40(a)(2)).

Regulations sub part E deals with ground water monitoring and corrective action. It establish criteria for establishment of ground water monitoring wells, sampling and analysis program, detection monitoring program, assessment monitoring program and detection standards.

Regulations sub part F details the closure and post closure requirements of landfill sites while sub part G deals with Financial Assurance criteria.

Bahawalpur landfill has been designed keeping in view the requirements of US EPA Subtitle 40 CFR.

2.16 COMPARISON OF INTERNATIONAL AND LOCAL ENVIRONMENTAL LEGISLATIONS

The ADB SPS requires application of pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards. The SPS states that when host country regulations differ from these standards, the EA will achieve whichever is more stringent.

In order to select the most stringent standards applicable, a mix of local Punjab Environmental Quality Standards (PEQS) and international (IFC) regulations have been selected. The IFC Environmental, Health, and Safety (EHS) Guidelines, General EHS Guidelines and Environmental standards are also applicable.

The **Table 2.4** presents IFC workplace noise standards that are applicable to the construction workers. It should also be noted that IFC EHS guidelines advise that where existing ambient noise levels already exceed thresholds, the project should not result in an increase of more than 3 dB over existing ambient noise levels at the nearest receptor location off-site.

A comparison of applicable local and international guidelines for ambient air quality has been provided in **Table 2.5** below. In the case of most pollutants, the Punjab

Environmental Quality Standards (PEQS) for ambient air quality are more stringent in comparison to USEPA and WHO/IFC standards. The applicable and most stringent parameters for each respective pollutant are highlighted in green.

Similar to the standards for air quality, the comparison of noise standards provided in **Table 2.6** clearly shows that the PEQS standards for noise are more stringent in comparison to the IFC standards. The only exception is the daytime noise level standard for Industrial areas where the IFC standard is more stringent (70 dB(A)) in comparison to PEQS (75 dB(A)) and so for this particular parameter, the IFC standard will be used. Apart from this one exception, the PEQS standards have been used for the proposed landfill development project.

Comparison of local and international water quality standards is provided as **Table 2.7**.

As far as regulations regarding other environmental parameters are concerned such as acceptable effluent disposal parameters, the local regulations i.e., PEQS take precedence over any other international regulations such as IFC.

Table 2.4: IFC Work Environment Noise limits

Type of Work, worPunjablace	IFC General EHS Guidelines
Heavy Industry (no demand for oral communication)	85 Equivalent level Leq,8h
Light industry (decreasing demand for oral communication)	50-65 Equivalent level Leq,8h

Table 2.5: Comparison of International and local Air Quality Standards*

Pollutants	USEPA		WHO/IFC		PEQS	
	Avg. Time	Standard	Avg. Time	Standard	Avg. Time	Standard
SO ₂	3 hrs	0.5 ppm	24 hr	20 mg/m ³	Annual Mean	80 mg/m ³
	1 hr	75 ppb	10 min	500 mg/m ³	24 hrs	120 mg/m ³
CO	8 hrs	9 ppm (11 mg/m ³)	-	-	8 hrs	5 mg/m ³
	1 hr	35 ppm (43 mg/m ³)			1 hr	10 mg/m ³
NO ₂	Annual Mean	100 ug/m ³ (53 ppb)	1 yr	40 mg/m ³	Annual Mean	40 mg/m ³
	1 hr	100 ppb	1 hr	200 mg/m ³	24 hrs	80 mg/m ³
O ₃	8 hrs	0.07ppm (148 ug/m ³)	8 hrs	100 mg/m ³	1 hr	130 mg/m ³
TSP	-	-	-	-	Annual Mean 24 hrs	360 mg/m ³ 500 mg/m ³
PM ₁₀	24 hrs	150 ug/m ³	1 yr	20 mg/m ³	Annual Mean	120 mg/m ³
			24 hr	50 mg/m ³	24 hrs	150 mg/m ³
PM _{2.5}	Annual Mean	15 ug/m ³	1 yr	10 mg/m ³	Annual Average	15 mg/m ³
	24 hrs	35 ug/m ³	24 hr	25 mg/m ³	24 hrs 1 hr	35 mg/m ³ 15 mg/m ³

*: The standards highlighted in green for each respective pollutant are the most stringent based on a comparison between local and international regulations and thus shall be applicable for the proposed project.

* In instances where the airshed is significantly degraded and the pollutant levels are already exceeding the ambient pollutant concentrations provided in the table above, it shall be ensured that the project activities cause as small an increase in pollution levels as feasible, and amounts to a fraction of the applicable short term and annual average air quality guidelines or standards as established in the project specific environmental assessment.

Table 2.6: Comparison of International and Local Noise Standards

Category of Area/Zone	Limit in dB(A) Leq			
	PEQS		WHO/IFC	
	Day Time 06:00 – 22:00	Night Time 22:00-06:00	Day Time 07:00 – 22:00	Night Time 22:00-07:00
Residential area (A)	55	45	55	45
Commercial area (B)	65	55	70	70
Industrial area (C)	75	65	70	70
Silence zone (D)	50	45	55	45

*: The standards highlighted in green for each respective Area/Zone are the most stringent based on a comparison between local and international regulations and thus shall be applicable for the proposed project.

* In instances where baseline noise levels are already exceeding the standards above, it will need to be ensured that the project activities do not cause an increment of more than 3 dB(A) from the baseline noise levels.

Table 2.7: Comparison of International and Local Water Quality Standards

Parameter	Unit	PEQS	WHO/IFC
Bacterial			
E-Coli	numbers/ml	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample
Total Coliform	numbers/ml	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample
Physical			
Color	TCU	≤ 15 TCU	-
Taste	No objectionable/Acceptable	-	-
Odor	No objectionable/Acceptable	-	-
Turbidity	NTU	< 5 NTU	
Total Hardness	mg/l	< 500 mg/l	
TDS	mg/l	< 1000	
pH		6.5-8.5	
Chemical			
Aluminum	mg/l	≤0.2	0.2

Parameter	Unit	PEQS	WHO/IFC
Antimony	mg/l	≤0.005 (P)	<0.005 (P)
Arsenic	mg/l	≤0.005 (P)	0.01
Barium	mg/l	0.7	0.3
Boron	mg/l	0.3	0.3
Cadmium	mg/l	0.01	0.0003
Chloride	mg/l	<250	250
Chromium	mg/l	≤0.05	0.05
Copper	mg/l	2	2
Cyanide	mg/l	≤0.05	0.07
Fluoride	mg/l	<1.5	1.5
Lead	mg/l	≤0.05	0.01
Manganese	mg/l	≤0.5	0.5
Mercury	mg/l	≤0.0001	0.0001
Nickel	mg/l	≤0.02	0.02
Nitrate	mg/l	≤50	50
Nitrite	mg/l	≤3	-
Selenium	mg/l	0.01	0.01
Residual Chlorine	mg/l	0.2-0.5 at consumer end	-
Zinc	mg/l	5	3

*: The standards highlighted in green for each respective Area/Zone are the most stringent based on a comparison between local and international regulations and thus shall be applicable for the proposed project.

3. PROJECT DESCRIPTION

3.1 PROJECT OVERVIEW

Development of Bioreactor landfill site at Mari Sheikh Shijra mouza Nouabad and MRF and Compost Plant at existing dumping site at Khanu Wali will provide strategic approach to sustainable management of solid waste covering all sources and all aspects, including generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency.

The proposed ISWM project comprises waste collection, a parking facility for dumpers & compactors, and a scientifically secured and well-designed landfill site with MRF.

The proposed IWMS within Bahawalpur city is crucial as it provides strategic approach to sustainable management of solid waste covering all sources and all aspects, including generation, segregation, transfer, sorting, treatment, recovery and disposal in a sound manner, with an emphasis on maximizing resource use efficiency. The operational protocols and modalities of the proposed landfill have been established to improve environmentally sound practices with respect to waste management and attempting to close existing bottlenecks in the system.

The proposed landfill will be developed at Mari Sheikh Shijra, mouza Nouabad located at 13km from the city center. The proposed landfill will be developed on 110 acres. The proposed location is currently an open area. Mostly the area is barren and agricultural. The population is sparse and although there are a few sensitive receptors, proper environmental assessments are being carried and resettlement plans are being prepared to minimize both environmental and socioeconomic impacts.

The key interventions planned under the project are provided below.

- Construction of Compost Plant and MRF at existing dumpsite located at Khanu Wali including construction and improvement of 05 Km access road
- Construction of New Engineered Bioreactor Landfill site at Mari Sheikh Shijra mouza Nouabad including new construction of 2.5 Km access road and improvement of 10 Km
- Upgradation of existing transfer station located at Band Road
- Construction of BWMC office building on 1.125 acres land at Hasilpur road
- Procurement of Primary and Secondary waste collection equipment and machinery

3.2 PROJECT NEED

Solid waste disposal is one of the basic indicators of environmental health. There is a deep relation between improper disposal of solid waste and incidence of vector borne diseases. Hence, efficient system of solid waste disposal is a crucial requirement of the community to minimize the health risks caused by such kind of waste. Current situation of solid waste disposal in Bahawalpur city is more alarming compared to other indicators of environmental health risk.

Currently no scientifically and engineered Landfill site is available in Bahawalpur. Only limited domestic waste collection with open dumping is in place.

Almost 74% ³of households dump their waste in open fields which is a threat to local environment in terms of health as it encourages fly breeding; attract rodents and vermin, cause water and soil pollution, and continually troubles the people from bad odors.

Punjab LG&CDD intends to establish a new Landfill Site for Bahawalpur. Based on the waste characterization data, a compost plant and a Material Recovery Facility is recommended. With the establishment of MRF and Compost Plants at existing dumpsite, a major portion of the solid waste generated will be diverted and, in turn, will prolong the lifespan of bioreactor landfill located at Mari Shijra village.

The waste generation rate of Bahawalpur is 0.548 kg/c/day. The projected solid waste generation is 483 tons per day in 2022 which will be about 1463 tpd in 2050. The waste generated can be broadly categorized as residential, commercial, construction demolition, animal waste, institutional, or medical.

Average waste composition of Bahawalpur in residential, commercial, institutional, parks and dumpsite areas contain the highest percentage organic waste at 63.44%, followed by plastic at 17.12%, other Non-Combustibles at 8.7%, paper at 4.70%, diapers at 4.60%, textile at 3.80%, metals at 2.32% and glass at 1.76%. All of the rest of the items were below 1%.

There are 24% recyclable components in the total waste collected. The organic components constituted 53% of the waste, and 24% of the waste had RDF potential. Therefore, the proposed values for planning waste utilization and recovery options are 24%, 53% and 24% for recycling, composting, and incineration/RDF, respectively.

Based on the waste characterization data, a compost plant and MRF is feasible at existing dump site. With the establishment of MRF and Compost Plants, a major portion of the solid waste generated will be diverted and, in turn, will prolong the lifespan of bioreactor landfill.

The proposed Bahawalpur landfill development will assist BWMC and other related agencies, to fully transform the SWM system in the city. The project also includes the installation of primary and secondary municipal solid waste (MSW) collection systems and development of International standard bioreactor landfill including MRF and composting plant to store municipal solid waste from Bahawalpur for at least 25 years.

3.3 PROJECT OBJECTIVES

The following will be the key objective of the proposed intervention:

- Achieve about 95% generated waste volume collection daily in urban areas and alternate day from rural areas.
- Confinement of waste at point of waste generation.
- One hundred (100) percent door to door collection.
- The transfer of recovering recyclables from informal sector to the formal sector by establishing a material recovery facility and reorganize primary waste collection system.
- Final disposal of the MSW with full environmental controls at an engineered landfill as per NEQS, IFC and USEPA Subtitle "D" 40 CFR specifications.
- Limited composting from source segregated organic waste from commercial waste generators.

³ Khan, A.A., Fatima, M., Khan, K. Spatial Analysis of Environmental Health Risks: A Case of Bahawalpur District, Pakistan. Pakistan Journal of Commerce and Social Sciences 2014, Vol. 8 (1), 238- 257.

- The targeted resource recovery and diversion of the waste from the landfill is maximized.
- Stop harmful air emissions from the landfill by installing daily cover, landfill gas recovery system and capping the closed portion of the landfill as per IFC guidelines.
- Zero tolerance for offsite migration of contaminated surface water and leachate migration into underground water.

The resource recovery and recycling targets are:

- Recovery of 20% recyclables out of 24 percent present in the waste stream as per WACS study
- About 5% percent C&D recycling (100 percent)
- 5-10% percent of organic waste composting
- About 100% recovery of medical waste and diversion from the landfill.

3.4 COMPONENT 1: WASTE COLLECTION & TRANSPORT TO BAHAWALPUR LANDFILL SITE

The operational modalities devised for successful implementation of waste collection are provided below.

3.4.1 Existing waste collection system in Bahawalpur

The existing solid waste management system of Bahawalpur is being managed by the Bahawalpur Waste Management Company (BWMC). The existing solid waste collection in general is divided into primary and secondary collection system. However, there is no proper solid waste disposal system in the Town and no bioreactor land fill site exists.

Major Problems

- Waste collected from few households
- Unauthorised dumping of household waste
- Unpaved roads generate dirt
- Poor areas have narrow access
- Sweepers depend on private work
- Inadequate equipment
- The BWMC lacks strategic direction, an under-developed workforce and poor management systems.
- Inadequate planning capacity, poor information and weak financial management.
- The administration is typically absorbed by its own internal procedures and processes, and largely deaf to the needs of citizens and communities.
- Information is still managed using a manual, paper-based system with a high level of inconsistencies, long outdated records and difficult access and retrieval. This makes for ad hoc, arbitrary decision-making with neither transparency nor accountability.
- The equipment and machinery of the SWM department is also constantly being used for removing encroachment and debris from roads.
- Similarly, management complains that due the negligence and inefficiency of line departments their workload also increases. Whenever there is construction of new road, street, laying of new sewerage line or water supply etc.
- Existing institutional arrangements for SWM suffer from fragmentation, lack of clear division of responsibilities, and inadequate planning, management and enforcement capacity.

- The legal and regulatory framework for SWM has shortcoming that limits its effectiveness. The main weaknesses are fragmentation and lack of clear allocation of duties and responsibilities. Existing solid waste management system is shown in **Figure 3-1** and describe in **Table 3.1**.

3.4.2 Existing Solid Waste Management and Fleet Analysis BWMC

BWMC have currently deployed 89 vehicles of different type and capacities to collect and dispose the waste generated on daily basis. Most of this fleet is quite old and may not be used in future waste collection operations. The **Table 3.1** below demonstrates the life and lifting capacity of current SWM collection fleet for Bahawalpur city.

Table 3.1: Existing solid waste collection fleet for Bahawalpur city

Sr. No.	Machinery	Quantity
1	Arm Roll Truck	4
2	Dumper Truck (5m ³)	10
3	Compactors (7m ³)	12
4	Compactors (13m ³)	2
5	Loaders	8
6	Tractor Trolleys	11
7	Mechanical Sweepers	2
8	Minitippers 1m ³	25
9	Minitippers 2.5 m ³	15
Total		89

Source: EDCM FS, 2023

The services of SWM are currently managed by the BWMC. The system deploys bioreactor workers, handcarts and mini dumpers to collect waste from households and sweep related waste. The waste is then stored in containers of different capacities. Transportation of waste is done through Arm-roll vehicles, dumpers, Tractor trolley and Compactors. However, there is a transfer station where waste is being dumped and transferred to dumpsite by loading it on dumpers and trolleys. No proper covering of vehicle is done while transporting waste from city/ transfer station to the dumpsite and littering is observed by the conveying vehicles on their way to the dumpsite. Current waste collection system of Bahawalpur is shown in **Figure 3.1** below. Photographs depicting existing management of solid waste by BWMC shown in **Figure 3.2**.

Figure 3.1: Current waste collection system in Bahawalpur

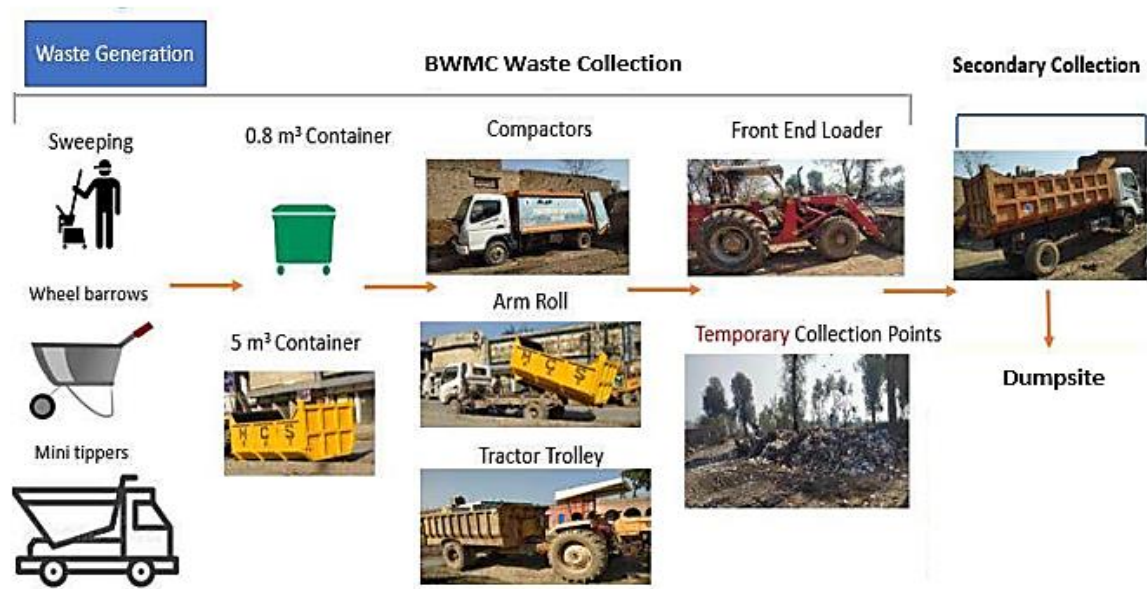


Figure 3.2: Modes of waste collection in Bahawalpur



Waste Collection through loaders and dumpers



Minidumpers used for waste for waste collection in streets



Waste collection through handcarts in congested streets



View of waste collection and transfer through Arm Roll Truck

The **Table 3.2** below provides the audit findings that was conducted to assess the existing activities being conducted from an environmental and social safeguards perspective and the required corrective measures that will be implemented.

Table 3.2: Audit of Existing Waste Collection System, Dump Site and Transfer Station and Required Corrective Actions

S/No.	Component	Audit Findings	Required Corrective Action
1	Storage of waste at source in Bahawalpur	▪ Lack of public awareness, motivation, and education ▪ Lack of civic sense and bad habits of people to litter ▪ Lack of cooperation from households, trade, and commerce ▪ Lack of litter bins in the city ▪ Long distance between community bin ▪ Resistance to change the public attitude	▪ Door to Door collection system shall be developed to reduce littering in the streets ▪ Strong behavior change communication programs would improve citizen's behavior. Communication program is included in project FS. ▪ Consider relocation of communal bins to attract more households ▪ Communal bins within city shall be selected in line with street requirements. ▪
2	Segregation of recyclables in Bahawalpur	▪ Lack of segregation of recyclables observed ▪ Lack of wide publicity through electronic and print media on waste segregation ▪ Lack of citizens' understanding how to use separate bins for storage of recyclables ▪ Lack of sufficient knowledge of benefits of segregation ▪ Lack of cooperation and negative attitude of people ▪ Lack of finances to create awareness ▪ Difficulty of educating scavengers ▪ Absence of by-laws	▪ Segregation and materials recovery facilities would be developed at existing dump site at Khanu Wali; ▪ Refuse Derived Fuel (RDF), facility would be made part of the MRF; ▪ Organic component of waste would be converted to organic compost and will be used in landfill for gas generation; ▪ In the medium term (3rd year onwards), efforts would be made to encourage segregation at source, with a 2-bin system. ▪ Environmental awareness and community interface program to increase awareness on segregation of recyclables is included in the project feasibility.
3	Waste Collection System in Bahawalpur	▪ Primary waste collection is carried out utilizing wheel barrows ▪ Secondary waste collection is carried out through 7 & 13 cubic meter compactors ▪ Citizens throw waste on streets instead of communal bins. ▪ Workers need to collect all scattered waste manually. ▪ Multiple transactions of waste till disposal site ▪ Lack of awareness and motivation	▪ Citizen's behaviour will be improved through environmental awareness and community interface program ▪ Procurement of primary collection vehicles like mini tippers handcarts is included in the project feasibility. ▪ All collection staff would have PPEs, in order to safeguard their health and safety; ▪ Citizens shall hold the key to accountability, to ensure that the daily door to door collection is performed.

S/No.	Component	Audit Findings	Required Corrective Action
		▪ Unavailability of adequate primary collection vehicles like mini tippers, handcarts etc. ▪ Insufficient response from citizens	▪ Multiple transactions of waste shall be avoided. The waste shall go either directly to landfill or through transfer station.
4	Daily sweeping of streets	▪ 100% manual sweeping system makes difficult for the sanitary workers to cover jurisdiction each day. ▪ Manual attendance management system is inefficient and leads to inefficiencies. ▪ Unavailability of workers on Sundays and public holidays	▪ With full Door to Door collection, the need for daily sweeping of all streets would be minimized to max twice a week; ▪ Focus would be on outcome-based indicators and not running after the worker's attendance. ▪ No need to sweep on Sundays.
5	Communal Storage	▪ Shortage of containers ▪ Lack of financial resources leading to broken and ill maintained bins; ▪ Lack of planning for waste storage depots or temporary storage locations; ▪ Inaccessible areas and narrow lanes that do not allow sufficient space for container	▪ Procurement of containers is included in the project feasibility ▪ There is need to remove broken and ill maintained bin however after repair these can be reused. ▪ All unnecessary communal storage points in residential areas shall be removed. ▪ No containers, no throwing by households into the streets; ▪ Only commercial areas and institutions would have communal bins; ▪ User charges would be levied to induce financial sustainability.
6	Transportation & Transfer Station at Band Road	▪ Transfer station is located at Band road at distance of 18.3 Km from proposed landfill site ▪ It is located at a distance of 6.5 km from the existing Khanuwali dumpsite ▪ Total area of transfer station is about 29 Kanal and 08 Marlas. ▪ Haphazard waste spread in nearby lands ▪ Odor problems due to long storage at transfer station ▪ Risk of vector spread and Risk of fire from transfer	▪ Upgradation of existing transfer station is included in project design ▪ Use of mobile transfer stations will be encouraged ▪ SOPs of smooth transfer station operations shall be developed ▪ Delayed storage at transfer station shall be avoided to reduce risk of vector spread ▪ There is need to develop policy that no waste touches the ground ▪ Segregation of recyclables shall be carried out at MRF located at Khanuwali to cater for economic losses ▪ Dust and odor control mechanism shall be developed for upgraded transfer station ▪ Waste would be carried in fully covered vehicles, in order to avoid any littering and pollution.

S/No.	Component	Audit Findings	Required Corrective Action
		station ▪ Absence of waste segregation facility and resources at transfer station ▪ Economic loss due to disposal of recyclable materials ▪ Increased scavenging activity in the Bahawalpur ▪ Many open vehicles for transport ▪ Old vehicles that are difficult to replace ▪ No route planning ▪ No scheduling for lifting of containers	▪ Number of vehicles would be minimized, with transfer stations and larger hauling containers. ▪
7	Waste Treatment	▪ Hardly any waste treatment in the formal sector - Lack of technical know-how for a scaled-up treatment facility ▪ Lack of institutional capacity	▪ Materials Recovery Facility (MRF) would be an integral component of the treatment and disposal system. ▪ Options for Private sector participation would be explored in operations of the MRF centres. ▪ Specialized skilled workers would be operating the transfer stations, and MRF.
8	Disposal of Waste at Existing Dump Site of Khanuwali	Located at 20.2 km from new proposed landfill site Located at 10 km from primary waste collection area Located 5.8 km from nearest population and 15 km from farthest population It is open dumping of mixed waste of about 800,000 tons without any environmental controls Additional 150,000 tons will be dumped until new landfill developed No bottom lining, leachate and gas collection system available Waste is not deposited with daily cover The migration of leachate has contaminated soil and ground water Haphazard waste spread in nearby lands Odor problems due to waste degradation Risk of vector spread and Risk of fire	▪ Proposed new landfill development will stop open dumping at Khanuwali and will fix further environmental degradation of the area ▪ Existing dumpsite will be rehabilitated through compaction, gas network, leachate collection system and application of daily cover ▪ Site closure plan for existing dumping including trenching, gas well network and necessary compactions will be developed and implemented once dumping will be stopped. ▪ New Landfill will be properly engineered/ designed, constructed and operated. ▪ Segregation, MRF and Composting facilities would enhance the useful life of Landfill.

S/No.	Component	Audit Findings	Required Corrective Action
		Economic loss due to disposal of recyclable materials Increased birds scavenging observed ▪ Lack of financial resources for a scientifically designed land fill site; ▪ Lack of technical personnel for LFS management; ▪ Lack of technical know-how for scientific disposal of waste ▪ Unavailability of appropriate land - Lack of institutional capacity	▪ New LFs will have proper facilities like reception areas, weigh bridge, workers accommodation access road, daily soil cover, workshops, wet weather area, security, lighting for 24 /7 usage and professionally trained workers to operate and supervise. ▪ Capacity building of BWMC shall be increased with respect to integrated waste management system in the city ▪ Adequate financial resources shall be arranged and allocated for rehabilitation of the existing dump site ▪ Application of daily cover shall be increased on existing dumpsite to reduce birds scavenging ▪ Detailed site analysis including soil, air and ground water sampling and monitoring at dump site and surrounding communities shall be carried out. ▪ The site mitigation, remediation and rehabilitation will be done by capping the site with final cover and install LFG system. About 0.8 million tons of waste need to be baled and depositing in the new lined landfill. It is estimated that this waste can be baled in about one year utilizing two baling units of 65-70 tons per hour baling capacity and operating for 16hrs/day.

3.5 SOLID WASTE STREAMS IN BAHAWALPUR

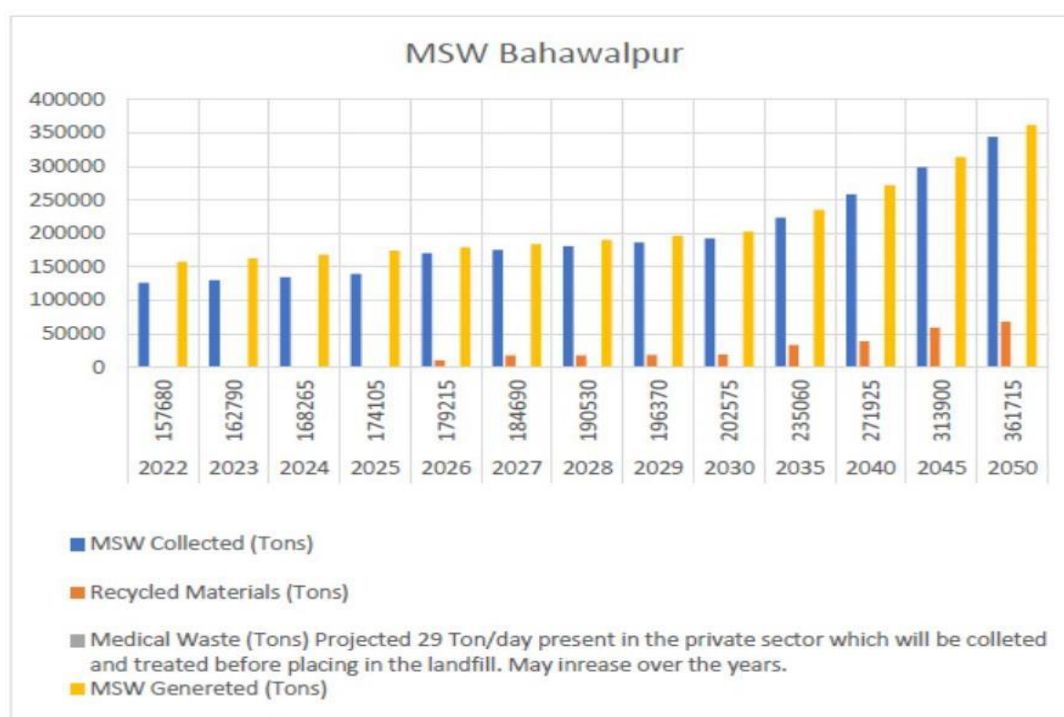
Total waste generation in Bahawalpur is broadly categorized in three types i.e. residential, commercial and bulk waste. Percentages of waste streams are established after careful review of the waste generation trends in the city and after analysing the primary and secondary data. The **Table 3.3** particularly defines the quantification of different waste kinds to help establish the suitable machinery resource for collection and disposal of each waste stream. The tonnage figure for calculation purposes was taken for the year 2025, which means a little higher tonnage to keep the system balanced and sustainable until the project completion and to avoid another procurement in the middle of project life. The current and future waste generation quantities are shown in below figure.

Table 3.3: Quantification of waste streams in Bahawalpur

Areas	Bahawalpur City	Percentages of Waste Streams
Total Daily Tonnage	477	
Municipal Solid Waste @ 60%	286	60
Commercial Waste @ 15%	72	15
Bulk Waste @ 25%	119	25
Total Waste	477	100

Source: WACS Report, 2022

Figure 3.3: Current and Future Waste Quantities of Bahawalpur



3.5.1 Waste Storage & Collection Proposed in Residential Areas of Bahawalpur

New operations model for solid waste storage and collection is purely based on one hundred percent door to door collection for residential waste, however for the commercial areas waste storage containers are also proposed to store, collect and later transfer the

waste to the transfer stations and or LFS. There is a need to emphasize and execute a very comprehensive awareness campaign in all work zones. A specific schedule of waste collection in different areas on fixed timings and the same shall be followed by the citizens.

For the future system design, the EDCM has proposed a model to take the citizens on board, aware them and make them accountable for successful execution of effective waste collection mechanism. The waste shall be collected from the doorstep of each household and they will not be allowed to throw waste out of their property except handing it over to the collection crew at the defined collection timings. Preferably the citizens shall be provided with garbage baskets for storage of waste inside their premises until the collection vehicle arrives to pick the waste up.

3.5.2 Primary Waste Collection

For residential waste the primary and secondary collection shall be carried out in four tiers of operation, the waste from very narrow streets shall be collected using the handcarts which shall offload in to Minitippers and Minitippers offload into compactors, later the compactors go to MRF for segregation and inert waste will go to LFS for final disposal.

Below are the salient characteristics of primary waste collection system proposed for Bahawalpur city.

- All waste generators will be provided adequately sized containers for two days storage of the waste. (40-45 litre)
- The primary door to door waste collection in narrow streets will utilize a combination of tricycle loaders and mini loaders similar to the Suzuki loader without hydraulics. The tricycles will carry 8 x 240-liter containers and mini loader will carry 12 x 240 litre containers. A crew of one driver and two workers is assigned to each vehicle. Worker will collect containers from households and empty in the 240 litre containers. At no time waste will be carried in open tricycle and mini loader. The 240 litre container with lid and strong wheels will be used.
- The 7-8 cm and 14 cm rear and side loader compactor will be used for collection of waste from larger households and streets which can take the compactors together with the waste from commercial and industrial waste generators. The residential waste generators will be provided 120L and 240L containers depending on size of the household and area of dwelling. Each commercial waste generator will be provided 240L or 1100L container.
- 16 -18 cm dump trucks will be used for construction and demolition waste.
- The green waste and wood waste will be collected through 12 cm hook lift containers. The hook container will be provided to commercial waste generators.
- The containers will be provided by BWMC under a simple contract with waste generator and service provider and service fee will be charged accordingly.

The primary waste collection fleet will comprise of:

- Tri-cycle electric or petrol operated without hydraulic for small streets.
- Mini loader without hydraulics.
- 7m³ and 13m³ side loaders and rear loader.
- Hook lift.
- Transfer trailers
- Motorcycles for supervisors
- 18m³ Dump trucks
- Mechanical Sweepers
- Tri-cycles for street cleaning workers

Containers

- 30-40 litre bins for Residential waste
- 120–240-liter wheeled containers for residential and commercial.

- Hook lift for commercial waste containers 12m³
- 1100-liter commercial waste containers

3.5.3 Secondary Waste Collection

All the generated waste will go to transfer station located at Band Road and then to MRF site located at the current landfill site. MSW will be processed through sort system to recover saleable recyclables. The residual waste will be pre-compacted and baled utilizing high speed and high-volume baling system with capacity of 70 tons/hr. The secondary waste collection and transportation system comprises of transfer trailers with a capacity to take 35-40 tons/trip. The number of trips from the transfer station to new landfill will be reduced by 65-70% and the air emissions from secondary waste collection will also be reduced by 70%.

Secondary Waste collection will comprise of long-haul transfer trailers with a carrying capacity of 30-40 tons baled waste. Assuming initially 90 percent of waste going to the landfill will require 14 trips of the transfer trailers and 3 trips per day in single shift. Five prime movers and 12 trailers will be more than adequate for this operation. With regular maintenance and refurbishment secondary waste collection equipment can be used for 20-25 years.

3.5.4 Procurement of SWM Equipment, Machinery and Vehicles

The project design consultant, Engineering Design and Construction Management (EDCM), has analyzed the future waste generation of the city and identified SWM equipment, machinery and vehicle requirements for current year and for project life span. The procurement plan has been established based on the review of existing waste collection fleet of BWMC and taking into consideration future waste generation rate. Proposed procurement of SWM fleet for solid waste carrying machinery is shown in **Tables 3.4** below.

Table 3.4: Proposed SWM Waste Carrying Machinery Procurement

Sr. No.	Equipment	Quantity
1	Rear and Side Loader Truck 13 cm	5
2	Rear and Side Loader Truck 7-8 cm	7
3	Tricycle loader without hydraulics	60
4	Miniloader without hydraulics	20
5	Hooklift Truck 12-20 CU YDS	3
6	Dump Trucks 18 cm	2
7	Transfer Trailers	4
8	Mechanical Sweepers	3
9	Street Cleaning Vehicles	40
10	Handcarts	150
11	Smallcars	2
12	Pickup for Supervisors	3
13	Motorcycle	15

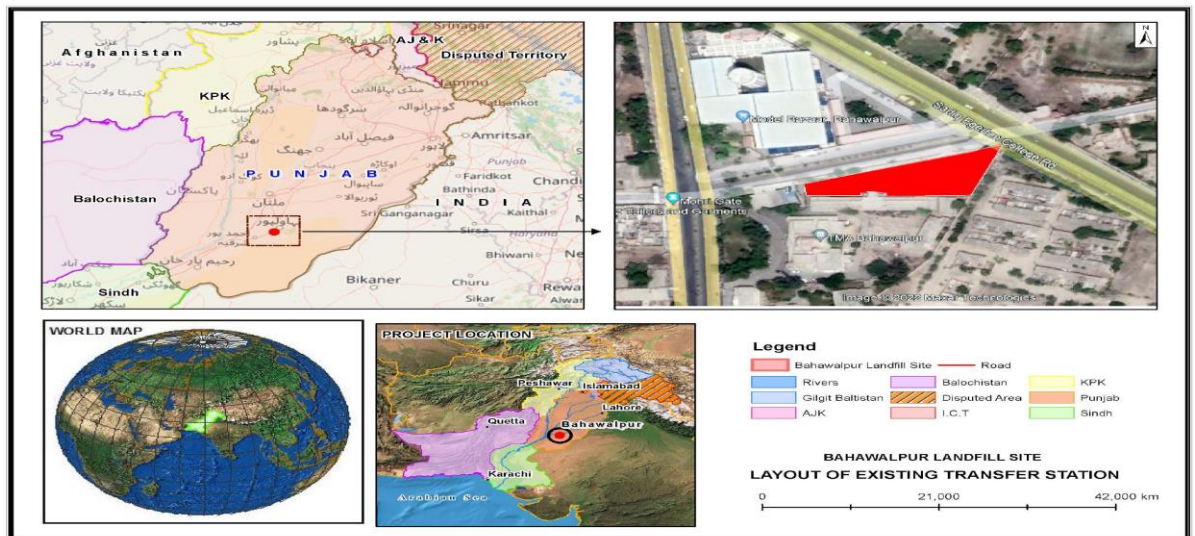
1. Source: EDCM FS Report, 2023

3.5.5 Transfer Station

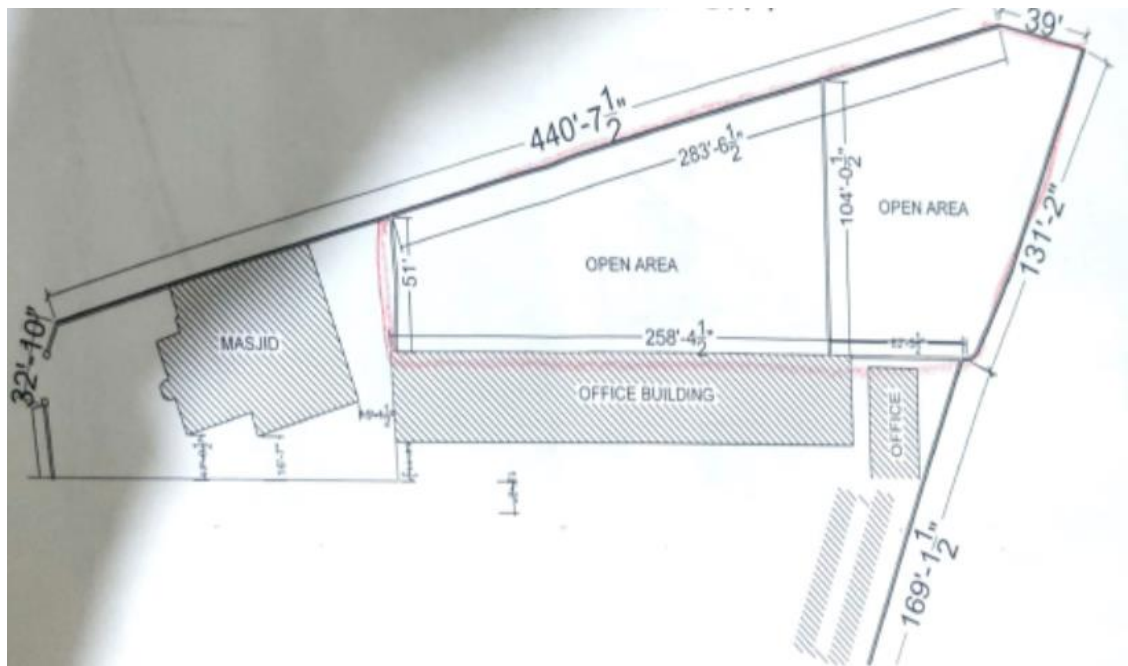
Currently, most waste collected by collection vehicles is taken to the transfer station at Band road, TMA, Bahawalpur directly. Total area of transfer station is about 29 Kanal and 08 Marlas. The coordinates of the existing transfer station are 29°23'57.58 N and 71°41'5.44 E.

Figure 3.4: Location and Layout of Existing transfer station of Bahawalpur

a) Location of Existing Transfer Station



b) Layout of Existing Transfer Station



The current transfer station located at Band road was proposed to be upgraded and retained in the operation. BWMC officials informed that the existing transfer station will be used only for transfer of waste.

Movement of smaller vehicles to the landfill site can be minimized to reduce negative environmental impact. Following types of transfer stations are proposed:

- **Mini Transfer Station** – Arm Roll vehicles containers of 15-20 m³ size, placed along a ramp in enclosures
- **Mobile Transfer Station** for vehicle to vehicle transfer – where space is constrained, large vehicles, like compactor trucks, could be used for emptying small collection vehicles.
- **Main Transfer Station** These transfer stations could be coupled with segregation or Material Recovery Facilities (MRFs), reducing load on the actual landfill site. Transfer stations will serve for transfer of waste from small capacity to large capacity vehicles to haul waste at SWMF. Waste segregation will be carried out at Material Recovery Facility, located at Old dump site. At present no new transfer station is planned and existing transfer station will be upgraded to accommodate waste transport operations.

3.5.6 BWMC Office Building

The BWMC office building will be developed on Hasilpur road in Government Employees Cooperative Housing Scheme (GECHS) . The building will be comprised of ground floor plus 4 floors. I will be develop on 1.125 acres land which is already under possession of BWMC. Building will serve as main office of BWMC and portion of the building will be rented out to some other companies in order to generate revenue for the BWMC. Site coordinates are 29.3877329863, 71.7559696409.

3.6 COMPONENT 2: SWMF DEVELOPMENT & OPERATION

3.6.1 Objective of SWMF Development

The proposed Landfill site at Mari Sheikh Shijra village mouza Nouabad, MRF and Compost Plant at Khanu Wali locality is an urban development project with the objective of providing waste collection and disposal services for the residents of Bahawalpur city. The project aims to benefit the current population of approximately 0.89 million that are estimated to increase to about 1.76 million by 2050. The project is designed with the objective to cater adverse environmental impacts of the present open dumping site and transfer station at Khanu Wali and Band road, which include:

- Haphazard waste spread in nearby lands
- Odor problems due to emission of CH₄, SO₂ and H₂S
- Risk of vector spread and Risk of fire & explosion of dump site gas
- Uncontrolled leachate infiltration causing land degradation and water pollution
- Economic loss due to disposal of recyclable materials
- Increased scavenging activity in the Bahawalpur

3.6.2 Scope of Works for SWMF development

In order to understand the impact of all the project phases and project locations to the receiving environment, it is necessary to provide details of the activities to be performed, its magnitude and duration.

The general step wise sequence of activities to be conducted for the SWMF development are described below. It shall be ensured that staging of activities takes place to manage any potential impacts, including traffic management issues.

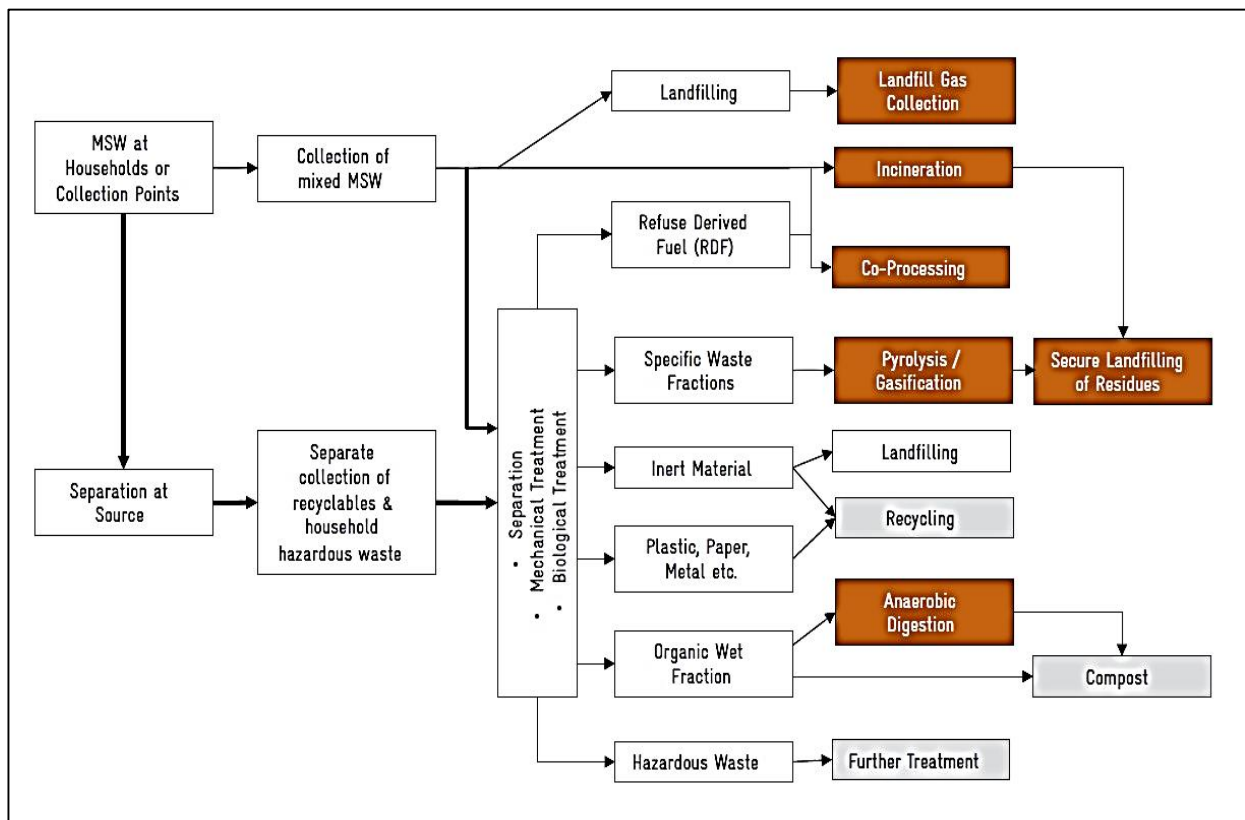
3.6.2.1 Pre-Construction/Design phase activities

The following activities have already been completed by PMU PICIIP and Engineering Design Construction Management (EDCM) consultant:

- PMU and EDCM consultant mobilization
- Waste amount and characterization study (WACS) study
- Geotechnical and topographic survey
- Project Feasibility Study
- Detailed Engineering Design (In progress)
- Social Due-Diligence

Overview of MSW Material Flow and Different utilization/treatment options that can be adopted for ISWMS of Bahawalpur are shown in below figure.

Figure 3.5: Overview of MSW Material Flow and Different Utilization/Treatment Option

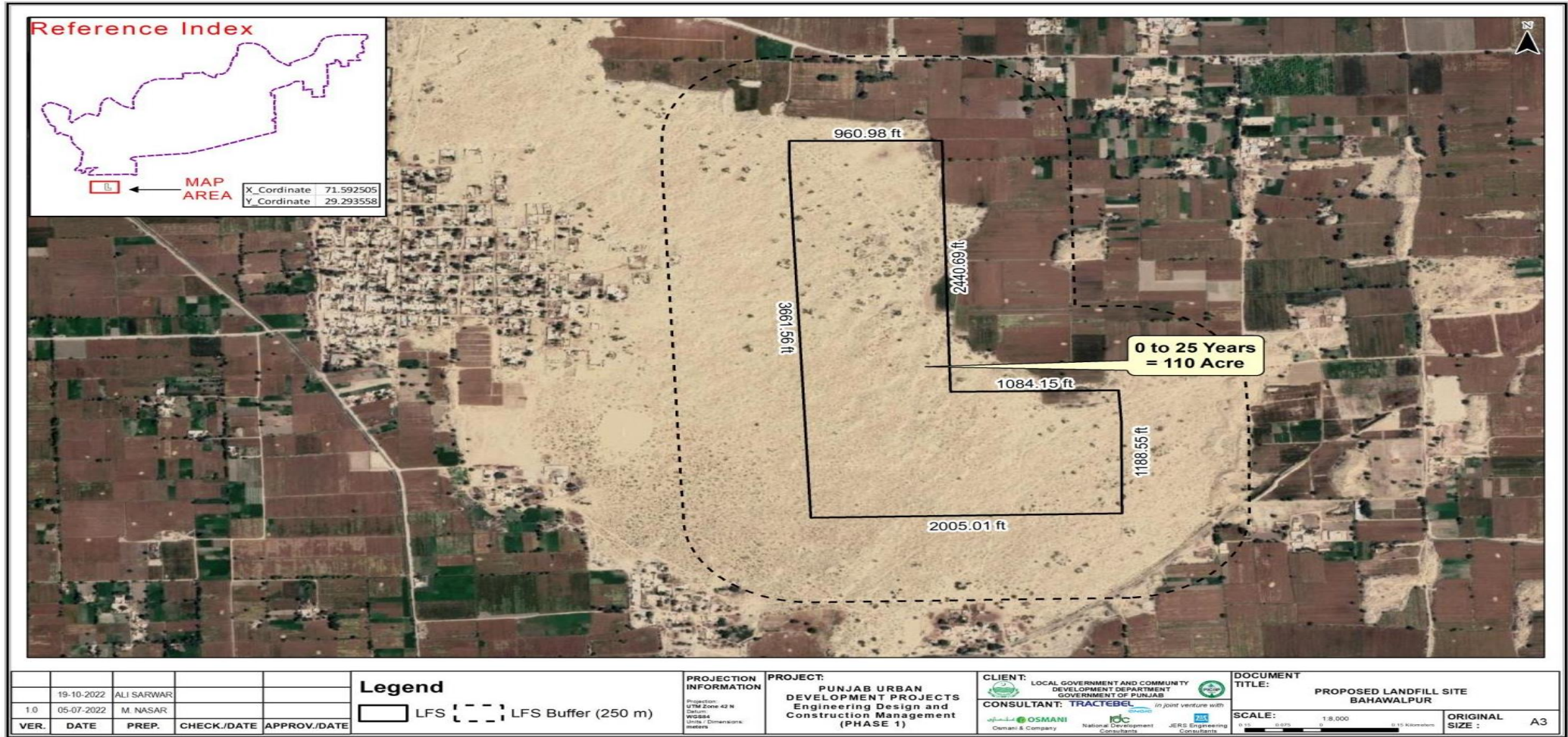


54. Project feasibility study provide detailed discourse on different waste treatment option and suggests below activities to be undertaken in order to develop SWMS of Bahawalpur.

- Construction of Compost Plant and MRF at existing dumpsite located at Khanu Wali including construction and improvement of 05 Km access road
- Construction of New Engineered Bioreactor Landfill site at Mari Sheikh Shijra mouza Nouabad including new construction of 2.5 Km access road and improvement of 10 Km main road
- Upgradation of existing transfer station located at Band Road

55. Key plan of Bahawalpur landfill site is provided in below **Figure 3.6**

Figure 3.6: Key Plan of Bahawalpur Landfill



3.6.3 Rationale for Site Selection

The proposed landfill has been selected on the basis that it must comply with basic Punjab government regulations, IFC EHS guidelines and US EPA Subtitle D 40 CFR for waste management facilities and the ADB SPS, 2009. Proposed selection of this landfill must take into account impacts from leachate, litter, dust, vector and odor on surrounding environment. The various factors that have been kept in focus while selecting the proposed landfill site are provided in **Table 3.5** below.

Table 3.5: Criteria for Site Selection

Factors considered for site selection	Rational for Site Selection
Landfill area and capacity to meet requirement of landfill site	There is adequate land area (approx. 110 acres) available at Mari Sheikh Shijra mouza Nouabad which can be used for landfilling for next 25 years.
Accessibility of landfill site	The landfill site can be accessed via Mari Sheikh Sijra and Basti Yar Muhammad road. About 2.5 km patch of access road will be new construction and improvement of 10 Km main road is included in the project. MRF is also accessible through Khanewal Bypass road however main access to road of about 05 Km will be constructed.
Site Stability	Site is located outside areas susceptible to natural or human-induced events or forces capable of impairing the integrity of landfill components. Examples of unstable areas are those with poor foundation conditions, areas susceptible to mass movements (landslides, rock falls, etc.) and areas with karst terrains (sinkholes). Geotechnical report has been carried out for the site and design is based on the findings of this report.
Land Use	The selected land is already in use for solid waste disposal therefore no or limited land use conflicts are expected. The adjacent land use of the proposed Landfill Site is a mixed type, i.e., barren and agriculture.
Critical Habitat/Sensitive ecosystem	Site is falling outside of critical habitats of plants, wildlife and sensitive ecosystems.
Restricted Zone, Wildlife/Forest Protected areas	Site is falling outside of restricted zone/wildlife/forest protected areas.
Wetlands Control	Site is located away from wetlands.
Site should be located outside of the 10-year groundwater recharge area for existing or pending water supply development	Site is located outside of the 10-year groundwater recharge area for existing or pending water supply development. However, the area naturally causes the subsoil water recharge during the rainy seasons.
Perennial stream	No perennial stream is available within 300 meters of the proposed landfill cell development. Further bottom lining

Factors considered for site selection	Rational for Site Selection
	of each landfill cell and leachate collection system ensures that no contamination is entering to perennial streams. Surface drainage network has been provided in detail design to avoid risk of surface runoff and contamination.
Topography	Landfill site is located in little mild sloped topography. Geotechnical study shows that topography is suitable for development of landfill site.
Ground Water Table	The depth of groundwater at the location of the proposed landfill site is between 15-20 m below the ground surface.
Flood plain & other climate risks	Landfill will not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste. Due to shallow groundwater and flooding zone at the operation stage, proper monitoring and maintenance of the leachate collection system are required, along with the appropriate lining of the earth. Surface drainage network has been provided in detail design of landfill site to avoid risk of surface runoff and contamination. Site should have run on and run off control system.
Seismic Risk/Fault lines	Probabilistic seismic hazard assessment shows that the project area falls in Zone-2A with peak horizontal ground acceleration of 0.08g-0.16g i.e. negligible damage (ground motion with return period of about 500 years) for soft rock foundation condition. Based on project location, Seismicity influencing the project area, area geology, field and laboratory investigation data and proposed structures, design parameters are in accordance with guidelines of Pakistan Building Code (PBC-2007).
Private/ Public water supply wells	No public water supply exists downstream of 500 m from the site. Similarly, no other irrigation or livestock water supply wells located down gradient of the landfill boundaries around a perimeter of 500 meters.
Airport Safety Control	Airport is located away from 5 miles radius (US EPA Criteria), at a distance of about 8 miles from the site, therefore no impacts of scavenging birds are anticipated on flight operations.
Sensitive Receptors	The nearest sensitive receptors are located at a safe distance from the proposed site. The boundary of the LFS was taken as a measuring point. However, design of the landfill site will be adjusted with 250m buffer area away from any sensitive receptor as per IFC guidelines. Furthermore, no LARP is required for site as land has already been acquired in 2018.

3.6.4 Proposed Design Considerations for Landfill

The design selection has a major influence on the construction, operation and restoration of the facility. The design concept depends on the ground conditions, the geology and hydrogeology of the site, the potential environmental impacts and the location of the waste disposal site. In order to incorporate advancement in technology and changes, a periodic review of the design shall be carried out, as the lifespan of a disposal site from commencement to completion is long compared to other construction projects. Aspects that have been considered in the design are briefly discussed below.

Nature and Quantity of the Waste

Nature of waste that will be landfilled at Bahawalpur will be only MSW. It is regarded as waste generated by households and waste of similar nature generated by commercial and industrial premises, institutions such as schools, hospitals and other facilities inhabited by people, construction and demolition of buildings, and from public spaces such as streets, markets, slaughter houses, public toilets, bus stops, parks and gardens.

Project design has proposed a set of mechanical & biological treatment (MBT) option after detailed techno-economic assessment:

- It is estimated that all the waste stream except the bulk waste (15%) will be diverted to MRF which will be located at existing dumpsite.
- For the first five-year, MRF will be able to recover five (05) percent valuable material from the waste while all the rest of the waste (organic, inert) will be dumped into the landfill. This waste will then be used as bioreactor for gas recovery starting from 3rd year until the post closure of the land fill until 10 years.
- The recovery percentage will gradually increase up to 15% to 20% of waste in future. The quantities of the waste diverted to material recovery facility and the mass balance is presented in the **Table 3.6**:

Table 3.6: Waste Quantities and Mass Balance

Year	Generation	Bulk Waste	MRF Input	Material	MRF Residual
	(t/d)	(t/d)	(t/d)	Recovery (t/d)	(t/d)
2025	477	71	405	20	385
2026	491	74	418	21	397
2027	506	76	430	22	409
2028	522	78	444	22	421
2029	538	81	457	23	434
2030	555	83	471	71	401
2031	571	86	486	73	413
2032	589	88	500	75	425
2033	606	91	515	77	438
2034	625	94	531	80	451
2035	644	97	547	82	465
2036	663	99	563	84	479
2037	682	102	580	87	493
2038	703	105	597	90	508

Year	Generation	Bulk Waste	MRF Input	Material	MRF Residual
	(t/d)	(t/d)	(t/d)	Recovery (t/d)	(t/d)
2039	724	109	615	92	523
2040	745	112	633	127	507
2041	767	115	652	130	521
2042	789	118	671	134	537
2043	812	122	690	138	552
2044	836	125	711	142	568
2045	860	129	731	146	585
2046	885	133	752	150	602
2047	910	137	774	155	619
2048	937	140	796	159	637
2049	963	145	819	164	655
2050	991	149	842	168	674

Source: EDCM FS Report, 2023

56. The major chunk of the organic waste along with the bulk waste and the MRF residual will be delivered to the bioreactor engineered landfill for final disposal shown in table below:

Table 3.7: Waste Disposal to Landfill

Year	Generation (t/d)	Bulk Waste (t/d)	MRF Input (t/d)	MRF Residual (t/d)	Landfill Input (t/d)
2025	477	71	405	385	456
2026	491	74	418	397	470
2027	506	76	430	409	485
2028	522	78	444	421	500
2029	538	81	457	434	515
2030	555	83	471	401	484
2031	571	86	486	413	498
2032	589	88	500	425	513
2033	606	91	515	438	529
2034	625	94	531	451	545
2035	644	97	547	465	561
2036	663	99	563	479	578
2037	682	102	580	493	595
2038	703	105	597	508	613
2039	724	109	615	523	631
2040	745	112	633	507	618

Year	Generation (t/d)	Bulk Waste (t/d)	MRF Input (t/d)	MRF Residual (t/d)	Landfill Input (t/d)
2041	767	115	652	521	636
2042	789	118	671	537	655
2043	812	122	690	552	674
2044	836	125	711	568	694
2045	860	129	731	585	714
2046	885	133	752	602	735
2047	910	137	774	619	756
2048	937	140	796	637	777
2049	963	145	819	655	800
2050	991	149	842	674	823

Source: EDCM FS Report, 2023

This would reduce the waste reaching the LFS and hence ensure the optimum land utilization.

Protection of Soil and Water

Bottom and cap lining system for each landfill cell has been designed for the protection of soil, groundwater and surface runoff. The liner system may consist of a natural or artificially established mineral layer combined with a geo-synthetic liner that must meet prescribed permeability and thickness requirements. Single composite liner system in compliance to US EPA Subtitle 40 CFR requirements is proposed by the EDCM.

Leachate Control and Management

An efficient leachate collection and removal system (LCRS) has been provided to ensure leachate accumulation at the base of the landfill and keep it to a minimum. The leachate system will consist of a leachate collection layer of either natural granular (sand, gravel) or synthetic drainage material (e.g. geonet or geo-composite) with pipe network to convey the leachate to treatment facility. Three stage open leachate treatment pond including potable Anaerobic treatment system will be adopted for leachate treatment.

Gas Recovery and Reuse

The accumulation and migration of gases from landfill facility must be controlled. Landfill gas will be collected through installation of perforated pipes within the cells. This gas transferred to gas recovery unit where it receives subsequent treatment and utilization, or disposal in a safe manner through flaring. Initially 1000m³ flaring system is provided in the conceptual design to manage landfill gas.

For the first five-year, MRF will be able to recover five (05) percent valuable material from the waste while all the rest of the waste (organic, inert) will be dumped into the landfill. This waste will then be used as bioreactor for gas recovery starting from third year until the post closure of the land fill until 10 years.

The recovery percentage will gradually increase up to 15% to 20% of waste in future.

Odor/Litter/Vector Control

Daily cover will be provided at end of each day to avoid risk of fire, wind littering, odor, vector breeding and dust hazards in the landfill. Working surface of waste will be covered with a soil layer called "daily cover" at the end of each working day. Amount of soil to be used in daily cover will be about 10% of the waste volume. Suitable quality of excavated material can be used as daily cover material.

Stability

Consideration has been given to the stability of the sub-grade, the base liner system, the waste mass and the capping system. The sub-grade and the base liner will be sufficiently stable to prevent excessive settlement or slippage.

Visual Appearance and Landscape

Consideration has been given to the visual appearance of the landfill site during operation and at termination of landfill site and its impact on the surrounding landforms. Necessary plantation will be carried out which will act as buffer zone from surrounding environment. Reasonable area has been allocated for plantation within and at boundary of facility to improve landscape of the area.

Operational and Restoration Requirements

Landfill will be operationalized in a phased manner. Site infrastructure has been included for the provision of; administration building, lookout tower, weighbridge, waste inspection area, wheel wash area, site services and security fencing to meet operational and restoration requirement.

Monitoring Requirements

One groundwater monitoring well will be maintained out of the drills made for geotechnical investigation. However, more wells may be constructed, if required, once the landfill starts operation.

3.6.5 Detailed Process Description

Following are the major operations that will be performed at the Bahawalpur Landfill site:

- Reception of the incoming waste stream;
- Placement and volume reduction of the waste through mobile compactors such as bulldozers;
- Installation of the landfill and environment control facilities

In a landfill, waste is spread in thin layers, compacted to the smallest practical volume and covered with the soil or other suitable material at the end of each day. When the disposal site reaches its ultimate capacity, a final layer of cover material is applied.

The detailed process description for disposal of MSW at the proposed site is presented in the following sections.

Weigh Bridge and Unloading Bay

Prior to the unloading, the trucks will pass over a weight bridge to determine the exact amount of collected garbage from the city every day. In order to minimize the solid waste collection vehicle's circulation inside the landfill boundary and to reduce emissions and odours, an unloading bay has been incorporated in the design. To reduce the possibility of littering, incoming collection vehicles will empty the waste on the tipping floor outside the building to reduce the circulation at the site. Weighbridge of 100 tons' capacity will be installed at the entrance gate for Bahawalpur landfill site. A pit type weigh bridge of size 20X5 m having modular cubical bolting assembly will be installed on steel platform which will be fixed on RCC raft. Schematic diagram of weighbridge is shown in **Figure 3.7** below.

Figure 3.7: Schematic Diagram of Weigh Bridge



Sorting Facility

The most suitable technological option for handling 470 tpd combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the landfill and saving landfill airspace for longer time, recovering the economic potential of the waste and improving environment through reducing the methane emission from the landfill. Organic waste generated from sorting facility will be diverted to composting plant and Bioreactor.

Composting

Limited composting will be carried out at existing dump site from source segregated waste from commercial waste generators that is animal dropping (dung), green waste and wood waste from nurseries, vegetable and fruit market and restaurants. Remaining organic waste will be utilized in Bioreactor landfill site in order to produce gas for recovery and revenue generation.

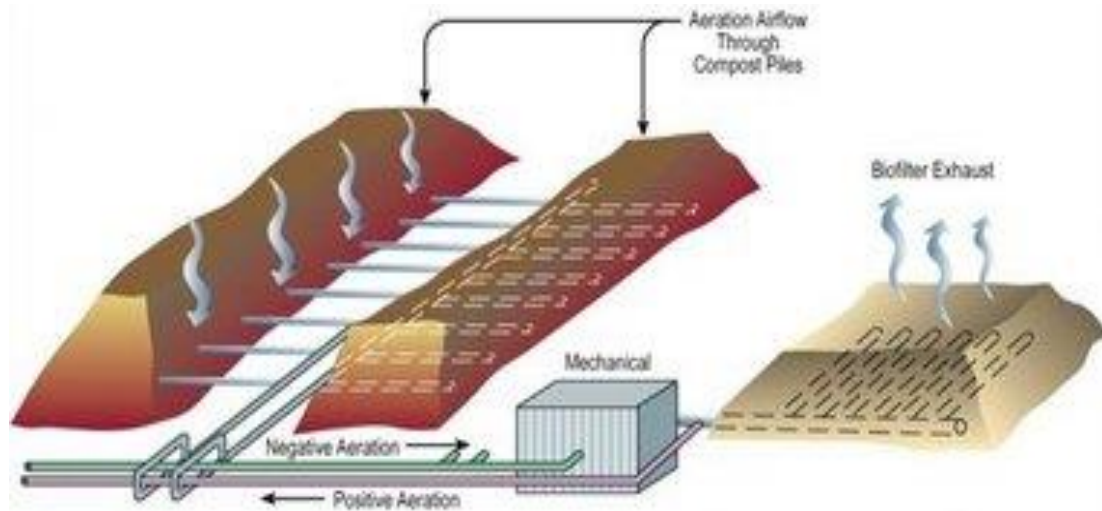
During the design phase, feasibility of choice of organic waste treatment has been discussed in detail, nonetheless, area for biological treatment of organic waste has been set aside at MRF location. All the waste collected from the city will first reach MRF for sorting and segregation. From there, organic waste and residual waste will be transported to composting area for final treatment and disposal.

Aerated static pile (ASP) composting with a capacity of 50 tons/day will be used. In ASP composting, perforated pipes are placed on the ground that are connected to a blower to push (positive) or pull (negative) air through the compost. Static piles offer process control for rapid biodegradation, and work well for facilities processing wet materials and large volumes of feedstocks.

Advantages of this composting method include the ability to maintain the proper moisture and oxygen levels for the microbial populations to operate at peak efficiency to reduce pathogens, while preventing excess heat, which can crash the system. Aerated systems also facilitate the use of biofilters to treat process air to remove particulates and mitigate odors prior to venting. However, aerated systems can dry out quickly and must be monitored closely to maintain desired moisture levels.

Two buildings of 50 tons per day composting facility 20 x 60 meters are proposed. One for active composting process and second for curing, screening and packaging. About 2400 square meters open area is required for receiving raw material and processing. Total area requirement for compost plant is 3 Acres.

Figure 3.8: Aerated Static Pile Composting for Bahawalpur Landfill



Material Recovery Facility (MRF)

A state-of-the-art MRF facility will be created to recover the recoverable recycles from mixed MSW. Initially the recovery will be less but it will increase gradually as primary waste collection incorporates confining of waste at point of waste generation and door to door waste collection system is implemented.

The MRF area is located at existing dumpsite. The sorting area will be constructed with steel structures for roof with a ceiling height reaching approximately two stories' high. Dedicated machinery will be provided for sorting and segregation area such as a front-end loader and fork lifter. Process flow description and 3D view of typical MRF is provided in **Figure 3.10 and 3.11**. The operations involved in MRF are as follows:

Waste will be off-loaded on a tipping floor at the MRF. The floor is divided into three chambers to ease the operations on first-in, first-out basis. The overall area can cater for 'two days' offloads, keeping a safety cushion for routine maintenance shutdowns. From tipping floor, front end loader will carry waste in batches and load into hopper. A bag opener is installed at the beginning of the segregation process. It will be used to open the closed bags. It will also work as a metering input device to control the throughput.

After passing the bag opener, the waste will pass through a small horizontal conveyor belt, where larger components of the waste will be removed manually before entering other sorting equipment. The removal of large items from sorting line will not only safeguard the facility against unnecessary loading of bulk waste, but it will also save the mechanical equipment from avoidable wear and tear. At the end of pre-sorting conveyor belt, a magnet will be installed to recover ferrous metals.

A Trommel screen with two distinct opening sizes of <90 mm and <6 mm is incorporated afterwards. Material below 90 mm is mostly organic, which will be dropped into trolleys placed right underneath the trommel. Once filled, the trolleys will be transported by tractors for further processing. As for the material < 6 mm which is primarily inert or fines, it will also be collected in a trolley and taken to landfill cells. This reject from MRF can be used as cover soil in waste cells.

Waste stream after the trommel screen will pass from a Ballistic Separator and separated into two main streams: a) 3D or rolling fraction where all PET, HDPE, PP and other heavy fractions tend to jump towards the lower end of the system and b) 2D or flat fraction where all film and flat material tends to move upwards. During this process, material is continuously shaken and consequently the dust and 'fines' are screened by the perforated surface of the blades.

Another chamber separates non-ferrous metals with the help of Eddy-Current technique of aluminium sorting. Afterwards, the material is fed onto a manual sorting conveyor belt located inside the picking station where plastics, glass, paper, cloth and other materials are picked before non-ferrous metals. Waste sorting manually will be collected in containers placed beneath the chutes, which will be emptied in their designated areas within the sorting facility. These materials can then be consolidated with the help of baler for ease of transportation.

Recyclables and RDF materials are fed onto a baler automatically to be packed in the shape of blocks. These are then stored for transportation to market. Industrial size shredder is proposed for reducing the size of larger waste components. The whole facility will have ventilation installed for creating a comfortable environment for the waste picking team.

The recycling and diversion target from mixed waste streams are provided below.

Table 3.7: Recycling and Diversion Targets

Diversion Targets			
Sr No	Description	Landfilling	Tons/Day
1	Year 1	100	477
2	Year 2	90	429
3	Year 3	80	382
4	Year 4	70	334

Recyclables Recovery Targets		
Sr No	Description	% Recovery
1	One year after MRF startup	6
2	Year 2	10
3	Year 10	15
4	Year 15-25	20

The processing capacity of MRF will be 60 tons per hour. MRF layout plan is shown in Figure 3.10.

Figure 3.10: MRF Layout Plan

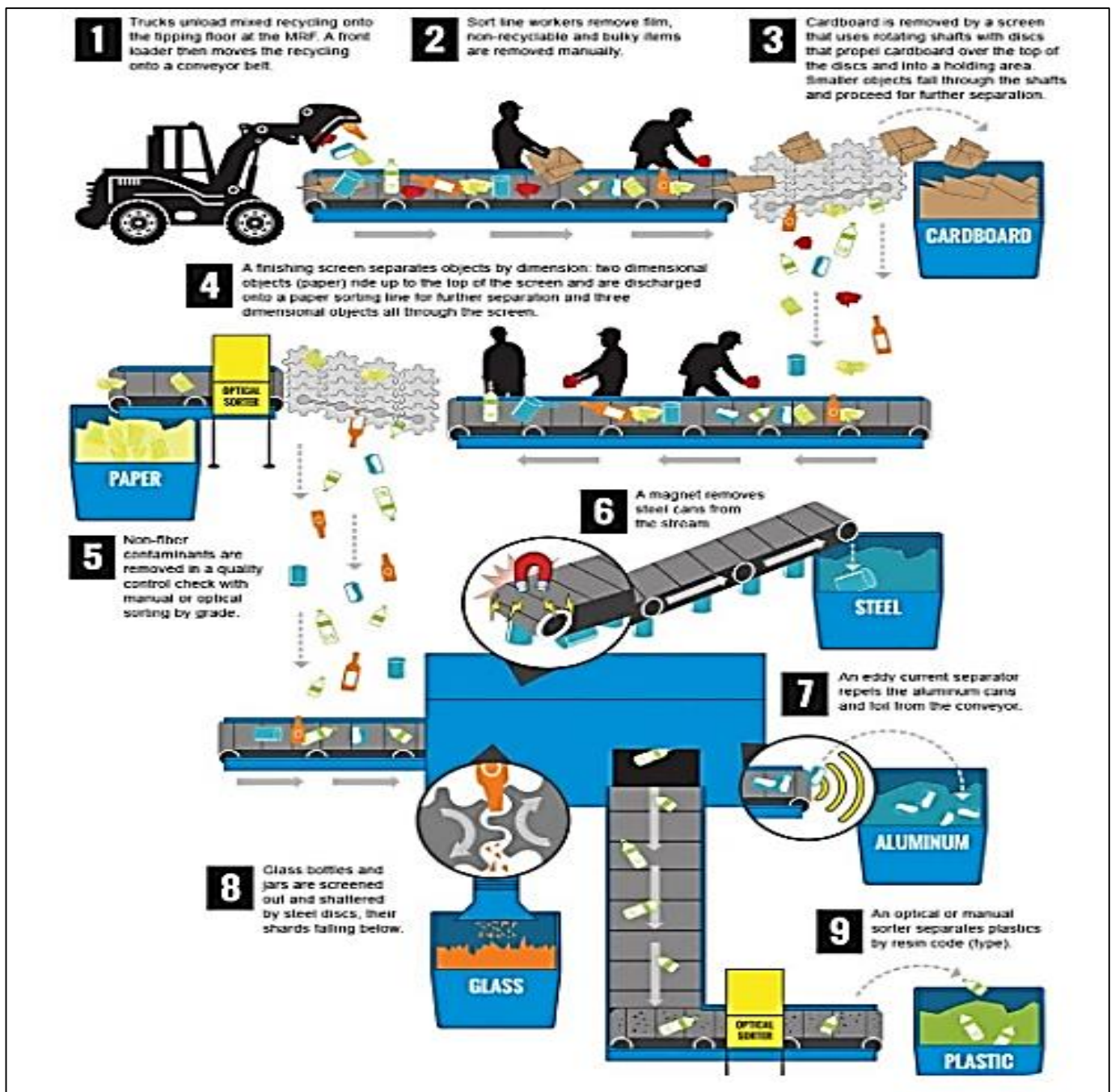
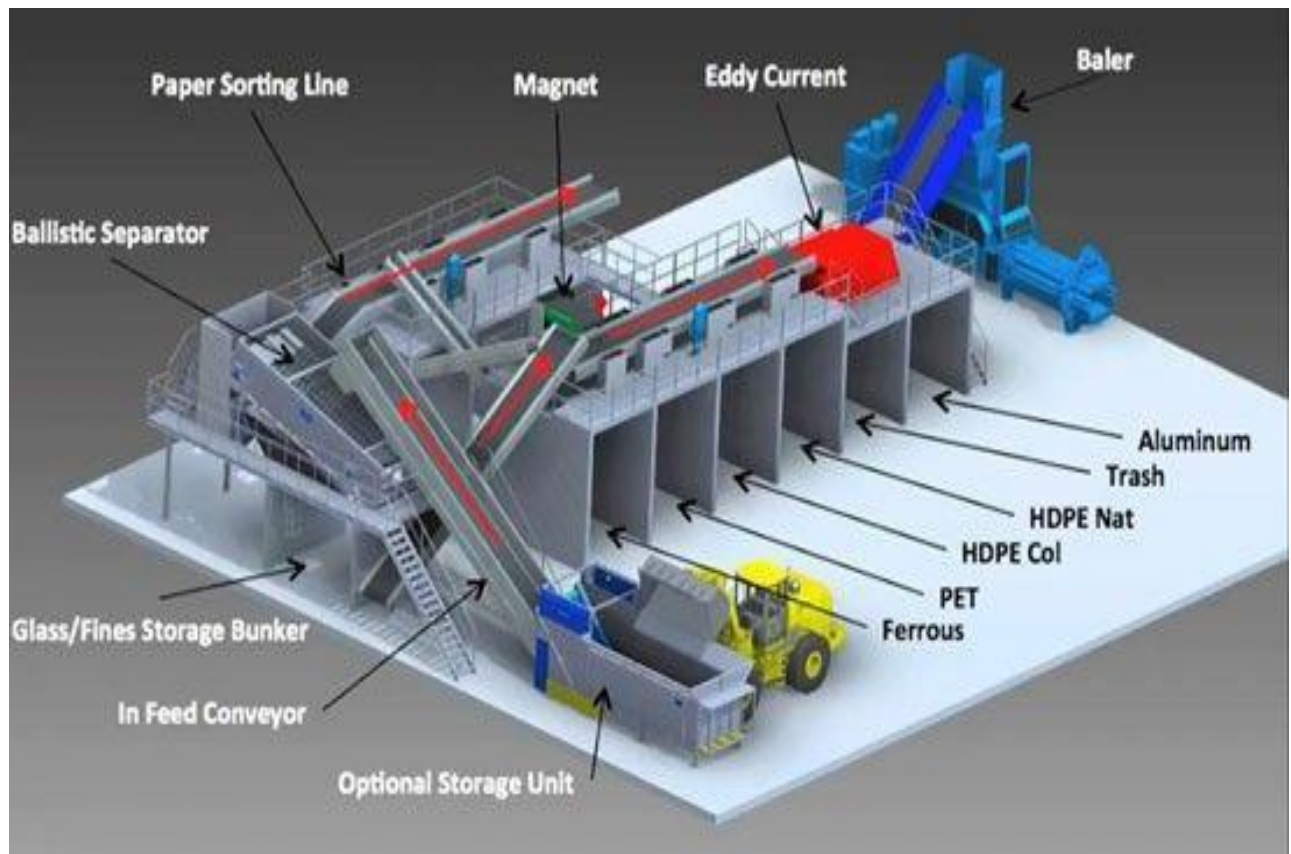


Figure 3.11: 3D view of a typical MRF



Source: <https://www.wastetodaymagazine.com/news/future-proofing-a-material-recovery-facility-sponsored-content/>

Construction and Demolition (C&D) Waste Recycling

Construction and Demolition (C&D) waste recycling will be carried out through dedicated unit. The construction and demolition waste recycling is simple and 100 percent can be recycled, reused and diverted from the landfill. The construction and demolition waste recycling will add in achieving diversion goals from the landfill.

The Waste Amount Characterisation Survey (WACS) study estimated C&D waste as 10% of total waste generated. Assuming fifty percent out of this estimation is C&D waste, a minimum of 30 tons per day of construction and demolition waste is generated in Bahawalpur City. C&D waste will be collected through dedicated C&D contractor and all components of waste will be processed, recycled and reused. Below are the interventions planned for C&D waste recycling.

- All Concrete, PCC and RCC can be processed to Produce Class II and Class III recycled Sub-Base and Base materials.
- Recovered Asphalt Concrete can be mixed in Recycled concrete or reused by mixing with fresh Asphalt concrete.
- All metal can be recovered and recycled.
- Wood component can be Processed and used as Mulch or raw materials for compost.
- Processed waste can be used as Cover material for landfills.

The volume of construction and demolition waste is low. A locally made custom designed concrete crusher with screen and conveyor system would be adequate equipment. A dust control system would be installed. One medium size shovel and one bob cat would be

required for feeding and maintenance of stock piles. Typical view of C&D recycling plant is provided in below **Figure 3.12**

Figure 3.12: C&D recycling plant



Hazardous and Medical Waste Management

The FS has recommended the segregated hazardous waste and medical waste collection and treatment. A dedicated medical waste management system will be developed including segregation at source of medical waste in designated waste containers and its treatment as per prevailing NEQS through autoclave or incineration. The incineration of medical waste is simpler and cost-effective option and is recommended in the FS.

A small portion of one of the landfill cells will be dedicated to deposit hazardous waste including treated medical waste. This part of landfill cell will have a double composite liner system.

Medical waste management system will be operational prior to start of MSW operation so that no medical waste goes to the landfill mixed with MSW.

3.6.6 Construction of Landfill Facilities

Following activities are involved in construction of bioreactor landfill:

- Landfill Cell Development
- Landfill Gas Management
- Leachate collection and treatment system
- Associated Infrastructure and Buildings

3.6.7 Landfill Cell Development

Landfill Design

The useable life of the landfill is 25 years. Four cells for depositing of the waste will be developed sequentially. The Cell 01 will receive waste for three years and will be filled up to the NGL. The landfill gas recovery wells are being installed as landfilling progresses. The landfill gas recovery system will be connected to ring main and flaring system. The beneficial utilization of landfill gas will start in year 4 of start of depositing the waste in cell 01. The second cell construction will start after two years of the start of receiving waste in cell 01. From fourth year the depositing of waste will commence in cell 02. The process of this leap frogging will continue till all four cells are filled up to NGL and gas recovery system becomes operational.

Once all four cells are filled up to NGL, the reverse filling of the waste will start at cell 01 and continue through all cells to achieve the final lines and grades.

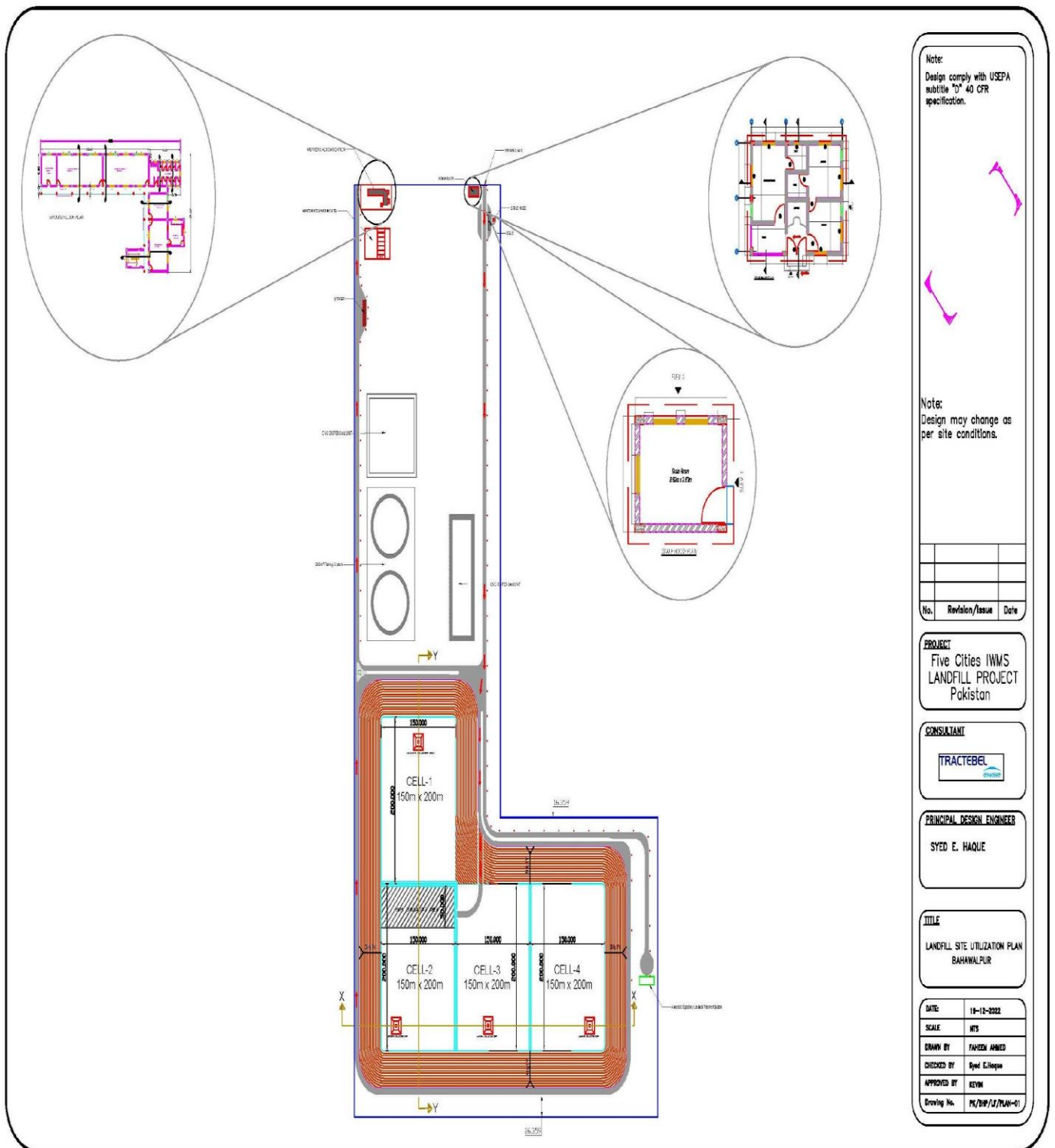
The gas recovery system will be extended to final lines and grades and final gas recovery system will be installed including final cover.

Location of waste cells and leachate collection and treatment is shown in **Figure 3.13** below:

The simple composite liner specifies a three feet clay liner will be used. The design spec allows use of alternate clay liner which is geo synthetic clay liner (GCL) with a permeability of 1×10^{-11} . This alternate clay liner is utilized for Bahawalpur. The components of the liner system are:

- Preparation of subgrade and side walls as per lines and grades and drawings.
- The compactor of the subgrade to 90-92 percent dry density.
- Installation of GCL liner as per the drawings.
- Installation of 2mm thick HDPE liner smooth on both sides as specified in the installation manuals to be supplied to contractors.
- Installation of geotextile 500 GSM. The heat welding of geotextile is not allowed; it will be double stitched using special stitching equipment (the field stitching machines are rapidly available in Pakistan).
- All three liners will be anchored into an anchored trench as per the design drawings.
- Installation of a drainage layer 30cm thick utilizing low ground pressure equipment not to exceed 6 psi.
- Installation of geotextile 500 GSM. The heat welding of geotextile is not allowed; it will be double stitched using special stitching equipment (the field stitching machines are readily available in Pakistan).
- This layer of geotextile will not be anchored in the trench and a portion of 2-meter length rolled and held at the top of the trench by loose soil.
- Installation of 50-60cm soil cover. The soil cover will be placed using low ground pressure equipment and procedure developed by site engineer and contractor.
- The Leachate collection and removal system (LCRS) will be installed as per design drawings.

Figure 3.13: Conceptual Plan of Bahawalpur Landfill



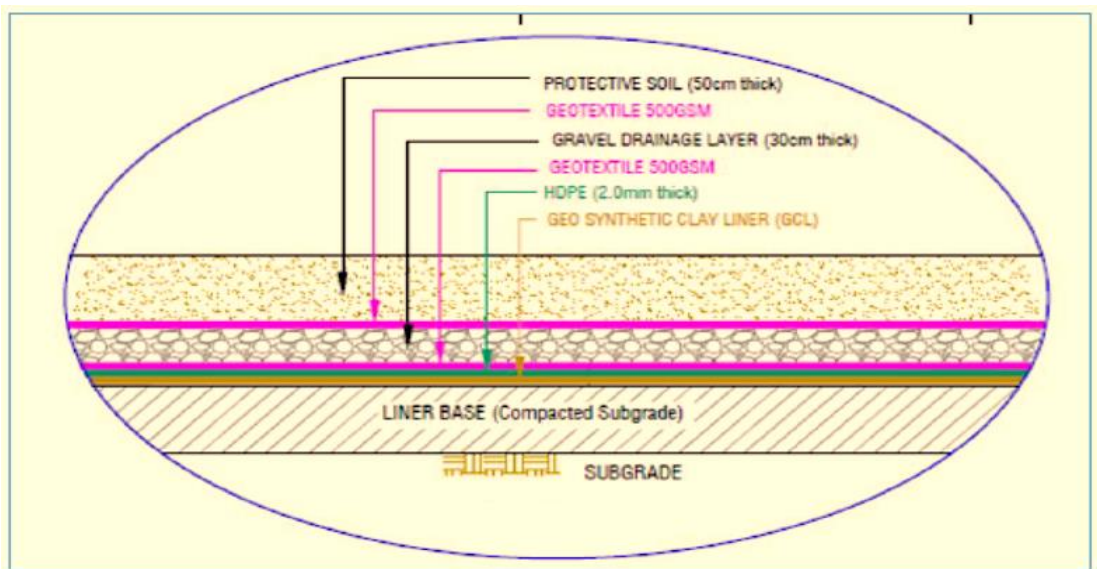
Bottom Lining of Landfill Cells

The liner system at the base of waste cells is aimed to protect the surrounding environment. It includes soil, groundwater and surface water protection through containment of leachate, controlling ingress of groundwater, and assisting in the control of the migration of landfill gas. The liner system must achieve consistent performance and has to be compatible with the expected leachate for the useful life of the facility.

Bottom lining of the landfill cells will be carried out through provision of lining at subsoil comprising of plastic and clay material as per international standards for bioreactor landfills. Bottom lining will be comprised of compacted sub-grade base, geo-synthetic clay liner (GCL) topped by 2 mm HDPE layer. Silty sand or geotextile (500 GSM) will be covered for the protection of the HDPE on the side slopes. Above geotextile gravel layer (30 cm thick) will be placed which will be topped up with sand layer (50 cm thick). Single composite liner system conforms to US subtitle 40 CFR and illustrated below.

The composite liner system consists of an upper component, which is a flexible membrane liner (FML) that satisfies specific thickness standards. The lower component must be constructed of at least a 2-foot layer of compacted soil and must exhibit a hydraulic conductivity of no more than 1×10^{-7} cm/sec. The combination of an FML and a compacted soil layer ensures adequate protection by providing both a highly impermeable upper liner to maximize leachate collection and removal, and a lower soil layer to serve as a back-up in the event of FML failure (56 FR 51060; October 9, 1991). The leachate collection system must be designed and constructed to maintain less than a 30-cm depth of leachate over the liner. Structure of composite liner system selected for Bahawalpur site is shown in below figure.

Figure 3.14: Structure of Composite Liner System



Final Capping Layer of Landfill Cell

Final capping of landfill cells will be carried out in order to limit and control the amount of precipitation that enter the waste and to limit wind and water erosion and burrowing animals' activity. Main objectives of the capping system are: minimizing infiltration into landfill, maximize surface drainage and run-off and gas control migration.

The top cover system will consist of the following arrangements:

- Thick top soil layer (6 inches) capable of supporting vegetation in order to protect the landfill surface from wind and water erosion.
- Drain Layer (18 inches) of at bottom to maximize runoff of precipitation while minimizing infiltration and preventing ponding of water on the landfill.

- Compacted soil layer or barrier of low permeability (1×10^{-5} cm/sec) to limit and control the amount of precipitation that enters the waste.
- Vent layer of reasonable thickness comprised of sand and gravel

Daily Cover

Daily cover is placed on working surface of waste in order to reduce the risk of fire, wind littering, odor, vector breeding and dust hazards in the landfill. It is a soil layer and is placed on each working day. Generally, the amount of soil to be used in daily cover will be about 10% of the waste volume. Suitable amount of daily cover is usually stocked at the landfill sites during landfill cell excavation. However, any suitable excavated material from construction works can be used as daily cover.

3.6.8 Landfill Gas Management

Landfill gas is produced through decomposition of organic fraction present in the MSW deposited to the landfill site by microbial activity. Landfill gas is composed of roughly 50 percent methane (the primary component of natural gas), 50 percent carbon dioxide (CO₂) and a small amount of non-methane organic compounds. Methane is a potent greenhouse gas 28 to 36 times more effective than CO₂ at trapping heat in the atmosphere over a 100-year period, as per the latest Intergovernmental Panel on Climate Change (IPCC) assessment report (AR5)⁴. Methane possesses the combustible and explosive properties and also a Green House Gas responsible for global warming. In order to limit landfill gas entrance into environment and to avoid fire and explosive hazards landfill gas collection system has been designed.

The gas recovery system is constructed with horizontal and vertical grid gas wells. The gas wells are connected to a ring main and flaring system combined with segregation of Methane gas and utilization of Methane in garbage trucks or is its conversion into CNG. This is the highest revenue generating component. Out of 477 tons/day of waste generation in year 2025 264 tons/day of organic waste component will be deposited in bioreactor. The landfill gas will be available even about 10 years after the final cover is installed in the year 2050.

Both Horizontal and Vertical gas collection systems will be implemented in the landfill. The gabion of the gas collection wells will be filled with gravel and these will be constructed with iron mesh. There will be a perforated HDPE pipe with pressure class in the center of the gas collection wells. The gap between the iron mesh and the perforated pipe will be filled with pebble stone.

Estimated gas production in 4th year will be about 220 Nm³/hr out of which 165 Nm³/hr will be extracted which will continue to increase over years of landfill operation.

Collected gas will be then transferred to gas flaring system. Initially 1000m³ gas flaring system is proposed and area has been allocated at the site. After few years of landfill operation landfill gas will be converted to CNG for further dispensing. Proposed gas collection system for Bahawalpur LFS is shown in below figure.

Figure 3.16: Horizontal Gas Collection Pipes

⁴ <https://www.epa.gov/lmop/basic-information-about-landfill-gas>

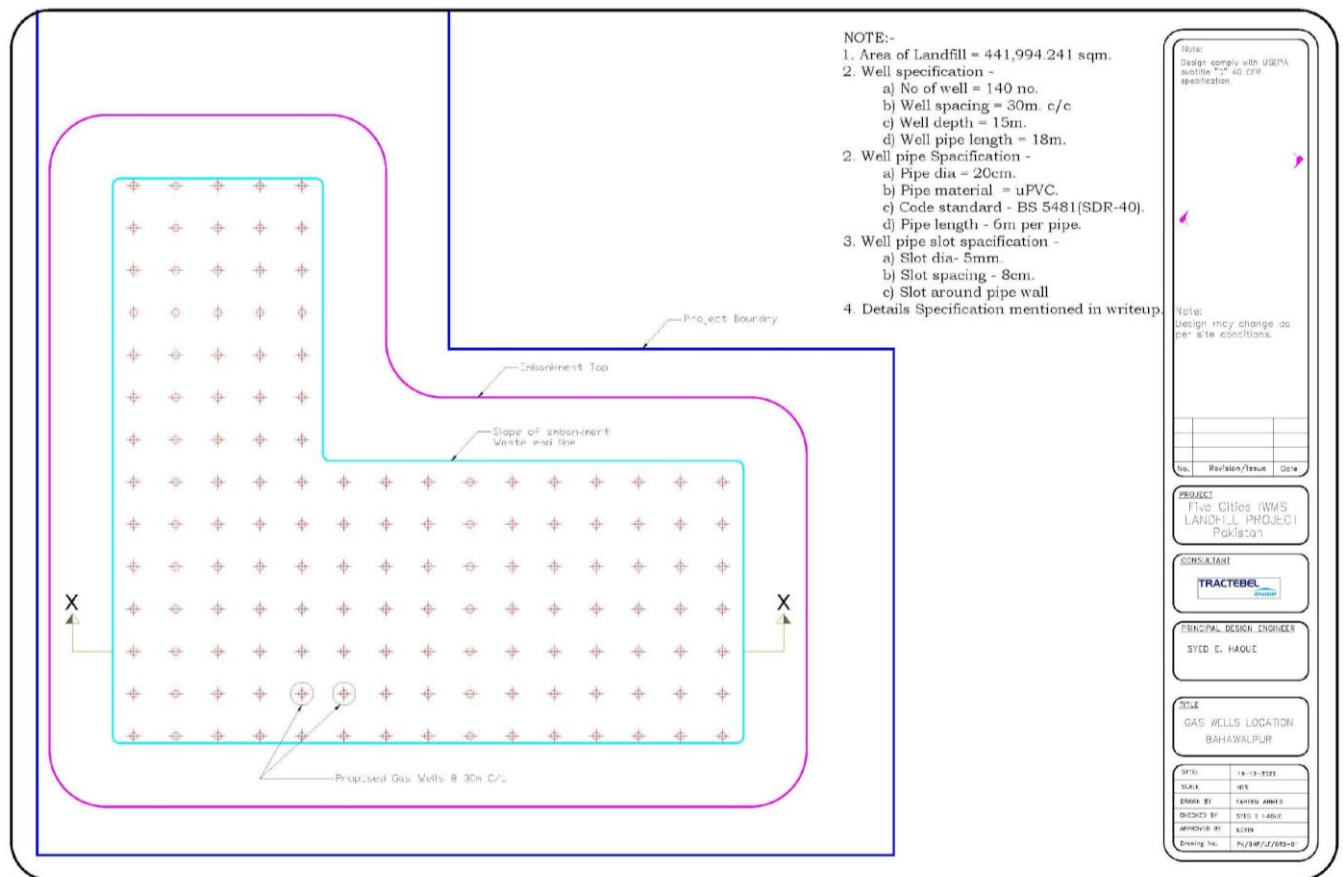
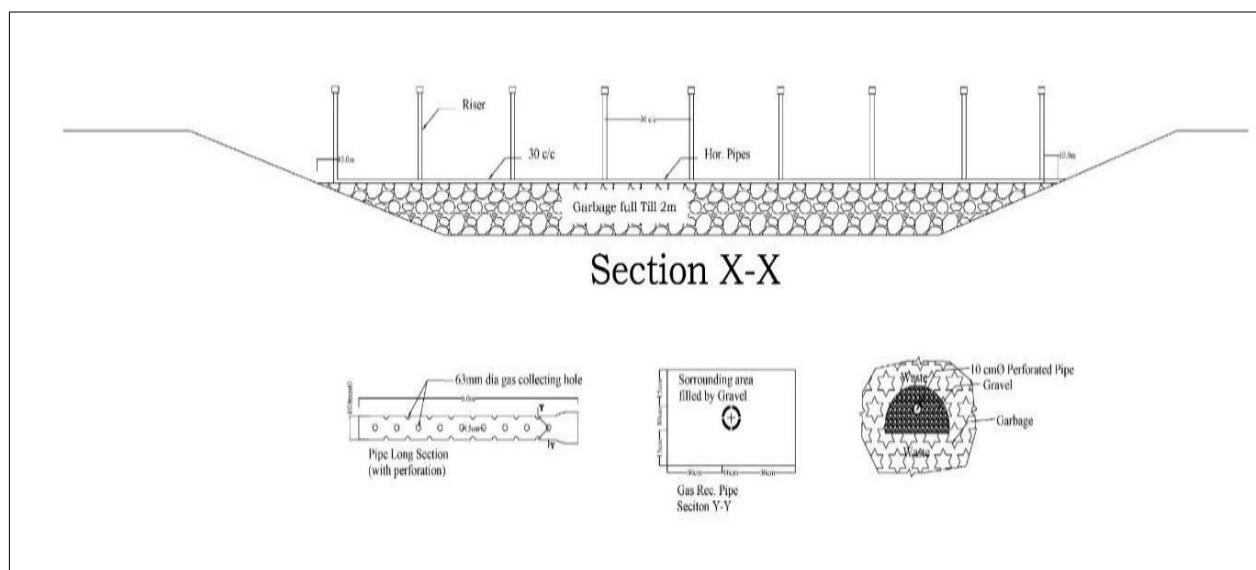


Figure 3.17: Vertical Gas Collection Pipes



EDCM is developing GASSIM 2 model for Bahawalpur Landfill site. GASSim is a computer software tool to carry out a Tier 1 screening assessment to ‘screen’ emissions from the former landfill and to identify the significance of risk associated with the former landfill on nearby receptors. The model input data is based on Site-specific data where possible. Appropriate assumptions and published data including GASSIM2 default values will be used where Site-specific data not available. Results of GASSIM 2 modelling will be incorporated in the updated EIA report.

3.6.9 Methane Gas to CNG Conversion Plant

The beneficial utilization of organic waste recommended in FS is an out of the box design of the landfill as a bioreactor and processing the organic waste to generate the revenue. The organic waste will be used as a resource in bioreactor landfill to maximize and regulate the landfill gas recovery system and conversion of methane component of the gas into CNG. The conversion of organic waste into LFG and Methane component conversion will generate a high revenue and contribute to the substantially of the project.

The organic waste will be beneficially utilized when it is deposited in the bio reactor landfill where it will generate regular and increased quantity of landfill gas which will contain 55-60 percent of Methane. The methane can be converted into electricity or CNG. The CNG option is a much better option as the electricity tariff for green energy is very low in Pakistan and the CNG rates are quite high.

3.6.10 Leachate Collection and Removal System (LCRS)

Leachate produced in a landfill is a liquid which percolates through the waste carrying suspended and soluble materials that originate from or are products of the degradation of the waste. This liquid needs to be managed on site to avoid any seepages into the ground, any spill-over into ditches and drains, influence on gas collection system or effect on the stability of waste fill. For Bahawalpur landfill site, leachate collection and removal system is being designed which is explained below.

- **Leachate Collection System**

Leachate is a waste product produced as a result of decomposition of organic fraction of waste by microorganisms in the landfill site. The mass balance in the leachate generally depends on the biological decomposition in the garbage body, amount of precipitation, temperature changes, and treatment of the leachate and/or transfer rate of the leachate to the treatment facility. This balance will be controlled and arranged according to the

conditions during the operation phase. The leachate is collected via main and auxiliary leachate pipes.

A leachate collection system comprising of a drainage layer of either natural granular (sand, gravel) or synthetic drainage material (e.g. geonet or geo-composite) will be considered. Synthetic drainage material may be used on sidewalls of the landfill cells, where the construction and operation of granular material may be difficult. Perforated leachate collection pipes and filter layer will complete the piping network for the waste cell.

▪ **Leachate Treatment**

The Leachate treatment system will comprise of a three-stage clarifier with aeration with diffusers or enclosed leachate treatment system utilizing anaerobic digestion system. In Bahawalpur anaerobic digestion system will be used for leachate treatment. The reason to select Anaerobic digestion is as follows:

- The three-stage clarifier with diffusers and aeration system requires a large area of 3000 square meters plus another 500 meters for installation of two high volume compressors and electrical equipment. The air compressors have to run continuously 24 hours. Since the ponds are open an order control system has to be installed. The water after treatment has to be disposed of in a waste water treatment plant. There is no waste water treatment plant functional in Bahawalpur. The treated water can only be used for landfill dust control only.
- A anaerobic digestion leachate treatment plant is completely enclosed produces electricity to offset the operations costs and the water quality is usable for landscaping. The sludge produces is an excellent quality compost.

▪ **Anaerobic Digestion Leachate Treatment System**

Three Stage Open Pond Leachate Treatment System or Anaerobic digestion system will be utilized. Anaerobic digestion is fully enclosed and most suitable option incorporated in the design. Overall anaerobic digestion is a proven technique and at present applied in a variety of waste streams. Promotion and application of utilizing sewage sludge using this technique is one of the solutions to various environmental problems and also a breakthrough in the field of waste recycling. The process flow diagram of series proposed for Bahawalpur facility are shown in **Figures 3.18** and **3.19** below.

Figure 3.18: Process Flow Diagram of 3 Stage Anaerobic Digestion

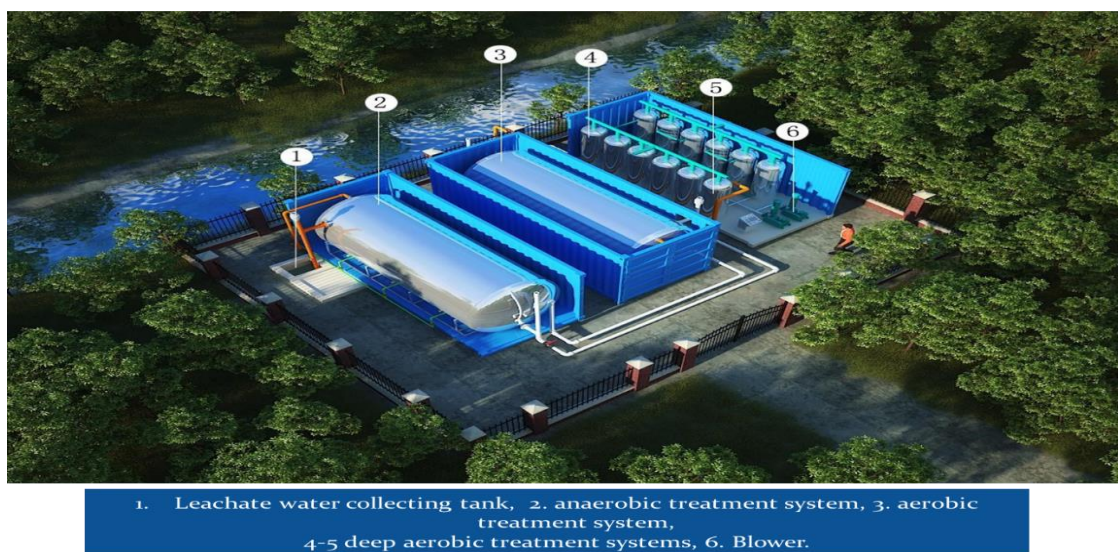


Figure 3.19: View of Three Stage Leachate Treatment System



Source: <https://appliedbiolchem.springeropen.com/articles/10.1186/s13765-021-00652-z>

The system shall be composed mainly of an anaerobic treatment system, an aerobic treatment system and a deep aerobic treatment system. The anaerobic treatment system will be composed of anaerobic tanks; the aerobic treatment system and deep aerobic treatment system will be composed of aerobic tanks and a blower. The leachate will be first treated by the anaerobic treatment system, and then treated by the aerobic treatment system and deep aerobic treatment system. During the anaerobic treatment process the biogas produced can be collected, purified and stored as a fuel for use.

Treated leachate will be stored for application like landscaping and sprinkling or it can be discharged to nearby municipal drains after compliance with PEQS. Some major advantages of this treatment technology are as follows:

- High quality of the treated water: The treated water is colorless and without odor, can be used for gardening.
- Easy to install and maintain. It can be installed in several days and operates automatically.
- No smell is produced due to the treatment because all the gas (biogas) produced is collected and used as fuel.

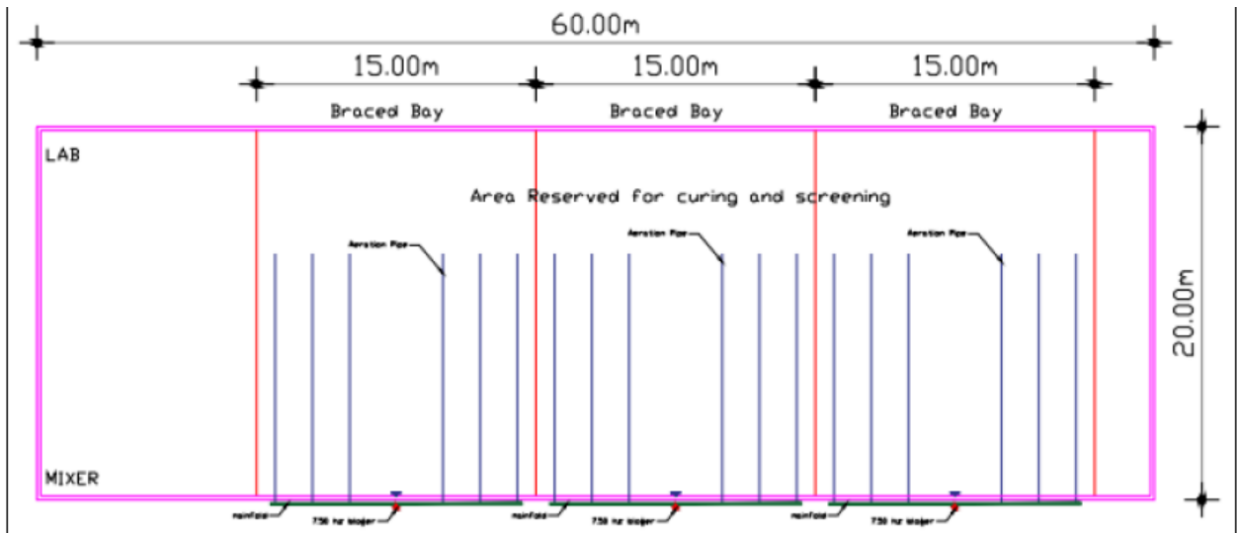
Infrastructure / Buildings

The proposed landfill will have proper facilities such as administration building, waste reception areas, weigh bridge, access roads, daily soil cover, security, the worker's accommodation, maintenance and washing area, CNG dispensing unit, LFG to CNG plant, flaring system, leachate treatment plant and unloading pad for vehicles.

The following building infrastructure is proposed:

Compositing Building

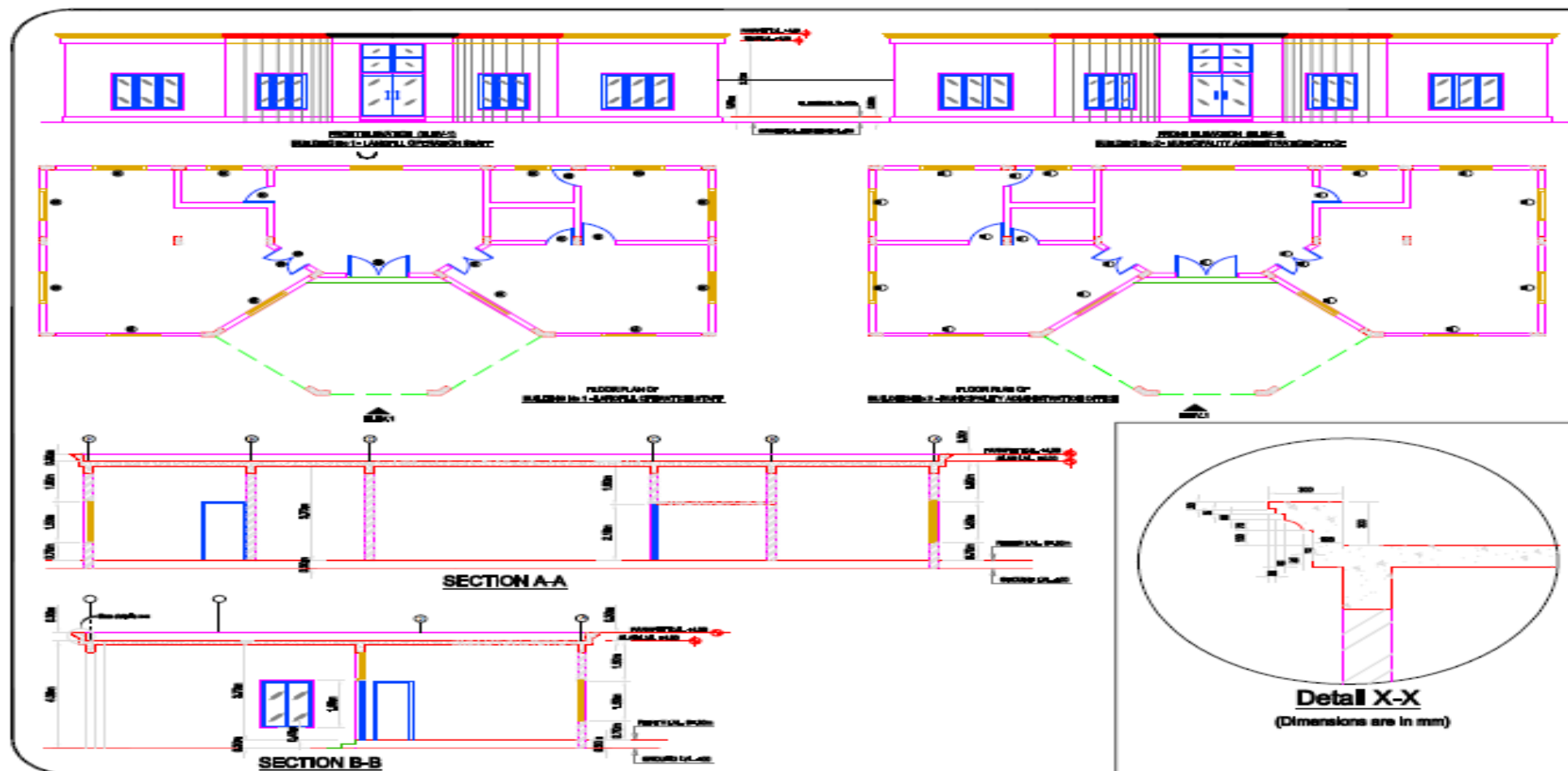
Two compost buildings will be constructed. Typical layout of compost building is provided in below figure.



Administration building

Administration building is designed within the landfill premises. It is planned such that it will accommodate landfill operations team, has a laboratory for quality control and MIS monitoring room for data acquisition and transfer to head office. The building also contains a conference room for meetings at landfill, an inventory room for storing supplies for repair and maintenance of landfill machinery and vehicles. There are showers, prayer area, rest rooms and a kitchen in the building. A car park outside the building is also designed for personnel's' vehicles. The area of the administrative building is surrounded by landscaping and greenery. The layout of admin building, including lookout tower, is presented in **Figure 3.20** below.

Figure 3.20: Layout of administration building at Bahawalpur Landfill

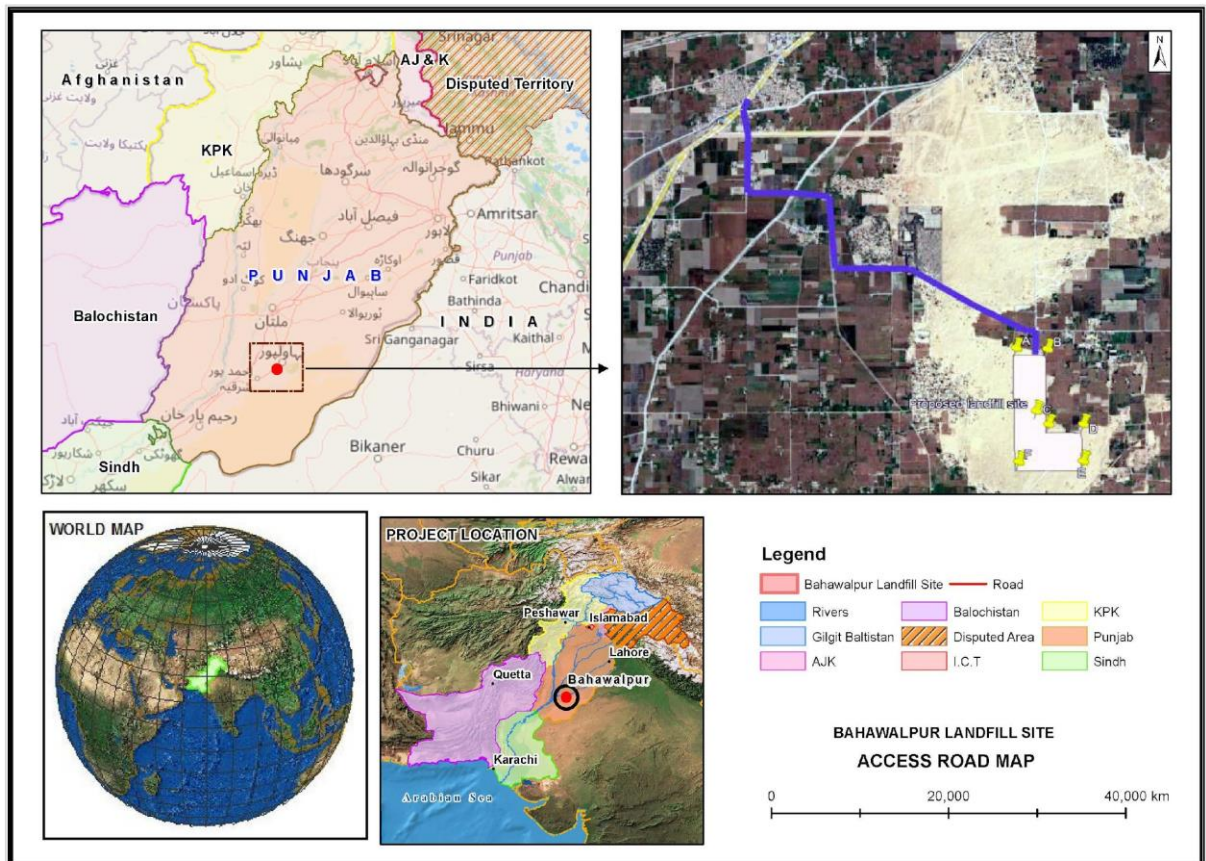


Construction of roads

Following approach roads will be constructed as part of Bahawalpur ISWMS.

- The TS+MRF location at the existing dumpsite site will require road improvement of about 5km.
- The access road to new landfill site will require 2.5km new road from the main access road and improvement of the main access road for about 10km. Location of access road to new landfill site is shown in below **Figure 3.21**

Figure 3.21: Access Road to New Landfill Site



Roads inside the premises will cover all periphery. Ideally road width will be 10 m wide with two lanes each 4 m for two-way traffic of waste carrying vehicles.

Surface Drainage Network

The runoff at landfill will be managed through the provision of surface water diversion channels and collection systems. Drainage for surface runoff along periphery is proposed through a network of RCC drainage channels. A surge pond is included in the project design to manage the surface drainage.

Wet Weather Area

Wet weather area is allocated to manage waste during monsoon.

Storage area for Soil Cover

Soil or similar inert material shall be used for the lifetime of the landfill site, to cover the waste on a regular basis. Extra thickness of "final cover" material shall also be required once the site has reached completion. The simple spreading of daily cover is a highly effective way to reduce the attraction of waste to birds,

suppress odor, prevent fly infestations, discourage rats and other animals and to reduce exposure to atmospheric conditions and to reduce wind-blown litter.

Ideally, cover material will be taken from within the site, increasing the available space for waste disposal and reducing the need to bring material from elsewhere. The material excavated from the site is estimated to be adequate for use as temporary and final cover material. Final confirmation will be made on remoulded permeability of the representative samples taken from the borrow source, if adopted. At this time, it is expected that the soil removed during excavation will be used.

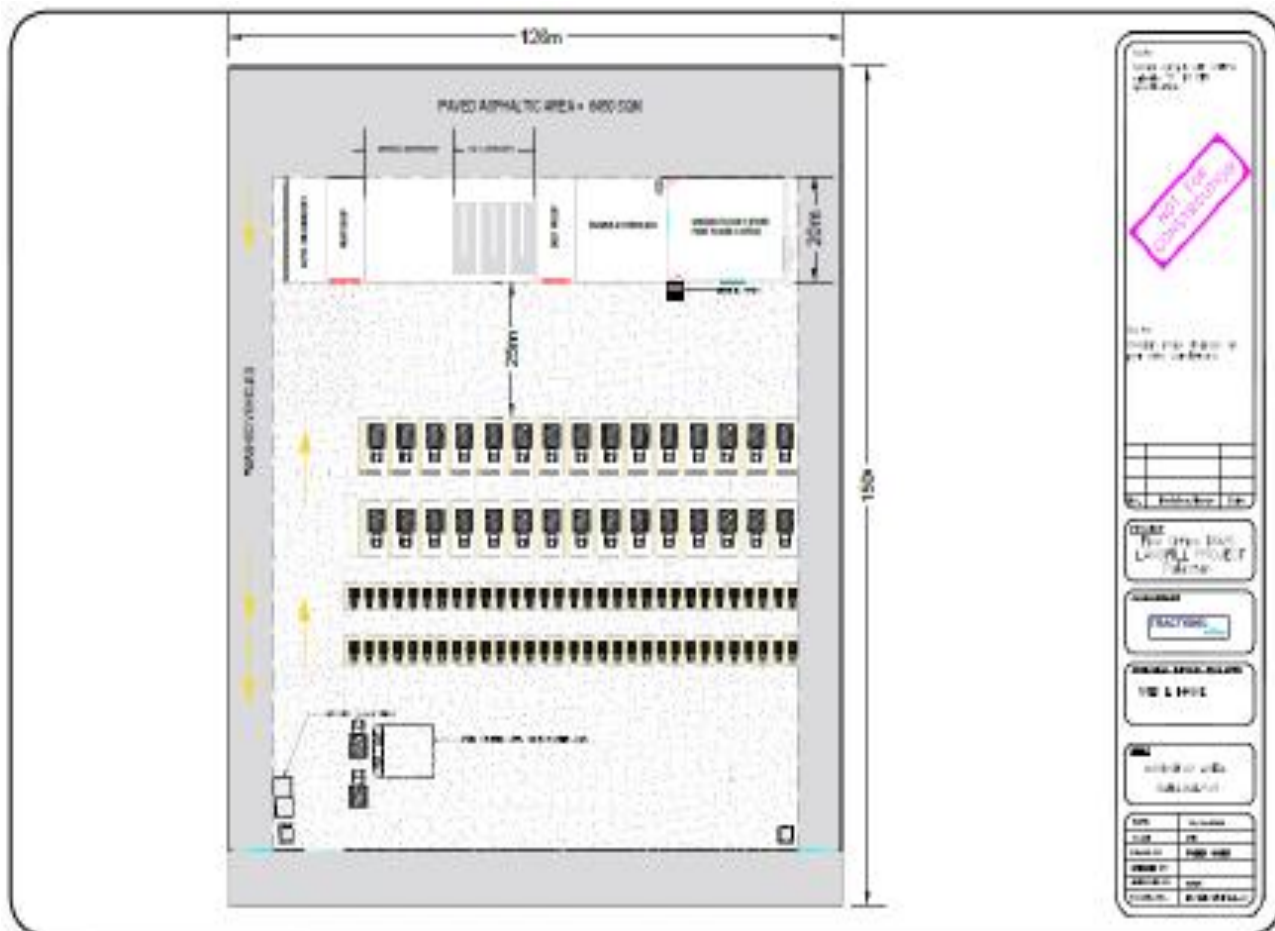
Wheel Washing and Vehicle Parking

A vehicle parking shed for landfill vehicles and occasional parking of waste carrying vehicles has been designed along with a workshop for routine repair and maintenance work. There will be pumps and nozzles that spray pressurized water to clean the wheels. The wheel washing unit will comprise of a sedimentation tank. The dirt on the wheels of vehicles will settle and the water in the pool will be transferred to wastewater sedimentation tank while the stale water can be used for washing the vehicles.

Workshops

Two workshops one for Category B vehicles (tired) and one for Category C vehicles (Truck) are included in project design to facilitate fleet maintenance works. Maintenance workshop layout is provided in below **Figure 3.22**.

Figure 3.22: Maintenance Workshop Layout



Tree Plantation/Buffer Zone

Inside the boundary wall, tree plantation will be conducted to create an environmental barrier between the external and internal environment. Indigenous tree plantation will be carried out which will serve as the buffer zone. For the landfill to present a clean and aesthetically pleasing view, buffer zone with tree plantation and landscaped berms will be done. Plantation will start as one of the earliest activities of site development. Once the design of landfill is approved and necessary funds mobilized, plantation activity can be started by BWMC.

Boundary Wall

The boundary around the landfill will be a wall constructed of brickwork of 9" thickness all around the premises.

3.6.11 Construction Phase Details for Landfill

Construction Schedule

The project construction phase is expected to last for a total of 2 years.

Construction phase activities

The activities to be conducted during construction phase of the project are provided below:

Development of Construction and Labor Camps

One of the first activities to be completed by the Contractor shall be the establishment of the construction and labor camp. The Contractor will also establish construction yards and sites (including storage and batching plant), offices and a workshop.

The construction of the proposed landfill will be divided into construction work packages and these packages will be awarded to the selected project Contractors.

The construction activity has to span over approximately twenty-four months. There shall be a number of contracts for a variety of works. The selected Contractors shall have the option to select suitable site(s) located near the project sites to establish his labor camps. If private land is selected, the contractor shall enter into contract with the private owner. During construction phase, an estimated 150-200 persons consisting of both semi-skilled and skilled human resource will be required.

Essential for the work bases is easy approach, availability of a suitable place for temporary storage of material and availability of water for construction in the vicinity. Presence of shade from trees close to the work bases can add to the comfort of the labor while taking rest during the hot season.

The location of storage materials and camps will be critical. Since the project contractor(s) will be responsible for identifying the suitable locations for storage and labor camps from the private sector, thus there will need to be clear guidelines for this process, which will need to be closely monitored by the implementing agency. As far as possible, the project design team shall be assigned the task to identify the suitable location(s) for storage of materials since inappropriate storage of materials may result disruption of the traffic movement.

The location of the batching and asphalt plants will be 300m away from any residential dwellings or sensitive receptors.

The proposed site for the Contractor's camp shall include the following facilities:

- **Labor camp site**
 - Accommodation
 - Kitchen
 - Dining area
 - Sanitation facilities
 - Septic tank
 - Liquid and solid waste disposal facilities
 - Generator(s), for operation when the power supply from the grid station was not available
- **Construction camp site**
 - Uncovered material storage
 - Covered material storage
 - Parking for vehicles and plant
 - Batching plant
 - Generator(s)
 - Site offices
- **Workshop site**
 - Workshop
 - Storage area
 - Generator(s)

- **Sites preparation**

There may be a need to carry out cutting and filling of the land in order to attain the designed ground elevation. During the process, areas above the design elevation shall be cut and spoils shall be used to fill areas below the designed elevation. The area is to be clean of any obstructions in areas where the general design elevation is already attained. Cut and fill activities will be carried out using mostly heavy mechanical equipment. Manual labor will be negligible.

The ground will be compacted until the desired ground bearing capacity is attained. This is to ensure that all structures, particularly the foundations to be erected are stable and will not be subject to subsidence, settlements and other earth pressures.

- **Development of Access Roads & Internal Roads, drainage facilities and other horizontal earth works**

Haul roads from the reception area to the entrance to each phase shall be designed to a standard adequate to allow trafficking of heavy vehicles. Haul roads may need to accommodate the passage of heavy construction vehicles e.g. steel

wheel compactors and tracked bulldozers. Service roads to other facilities on site e.g. leachate treatment plant, gas extraction system, should be to an adequate standard to allow access by service vehicles⁵

Particular attention should be given to the access point to each cell. It is important that the access routes chosen do not put the liner at risk. Typical access ramps will be up to 6m in width and have slopes up to 10%.

- **Construction of Admin building infrastructure within Landfill site**

Site building infrastructure must be designed, constructed and maintained to a high standard and should include the following facilities:

- Administration building consisting of an administration office, first aid area and general reception area;
- Sanitary facilities: showers and toilets;
- Staff facilities: lockers and mess room;
- Waste reception area;
- Equipment maintenance and fuel storage; and
- Parking area.

Purpose built buildings will be constructed with on-site laboratory facilities provided as necessary. The administration building would include a working telephone, a facsimile machine and would be suitable for the storage of records.

- **Construction of the weighbridge system and Unloading Bay and its components**

The weighbridge should be located adjacent to the waste reception area and sufficiently far enough away from the public road to avoid queuing onto the road. Weighing facilities should be adequate to accommodate the weighing of both incoming and outgoing traffic if necessary.

- **Construction of MRF & Allied Machinery**

- **Landfill Site Construction**

The development of the landfill area will consist of the following activities:

- Excavation for landfill cell and bottom lining along with leachate collection system & gas collection pipes;
- Construction of the access ramps, leachate treatment ponds;
- Construction of Gas Flaring System and CNG Dispensing Unit
- Run off and run on collection network;
- Final capping arrangements;
- **Construction of BWMC Office Building at Hasilpur road**

BWMC office building infrastructure must be designed, constructed and maintained to a high standard and should include:

- Ground floor plus 4 storeys, first aid area and general reception area;
- Sanitary facilities: showers and toilets;

⁵ https://www.epa.ie/pubs/advice/waste/waste/EPA_landfill_site_design_guide.pdf

- Offices, meeting rooms and canteen
- Equipment maintenance and fuel storage; and
- Parking area.

Construction Machinery Requirement

For storing materials, stocking equipment and parking machinery and vehicles, the Contractor(s) shall require open and accessible sites close to the labor camps. The Contractor(s), at his own expense, but keeping in view his contractual obligations to honor the applicable national and international guidelines regarding level of pollution, shall make the arrangements.

The **Table 3.8** below outlines the approximate number of major machinery and vehicles that are envisaged to be required for the project construction works.

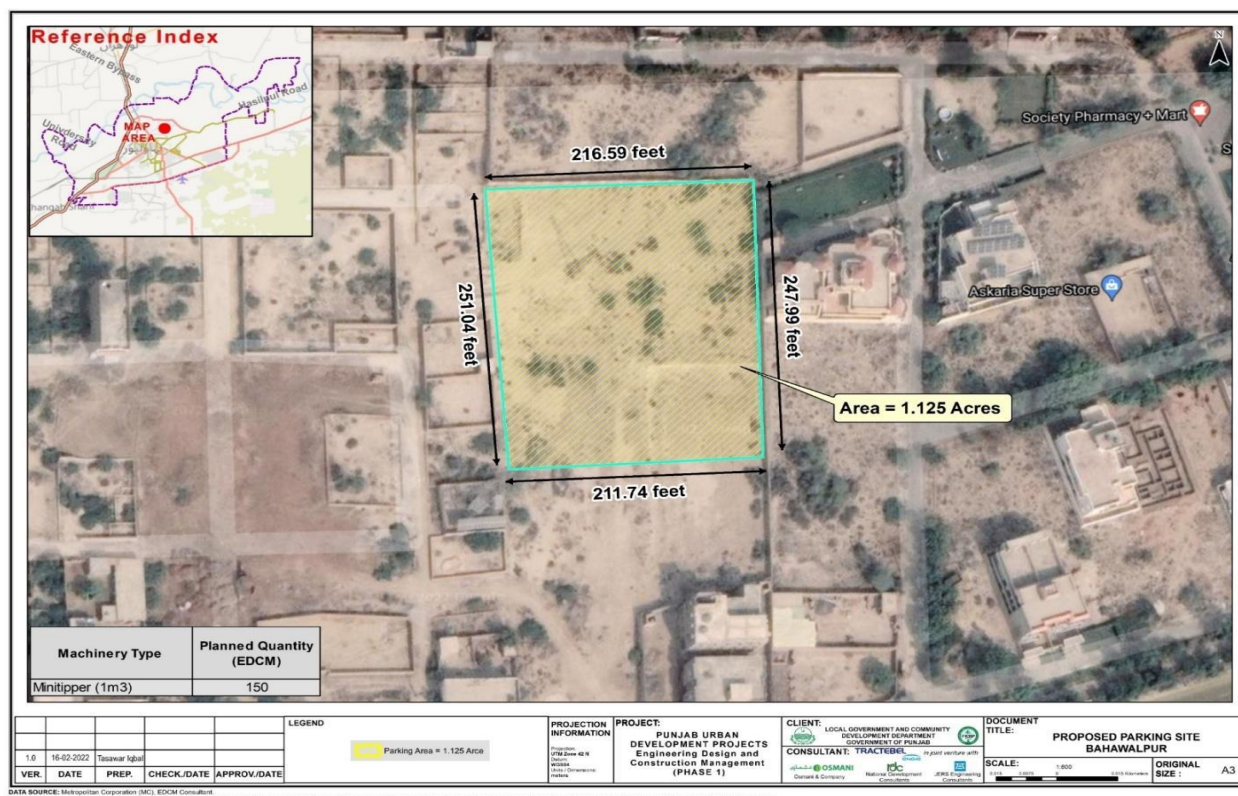
Table 3.8: Estimated Contractor's Equipment and Machinery

Sr. No.	Machinery / Equipment	Quantity required*
1	Excavators	4
2	Dumpers	2
3	Batching Plants	1
4	Loaders	2
5	Power Generators	4
6	Rollers	2
7	Tractor Trolley	6
8	Transit Mixer	1
9	Compactor / Roller	2
10	Crane	1
11	Crush Plant	1
12	Concrete Pump	1
13	Vibro Hammer	1
14	Welding Generators	2
15	Watering Tanks (moveable)	3
16	Haulage Trucks	20
17	Cars/Pickups	8

* Number of machinery is indicative and can be changed subject to working schedule.

Parking area of 1.125 Acres will be reserved to accommodate the machinery and equipment required during construction and operational phases. **Figure 3.23** shows the parking area for the proposed landfill.

Figure 3.23: Parking Area for the proposed landfill site



Construction Materials Requirement

During the construction phase, construction materials in considerable volumes will be required. Typical material required for landfill cell development include base mineral liner, cap barrier layer, leachate drainage blanket; other drainage layers e.g. capping layer and groundwater/surface water, gas collection and venting system, road material and daily cover. The common source of the material require for civil work are described in **Table 3.9** below.

Table 3.9: Source of Raw Material

Sr.#	Raw Material	Source
1	Earth Material	Available locally, borrowed from the lands acquired for the project.
2	Aggregate	Available at many sources within the vicinity of the site.
3	Rip-rap material	Available locally from nullah bed deposits and rock excavations.
4	Sand	Sand is available in near vicinity and river bed.
5	Water	Ground water is available at depth of 15-20 meter and it will be used for construction purpose.
6	Cement	Ordinary Portland Cement is suitable, which is available at various factories in Pakistan.
7	Reinforcement steel	Steel re-rolling mills in Bahawalpur meeting the standards from the billet produced either by Pakistan steel or imported. These will serve the purpose of steel availability.

Sr.#	Raw Material	Source
8	Energy	Electricity supplies are available at the site through MEPCO grid.

3.6.12 Operation Phase Details for Landfill

Scope of Activities

The activities to be conducted during the operational phase of proposed project are provided in **Table 3.10** below.

Table 3.10: Operation Phase Activities

Landfill Development	Operation activities involved
Waste hauling to LFS	The compactor truck will transfer waste from Bahawalpur city to the landfill site.
Weigh Bridge and Unloading Bay	▪ Weighing operation ▪ Maintenance of mechanical and electrical equipment
Landfill site operations	▪ Waste inventory management ▪ Compaction and size reduction ▪ Landfilling ▪ Daily cover ▪ Leachate management (i.e., collection, treatment and disposal) ▪ Landfill gas management (i.e., monitoring, collection, flaring) ▪ Environmental monitoring
MRF and Compost Site Operations	▪ Material Recovery Facility operations ▪ Composting Facility Operations ▪
General Operations	▪ Admin block operations ▪ Maintenance of equipment and machinery ▪ Vehicle servicing ▪ Disposal of solid waste and waste water generated during operations ▪ Workers Health and Safety ▪ Site Security

Operation Equipment and Machinery

The equipment required during the operation phase of the landfill site can be divided into three functional categories: waste movement and compaction, earth cover transport and compaction, and support functions. The **Table 3.11** below provides the equipment expected to be required for operation phase of the landfill site.

Table 3.11: List of Equipment and Machinery for operation phase of Landfill Site

Sr. No.	Machinery / Equipment	Equipment use in landfill operations	Quantity required*
1	Bucket Loader	It is used to fill earth cover material into vehicles at landfill site.	1
2	Chain Dozer	It is used for levelling of waste or excavated soil at the landfill site.	1
3	Trash Compactor	It is used for compaction, propulsion and spreading of waste in a landfill.	1
4	Hydraulic Excavator	It is used for Excavation purposes.	1

* Number of machinery is indicative and can be changed subject to working schedule.

Manpower Requirement

Estimated manpower requirements during construction phase of the landfill would be about 150 persons while during operation phase would be 50 persons.

3.6.13 Closure and Post Closure Plan for Landfill

Both the Closure and Post Closure plans will come into effect towards the end of the Landfill's useful life, usually 40 to 50 years from commencement of operation of the landfill. In this time, there could be marked changes made to them depending on how environmental and socioeconomic conditions in and around the site and Bahawalpur city have evolved.

The closure plan will include:

- Landfill cover and landscaping of the completed site;
- Long term plans for the control of runoff, erosion, gas and leachate collection & treatment.

Post closure plan will include:

- Routine inspection of completed landfill;
- Maintenance of surface water diversion facilities, landfill surface grades, the condition of liners;
- Maintenance of landfill gas and leachate collection equipment;
- Long term environmental monitoring plan so that no contaminants are released from the landfill site.
- These plans have yet to be developed but will be customized to the proposed landfill facility and will be prepared within first few years after commencement of the landfill.

3.7 Short Term Design Horizon

The short term design horizon proposed by EDCM is detailed below.

- Environmental awareness program will be developed and implemented throughout project life. This program must be translated in Urdu and any other local language prior to start-up of the project. The print and audio visuals material for environmental awareness will be developed in first six month of year 2023 and implementation should start from seventh month of year 2023.

- The CSR program will be developed in parallel and integrated in the environmental awareness program.
- The training of current management and staff to enable them to operate the redesigned waste collection system and landfill must be started by April of year 2024.

3.8 Long Term Design Horizon

The long term design horizon proposed by EDCM is detailed below.

- Design and development of four MSW disposal cells sequentially. The first cell will be developed in phase -1 of cell development process with a capacity to receive waste for 6-7 years.
- The Transfer station and MRF building and infrastructure has a designed life of more than 25 years.
- The equipment recommended for the TS and MRF together with landfill operation will have a useable life of 25 years with regular maintenance and a refurbishment after 12 years (in 13th year). The refurbishment funding is incorporated in the project FS. Please note that refurbishment also includes replacement of some equipment.

The financial sustainability of project is ensured through following sources of revenue:

- Revenue from residential
- Revenue from MRF
- Revenue from LFG
- Revenue from Medical Waste

3.9 Environmental Awareness and Community Outreach Program

The main components of environmental awareness program are provided below.

- Environmental Awareness at Primary, Secondary and High School Levels through developed environmental and waste management program
- Direct Contact through Door to Door visit by Awareness Coordinators and

Volunteers

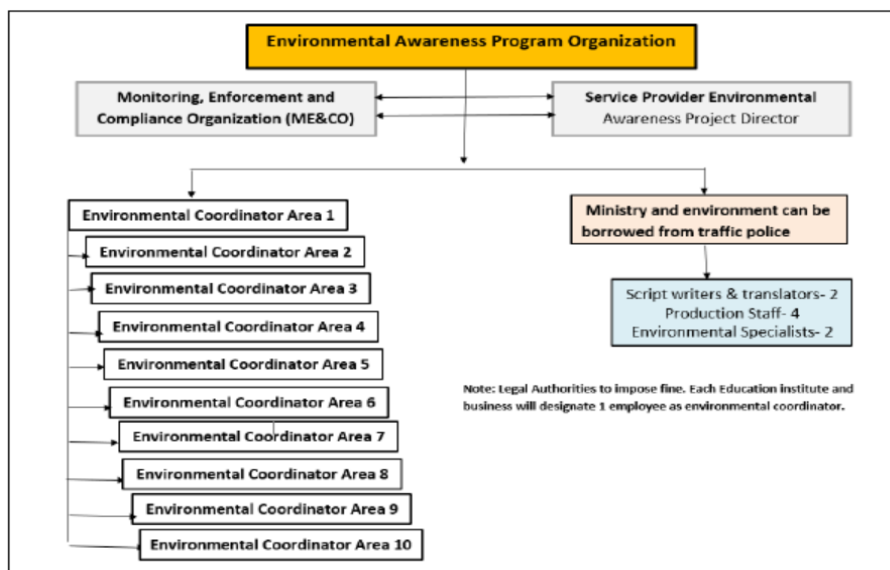
- Mass Media Utilization: Televisions, radios and seminars. Environmental
- Awareness teams will start these mass media awareness program as soon after approval of awareness department of local government and education department.

Punjab LG&CDD will develop a media interface through existing channels and also start publishing an environmental and waste management bi-monthly newsletter. It is suggested that an Environmental Awareness FM radio may be established to organize talk shows and light entertainment. All programs will be in English, Urdu or any other major spoken language.

The local government entity (Mayor's office) will allocate a full-time environmental education expert to the organization who will head the organization and community awareness programs. He will be assisted by four environmental education specialists.

Organization of environmental awareness program is illustrated in below Figure 3.24

Figure 3.24: Organization of environmental awareness program



57. Organization to stop littering is illustrated in below **Figure. 3.25**

Figure 3.25: Organization of environmental awarenss program



3.10 CLIMATE RISKS OF PROJECT

3.10.1 Climate Change Trends and Extremes in Bahawalpur

Bahawalpur lies on elevation of 117m above mean sea level. The climate here is dry. During the year, there is virtually no rainfall in Bahawalpur. According to Köppen and Geiger, this climate is classified as BWP. The city witnesses some of the extreme temperatures in the country. The summer season starts from the month of April and continues till October, while the weather is pleasant and cold from November to February. Besides, dust storms are also common in the area.

Due to less average annual rainfall (143 mm) the city features an arid climate with sweltering summers and cold winters. The wettest year observed was 2021; with an annual total rainfall of 166.2 mm. Minimum annual rainfall was 119 mm recorded in 2017

Based on the past decade data, the month with the maximum precipitation on average is July with 27.67 mm of precipitation. The month with the least precipitation on average is October with an average of 2.33 mm.

The average temperature for the past decade in Bahawalpur is 89.6°F (32°C). The warmest month, on average, is July with mean temperature of 104.36°F (40.2°C). The coolest month on average is January, with mean temperature of 66.56°F (19.2°C).

The wind experienced at any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Wind speed usually blows from the north to south after the wind has arrived strongly and steadily from those quarters for a day or more. In fall season, the rain clouds come mostly from west due to western depression/disturbance.

Based on the past decade data, the maximum average wind speed of 16.70 kmph is recorded in the month of July while average minimum wind speed of 7.71 kmph was observed in November.

The quantity of leachate generated in a landfill is strongly dependent on the quantity of infiltrating water. This, in turn, is dependent on weather and operational practices. The amount of rain falling on a landfill largely controls the leachate quality generated. The daily leachate amount generated from the proposed Bahawalpur site is calculated which is 6.06 m³/d owing to the fact that area received less precipitation as compared to other districts. All the rainwater outside the landfill site will be expelled and does not enter the landfill cells.

Dust storms in the area will be a source of wind-blown litter which can scatter away from the landfill sites and can be a source of soil pollution and public nuisance.

3.10.2 Climate Change Considerations for Landfill Site

Climate change can impact different aspects of the landfill site due to projected increased temperatures and intense floods from heavy rainfalls at the location of the landfill site. These climatic changes in the nearby areas can also have serious consequences at the landfill site due to flash flooding.

Likelihood of climate change related hazards will be included in sensitivity assessment that could negatively affect the functioning of the landfill site including direct impacts (accessibility, physical damage, water damage) and indirect impacts (accidental fire, explosion or ecosystem damage). These direct and indirect impacts can affect the landfill site in terms of damage to liner or cover materials, washout of contaminated contents, leachate collection and removal, landfill gas management etc.

In addition to the impacts of changing climate, landfill sites can also be a source of greenhouse gas emissions which need to be considered for climate change mitigation options. These gases can also create a fire hazard due to a change the decomposition rates caused by increased temperatures.

Three aspects of landfill sites are assessed for potential climate change impacts (temperature, precipitation, winds, fire hazard) in terms of exposure and sensitivity: 1) underground components, 2) over-ground components and 3) Site infrastructure and operations, provided as **Table 3.12** below.

Table 3.12: Sensitivity Considerations for Landfill Site

System Components		Vulnerabilities		
		Physical Damage	Water Related Damage	Access
Landfill Components	Pipe systems for leachate treatment and disposal of landfill gas collection and transfer	X	X	X
	Transfer pumps for leachate and landfill gas	X	X	
	Treatment pond for leachate	X		X
	Pre-treatment of landfill gas (coolers, condensers, blowers)	X	X	
	Landfill gas flares	X	X	X
	Storage containers for chemicals	X	X	X
	Disposal system for treatment residuals	X	X	X
	Discharge system for treated leachate	X	X	
	Auxiliary and monitoring equipment	X	X	
	Synthetic materials (e.g. geomembrane in liners or cover system, geotextile for leachate filtration)	X	X	
	Bottom layer of unlined waste		X	
	Vegetative layer for an evapotranspiration cover	X	X	
	Groundwater or landfill gas monitoring wells	X		X
	Composting facility & AD system	X	X	
	Material Recovery Facility	X	X	
Infrastructure and Landfill Site Operations	Surface water drainage systems	X	X	X
	Mobile Transfer Stations		X	X
	Fencing, boundary walls for access control and litter prevention	X		
	Unpaved road to landfill site			X
	Buildings, sheds etc.	X	X	X
	Natural gas and electricity connections/lines	X	X	X
	Fuel storage and transfer	X	X	X
	Water supply	X	X	X
	Machinery and vehicles	X	X	X

58. The above-mentioned sensitivity and exposure analysis is based on available information in the concept designs, detailed design, other reports and information on general components of a landfill site.

Development of Bahawalpur Landfill is align with ADB commitments of Paris agreement as it will control landfill gas emissions particularly methane emissions which is potent GHG. Landfill gas is composed of roughly 50 percent methane (the primary component of natural gas), 50 percent carbon dioxide (CO₂) and a small amount of non-methane organic compounds. Methane is a potent greenhouse gas 28 to 36 times more effective than CO₂ at trapping heat in the atmosphere over a 100-year period. Methane possesses the combustible and explosive properties and also a Green House Gas responsible for global warming. Further development of well-engineered landfill will control climate risks such as increased surface run off entering the existing dumping and proposed landfill cells. Application of daily cover on waste will control windblown litter and will reduce public nuisance. Further project include landfill gas recovery and reuse which will ultimately reduce carbon emission resulting from combustion of conventional fuels.

4. DESCRIPTION OF ENVIRONMENT

4.1 GENERAL

Bahawalpur, lying just south of the Adamwahan Empress Bridge on Sutlej River, is situated 17 km from Lodhran, 90 km from Multan, 420 km from Lahore, 122 km from Burewala, 90 km from Vehari, 270 km from Faisalabad and about 700 km from the national capital, Islamabad⁶.

It is a fertile alluvial tract in the Sutlej River valley. East of Bahawalpur is the Pat, still inhabited or Bar, a tract of land considerably higher than the adjoining valley. It is mostly desert. Farther east, the Cholistan, is a barren desert tract, bounded on the north and west by the Hakra depression with mound ruins of old settlements along its high banks; it is by nomads. Bahawalpur district has a total area of 24,830 km²⁷. Approximately two-third of the district (16,000 km²) is covered by the Cholistan Desert, which extends into the Thar Desert of India⁸.

Baseline environmental and social profile of the project area was developed by collecting information through field surveys, literature review of available secondary data including maps prepared by the Geological survey of Pakistan, electronic and print media, published literature, District Census Reports (DCRs), and studies previously conducted in district and archives of the experts and on site environmental monitoring and surveys.

The proposed landfill site is located at Mari Sheikh Shijra mouza Nouabad in the outskirts of Bahawalpur city at a distance of approximately 13km from the city centre. Field surveys for the project area were carried out in November and December 2022 by EDCM team. The description of various features of the project area environment including the physical, ecological, cultural and socio-economic environmental aspects are presented in the following sub-sections.

4.2 PHYSICAL RESOURCES

4.2.1 Topography

The District Bahawalpur can be divided into three parts i.e. the riverain area, the plain area and the desert area. The riverain area lies close to the River Sutlej, which flows in the north along its boundary with Lodhran and Vehari Districts. The area is inundated during floods. The irrigated track is higher than the riverain area. Most of the land has been brought under cultivation.

The desert area is known as the Cholistan. It runs along the entire eastern boundary of Bahawalpur District in the north and Rahimyar Khan District in the south. The surface of the desert consists of a succession of sand dunes rising in some places to a height of 150 meters. The project site is located in the desert land of the Nouaabad⁹.

Regions to its west are fertile alluvial tracts irrigated by the Sultej River. East of Bahawalpur is the Pat, or Bar - a tract of land at considerably higher altitude than the adjoining valley. Farther east, the Cholistan, is a barren desert tract, bounded on the north and west by the Hakra depression. **Figure 4.1** represents the topography of the project.

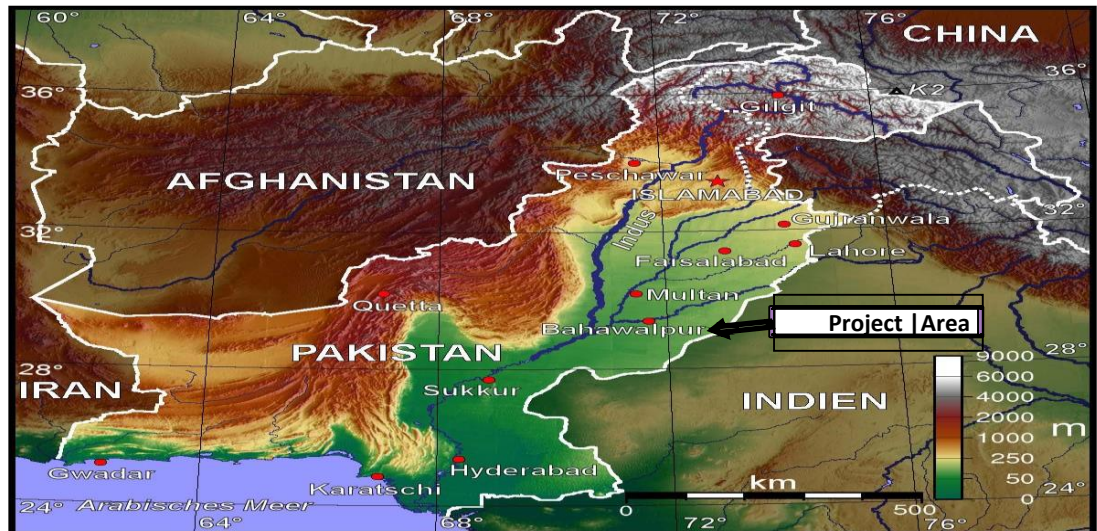
⁶ **Source:** Master Planning and Detailed Designing for Development of Bahawalpur Industrial Estate

⁷ Bahawalpur". Punjab Portal. Retrieved 17 August 2022

⁸ https://en.wikipedia.org/wiki/Bahawalpur_District#cite_note-3

⁹ Bahawalpur". Punjab Portal. Retrieved 17 August 2022

Figure 4.1: Topography of the Study Area



The project site has flat terrain. The sand dunes are deposited all over the project area which comprises of mostly flat terrain with scattered vegetation consisting of bushes, grasses and some trees across the site.

The project area is a fertile alluvial tract that is irrigated by canal waters and tube wells with widely grown crops wheat, cotton, and sugar cane, while palm dates are also planted at various locations near the project site (1-2Km distance). The soil is formed by alluvial or alluvial deposits dominated by silt and large particles of sand. The surrounding of project site is fertile land suitable for agricultural activity while soil near canal comprises fertile alluvial tract. The surface is irregular throughout the project site as shown in **Figure 4.2**

Figure 4.2: View of Project Site



The project area comprises of small sand dunes amidst of Bahawalpur agricultural areas located near villages Mari Sheikh Shijra and Basti Yar Muhammad. Total area of the project is 110 acres and its coordinates are 29°17'44.86 N and 71°35'30.34 E.

4.2.2 Geology and Soil

The major chunk of the project land comprising of sandy and clay patches. The soil in general is made up of alluvial deposits having clayey loam at “Dahars” (flat

areas between dunes) with low sand dunes at scattered places. The size of sand dunes ranges from 0.01 to 0.50 km² and up to the height of 6 m. clayey loam deposits are about 1.5 to 5.0 m thick and pure sand starts below the hard clayey surface¹⁰

The distribution of Tertiary rocks in the project area is unknown, except in the Pabbi Hills area, in northeastern Chaj Doab, where rocks of the Siwalik system are exposed. In the area of -the buried bedrock ridge, in Chaj, Rechna, and Bari Doabs, exploratory drilling has revealed that the Precambrian basement rocks are overlain directly by Quaternary alluvium. The northeast and southwest of the bedrock ridge, test holes drilled to a maximum depth of about 1,500 feet bottomed in alluvium. Hence, no information is available concerning the total thickness of the alluvial deposits, the southward extension of Tertiary or older sedimentary rocks from the Salt Range and the Pabbi Hills, and the depth to the basement complex in most of the area.

Ground-water reservoir of the area is contained almost exclusively in the alluvial deposits. The alluvium of the Punjab Plains, derived from the mountain ranges to the north, has been deposited by the present and ancestral tributaries of the Indus River. The alluvial complex of Pleistocene and Recent age represents the latest phase of sedimentation in an environment that had its beginnings in mid-Tertiary time: the deposition of predominantly fluvial sediments in a subsiding trough a fore-deep adjacent to the rising Himalayan ranges.

The alluvial complex consists principally of fine to medium sand, silt, and clay. Beds of gravel or very coarse sand are uncommon. Pebbles of siltstone or mudstone may be found embedded in silty or clayey sand in many places. Also associated with fine-grained strata are concretionary zones or nodules of kankar, a calcium carbonate deposit of secondary origin. The study of drill cuttings and electric logs has shown the absence of thick horizons of pure clay within the alluvium. Except for local clay lenses, a few feet thick, the finer parts of the alluvium consist generally of sandy, gravelly, or silty clay. Although there are local concentrations of fine-grained sediments of considerable thickness, individual strata are generally lenticular and have little horizontal or vertical continuity. The random distribution of coarse and fine-grained sediment within the alluvial complex is entirely consonant with its mode of deposition by large constantly shifting streams.

The project area is positioned in the southern part of the Punjab Plain which is a vast plain of the alluvial material deposited by the five main rivers of the Indus River System crossing the Punjab Plain. The alluvial deposits at the site are deposited by the old course of one of these rivers, the river Sutlej. The alluvial deposits around the site comprise stream bed, meander-belt deposits and flood plain deposits, deposited by the shifting of river course. The alluvial plain at the site mainly consists of silty clay/clayey silt, sandy silt and sand layers of varying thickness.

The soil is sandy, while the soil of central Bahawalpur mostly consists of the plains of Indus basin which is at the height of not more than 150 meters above sea level. But the southwestern desert, which is called Rohi or Cholistan, is mostly undulated due to the presence of sand dunes. The height of the sand dunes does not exceed 150 meters (according to Imperial Gazetteer of 1901 height of dunes was not more than 500 feet). Before the construction of Sutlej valley Project's Canal system, the irrigation was carried out with the flood water of Sutlej. This area is called "Otarh." The second major area in terms of topography, extending between the railway line and the passage of Hakra, comprises of clay. The special

¹⁰ Bahawalpur". Punjab Portal. Retrieved 17 August 2022

ingredients are silt and sand dunes. Locally this is known as “Hitarh” and this is the prosperous and fertile area of the dwellings and markets of the colonies of Sutlej valley Project. Imperial Gazetteer concluded had divided this area lengthwise into three great strips: Rohi or Cholistan (desert); the central tract was Bar or Pat (upland); and the third was fertile alluvial tract in river valley called Sind.

Site Specific Investigation

M/S GEO BAND (the service provider) was hired by the EDCM to provide its services for Geotechnical Investigation of Bahawalpur Landfill Site. The team mobilized to Landfill site on 14 October, 2022 with all necessary equipment and tools along with skilled staff and one (01) experienced civil engineer and after getting NOC from EDCM the field work was started on 16 October, 2022 and the field investigations were completed on 21 October, 2022.

The exploratory boreholes were drilled in the project area by M/s GEO BAND (**Table-4.1**). Five (05) borehole were explored by using auger drilling method. Visual inspection and logging of in-situ substrata were carried out at site by an experienced engineer of the M/s GEO BAND. The boreholes detailing, reference number of boreholes, the lithological description of the material encountered with depth, structural details of each layer, method of drilling. The results of in-situ testing, the depth and elevation of the borehole and the depth of ground water table are present in geotechnical investigation of report of the project.

Table 4.1: Details Boreholes Locations and Depth –Bahawalpur Landfill Site

Sr No.	Borehole No.	Coordinates		Drilling Depth (m)
		N	E	
1	BH-01	3243377	752238	15
2	BH-02	3243267	751984	18
3	BH-03	3243229	751750	20
4	BH-04	3243218	751460	16
5	BH-05	3243357	751471	18

59. Test pits were excavated manually to physically examine and delineate the sub-surface strata and evaluate the pavement design parameters. (04) Number of test pits were excavated as per given plan. Field density test were performed with core cutter method. Details of excavated test pits are given in **Table 4.2**.

Table 4.2: Details of Excavated Test Pits

Sr No.	TP No.	Coordinates		TP Depth (m)
		N	E	
1	TP-01	3243444	751402	2
2	TP-02	3243348.63	752291.77	2
3	TP-03	3243171.82	751835.63	2
4	TP-04	3243334	751408	2

Based on detailed geotechnical investigations, it has been assessed that the whole proposed landfill site consists of sand dunes with considerably elevation difference between boreholes. Generally Silty Sand (SM / SP) dominates up to 4-6 m depth afterward 2-3m Silty Clay/Lean Clay and Sandy Strata (SP-SM)/Silty Sand (SM) is observed till borehole termination depth. A Silty Clay (CL-ML)/Lean Clay (CL) layer of 1-2m is observed at varying depth of 12-14m in all boreholes except BH-03. However, in all four excavated test pits, Silty Sand (SM) is

dominant up to termination depth. Soil consistency is loose upto 3 m in two boreholes (BH-01 & BH-02) while medium dense upto 20m depth.

The GWT was encountered at 14m, 16m, 14.80m and 16.5m in BH-01, BH-02, BH04 and BH-05 respectively. GWT is not encountered in BH-03 during the period of investigations.

For sub-surface soil classification, thirty-one (31) selected soil samples were subjected to sieve analyses. Sieve analyses of all representative samples show that fines range from 15% - 100%. However, four (04) soil samples, one from each test pit were subjected to sieve analysis. Test reveals that percentage of fines ranges from 8% to 28%. Out of tested samples selected from boreholes, plasticity index range from 28 -38%.

Maximum dry density ranges from 1.663 – 1.69 gm/cc and optimum moisture content ranges from 13.2 % to 14.5 %.

Table 4.3: Summary of ground conditions across Project Site

Borehole No.	Depth (m)	Description
BH-01		
BH-01	2	Silty Sand
BH-01	3	Silty Sand
BH-01	4	Silty Clay
BH-01	5	Lean Clay
BH-01	6	Lean Clay
BH-01	7	Sandy Silt
BH-01	9	Silt
BH-01	12	Lean Clay
BH-02		
BH-02	2	Sandy Silt
BH-02	5	Lean Clay
BH-02	6	Lean Clay
BH-02	7	Lean Clay
BH-02	8	Lean Clay
BH-02	9	Silty Sand
BH-02	12	Silt with Sand
BH-02	14	Lean Clay
BH-02	16	Silty Sand
BH-02	16	-
BH-03		
BH-03	2	Silty Sand
BH-03	5	Silty Sand
BH-03	7	Silty Clay
BH-03	8	Lean Clay
BH-03	10	Silty Sand

Borehole No.	Depth (m)	Description
BH-03	12	Silty Sand
BH-04		
BH-04	1	Silty Sand
BH-04	3	Silty Sand
BH-04	4	Silty Sand
BH-04	9	Silty Sand
BH-04	10	Silty Sand
BH-04	11	Silty Sand
BH-04	14	Lean Clay
BH-04	14.8	Silty Sand
BH-05		
BH-05	2	Silty Sand
BH-05	7	Silty Sand
BH-05	10	Silty Sand
BH-05	11	Silty Clay
BH-05	16	Silt

Baseline quality of soil at existing dumping area and surrounding proximity of landfill site will be carried out prior to closure of the existing dumping site and commencement of MRF operation to assess any possible contamination.

In addition, the recommendations of the geotechnical investigation of the project site are as follows:

- The foundations shall be placed at such a depth which is not influenced by weather, flooding and erosion besides any cavity structure within subsurface.
- For shallow foundation, if weak/soft soil is encountered at the excavation base level, further excavation up to 1 to 1.5 m and replacement with selected engineering fill is recommended. This select fill should be compacted in layers appropriate to the type and size of compaction equipment, to at least 75 % relative density or 95 % of Modified Proctor dry density, as appropriate. Alternatively, place four layers (of 6 inches' thickness) having proportions of 70% crushed stone and 30 % sand before the placement of lean concrete and foundation. It must be ensured that compaction on each layer must not be less than 95% of modified Proctor dry density. In this way, bearing capacity of the area can be increased.
- Proper factors of safety against uplift and lateral loads should also be checked for the adequacy of the foundation depth.
- Type A and Type B protection (based upon BS8102) is recommended along with reinforced concrete designed to BS8007. Type C with wall and floor cavity and DPM.
- The drainage provisions at the time of construction must be checked to ensure that there is no risk of flotation, from flooding of excavations around the structure
- Excavation support system requirements may be recommended at later stage by the geotechnical engineer after architectural plans are finalized.

- During excavation and construction of foundations, before pouring lean concrete, the excavation should be inspected by an experienced geotechnical engineer

4.2.3 Climate

Seasonal climatic conditions must be considered for the design and execution of the project. The climate including air, temperature and precipitation is an influencing factor, affecting the construction and other engineering structures. However, to determine the overall effect of the climatic stresses, daily and seasonal temperature changes and precipitation must be considered.

Bahawalpur lies on elevation of 117m above mean sea level. The climate here is dry. During the year, there is virtually no rainfall in Bahawalpur. According to Köppen and Geiger, this climate is classified as BWP. The city witnesses some of the extreme temperatures in the country. The summer season starts from the month of April and continues till October, while the weather is pleasant and cold from November to February. Besides, dust storms are also common in the area.

Rainfall and Temperature

Due to less average annual rainfall (143 mm) the city features an arid climate with sweltering summers and cold winters. The wettest year observed was 2021; with an annual total rainfall of 166.2 mm. Minimum annual rainfall was 119 mm recorded in 2017

Based on the past decade data, the month with the maximum precipitation on average is July with 27.67 mm of precipitation. The month with the least precipitation on average is October with an average of 2.33 mm.

The average temperature for the past decade in Bahawalpur is 89.6°F (32°C). The warmest month, on average, is July with mean temperature of 104.36°F (40.2°C). The coolest month on average is January, with mean temperature of 66.56°F (19.2°C).

Data of average temperatures, precipitation and soil temperature recorded is provided in **Table 4.4**, **Figure 4.4** and **Figure 4.5** showing monthly temperature and precipitations for project area during the past decade (Year 2012-2021).

Table 4.4: Metrological Data Records of Bahawalpur¹¹

Month-Year	Parameters					
	Average Temperature (°C)			Average Rainfall (mm)	Humidity (%)	Average Wind (kmph)
	Maximum	Minimum	Average			
Jan-12	22	11	18	0	37	7.7
Feb-12	23	11	19	0	34	10
Mar-12	32	18	27	0.1	27	10.7
Apr-12	37	26	33	16.2	27	10.9
May-12	43	32	40	13.8	14	10.3
Jun-12	45	34	42	6.2	22	16
Jul-12	44	35	41	5.5	29	15.5

¹¹ **Source:** <https://www.worldweatheronline.com/bahawalpur-weather-averages/punjab/pk.aspx>

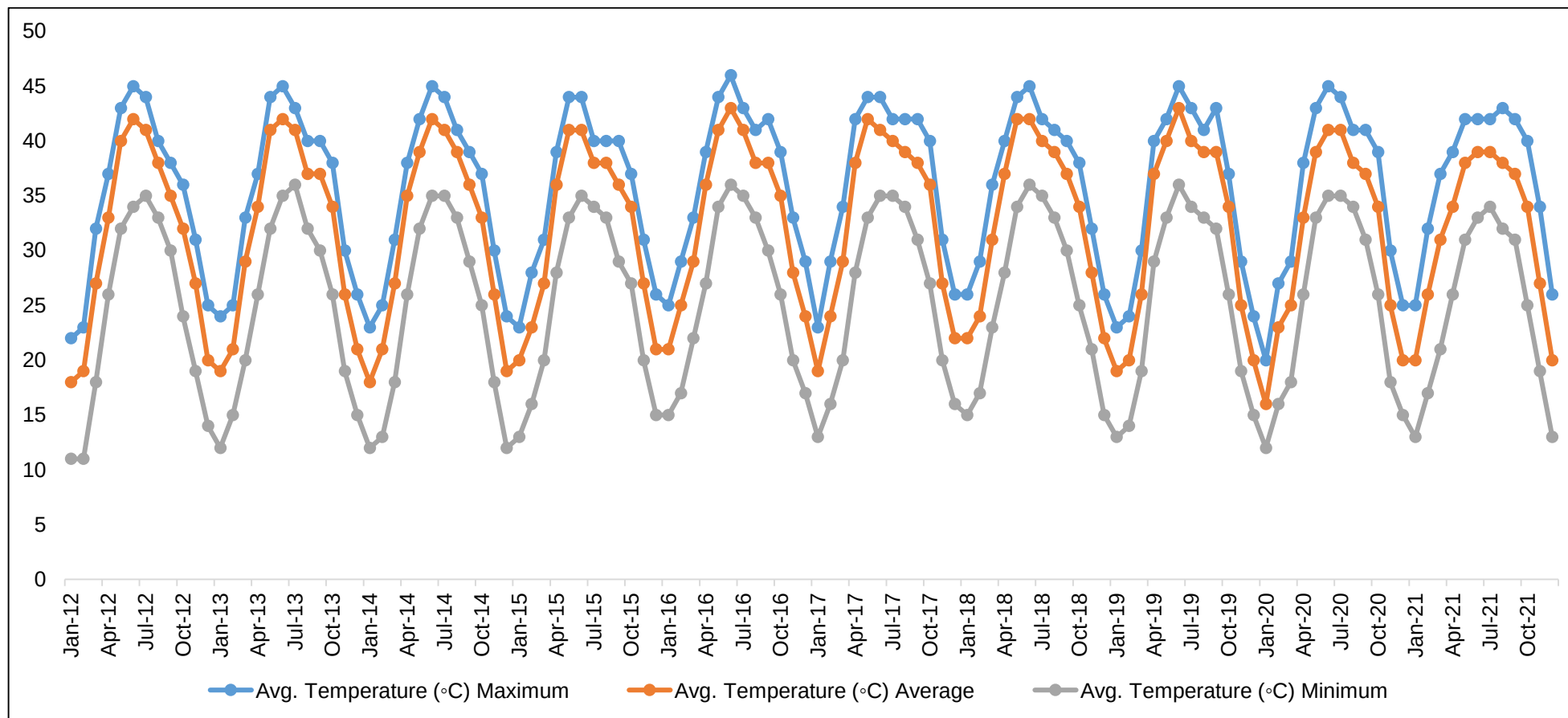
Month-Year	Parameters					
	Average Temperature (°C)			Average Rainfall (mm)	Humidity (%)	Average Wind (kmph)
	Maximum	Minimum	Average			
Aug-12	40	33	38	37.43	40	12.1
Sep-12	38	30	35	44.9	41	11.2
Oct-12	36	24	32	0.2	27	7.4
Nov-12	31	19	27	0	28	6.8
Dec-12	25	14	20	0.6	32	7.8
Jan-13	24	12	19	0	27	7.6
Feb-13	25	15	21	28.3	45	10.4
Mar-13	33	20	29	2	29	10.2
Apr-13	37	26	34	13.6	22	10.1
May-13	44	32	41	0.4	12	12
Jun-13	45	35	42	9.5	23	15
Jul-13	43	36	41	9.8	31	14.3
Aug-13	40	32	37	57.1	40	13
Sep-13	40	30	37	0	32	13.1
Oct-13	38	26	34	0.1	29	7.5
Nov-13	30	19	26	1.9	31	6.4
Dec-13	26	15	21	0	31	6.7
Jan-14	23	12	18	0	36	7.4
Feb-14	25	13	21	2.2	34	9.2
Mar-14	31	18	27	5.67	32	10.6
Apr-14	38	26	35	3.15	22	10.2
May-14	42	32	39	20	21	9.8
Jun-14	45	35	42	0.7	24	18
Jul-14	44	35	41	14.63	30	14.8
Aug-14	41	33	39	5.68	34	14.5
Sep-14	39	29	36	49.67	37	13.9
Oct-14	37	25	33	1	26	8
Nov-14	30	18	26	0	26	6.8
Dec-14	24	12	19	0	27	6.6
Jan-15	23	13	20	0	38	7.6
Feb-15	28	16	23	2.9	34	11
Mar-15	31	20	27	19.94	31	11.2
Apr-15	39	28	36	12.71	21	11.8
May-15	44	33	41	5.3	13	11.8
Jun-15	44	35	41	8.73	23	13.1
Jul-15	40	34	38	76.86	38	14.8

Month-Year	Parameters					
	Average Temperature (°C)			Average Rainfall (mm)	Humidity (%)	Average Wind (kmph)
	Maximum	Minimum	Average			
Aug-15	40	33	38	46.7	38	14.1
Sep-15	40	29	36	24.8	30	13
Oct-15	37	27	34	5.6	23	9.5
Nov-15	31	20	27	0	23	8.1
Dec-15	26	15	21	0.07	22	7.1
Jan-16	25	15	21	0.2	27	7.8
Feb-16	29	17	25	0.3	20	8.2
Mar-16	33	22	29	37.4	33	10.1
Apr-16	39	27	36	5.25	17	10.4
May-16	44	34	41	8.54	17	13.9
Jun-16	46	36	43	5.48	22	13.9
Jul-16	43	35	41	15.71	33	13
Aug-16	41	33	38	23.9	36	10.7
Sep-16	42	30	38	0	28	10.8
Oct-16	39	26	35	0	16	7.6
Nov-16	33	20	28	0	17	6.9
Dec-16	29	17	24	0	21	6.9
Jan-17	23	13	19	5.1	41	9.2
Feb-17	29	16	24	0.7	22	8.9
Mar-17	34	20	29	0.4	22	9.5
Apr-17	42	28	38	3.5	15	10.7
May-17	44	33	42	3.2	16	10.9
Jun-17	44	35	41	29	27	13.8
Jul-17	42	35	40	7.8	33	13.2
Aug-17	42	34	39	11.1	32	14.7
Sep-17	42	31	38	0.3	23	9.3
Oct-17	40	27	36	0	13	6.8
Nov-17	31	20	27	3.5	21	6.7
Dec-17	26	16	22	16.3	22	7
Jan-18	26	15	22	0	20	7.6
Feb-18	29	17	24	0.7	27	9.7
Mar-18	36	23	31	0.1	21	10.2
Apr-18	40	28	37	5.2	16	11.3
May-18	44	34	42	7.9	12	11.1
Jun-18	45	36	42	17.6	23	15.7
Jul-18	42	35	40	23.7	33	16.3

Month-Year	Parameters					
	Average Temperature (°C)			Average Rainfall (mm)	Humidity (%)	Average Wind (kmph)
	Maximum	Minimum	Average			
Aug-18	41	33	39	4.5	36	16.7
Sep-18	40	30	37	0.7	31	13.7
Oct-18	38	25	34	0	16	7.3
Nov-18	32	21	28	0	20	7.4
Dec-18	26	15	22	0	22	7.3
Jan-19	23	13	19	6	31	9.6
Feb-19	24	14	20	35.3	38	10.9
Mar-19	30	19	26	30.9	35	11.3
Apr-19	40	29	37	15.1	20	11.8
May-19	42	33	40	22.2	17	12.9
Jun-19	45	36	43	12.7	19	16
Jul-19	43	34	40	42.8	35	20
Aug-19	41	33	39	41.4	37	16.4
Sep-19	43	32	39	24.7	32	15.8
Oct-19	37	26	34	4.4	25	10.5
Nov-19	29	19	25	12.1	34	9.9
Dec-19	24	15	20	19	29	6.8
Jan-20	20	12	16	9.6	45	10.9
Feb-20	27	16	23	0	29	11.4
Mar-20	29	18	25	61.9	42	13
Apr-20	38	26	33	14.7	25	12.6
May-20	43	33	39	16.1	17	14
Jun-20	45	35	41	10.9	24	21.3
Jul-20	44	35	41	29.2	31	20.5
Aug-20	41	34	38	93.4	40	18.7
Sep-20	41	31	37	25.3	32	14.4
Oct-20	39	26	34	0	13	9.7
Nov-20	30	18	25	0.1	23	9.5
Dec-20	25	15	20	0.5	29	8.4
Jan-21	25	13	20	0	24	8.7
Feb-21	32	17	26	0	18	9.6
Mar-21	37	21	31	7.4	19	11.8
Apr-21	39	26	34	2.7	16	13.3
May-21	42	31	38	28.5	23	16.2
Jun-21	42	33	39	23.5	31	21.9
Jul-21	42	34	39	50.7	37	20

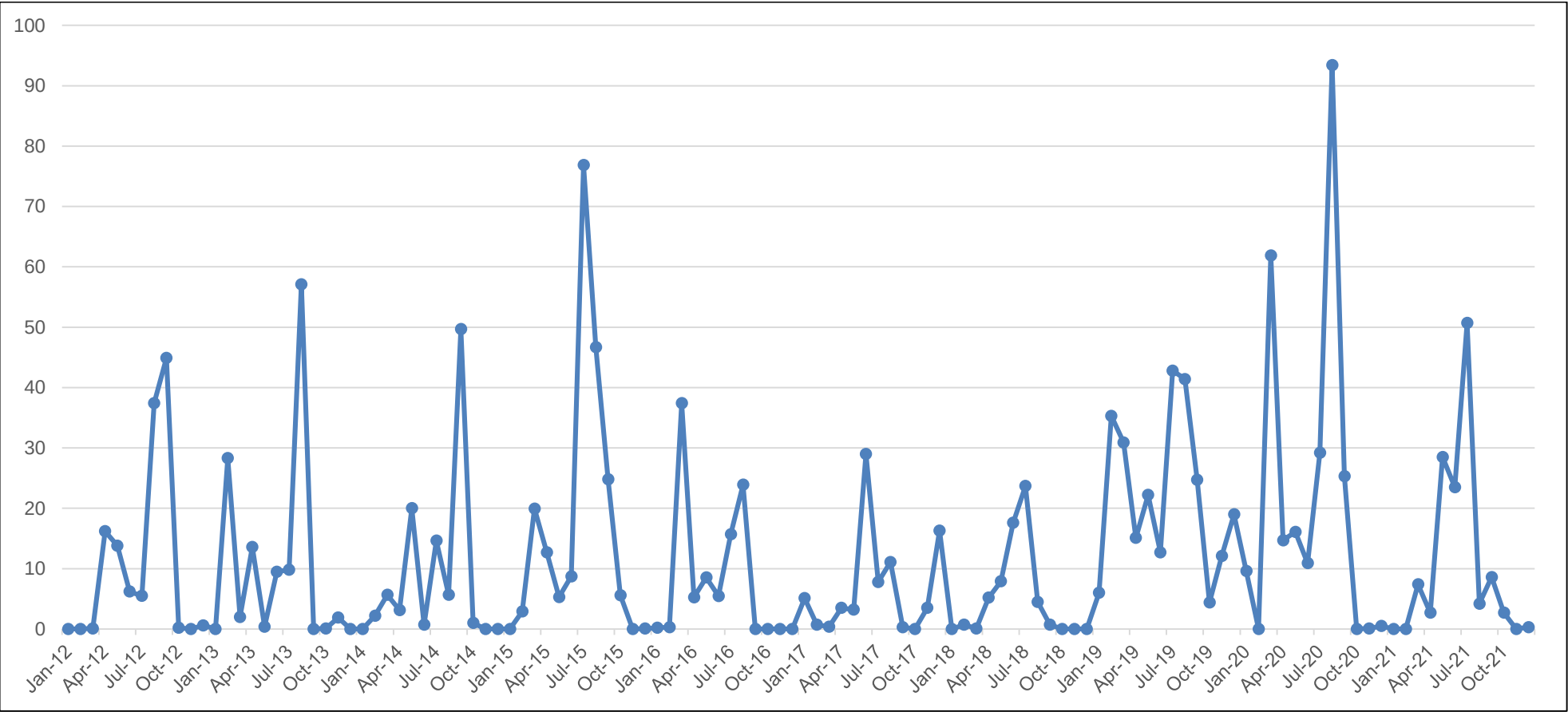
Month-Year	Parameters					
	Average Temperature (°C)			Average Rainfall (mm)	Humidity (%)	Average Wind (kmph)
	Maximum	Minimum	Average			
Aug-21	43	32	38	4.2	33	21.9
Sep-21	42	31	37	8.6	41	14.8
Oct-21	40	25	34	2.7	25	12.7
Nov-21	34	19	27	0	17	8.6
Dec-21	26	13	20	0.3	22	6.7

Figure 4.4: Graphical Representation of Temperature of Bahawalpur (Year-2012-2021)¹²



¹² Source: <https://www.worldweatheronline.com/bahawalpur-weather-averages/punjab/pk.aspx>

Figure 4.5: Graphical Representation of Average Rainfall in Bahawalpur (Year 2012-2021)¹³



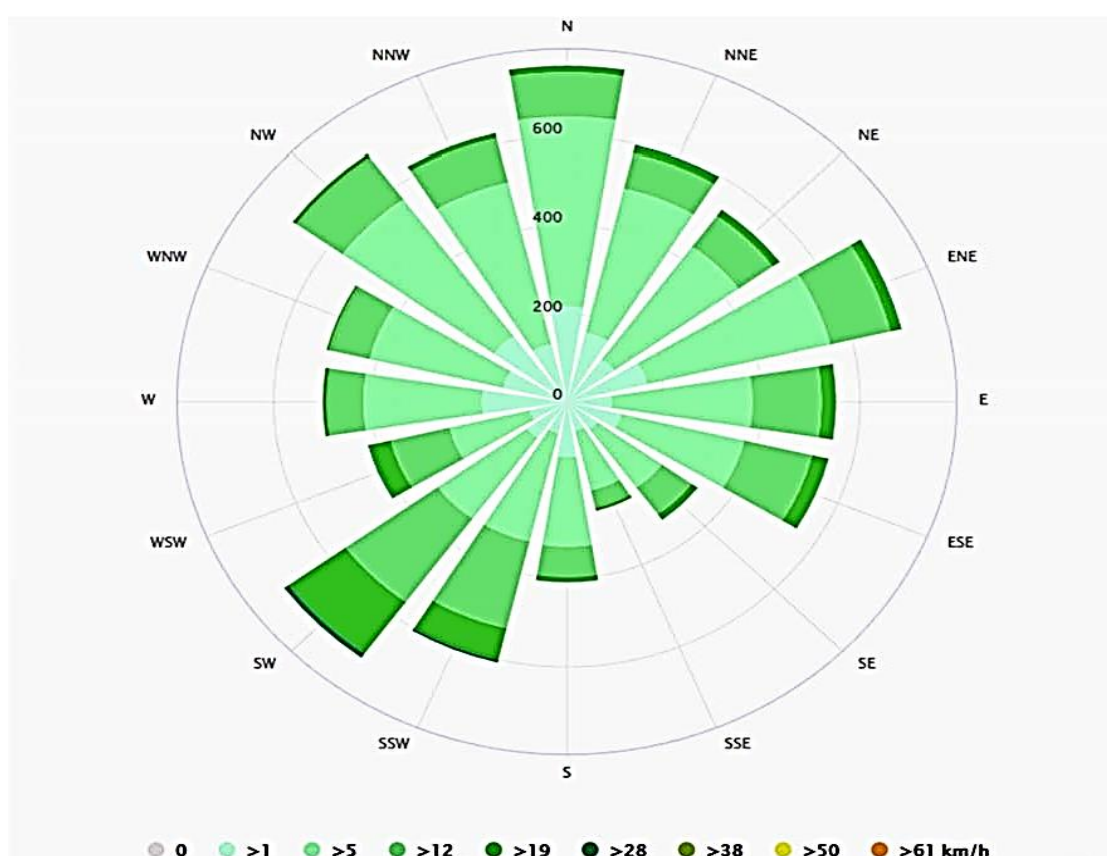
¹³ **Source:** <https://www.worldweatheronline.com/bahawalpur-weather-averages/punjab/pk.aspx>

Wind Speed and Wind Direction

Based on the past decade data, the maximum average wind speed of 8.8 kmph is recorded in the month of June while average minimum wind speed of 1. kmph was observed in December.

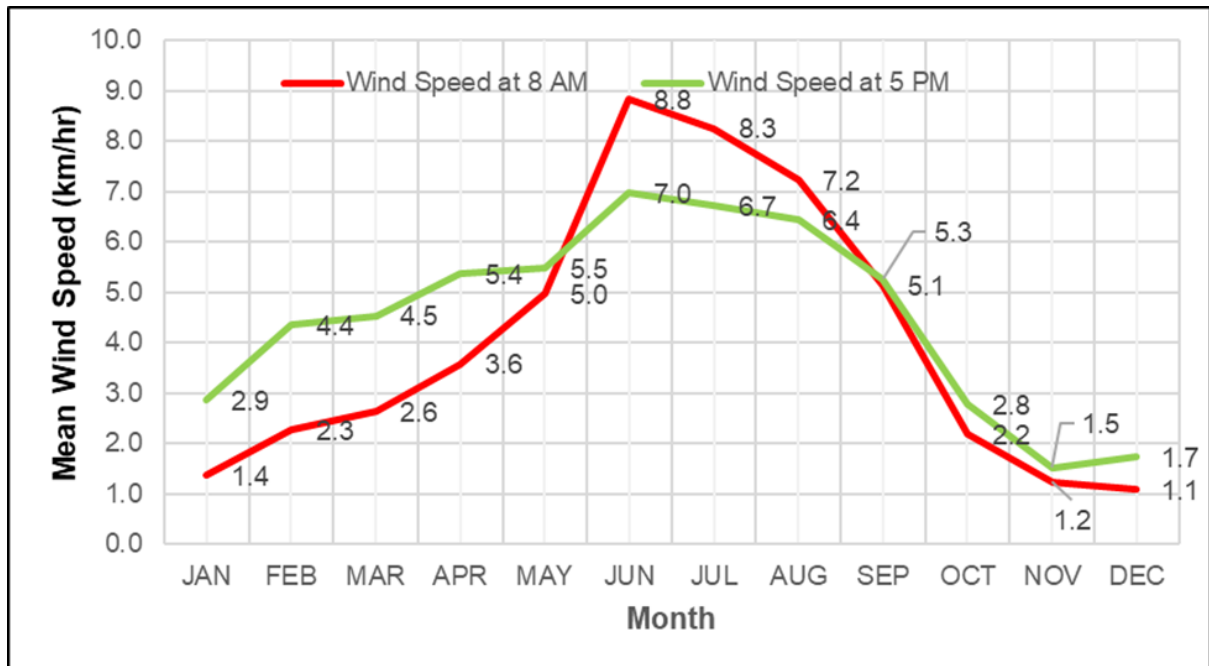
The wind experienced at any location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. Wind speed usually blows from the north to south after the wind has arrived strongly and steadily from those quarters for a day or more. In fall season, the rain clouds come mostly from west due to western depression/ disturbance. **Figures 4.6** show that dominant wind direction of Bahawalpur is from North to South. **Figure 4.7** represents the wind speed.

Figure 4.6: Wind Rose for the Bahawalpur¹⁴



¹⁴ Source: https://www.meteoblue.com/en/weather/forecast/modelclimate/bahawalpur_pakistan_1183883

Figure 4.7: Wind Speed in Bahawalpur

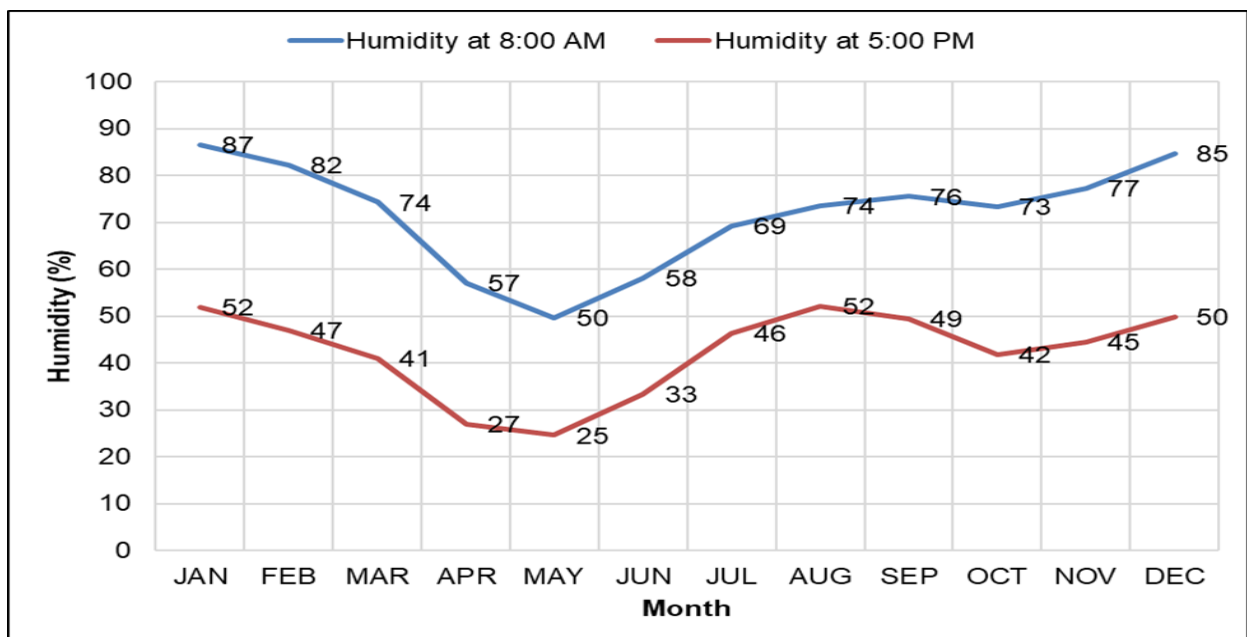


Relative Humidity

During the past decade, the city is experiencing on average maximum humidity of 87% in January and a minimum of 5% in the evenings in May.

Heat waves occur during the hottest months of May and June and can result in temperatures approaching 45°C. Longer periods of rate of increase of maximum temperature together with heat waves and increased precipitation can cause increases in humidity and water consumption. Graphical representation of Humidity is shown in below figure.

Figure 4.8: Graphical Representation of Humidity (Year-2012-Year 2021)



|,lp.;/

4.2.4 Seismology

According to Seismic Zoning Map of Pakistan, Bahawalpur falls in Zone 2A (Lower limit of moderate damage).

Pakistan Building Code (PBC) and Unified Building Code (UBC) provide guidelines for ascertaining parameters for design of foundations. The project site falls in southern part of Punjab plain which shows very low to moderate level of seismicity. The project region has also been subjected to shaking in the past due to earthquakes in the Suleiman Range located about 140 km northwest to the site.

The basement rocks underlying the southern part of the Punjab Plain show very low seismicity indicating stable basement region. So the main source of shaking at the project site is related to moderate to large earthquakes in the seismically active Suleiman Range.

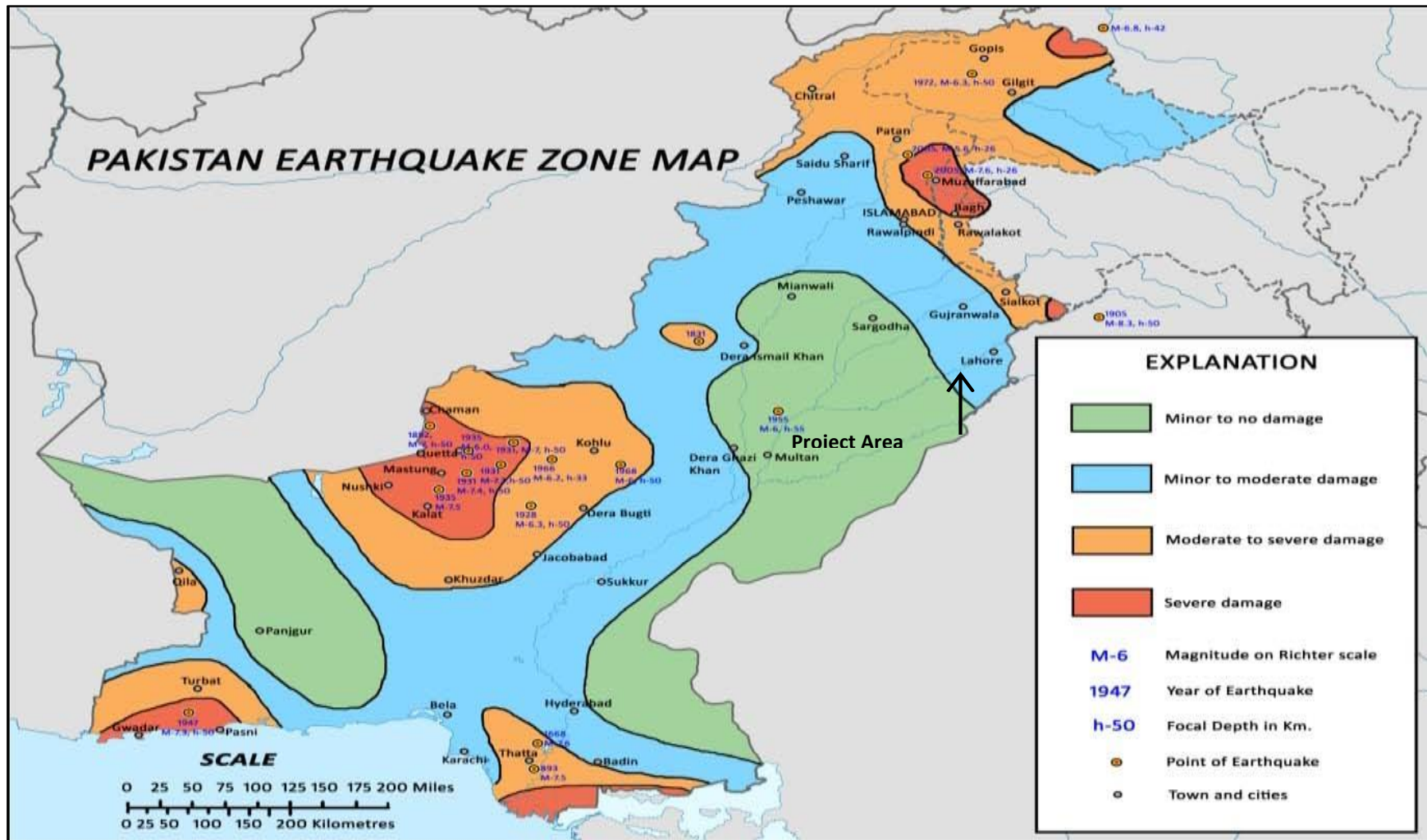
Probabilistic seismic hazard assessment shows that the project area falls in Zone-2A with peak horizontal ground acceleration of 0.08g-0.16g i.e. negligible damage as given in Figure 4-5. Based on project location, Seismicity influencing the project area, area geology, field and laboratory investigation data and proposed structures, design parameters are given in **Table 4-5** in accordance with guidelines of Pakistan Building Code (PBC-2007).

Table 4-5: Seismic Design Parameters

Design Parameters	Design Value
Seismic Zone	2A
Peak Horizontal Ground Acceleration	0.08g to 0.16g
Seismic Zone Factor “Z”	0.15
Type SD & SE Seismic Coefficient “Ca”	0.22 & 0.30
Soil Profile Seismic Coefficient “Cv”	0.32 & 0.50
Seismic Source	Type C
Near Source Factor “Na” 1	1
Near Source Factor “Nv”	1

It is therefore recommended that the project should be designed to cater the requirements of Zone 2A of seismic provisions after giving due consideration to the soil profile at site. **Figure 4.9** shows seismic zoning map of Punjab indicating location of the proposed project.

Figure 4.9: Seismic Zones of Pakistan



4.2.5 Surface water

Only Sutlej river flows in the north side of the district. Its length is 176 km from Head Islam to Head Panjnad. The major source of irrigation was the water of Hakra River but with the drying of the river the area was desiccated and left with only grazing lands. The river supplied water regularly to this region until 1200 BC but near 600 BC it became irregular in flow and subsequently vanished.

The project is located at 13 km on the south of the Sutlej River and lies in the Cholistan region near the Thar Desert, where effect of recharge is significant. As such, the sub soil water quality has improved over the period.

A non-perennial irrigation canal Shimshahi canal flows through the project area. The canal is operated from April to September (Kharif Season). One surface water sample was collected from this canal and analyzed from EPA certified lab. The results of the tests are presented in **Table 4.6** and **Appendix A.4**. The coordinates of the Shimshahi canal are 29° 31'34.03" N and 71° 59'33.72" E. The elevated TDS concentrations are reported due to increased alkalinity and calcium concentrations and accelerated dissolution of calcium carbonate. Also high sulfate concentrations is due to spilling of sulfur compounds from impervious areas and wastewater leaks or illicit discharges.

Table 4.6: Surface Water Quality Analysis

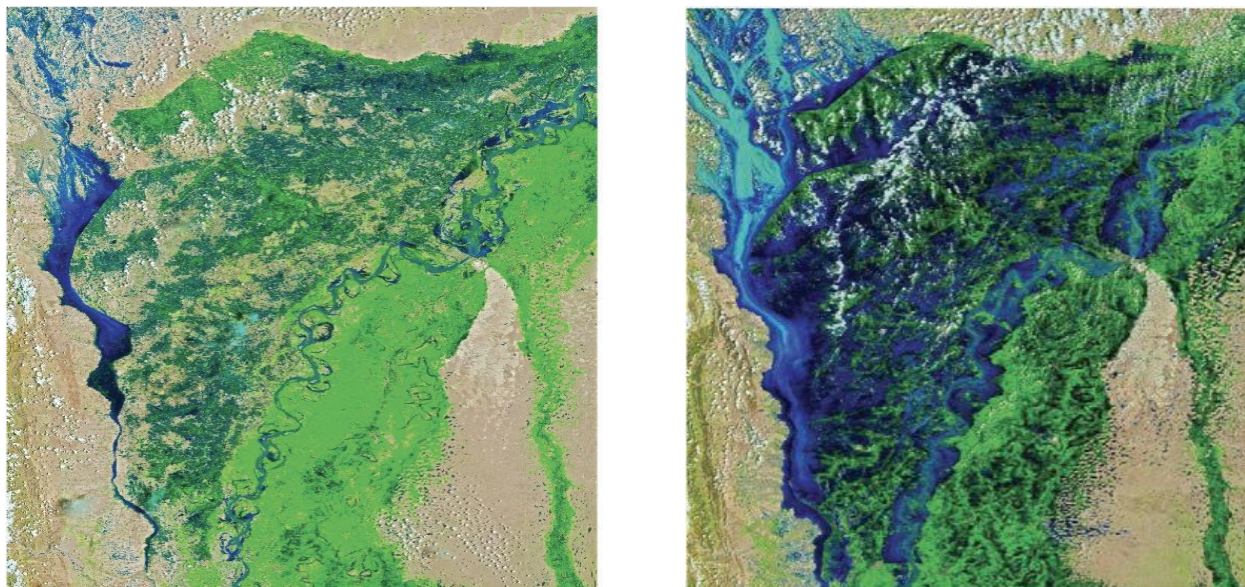
Parameters	Analysis Method	Unit	LOR	Result
Temperature	-	0C	-	11.0
pH	APHA-4500H ⁺ B	pH unit	0.1	7.60
Total Dissolved Solid (TDS)	APHA-2540 C	mg/l	1.0	250.0
Color	APHA-2120 B/C	Pt/Co	5.0	68.0
Odor	In-house	-	-	Odorless
Turbidity	APHA-2130 B	NTU	-	N.D
Salinity	APHA 2520-B	Ng/l	-	0.125
Oil and Grease	USEPA-1664	mg/l	1.0	<1.0
Biological Oxygen Demand	APHA, 5210	mg/l	2.0	26.0
Chemical Oxygen Demand	APHA-5220-D	mg/l	5.0	80.0
Total Suspended Solid	APHA-2540-D	mg/l	5.0	39.0
Phenolic Compound	APHA-5530 D	mg/l	0.00 1	<0.001
Chloride (Cl)	APHA-4500Cl- B	mg/l	0.5	35.22
Fluoride (F)	APHA-4500F- C	mg/l	0.01	<0.01
Detergent	APHA-4500-SO4C	mg/l	-	N.D
Sulphate	APHA-4500-SO4C	mg/l	0.41	83.14
Sulphide	APHA-4500-S2-E	mg/l	-	N.D
Ammonia	APHA-4500-NH3-B	mg/l	0.00 2	<0.002
Arsenic	APHA-3500As B	mg/l	0.01	<0.01
Chlorine	APHA-4500Cl-B	mg/l	1.0	<1.0
Lead	APHA-3500-Pb B	mg/l	0.01	<0.01
Total Toxic Metals	-	mg/l	-	ND

Parameters	Analysis Method	Unit	LOR	Result
Mercury	APHA-3500-Hg B	mg/l	0.00 1	<0.001
Pesticides	APHA-6630 B	mg/l	-	ND

Source: EIA baseline survey, 2022

4.2.6 Floods

Pakistan ranks among the top 10 countries worldwide most affected by climate change¹⁵. Between June and August 2022, torrential rains and a combination of riverine, urban, and flash flooding led to an unprecedented disaster in Pakistan. According to the National Disaster Management Authority (NDMA), around 33 million people that is, one in seven have been affected by the floods, including nearly 8 million displaced. The floods have taken the lives of more than 1,700 people, one-third of which were children.¹⁶ Rain-induced floods, accelerated glacial melt, and resulting landslides devastated millions of homes and key infrastructure, submerging entire villages and destroying livelihoods. Preliminary estimates suggest that, as a direct consequence of the floods, the national poverty rate will increase by 3.7 to 4.0¹⁷ percentage points, pushing between 8.4 and 9.1 million people into poverty. As of October 11, 94 districts were declared as “calamity hit,” accounting for more than half of all districts in the country. The majority were in the provinces of Baluchistan, Sindh, and Khyber Pakhtunkhwa (KP). Out of the 25 poorest districts in the country, 19 were calamity-affected.



Extent of Flooding Comparison in Pakistan Between August 4 And 28, 2022¹⁸

¹⁵ Eckstein, David, Vera Künzel, and Laura Schäfer. 2021. “Global Climate Risk Index 2021.” German watch Briefing Paper. <https://www.germanwatch.org/en/19777>.

¹⁶ NDMA. October 19, 2022. “NDMA Floods (2022): Sitrep Report No. 128.” <https://cms.ndma.gov.pk/storage/app/public/situation-reports/October2022/QECa7rSLzWINuxZFHV.pdf>.

¹⁷ Source: <https://www.worldweatheronline.com/bahawalpur-weather-averages/punjab/pk.aspx>

¹⁸ The images combine shortwave infrared, near infrared, and red light (bands 6-5-4) to better distinguish flood waters (deep blue) beyond their natural channels. Original image sourced from: <https://earthobservatory.nasa.gov/images/150279/devastating-floods-in-pakistan>.

River Sutlej flows along the northern boundary of the District Isalm Head works is located on Bahawalpur / Muzaffar Garh border of the District. Around 3.25 lacs cusecs of water passed during the monsoon season, however, the district marked as low risk due to floods. In specific the proposed project area is also low risk due to the floods effects.

4.2.7 Baseline Environmental Monitoring

As part of the EIA baseline instrumental monitoring was planned for collection of filed data regarding environmental parameters for air, water, noise, etc. An environmental laboratory; accredited with Environment Protection Agency; was engaged for this purpose. The monitoring locations were selected keeping in view the nearest residential dwellings, waste transportation route, downstream wind directions and availability of the sensitive receptors. The numbers are location for each parameter selected for the instrumental monitoring are enlisted below:

Air Monitoring: Six different locations around the landfill site were selected for ambient air quality monitoring. These locations namely Basti Rama, BastiYar Muhammad, Basti Karim Bukhsh, Basti Meriwala Khoon, Basti Rasheedabad and Basti Chachran were monitored for PM₁₀, PM_{2.5}, CO, NO, NO_x, SO₂ etc for 24hrs, the monitored results then compared with PEQS and WHO for air standards.

Noise Levels Monitoring: Six different locations around the landfill site were selected for ambient noise monitoring. These locations namely Basti Rama, BastiYar Muhammad, Basti Karim Bukhsh, Basti Meriwala Khoon, Basti Rasheedabad and Basti Chachran were monitored for ambient noise for 24hrs, the results then were compared with PEQS and WHO for noise standards.

Water Monitoring: Ground and surface water sampling and analysis was carried out from the available sources in the project area.

The details of the sampling and monitoring outputs are given in below paragraphs while monitoring location map is given at figure 4.12.

4.2.8 Groundwater

Groundwater is being pumped by installing private tubewells for agriculture and domestic uses in all major settlements near the project site. Water well drilling industry is well developed in Bahawalpur. As reported by the local drillers, sub-surface formations, up to 400 feet depth, are mostly sands with intermittent thin layers of clay. Groundwater is reported to be generally of good to marginal quality.

Most of the town is served with water supply system whereas rest of the area is without it and people have their own sources of water mostly hand pumps / power pumps.

Presently PHED is executing rehabilitation and augmentation of Urban Water Supply Scheme for Bahawalpur City. This would help in drinking water supply needs and increase in service coverage.

As part of EIA baseline, one ground water sample was collected from Basti Chachran and analyzed from EPA certified lab. The results of the tests are presented in **Table 4.7** and **Appendix A.4**, which indicates that all parameters of the ground water samples taken are within the applicable PEQS and WHO standards with no exceedances observed. Ground water sample collection is shown in **Figure 4.10** while ground water sampling location is provided as **Figure 4.12**.

Table 4-7: Groundwater Water Quality Analysis

S No.	Parameters	Analysis Method	Units	PEQS	WHO	Results
1	pH	APHA-4500H+ B	--	6.5-8.5	6.5-8.5	7.6
2	Taste & Odor	In-house	--	Non Objectionable	Non Objectionable	Non Objectionable
3	Color	APHA-2120 B/C	TCU	<15	<15	5
4	Turbidity	APHA-2130 B	NTU	<5	<5	3
5	Total Coliform	APHA:9222 B	Number/100 mL	0 Number/100 mL	0 Number/100 mL	0
6	E-Coli	APHA:9222 D	Number/100 mL	0 Number/100 mL	0 Number/100 mL	0
7	Total Dissolved Solids (TDS)	APHA-2540 C	mg/L	<1000	<1000	468
8	Total Hardness	APHA-2340 C	mg/L	<500	--	121
9	Nitrate	APHA-4500NO3 B	mg/L	≤50	≤50	4.9
10	Nitrite	APHA-4500NO2 B	mg/L	≤3	≤3	0.035
11	Ammonia	APHA-4500-NH3-B	mg/L	---	---	0.07
12	Arsenic	APHA-3500As B	mg/L	<0.05	<0.01	N.D.
13	Antimony	APHA-3500Sb B	mg/L	<0.005	<0.005	N.D.
14	Barium	APHA-3500Ba B	mg/L	0.7	0.7	N.D.
15	Chloride	APHA-4500Cl- B	mg/L	250	250	82
16	Fluoride	APHA-4500F- C	mg/L	<1.5	1.5	0.76

Figure 4.10: Water Sampling Analysis



Ground water table in the project area is at depth of 15-20 meter. Ground water table is at reasonable depth from landfill cell and further bottom lining of landfill cells will control seepage of leachate.

Furthermore, active life of landfill cell is about 4-5 years and after that, final capping will be placed. After that, there are minimal chances of percolation of water in the landfill cell and hence limited leachate production. Furthermore, leachate collection system will be in place at bottom lining of the landfill cell and it will work even after final capping of landfill cell to collect and treat any volume of leachate. Keeping in view these design considerations, leachate percolation to ground water is not expected. Also, ground water quality monitoring wells are incorporated in the project design. Ground water quality will be monitored on frequent intervals to assess any leachate contamination. If required, ground water samples of surrounding areas will also be analysed to trace any leachate contamination.

Groundwater Hydrology

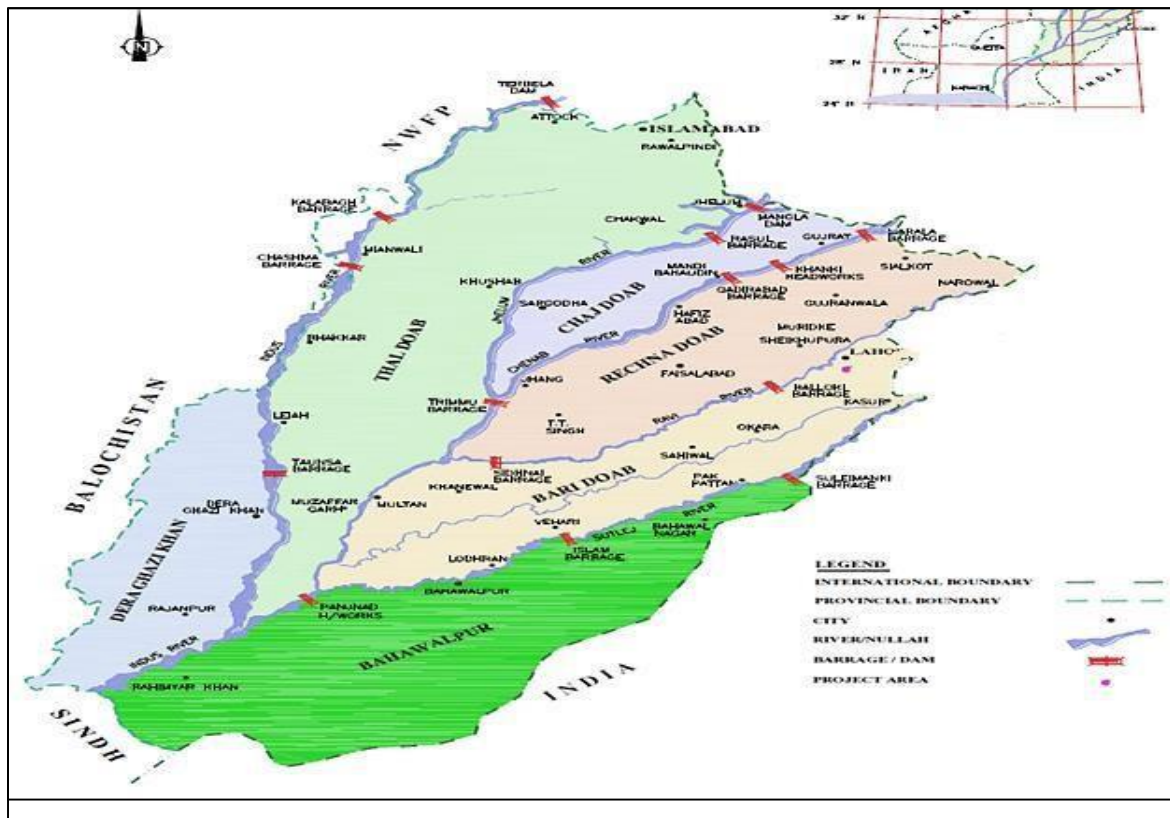
In general, subsurface stratigraphy at the site consists of three basic litho logical units as given below:

- Lean Clay/Sandy Strata
- Sandy Silt/Silt
- Silty fine Sand/fine Sand

The soil is alluvial with sandy textured sand dunes covering 50 to 60 percent of the area. These soils are the alluvial deposits of the recent geologic times. The soil of central Bahawalpur mostly consists of the plains of Indus basin, which is at the height of not more than 150 meters above sea level. But the southwestern desert, which is called Rohi or Cholistan, is mostly undulated due to the presence of sand dunes. The height of the sand dunes does not exceed 150 meters' Main soil types of Cholistan desert are sand dunes (44%), sandy soils (37%), loamy soils (2%) and saline-sodic clayey soils (17%). **Figure 4.11** shows the hydrology of the project area.

The depth of water table is also depleting over the period. Due to increased number of private tube wells being installed in the location of sub project, the ground water is depleting. Recharge from surface /rain water shall help in reduction of depth of sub soil water table. During dry periods, the situation sometimes becomes quite serious.

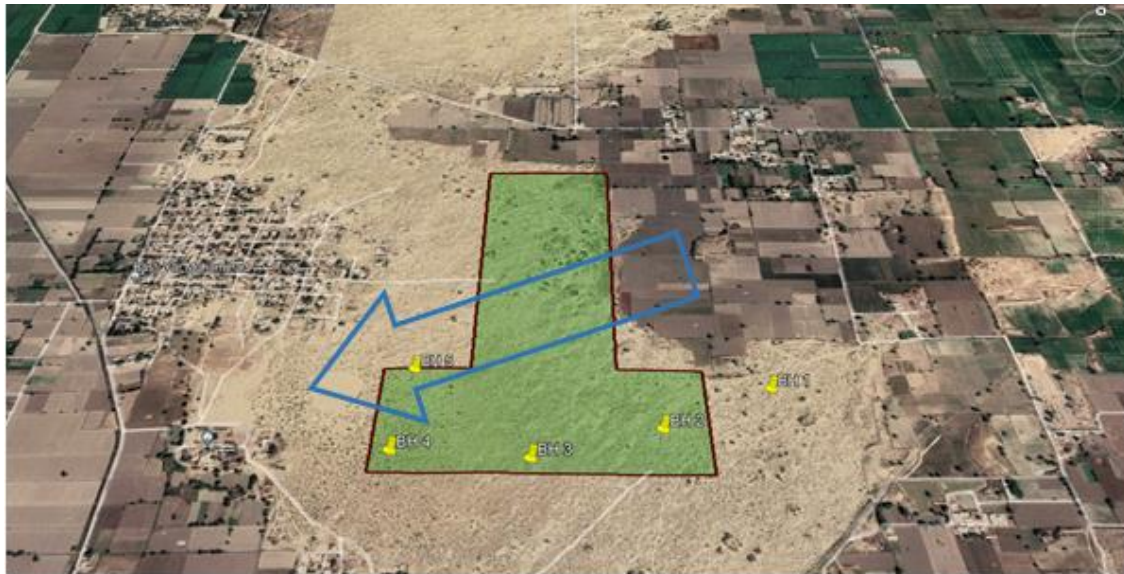
Figure 4.11: Hydrology of the Project Area



A detailed hydrological analysis was carried out for estimation of leachate leaking effect on ground water quality. Leachate leak from any of the storage cells may result in the contamination of the water table below the LFS. The geology of the site is Sandy Silt (Moderately High Permeability) with occasional bands of Lean Clay of low permeability.

The water table, based on actual data from site as well as the surroundings of LFS, shows that the water table is sloping towards nearby mosque and a few households. Below figure shows the community location and the ground water flow from North-East towards South West in the surrounding of the LFS.

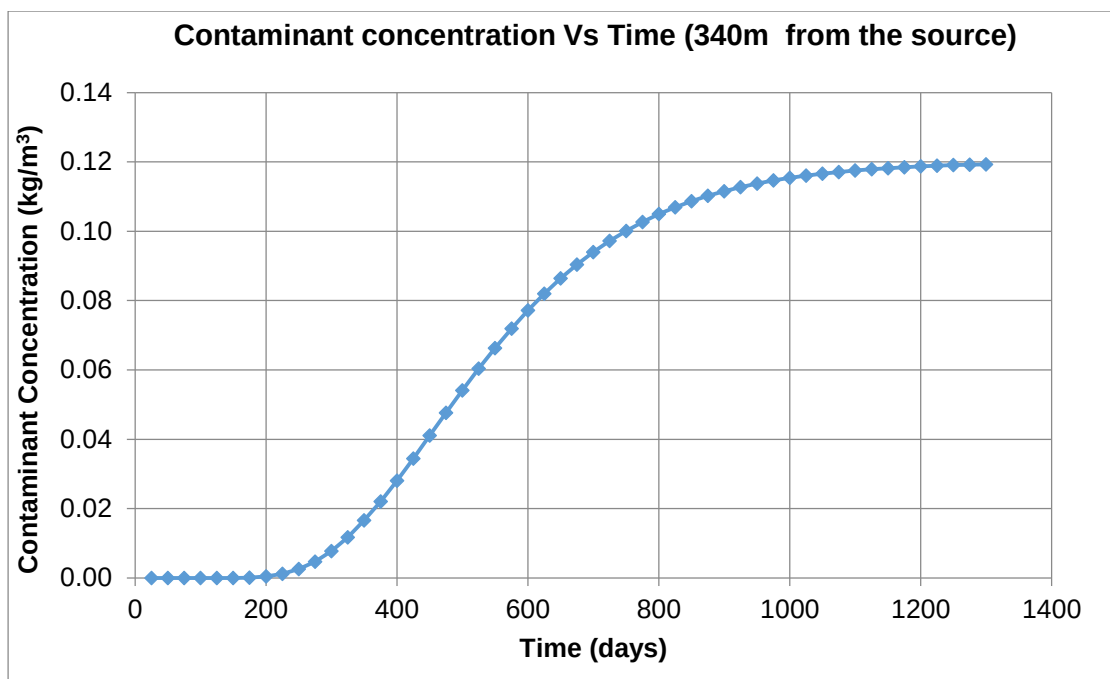
Figure 4.2: Location of tube wells and groundwater levels showing underground flow direction



The nearest communities with respect to the proposed LFS is at risk in the direction of the flow are residential houses (Distance 340m), and a Mosque (Distance 320m). The risk analysis indicates that the contamination of groundwater from possible leakage of a storage cell may result in the uptake of contamination by the nearby community.

Key points of hydrological analysis are highlighted below

- Nearest well is located at the local community 340m away from the landfill site The hydrogeological analysis was based on a very conservative estimate of contaminant movement through strata considering no bio decay, diffusion or retardation is occurring to model worst-case scenario.
- Based on analysis, it will take a total of **310 Days** for contamination to start appearing at the nearest tube. Time required to reach the full concentration of 0.12 kg/m³ will be 1010 days
- Once the contamination start appearing in the water supply from the tube well it will take about 700 more days to reach full concentration.
- Under part 2a of section 57 (Environmental Protection Act 1990, UK Guidance) as the amount of contamination is below the guidelines values for contamination the part of the land cannot be described as contaminated land here.
- However, there is a significant chance of harm if the amount of groundwater flow reduces or the contamination level increases above the current levels. Therefore, it is recommended to use observation boreholes to monitor groundwater quality and also additional checks should be made on monthly basis by collecting water samples from the nearest tube well for detection of any contamination. If any contamination is detected, then the necessary action to plug the breach should be completed with 310 days. Breakthrough curve of Contaminant concentration at local community location with time is shown in below figure.



- The leachate discharge should be measured on regular basis to indicate barrier breach from loss of leachate.
- Detailed hydrological analysis is attached as **Appendix A-18** of the report.

4.2.9 Noise

Noise measurement was carried out at six locations near Basti Rama, Basti Yar Muhammad, Basti Karim Bukhsh, Basti Meriwala Khoon, Basti Rasheedabad and Basti Chachran. The map showing the selected ambient noise monitoring locations and their respective noise readings are provided as **Figure 4.12** below with the comparison of the results also presented in **Table 4.8** below.

While the results indicate the ambient noise levels being within the PEQS guidelines during the daytime, however, exceedance was observed at the night time at only one location (Basti Chachran) in the project area. There are no sensitive receptors with regards to noise levels within 500 meters from the proposed landfill site.

Table 4.8: Noise Levels Monitored data (Leq)

Sr. No.	Locations	Unit	Minimum	Maximum
Day Time (06:00 AM – 10:00 PM)				
1	Basti Rama	dB(A)	46.5	48.37
2	BastiYar Muhammad		48.9	50.49
3	Basti Karim Bukhsh		59.5	60.57
4	Basti Meriwala Khoon		51.5	52.01
5	Basti Rasheedabad		49.5	50.46
6	Basti Chachran		58.0	59.0
Night Time (10:00 PM – 06:00 AM)				
1	Basti Rama	dB(A)	46.5	47.80
2	BastiYar Muhammad		48.0	49.81
3	Basti Karim Bukhsh		47.5	48.15
4	Basti Meriwala Khoon		49.5	50.6
5	Basti Rasheedabad		46.5	47.86

Sr. No.	Locations	Unit	Minimum	Maximum
6	Basti Chachran		55.5	56.3
	WHO Guidelines		70	
PEQS: Punjab Environmental Quality Standards for Noise				
		Day Time	Night Time	
a)	Residential Area	55	45	
b)	Commercial Area	65	55	
c)	Industrial Area	75	65	

4.2.10 Air Quality

Ambient Air Quality Monitoring have been carried out for 24hrs at six different locations around the landfill site. i.e Basti Rama, BastiYar Muhammad, Basti Karim Bukhsh, Basti Meriwala Khoon, Basti Rasheedabad and Basti Chachran.

The concentrations of PM_{2.5} in µg/m³ were recorded 14.93 at Basti Rama, 12.34 at Basti Yar Muhammad, 15.85 at Basti Karim Bukhsh, 9.39 at Basti Meriwala Khoon, 14.61 at Basti Rasheedabad and 10.97 µg/m³ Basti Chachran. All values were in compliance with PEQS, however, exceedance of WHO value was observed at Basti Karim Baksh.

The concentrations of PM₁₀ in µg/m³ were 64.03 at Basti Rama, 59.37 at Basti Yar Muhammad, 68.36 at Basti Karim Bukhsh, 52.93 at Basti Meriwala Khoon, 57.95 at Basti Rasheedabad and 54.49 at Basti Chachran. All values were in compliance with PEQS as well USEPA standards for PM₁₀ in ambient air, however, the stringent WHO guideline values were exceeded at all locations.

The concentrations of CO in mg/ were 0.27 at Basti Rama, 0.49 at Basti Yar Muhammad, 0.73 at Basti Karim Bukhsh, 0.39 at Basti Meriwala Khoon, 0.38 at Basti Rasheedabad, 0.30 at Basti Chachran. All values were in compliance with PEQS, USEPA and WHO standards.

The concentrations of NO in µg/m³ were 6.26 at Basti Rama, 10.27 at Basti Yar Muhammad, 13.22 at Basti Karim Bukhsh, 7.01 at Basti Meriwala Khoon, 9.46 at Basti Rasheedabad and 8.93 at Basti Chachran. All values were in compliance with the PEQS as well USEPA standards for NO in ambient air, however, the stringent WHO guideline values were exceeded at all locations.

The concentrations of NO₂ in µg/m³ were 7.53 at Basti Rama, 12.40 at Basti Yar Muhammad, 14.34 at Basti Karim Bukhsh, 8.44 at Basti Meriwala Khoon, 10.24 at Basti Rasheedabad and 10.42 at Basti Chachran. These results indicated the currently ambient air was in compliance with the PEQS, USEPA and WHO standards.

The concentrations of SO₂ in µg/m³ were 6.60 at Basti Rama, 12.08 at Basti Yar Muhammad, 15.95 at Basti Karim Bukhsh, 8.42 at Basti Meriwala Khoon, 11.07 at Basti Rasheedabad and 10.09 at Basti Chachran. All values were in compliance with the PEQS as well USEPA standards for SO₂ in ambient air, however, the stringent WHO guideline values were exceeded at all locations.

The map showing the selected air quality monitoring locations and their respective ambient air quality readings are provided as **Figure 4.12** below with the comparison of the results presented as **Table 4.9** below.

Figure 4.12: Sampling Locations for Environmental Monitoring

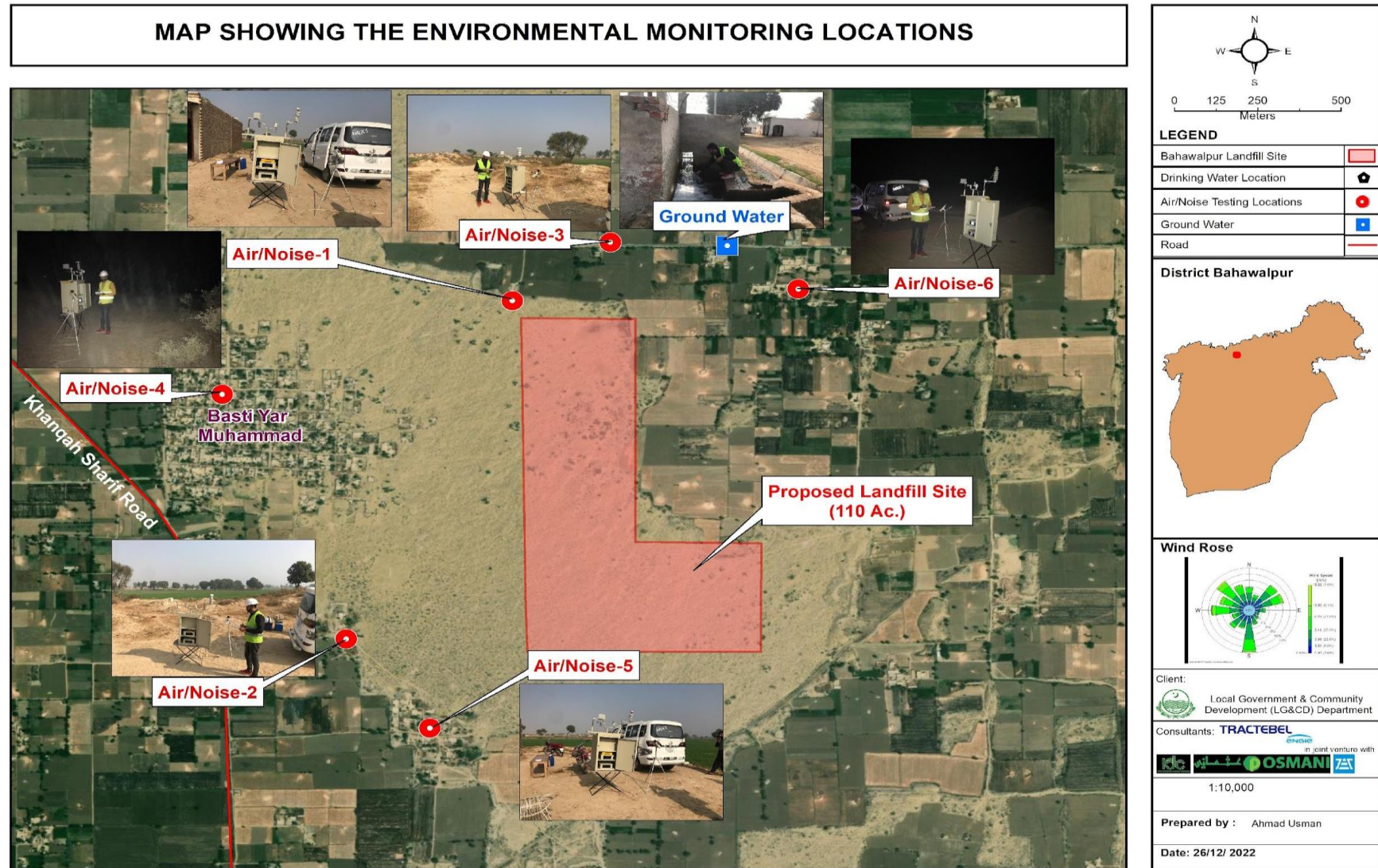


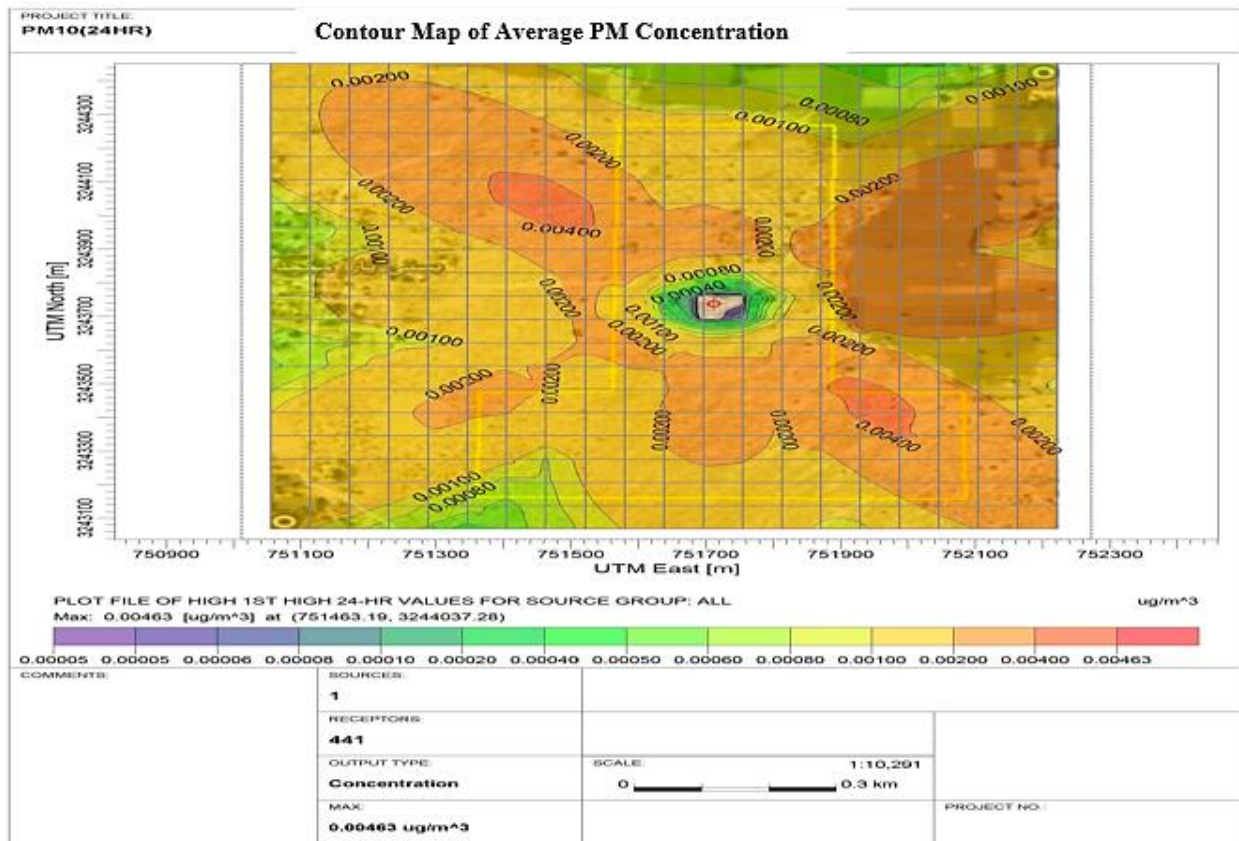
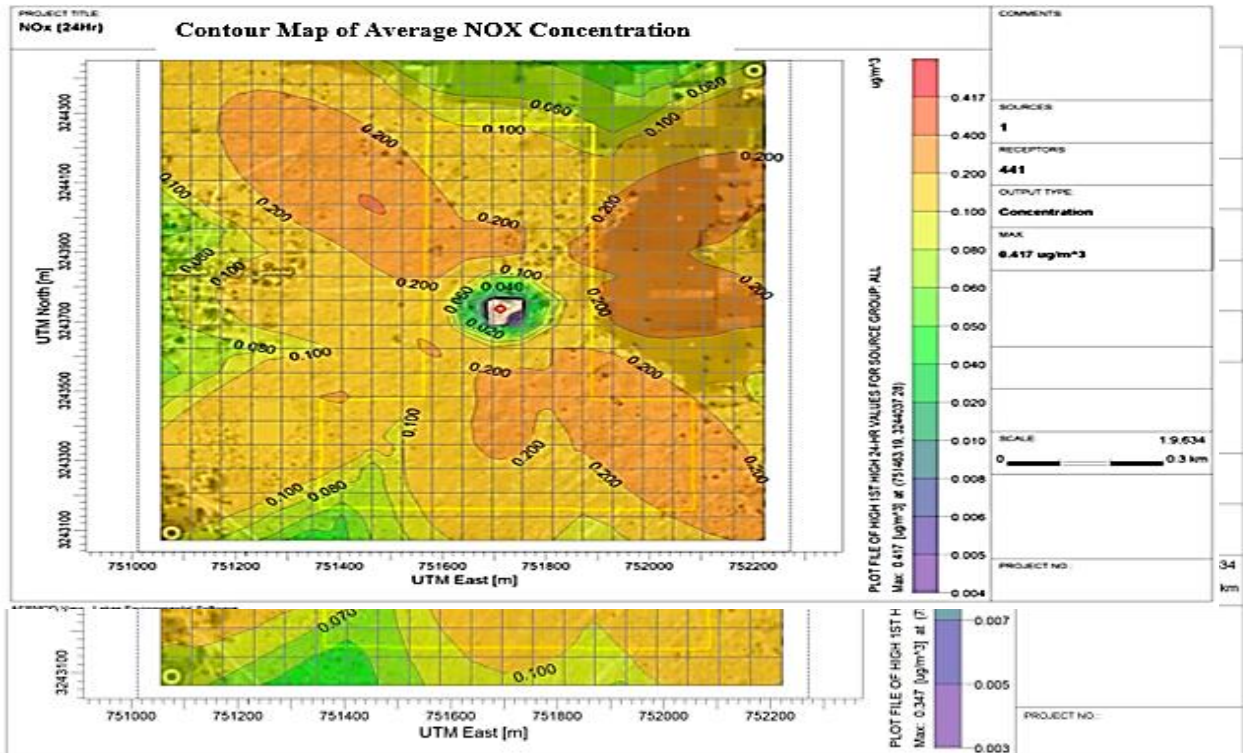
Table 4.9: Ambient Air Quality Monitoring Results (24 hrs) in Project Area¹⁹

Sr. No.	Parameter	Results						USEPA	WHO/IFC	PEQS
		Basti Rama	BastiYar Muhammad	Basti Karim Bukhsh	Basti Meriwala Khoon	Basti Rasheedabad	Basti Chachran			
1	PM _{2.5}	14.93 (µg/m ³)	12.34 (µg/m ³)	15.85 (µg/m ³)	9.39 (µg/m ³)	14.61 (µg/m ³)	10.97 (µg/m ³)	35 (µg/m ³) (24hrs)	15 (µg/m ³) (24hrs)	35 (µg/m ³) (24hrs)
2	PM ₁₀	64.03 (µg/m ³)	59.37 (µg/m ³)	68.36 (µg/m ³)	52.93 (µg/m ³)	57.95 (µg/m ³)	54.49 (µg/m ³)	150 (µg/m ³) (24hrs)	45 (µg/m ³) (24hrs)	150 (µg/m ³) (24hrs)
3	CO	0.27 (mg/m ³)	0.49 (mg/m ³)	0.73 (mg/m ³)	0.39 (mg/m ³)	0.38 (mg/m ³)	0.30 (mg/m ³)	11 (mg/m ³)(08 hr)	-	05 (mg/m ³)(24 hr)
4	NO	6.26 (µg/m ³)	10.27 (µg/m ³)	13.22 (µg/m ³)	7.01 (µg/m ³)	9.46 (µg/m ³)	8.93 (µg/m ³)	-	-	40 (µg/m ³) (24 hr)
5	NO ₂	7.53 (µg/m ³)	12.40 (µg/m ³)	14.34 (µg/m ³)	8.44 (µg/m ³)	10.24 (µg/m ³)	10.42 (µg/m ³)	100 ppb (1hr)	25 (µg/m ³)(24 hr)	80 (µg/m ³) (24 hr)
6	SO ₂	6.60 (µg/m ³)	12.08 (µg/m ³)	15.95 (µg/m ³)	8.42 (µg/m ³)	11.07 (µg/m ³)	10.09 (µg/m ³)	75 ppb (1hr)	40 (µg/m ³)(24 hr)	120 (µg/m ³) (24 hr)

¹⁹ The ambient air quality was monitored using the AQM 65, which is a fully integrated air monitoring station that delivers near reference levels of performance. The AQM 65 offers the optimal balance for measuring criteria pollutants to WHO air quality limits. With the AQM65 continuously measuring of common air pollutants was carried out and then results are produced on 24 hours average. AQM 65 ensures air quality data is reliable and robust in compliance to USEPA (40 CFR Part 53) and EU (2008/50/EC).

Air Dispersion Modelling

The special dispersion of the pollution levels around the project site was modeled for ground level concentration. Dispersion of maximum pollutants is found in the north east direction driven by the south-westerly wind. Models for dispersion of NO_x , and PM based 24-Hour Averages for proposed facilities have been recorded. Contour maps of average concentration are shown in below figures.



The results of modeling show that the 24-hour average highest ground level concentration of CO from the flare remains $0.347\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) NO_x from the flare remains $0.417\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) and PM₁₀ from the plant remains $0.00463\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) when flare operating at its normal conditions.

The color contours maps plotted by the model for the proposed emissions effect of the proposed flare display the extent of dispersion of the pollutants. The dispersion plumes shown in above figures show that the plant is located at 1000 meters from the origin set at top left corner of the map. Contours maps expand to 5000 meters from the flare site. The contours show that the emissions disperse in north-east-north direction.

It is pertinent to mention that all the emissions are well in compliance with the WHO and national ambient air quality standards.

Air dispersion modelling report of the site is attached as **Appendix A 19** of the report.

4.2.11 Land Use

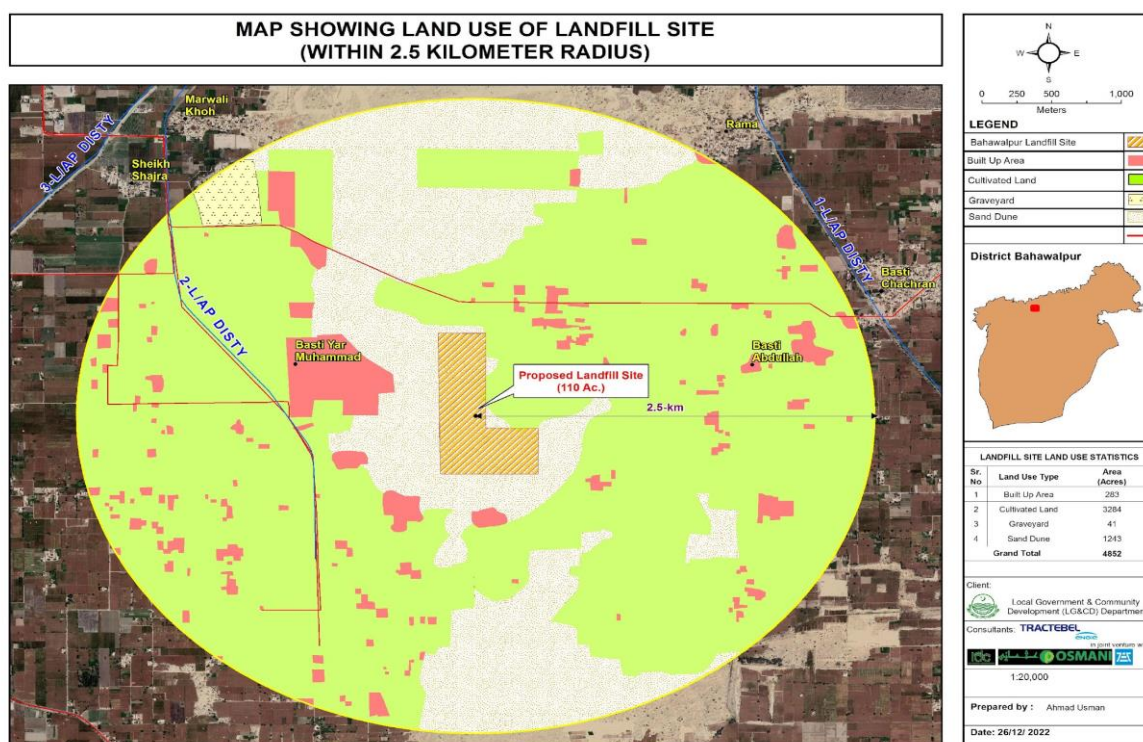
Bahawalpur is the 11th largest city in Pakistan by population as per a 2017 census, with a population of 762,111. It's also the largest city by land area consisting of Cholistan, the largest desert of Punjab

Ahmed T, Nawaz R, Ahmed A (2021) conducted a study to monitor the land use/land cover changes and urban sprawl of Bahawalpur city with the application of geo-information techniques by using remote sensing data. The study identified built up area, agricultural land, barren land and water body as four major classes that have provided a substantial change in the city of Bahawalpur.

The study observed significant changes in land use and land cover pattern in the city of Bahawalpur. Forest land, agricultural land, barren land and urban land use classes were defined and their areas were estimated using downloaded satellite images. A decrease in area of forest land was observed from 23.28 km² (2003) to 2.48 km² (2018). Reduction in barren area was also found from 8.11 km² during the study period of sixteen years. In contrast, an increase has been observed in urban area from 41.42 km² in 2003 to 60.28 km² in 2018. An increase of agricultural land was also estimated from 19.16 km² (2003) to 25.77 km² (2018). Agriculture should be made environmentally friendly by enhancing technology of land use and better assessment of environmental health.

Land Use/Land Cover analysis within 2.5 Km radius of landfill site has been carried out which shows cultivated land is major land use followed by built up area. Landfill site is surrounded by cultivated land from east side and sand dunes on west side. Land use map of the site is provided in **Figure 4.13** below.

Figure 4.13: Land Use/Land Cover Map of the Project Area



4.3 SENSITIVE RECEPTOR MAPPING TO ASSESS COMPLIANCE WITH IFC EHS CLAUSE²⁰

The IFC EHS clause specific to Landfill Siting states the following

“The location of the landfill should take into account potential impacts associated with releases of polluting substances including the following:

Proximity to residential, recreation, agricultural, natural protected areas, or wildlife habitat and areas prone to scavenging wildlife, as well as other potentially incompatible land uses:

Residential development should be typically further than 250 meters from the perimeter of the proposed landfill cell development to minimize the potential for migration of underground gaseous emissions.

A detail site survey was conducted by a team of social specialist, environment specialist of EDCM, project engineer of city implementation unit and local area representative during the November 2022.

There are clusters of settlements including Bastic Rama, Basti Chachran, Basti Yar Muhammad and Basti Rasheedabad around the project site. All the settlements are located at a safe distance from the landfill site.

²⁰ <https://www.ifc.org/wps/wcm/connect/5b05bf0e-1726-42b1-b7c9-33c7b46ddda8/Final%2B-%2BWaste%2BManagement%2BFacilities.pdf?MOD=AJPERES&CVID=jqeDbH3&id=1323162538174>

The nearest settlement is situated at a distance of 520m from the boundary of the landfill site.

Nearest receptors of BWMC office building are Islamia University of Bahawalpur (210 m), Government Employees Cooperative Housing Scheme (GECHS) High School (210 m), Bahawalpur A Block Market (200 m), CRC Wasaib Explorer campsite (130 m) and Almukhtar Hotel (135 m). Sensitivity of all the receptors is low since construction of building is limited to its acquired area and no impact on these receptors is anticipated.

Table below gives and pictorial view of the receptors. The details of these survey findings are provided in the **Figure 4.20** below.

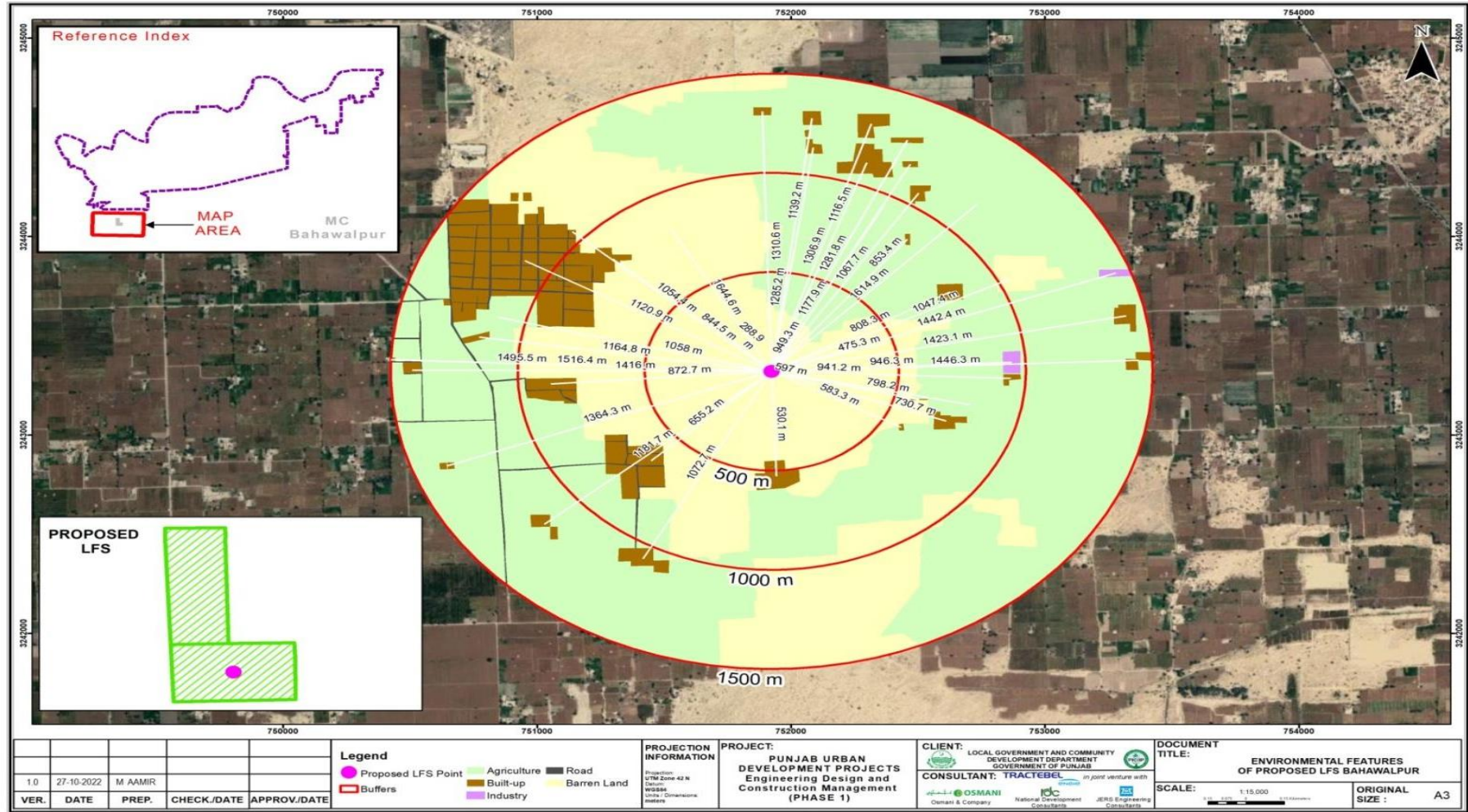
Types of Receptors	Sensitivity	Pictorial view
School	Low	
School	Low	
School	Low	

School	Low	
School	Low	
School	Low	
School	Low	
School	Low	

School	Low	
Hospital	Low	
School	Low	
School	Low	
Hospital	Low	

Fire Emergency	Low	
Teaching hospital	Low	

Figure 4.20: Nearest Receptors in Project Area



4.4 ECOLOGICAL ENVIRONMENT

The Flora and Fauna survey were conducted during the month of October and November 2022. A Team of Botanist and environmentalists visited the project site from 15-10-2022 to 10-11-2022 for screening and detailed analysis. The plants and animal's species observed, identified and recorded using standard biological methods.

Ecological survey report listed species which are dominant and common in the project area. The area around the project site is potential habitat of these species. Bahawalpur is the region cited by many research papers as the habitats of Hog Deer, Houbara bustard and Brown roofed turtles (Khurram Saeed, 2012). Hog deer is usually found along the Sindh river and its off shooting canals, Houbara found along fresh water bodies and brownroofed turtle along wetlands of canals and fields around Chenab and Sindh river.

Integrated Biodiversity Assessment Tool (IBAT) screening was carried out to identify the biodiversity features and species that are located within the following buffers: 1 km, 3 km and 5 km. There were no protected and/or key biodiversity areas found within 5 km buffer from the landfill site. There are 36 threatened species that are potentially found within 50 km from area of interest, which include 18 avian species, 09 reptilian species, 05 mammalian and 04 Actinopterygii. As project area is located in urban sprawl of Bahawalpur city and habitats have been converted into human settlements at large scale, therefore, no impact on such species is expected from project activities. IBAT screening report is attached as **Annexure A.10**.

Consultation with forest and wildlife department carried out during EIA field survey and findings are further verified through IBAT screening. Based on analysis there is no endangered species and key biodiversity area falling in close proximity of the site therefore no biodiversity management plan is required. NOC from Punjab Wildlife department is obtained for the project which clearly states that project area is not corridor of key species of concern and department has no objection with respect to project execution. NO from wildlife department is attached as Annexure **A.17**.

4.4.1 Flora

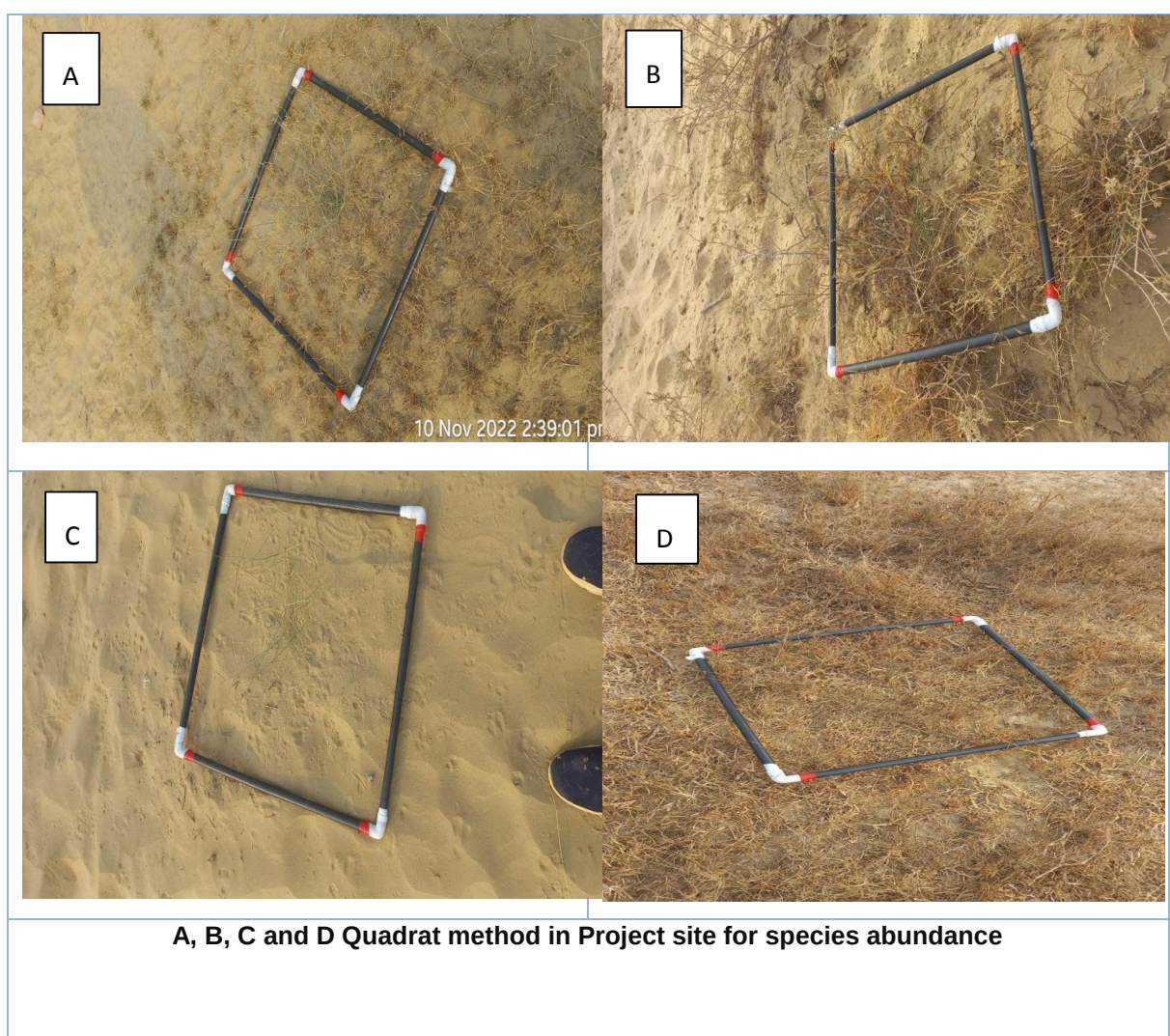
Ecological surveys conducted for the study of flora, which included project area. The identification of the plants and labelling of Herbarium sheets carried out by using Flora of Pakistan (Ali and Qaiser, 1992-2007; Ali and Nasir, 1990-92).

4.4.2 Flora Sampling Methodology

The sites based upon the presence of natural vegetation selected and surveyed through Transect walks. Within each sample plot, all plants were divided into four layers, i.e. tree, shrub, herb and grass layer. The size of sample was 100 m² at each sampling site (Figure 1). A long measuring tape (25m) was laid across the stand in the communities under study and fixed with two hooks at two ends (*Fang et al, 2012*).

The individual plants recorded touching the measuring tape and the distance from a particular end. For abundance and measurement 10×10m, quadrats were used for tree vegetation, 5×5m quadrats for shrubs and 1×1m were taken for herbs and grasses (*Sharma et al. 2014, Sadia et al, 2021*).

Figure 4.14: Flora Sampling of the Project area



4.4.3 Flora Data Analysis and Interpretations

The abundance of species in the project areas was determined using the DAFOR scale. Specifically, the Dominant, Abundant, Frequent, Occasional, Rare and Absent (the DAFOR) scale records the vegetative cover of an area and represents the abundance of species (Hearnshaw *et al* 2010). DAFOR scale is presented in below table.

Table 4.10: DAFOR Scale to analyze abundance

Abundance (% age)	DAFOR Class	Abbreviation
51 – 100	Dominant	D
31 – 50	Abundant	A
16 – 30	Frequent	F
6 – 15	Occasional	O
1 – 5	Rare	R
0	Absent	X

The IUCN Red List Categories of Flora of Punjab visited to collect the relevant Data on the Flora of Punjab. Being an easily and widely understood system for classifying species at high risk of global extinction was used. The general aim of the system is to provide an explicit, objective framework for the classification of the broadest range of species according to their extinction risk. However, while the Red Data List may focus attention on those taxa at the highest risk, it is not the sole means of setting priorities for conservation measures for their protection.

Species belonging to 18 families reported 63 plant species from project site and adjacent areas (Sadia *et al*, 2021, Ahmad *et al*, 2012). Among them 16 tree species, 09 shrubs, 20 herbs and 18 grass species found. *Acacia modesta*, *Dalbergia sissoo*, *Albizia lebbek*, *Phoenix dactylifera*, *Prosopis juliflora* and *Tamarix aphylla* were common trees. *Capparis decidua*, *Ziziphus nummularia*, *Calotropis procera*, *Parthenium hysterophorus*, *Convolvulus arvensis*, *Achyranthes aspera* and *Citrullus colocynthus* were commonly found herb and shrub species. *Aristida depressa*, *Eleusine indica*, *Cenchrus biflorus*, *Phragmites karka*, *Cymbopogon jwarancusa*, *Cynodon dactylon*, *Saccharum munja* and *Saccharum spontaneum* were common grasses and five species of sedges observed. Tree diversity of the project area is provided in **Table 4.11** and **Figure 4.15**.

Figure 4.15: Floral Families Diversity

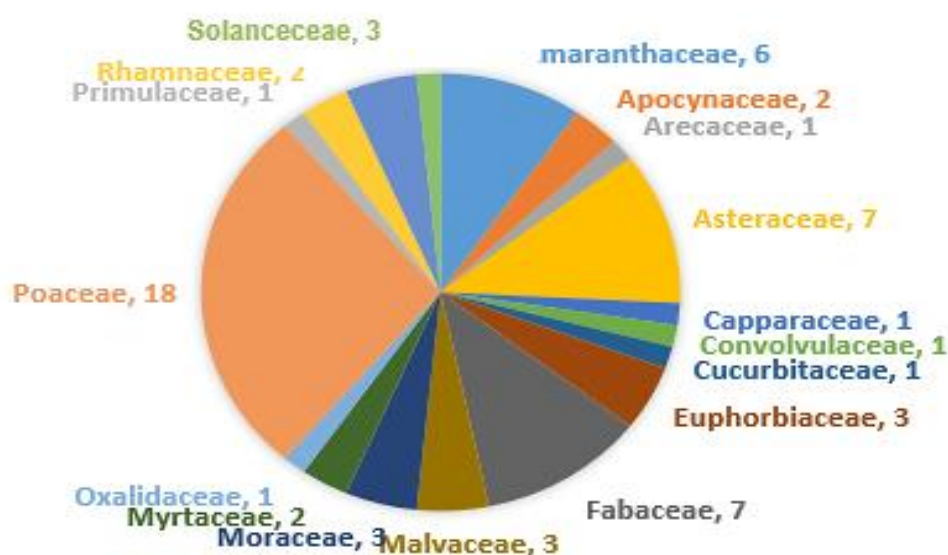


Table 4.11: Tree Diversity in Project Area

Sr · N o	Scientific Names	Common Names	Families	Habitat Types		DAFOR Scale	IUCN Red List Statu s
				Proje ct Area	Peripher al Area		
1	<i>Acacia nilotica</i>	Wild Acacia	Fabaceae	F	O	F	NE
2	<i>Acacia modesta</i>	Small Acacia	Fabaceae	D	A	A	NE
3	<i>Albizia lebbek</i>	Siris	Fabaceae	X	R	R	NE
4	<i>Azadirachta indica</i>	Neem tree	Malvaceae	X	O	O	LC
5	<i>Callistemon lanceolatus</i>	Bottle brush	Myrtaceae	X	O	O	NE
6	<i>Dalbergia sissoo</i>	Indian rosewood	Fabaceae	F	F	F	LC
7	<i>Eucalyptus camaldulensis</i>	Eucalyptus	Myrtaceae	X	A	F	NT
8	<i>Ficus virens</i>	Wild Fig	Moraceae	R	O	R	LC
9	<i>Ficus religiosa</i>	Sacred fig	Moraceae	X	R	R	NE
10	<i>Melia azedarach</i>	Chinaberry tree	Malvaceae	X	O	O	LC
11	<i>Morus alba</i>	Mulberry	Moraceae	X	O	O	LC
12	<i>Phoenix dactylifera</i>	Dates	Arecaceae	X	O	O	LC
13	<i>Prosopis cineraria</i>	Jand	Fabaceae	O	F	O	NE
14	<i>Prosopis juliflora*</i>	Mesquite	Fabaceae	F	D	D	NE
15	<i>Tamarix aphylla</i>	Athel tree	Tamaricaceae	O	O	O	NE
16	<i>Ziziphus jujuba</i>	Jujube	Rhamnaceae	F	A	F	LC
* = Invasive, D = Dominant, A= Abundant, F= Frequent, O = Occasional and R=Rare X= Absent. IUCN Red List Status: LC=Least Concern, NE=Not Evaluated DD= Data Deficient							

Source: EDCM Ecology Survey, November 2022

List of Shrubs, Herbs and Grass species found in the project area are shown as **Table 4.12, Table 4.13 and Table 4.14.**

Table 4.12: List of Shrubs in Project Area

Sr · N o	Scientific Names	Common Names	Families	Habitat Types		DAFO R Scale	IUCN Red List Statu s
				Proje ct Area	Peripher al Area		
1	<i>Abutilon indicum</i>	Abutilon	Malvaceae	O	F	F	NE
2	<i>Alhagi maurorum</i>	Alhagi	Fabaceae	X	O	F	NE
3	<i>Calotropis procera</i>	Apple of sodom	Apocynaceae	A	F	A	NE
4	<i>Capparis decidua</i>	Karira	Capparaceae	A	A	A	DD
5	<i>Nerium oleander</i>	Kaner	Apocynaceae	X	F	F	LC
6	<i>Suaeda fruticosa</i>	Suaeda	Amaranthaceae	F	O	F	LC
7	<i>Ricinus communis</i>	Arind	Euphorbiaceae	O	F	O	NE
8	<i>Xanthium strumarium</i>	devil fruit	Solanaceae	O	O	O	LC
9	<i>Ziziphus nummularia</i>	Lotebush	Rhamnaceae	A	A	A	NE
* = Invasive, D = Dominant, A= Abundant, F= Frequent, O = Occasional and R=Rare X= Absent. IUCN Red List Status: LC=Least Concern, NE=Not Evaluated DD= Data Deficient							

Table 4.13: List of Herbs in Project Area

Sr · N o	Scientific Names	Common Names	Families	Habitat Types		DAFO R Scale	IUCN Red List Statu s
				Proje ct Area	Peripher al Area		
1	<i>Achyranthes aspera</i>	Devil's horsewhip	Amaranthaceae	O	F	F	NE
2	<i>Aerva javanica</i>	kapok bush	Amaranthaceae	R	O	O	NE
3	<i>Ageratum conyzoides</i>	Ageratum	Asteraceae	R	R	R	NE
4	<i>Alternanthera sessilis</i>	Joyweed	Amaranthaceae	A	A	A	LC

5	<i>Amaranthus viridis</i>	Slender amaranth	Amaranthac eae	A	F	F	NE
6	<i>Anagallis arvensis</i>	scarlet pimpernel	Primulaceae	O	A	F	LC
7	<i>Atriplex vesicaria</i>	Atriplex	Amaranthac eae	X	O	O	LC
8	<i>Carthamus oxyacantha</i>	Thistle	Asteraceae	O	F	O	LC
9	<i>Cirsium arvense</i>	Lay	Asteraceae	X	R	R	LC
10	<i>Convolvulus arvensis</i>	Convolvulus	Convolvulac eae	O	F	F	NE
11	<i>Conyza canadensis</i>	Fleabane	Asteraceae	O	O	O	NE
12	<i>Citrullus colocynthus</i>	Bitter cucumber	Cucurbitacea e	F	F	F	NE
13	<i>Datura innoxia</i>	Datura	Solanaceae	O	F	F	NE
14	<i>Echinops echinatus</i>	Globe Thistle	Asteraceae	R	O	O	NE
15	<i>Euphorbia prostrata</i>	Prostrate sandmat	Euphorbiace ae	R	R	R	NE
16	<i>Helianthus petiolaris</i>	Prairie Sunflower	Asteraceae	X	O	O	LC
17	<i>Oxalis corniculata</i>	Oxalis	Oxalidaceae	X	O	O	NE
18	<i>Parthenium hysterophorus*</i>	Parthenium	Asteraceae	O	A	F	NE
19	<i>Solanum xanthocarpum</i>	Yellow berry	Solanaceae	F	F	F	NE
20	<i>Trianthema portulacastrum</i>	It sit	Euphorbiace ae	R	O	O	NE

* = Invasive, D = Dominant, A= Abundant, F= Frequent, O = Occasional and R=Rare X= Absent. IUCN Red List Status: LC=Least Concern, NE=Not Evaluated DD= Data Deficient

Table 4.14: List of Grasses in Project Area

Sr · N o	Scientific Names	Common Names	Families	Habitat Types		DAFO R Scale	IUCN Red List Statu s
				Projec t Area	Peripher al Area		
1	<i>Arundo donax</i>	Giant reed	Poaceae	X	X	F	LC
2	<i>Aristida depressa</i>	<u>Wiregrasses</u>	Poaceae	O	A	A	LC
3	<i>Cenchrusbiflorus</i>	Bhurrand	Poaceae	F	F	F	LC
4	<i>Cenchrus ciliaris</i>	Cenchrus	Poaceae	F	A	A	NE
5	<i>Cenchrus stigras</i>	Dhamal	Poaceae	X	O	O	NE
6	<i>Chrysopogon aucheri</i>	Tilla grass	Poaceae	O	X	O	NE
7	<i>Cynodon dactylon</i>	Dub grass	Poaceae	F	A	A	NE
8	<i>cymbopogon jwarancusa</i>	Oil grass	Poaceae	O	O	F	LC
9	<i>Digitaria ciliaris</i>	Crab grass	Poaceae	O	O	O	NE
10	<i>Echinochloa colona</i>	Jungle rice	Poaceae	O	F	F	NE
11	<i>Eleusine indica</i>	Crows feet	Poaceae	F	O	F	LC
12	<i>Heteropogon contortus</i>	Tanglehead	Poaceae	X	F	F	LC
13	<i>Panicum antidotale</i>	Blue Panic Grass	Poaceae	X	O	O	NE
14	<i>Phragmites karka</i>	Common reed	Poaceae	X	X	A	LC
15	<i>Poa annua</i>	Poa grass	Poaceae	O	O	O	LC
16	<i>Saccharum munja</i>	Munj sweetcane	Poaceae	F	F	F	NE
17	<i>Saccharum spontaneum</i>	Wild sugar	Poaceae	O	O	O	LC
18	<i>Themeda anathera</i>	Lungi	Poaceae	F	A	F	LC
* = Invasive, D = Dominant, A= Abundant, F= Frequent, O = Occasional and R=Rare X= Absent. IUCN Red List Status: LC=Least Concern, NE=Not Evaluated							

Floral diversity of the project area is presented in **Figure 4.16**

Figure 4.16: Flora of the Project area



A) *Acacia modesta*



B) *Ziziphus jujuba*



D) *Calotropis procera*



E) *Suaeda fruticosa*



F) *Cenchrus biflorus*



G) *Capparis decidua*



H) *Citrullus colocynthus*



I) *Alhagi maurorum*



J) *Aerva javanica*



K) *Solanum xanthocarpum*



L) *Tamarix aphylla*

4.4.4 Fauna

Ecological surveys conducted for the study of fauna, which included project area. Data collection, analysis and interpretations as well as findings are fully described below.

4.4.5 Fauna Sampling Methodology

Fauna sampling methodology includes mammal's assessments, spoor tracking, scats survey, public survey and avifauna assessment, fish, reptile and amphibian assessment.

4.4.6 Mammal Assessment

A significant number of mammalian species are nocturnal, which means that they are predominantly active during the night and remain elusive during daytime, hence apart from direct sightings, indirect sampling methods were used. These methods compensate for the lack of night field surveys and enable detailed sampling without relying on direct observations and trappings. Mammal assessment was carried out using methods described by Roberts (1997, 2005). The survey was conducted by three surveyors from dawn till dusk for a period of three days.

4.4.7 Spoor tracking

Spoor tracking is an indirect survey method which uses observations such as footprint, burrows, den sites etc. to indicate the presence of a species. The method is simple, cost effective and comprehensive as it reduces dependency on direct sighting. However, the extent of details of a footprint and its preservation entirely depends on the suitability of soil.

Figure 4.17: Spoor tracking around landfill site



4.4.8 Scats Survey

Another indirect method is the use of fecal matter to identify species. The morphometric analysis (size and shape) of the fecal matter allows identification of the taxonomic group (Chame 2003). The method acts as a supplement to spoor tracking and an excellent measure of mammalian diversity and its abundance.

Figure 4.18: Scat survey around landfill site



4.4.9 Public Survey

The local people at the survey sites interviewed regarding the species presence, abundance, and threats. Due to nocturnal habit and elusive nature, several mammalian species may go unreported if the survey solely relied on direct observations.

4.4.10 Avifauna Survey

The Avifauna survey was based on, line-transect, point count, general observation and call recognition. The survey was conducted from dawn till dusk the activity and detectability of the avifauna remained at optimal level. The birds were observed with binoculars (10 x 50), and identified with the help of acclaimed field guide Grimmett et al., 2008. The point count method involved walking on a line transect and taking observations after a settling period of one minute.

4.4.11 Fish Assessment

Fishes collected from wetlands, streams (small rainy water channel) and ponds using local available gears and nets. Local area fisherman was also interviewed to collect data regarding fishes.

4.4.12 Reptile Assessment

Active search method adopted whereby debris, logs, wetlands and ponds searched for reptiles and amphibians for signs such as shed skin. Therefore, the survey primarily focused on search of indirect evidence through active searching. Some members directly observed during the survey. Khan, M.S (2006) used for the identification key and distribution of species. The Reptile and Amphibian species found dead due to road kill or otherwise on roads or adjacent areas within 500 m observed.

4.4.13 Fauna Data Analysis and Interpretations

The fauna species observed and recorded at and around the project site. Total seventeen bird's species, eleven mammals' species, five reptiles, two amphibians, four fish and three grazing mammals' species were observed. The common birds include Common Myna, Laughing Dove, Common Quail, and Collared-Dove, Cattle egret, Indian Robin, Indian roller, House crow, Black partridge, Common Babbler and Grey partridge. Dog, Donkeys, Squirrel, Jackals and mongoose were common mammals. Some species of birds, amphibians and reptiles were also noted.

60. The fauna present in the project area of the landfill site is provided in **Table 4.15** below.

Table 4.15: Existing Fauna in Project Area

Scientific Names	Common Names	IUCN Status	Scientific Names	Common Names	IUCN Status
BIRDS			MAMMALS		
<i>Acridotheres tristis</i>	Common Myna	LC	<i>Vulpes vulpes</i>	Red Fox	LC
<i>Spilopelia senegalensis</i>	Laughing Dove	LC	<i>Bos Taurus</i>	Cow	LC
<i>Alcedo atthis</i>	Common kingfisher	LC	<i>Canis aureus</i>	Golden jackal	LC
<i>Coturnix coturnix</i>	Common Quail	LC	<i>Canis familiaris</i>	Dog	LC
<i>Streptopelia decaocto</i>	Collared-Dove	LC	<i>Equus asinus</i>	Donkey	LC
<i>Bubulcus ibis</i>	Cattle egret	LC	<i>Felis catus</i>	Cat	LC
<i>Centropus sinensis</i>	Greater or Brown Coucal	LC	<i>Funambulus palmarum</i>	Indian squirrel	LC
<i>Copsychus fulicatus</i>	Indian Robin	LC	<i>Herpestes edwardsi</i>	Mongoose	LC
<i>Coracias benghalensis</i>	Indian roller	LC	<i>Lepus capensis</i>	Cap/wild hare	LC
<i>Corvus splendens</i>	House crow	LC	<i>Rattus rattus</i>	Common rat	LC
<i>Dicrurus macrocercus</i>	Black drongo	LC	<i>Sus Scrofa</i>	Wild Boar	LC
<i>Eudynamys scolopaceus</i>	Asian koel	LC	AMPHIBIANS		
<i>Francolinus francolinus</i>	Black partridge	LC	<i>Hoplobatrachus tigerinus</i>	Indian Bull Frog	LC
<i>Argya caudata</i>	Common Babbler	LC	<i>Duttaphrynus melanostictus</i>	Asian Toad	LC
<i>Ortygornis pondicerianus</i>	Grey partridge	LC	FISHES		
<i>Passer domesticus</i>	House Sparrow	LC	<i>Gibelion catla</i>	Thaila	LC

Scientific Names	Common Names	IUCN Status	Scientific Names	Common Names	IUCN Status
<i>Pycnonotus cafer</i>	Red-vented bulbul	LC	<i>Channa punctata</i>	Daula	LC
REPTILES			<i>Labeo calbasu</i>	Kalbans	LC
<i>Hemidactylus frenatus</i>	Common house gecko	LC	<i>Labeo rohita</i>	Rahu	LC
<i>Anguis fragilis</i>	Slow worm	LC	GRAZING MAMMALS		
<i>Bungarus caeruleus</i>	Common krait	LC	<i>Bos Taurus</i>	Cow	LC
<i>Urosaurus ornatus</i>	Tree lizard	LC	<i>Capra hircus</i>	Domestic goat	LC
<i>Testudines spp.</i>	Turtle	LC	<i>Equus asinus</i>	Donkey	LC
D = Dominant, A= Abundant, F= Frequent, O = Occasional and R=Rare X= Absent. IUCN Red List Status: LC=Least Concern, NE=Not Evaluated					

Source: EDCM Ecology Survey, Nov 2022

Species of sepecial concern found in the vicinity of the project area are mentioned below in the **Table 4.16** with their respective IUCN status in the Red List. No endangered species are present in the project area.

Table 4.16: IUCN Status of Fauna in Project Area

Sr. No	Species of Concern	Expected habitats	Observations	IUCN Status
1	Hog deer (<i>Axis porcinus</i>)	Along the belt of Sind river and other Plains nearby the Sind rivers off shooting canals.	Not Found	Endangered
2	Houbara bustard (<i>Chlamydotis undulata</i>)	All the South and central Punjab found in fresh water bodies and canals.	Not Found	Vulnerable

Source: EDCM Ecology Survey, Nov 2022

There is no protected area and wildlife sanctuary in the vicinity of the project area. The fauna present in the project area of the landfill site is shown in **Figure 4.19** below.

Figure 4.19: Key Fauna of the Project area



a) Mongoose



b) Tree Lizard



c) Hare



d) Common rat



e) Laughing Dove



f) Turtle*

	
g) Indian squirrel	h) House Sparrow
	
i) Grazing mammals	j) Common Krait*

Source: EDCM Ecology Survey, Nov 2022

* <https://animalia.bio/common-krait>

4.5 Critical Habitat Assessment (Cha)

‘Critical Habitats’ are defined in Paragraph 16 of the IFC PS6 (2019) as areas harbouring high biodiversity value. This includes areas that meet at least one or more of the following seven criteria:

- i. Habitat of significance importance to globally or nationally Critically Endangered (CR) or Endangered (EN) species;
- ii. Habitat of significance importance to endemic and/or restricted-range species;
- iii. Habitat supporting globally significant concentrations of migratory and/or congregator species;
- iv. Highly threatened and/or unique ecosystems; and
- v. Areas associated with key evolutionary processes.
- vi. Areas either legally protected or officially proposed for protection.
- vii. Areas having biodiversity of significant social, economic, or cultural importance to local communities.

ADB SPS 2009 Definition of Critical Habitat

A subset of both natural and modified habitat that deserves particular attention. Critical habitat includes areas with high biodiversity value, including habitat required for the

survival of critically endangered or endangered species; areas having special significance for endemic or restricted-range species; sites that are critical for the survival of migratory species; areas supporting globally significant concentrations or numbers of individuals of congregatory species; areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and areas having biodiversity of significant social, economic, or cultural importance to local communities. 27. Critical Habitat is a subset of natural or modified habitats. Paragraphs 11 and 13 of the IFC PS 6 (2012, updated 2019) provide definitions for, respectively, modified and natural habitats:

Modified Habitats: Modified Habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.

Natural Habitats: Natural Habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

Keeping in view the baseline ecological survey conducted by the EDCM team and the IBAT proximity analysis, it can be safely concluded that in project area there is no any habitat critical for flora and fauna specie. Therefore, potentially only critical modified habitat could be identified in this area.

4.6 SOCIO-ECONOMIC ENVIRONMENT

This section includes a summary of the prevailing socio-economic conditions in the project area and the population that will be potentially affected by the Project. To ascertain the socio-economic condition of the project area, primary and secondary data was collected including social and physical infrastructure in the project area.

A report jointly produced by TAMA and Center for Economic Research (2010), Pakistan (CERP) regarding estimation of baseline indicators (other than livestock) and assisted in development of indicators²¹.

61. According to the study, the district of Bahawalpur has a highest poverty headcount ratio, and the variation at sub district level is even higher. Bahawalpur City, which is district headquarter as well, has the lowest poverty rate 41%, whereas Ahmadpur East is the tehsil with highest poverty rate of 62.09%. Bahawalpur Sadar has a higher poverty rate.
62. To assess the socioeconomic conditions of the project area, consultations were carried out with 160 participants including 65% male and 33% female participation. Households (HH) has been studied during field survey based on individual interviews as well as focus group discussions/ public consultations. These people are considered as project affected people and during socio-economic survey, interviews were held with them to brief them about project and to seek their views. In addition, the secondary data, including Economic Survey of Pakistan (2021-2022), Bureau of Statistics (2017-18), and MICS of Punjab has been consulted. Survey questionnaire for conducting FGDs is provided as **Appendix A.2**.

²¹ <https://www.theigc.org/wp-content/uploads/2014/11/Cheema-Khwaja-2010-Working-Paper.pdf>

63. For the purpose of the environmental and social assessment and sensitive receptor data collection, a two-kilometer-wide, corridor along the proposed project site has been considered as the study area or the project area. Most of the field data collection was carried out within this corridor though where relevant data was also collected from a wider area along the proposed project site. The reason for selecting this corridor is to cover those areas that have a potential to be affected by the project activities.

4.6.1 Administrative Setup

64. The area of Bahawalpur City is about 96 square kilometres. The City has Buildings; places built by the former Rulers of Ex-Bahawalpur State have prime importance for Bahawalpur City. Noor Mahal, Darbar Mahal Gulzar Mahal and Doulat Khana are remarkable in these buildings. Bahawalpur (city) is a walled city with two major intersecting roads running east to west and north to south respectively and terminating at four gates. It is linked to other cities by major railway and four sub-regional roads.
65. The project area falls in the administrative jurisdiction of District Bahawalpur, which is under general charge of the Deputy Commissioner, followed by five Assistant Commissioners and ten Magistrates responsible for the coordination of function of all the nation building departments in the district. The judicial administration of the district is under the charge of district and session judge along with five additional district judges. Administrative division of Bahawalpur is shown in **Table 4.17** below.
66. The names of the major settlements falling in the project area are Mari Sheikh Shijra, Basti Yar Muhammad, Masti Rasheedabad, Basti Rama and Basti Chachran.

Table 4.17: Administrative Division of Bahawalpur City

S.No.	Name of Tehsil	No of Union Councils
1	Ahmad pur sharqiya	31
2	Bahawalpur	36
3	Hisalpur	14
4	Khairpur Tamewali	8
5	Yazman	18
Total		107

4.6.2 Demography and Population

The population of Bahawalpur district is 3,668,106 as per 2017 Census Report. The urban parts of the project area are densely populated due to availability of resources and employment opportunities. In the rural parts, population varies in villages and settlements depending on several factors e.g. water, accessibility, employment etc.

The average annual growth rate of population in the district during intercensal period 1998-2017 was 3.07 percent. The total area of the district is 24,830 square kilometres which gives population density of 98 persons per square kilometre as against 59 persons observed in 1981 indicating a fast growth rate of the district.

Later on 1998, the massive efforts are made to count the population and census bureau carried out latest census and released the latest statistics. of 2017 at the national, provincial and district level.

By the annual growth rate of 2.18%, the population of District Bahawalpur is estimated as 3,668,106 persons out of which 1,879,311 were male and 1,788,578 were female. Sex ratio is measured as 105.07 percent. The following table gives population, its intercensal increase and average annual growth rate.

Table 4.18: Demography of Bahawalpur District

Household s	Population-2017				Population 1998	1998- 2017 Average Annual Growth Rate
	Male	Female	Trans- gender	All Sexes		
584,864	1,879,311	1,788,578	217	3,668,106	2,433,091	2.18

*Source District wise population Census 2017 by Pakistan Bureau of Statistics: Government of Pakistan.

4.6.3 Religion

The population of the district is predominantly Muslims i.e. 98.1 percent. The next higher percentage is of Hindu with 0.9 points followed by Christian 0.6 percent. While other minorities like Ahmadis, Schedule Castes etc. are very small in number as shown in the table given below:

Table 4.19: Major Religions in Bahawalpur

Religion	Bahawalpur		
	All Areas (%)	Rural (%)	Urban (%)
Muslims	98.1	98.1	98.0
Christians	0.6	0.3	1.4
Hindu	0.9	1.1	0.3
Ahmadis	0.1	0.1	0.1
Scheduled Castes	*	*	*
Others	0.3	0.3	0.1

* Refers to a very small **number**

Source: Pakistan Bureau of Statistics 2017

4.6.4 Cultural and Archaeological sites

In Bahawalpur, following sites are of cultural significance:

- Tomb of Abu Hanifa, Uchh Sharif, Bahawalpur.
- Tomb of Bibi Jawidi, Uchh Sharif, Bahawalpur.
- Tomb of Nuria, Uchh Sharif, Bahawalpur.
- Tomb of Bhawal Halee, Uchh Sharif, Bahawalpur.
- Tomb of Musa Pak Shaheed, Uchh Sharif, Bahawalpur.

No archaeological and cultural site was observed in close proximity of Bahawalpur landfill site.

The city of Bahawalpur has a rich heritage and is an important hot spot for historians as well as archaeologists. Bahawalpur is known for its cotton, silk, embroidery, carpets, and extraordinarily delicate pottery. The Punjab Small Industries Corporation (PSIC)

has established a Craft Development Center for Cholistan area, outside Farid Gate, Bahawalpur from where handicrafts manufactured in Cholistan can be purchased.

4.6.5 Ethnicities in Project Area

According to baseline survey, it was found that the largest part of the respondents i.e. 38% were Larah, 24% were Jutt, 14% were Lashari, 08% were Qureshi, and 06% were Bhutta. While 04% were Syed and Khokar each and 02% were Chohan. The castes of the sampled respondents are given in **Table 4.20** below.

Table 4.20: Ethnicities in Project Area

Caste / Ethnic Group			
Sr. No.	Caste / Ethnic Group	Number	Percentage (%)
1	Larah	38	38
2	Jutt	24	24
3	Lashari	14	14
4	Qureshi	08	08
5	Bhutta	06	06
6	Syed	04	04
7	Khokar	04	04
8	Chohan	02	02
Total		100	100

4.6.6 Languages

67. The mother tongue refers to the language used for communication between parents and their children in any household. Siraiiki is the predominant language being spoken by majority (64.3 percent) of the population of the district followed by Urdu, Pushto and Punjabi being spoken by 5.5, 0.6, and 28.4.

4.6.7 Main Sources of Livelihood/Income

Socioeconomic survey findings depicted that out of 100 respondents, majorities i.e. 46% are doing labor, 36% of the respondents are working as farmers in agricultural fields, 08% are doing their own businesses, 04% of the respondents are doing services and livestock and 02% belongs to some other source of income which they do not want to mention here. Source of income of the respondents are shown in **Table 4.21**.

Table 4.21: Source of Income of Respondents

Sr. No.	Source of Income	Number	Percentage (%)
1	Business/shop	08	08
2	Labor	46	46
3	Agriculture	36	36
4	Livestock	04	04
5	Service	04	04
6	Any Other	02	02
Total		100	100

4.6.8 Transport

The road infrastructure in Bahawalpur is generally good for existing requirements. As with other cities under review, there are no signals on any Chowk and no urban bus or van services are available. Mixed motorised and non-motorised traffic increase congestion on roads.

Bahawalpur has its own airport built by the Dubai Civil Aviation Department. Bahawalpur Airport links the city with various Pakistani cities such as Dera Ghazi Khan, Islamabad, Karachi and Lahore with the national flag carrier, Pakistan National Airlines. The airline has launched international flights to Dubai and plans to introduce more international destinations. There are also daily bus and train services to and from Multan, Lahore, Sukkur and Karachi.

4.6.9 Industry

The Most famous industries lying in Bahawalpur area include Fertilizer, Sugar, Cotton, and Textile, Beverages, flour & Cottage Industries. Fuji Fertilizer Company, Unilever, Jamal Din wali Sugar Mill, Hamza Sugar mill, Itehad Sugar Mills are the most important industries playing fundamental role in the economy of the area.

Being an industrial expanding city the government has revolutionized and libertised various markets allowing the Caustic Soda, Cotton Ginning & Pressing, Flour Mills, Fruit Juices, General Engineering, Iron & Steel Re-rolling Mills, Looms, Oil Mills, Poultry Feed, Sugar, Textile Spinning, Textile Weaving and Vegetable Ghee & Cooking Oil industries to flourish.

68. There is no industry in the close proximity of the proposed Bahawalpur Landfill site.

4.6.10 Health Care

Health conditions are one of the major determinants of a society's social development and quality of life. Healthy manpower is imperative for advancement and economic growth. The major health facilities available in the district are District Headquarter Hospital, Tehsil head quarters Hospital at each Tehsil along with M.C. Health Centre, Primary Rural Health Centers, Primary Dispensaries, Basic Health Units, TB Centers and 72 Dispensaries. The Zila Council is also running dispensaries, MC Centers and Veterinary Hospitals.

In the project area, there is a Victoria hospital located at a distance of 950 m from landfill and a couple of maternity facilities (in isolated homes) to facilitate the health of communities residing in the project area. Victoria hospital has a capacity of 1409 beds which produces 1.2 tons of hospital waste. This is either burnt or disposed openly in barren areas. As reported by the locals, diseases like Flu, Chest Infection, Dengue, Skin diseases like Scabies and typhoid has rapidly increased due to the presence of uncovered and untreated municipal solid waste here in Mari Sheikh Shijra.

4.6.11 Literacy Rate

The district has literacy rate of 35% (2007-2008) with male literacy rate at 44.9% and female at 24%. Looking across regions, 57% of urban population (Male: 52.9%; Female: 47.1%) and 26.3% rural population (Male: 36.4%; Female: 15.1%) of Bahawalpur are literate. However, according to (Multiple Indicator Cluster Surveys) MICS 2017-18 survey, the literacy rate above 10 years is 45% (Male 51.66%; Female: 48.34 %). Similarly, urban rural distribution shows 65% urban population (Male: 52.5 %; Female: 47.5%) and 37% rural population (Male: 51.3 %; Female: 48.7%) is literate.

4.6.12 Education

Education plays a pivotal role in changing social and economic condition of the individuals. There are over 1600 government primary schools- 45% of which are for girls. Middle schools are 226, over 60% are for girls, and 39% for boys, while high schools are 125 and 62% are for boys. As level of education increases, percentage of boys schools increases in the district. However, higher secondary schools are the same in the district, 14 each.

Total number of arts and science degree colleges are 18 having enrolment of almost 20,000 students and teaching strength of 543. The higher education institutions in Bahawalpur district include; Islamia University of Bahawalpur, Asian college of Technology Hasilpur Road Bahawalpur, Rise School of Accountancy, Tebiya College, Four Elementary colleges for teaching training, Quaid-e-Azam Medical College (QAMC), Government Sadiq Egertin College (SE College), Government Sadiq Degree College for Girls, Millat College and Post Graduate College Baghdad Road. Number of educational institutions by sex and type is given in the **Table 4.22** below.

Table 4.22: Educational Institutions by Sex and Type

Sr. No.	Name of Institutions	Institute		
		Male	Female	Private
1	Primary	797	756	138
2	Middle	80	85	120
3	High/Secondary	04	03	-
4	Intermediate Colleges	03	02	-
5	Degree Colleges	02	03	-
6	Vocational Institute	02	01	-
Total		888	850	258

Source: Pakistan Bureau of Statistics 2017

4.6.13 Types of Dwellings

Housing conditions of the respondents have been analyzed according to the type of houses in which they were residing. The house or building constructed with concrete or burnt bricks fall in pacca category whereas house or building constructed with burnt bricks with mud comes under semi-pacca category while house constructed with mud bricks or temporary wooden logs etc. are categorized as kacha house. Project area population is mostly living in semi-pacca and pacca houses.

A high concentration of residential settlements is located to the south of the proposed site, a part of which is already being used for dumping of solid waste at close proximity to the proposed site. Furthermore, sparsely scattered residential settlements are lying at varying distances around other sides of the proposed landfill site.

Based on the survey, 08% of them live in the pacca houses made up of bricks and concrete whereas 16% live in the semi-pacca houses. While majority i.e. 76% respondents live in the kaccha houses. **Table 4.23** shows the type of construction of the houses.

Table 4.23: Type of Construction of the Houses

Type of Construction of the Houses			
Sr. No.	Type	Number	Percentage (%)
1	Pacca	08	08

2	Semi-Pacca	16	16
3	Kaccha	76	76
Total		100	100

4.6.14 Energy Supplies

The residents of project area are reliant on electricity available from the grid through BESCO (Bahawalpur Electric Supply Company). Due to long duration load-shedding particularly during summer, there is an increasing trend of using diesel generator and installing solar PV systems in both residences and businesses in order to ensure energy reliability.

4.6.15 Major Source of Drinking Water

Sampled respondents are depending upon a number of sources of water for domestic use which is shown in Table below. Hand pumps/Electric motor is the main source of water for domestic use in the proposed project area (93%) respondents get water from this source and remaining 07% respondents use Filtration plants as the source of water for domestic purpose.

Table 4.24: Source of Water for Domestic use

Source of Water in Project Area			
Sr. No.	Source of Water	Number	Percentage (%)
1	Hand pumps/Electric motor	93	93
2	Filtration plant	07	07
Total		100	100

4.6.16 Sewerage System

The sewerage system in Bahawalpur covers 70% of the city and serves 82% of the population. There are 5 existing wastewater disposal (pumping) stations, which are periodically out of order. At present there is no facility for treatment of the waste water.

The wastewater pumped from disposal stations is utilized without any treatment by farmers for irrigation, presenting a potential health hazard. The excess wastewater from the disposal stations is pumped either into the Sutlej River or into canals.

A major component under the Southern Punjab Basic Urban Services Project (SPBUSP) for TMA Bahawalpur City is the construction of new sewerage system. However, a proper sanitation plan has still not been developed.

4.6.17 Social amenities in the project area

During the field survey, the access/ availability of the social amenities/ basic infrastructure in the vicinity of the proposed landfill site was asked from the surveyed households as well as physically observed at site. It was noted that facilities such as Electricity, Sui Gas, Water Supply, Telephone, Sewerage Drainage, school are available in the settlement or in its vicinity.

4.6.18 Existing Scavenging Practices

It is estimated that nearly 483 tons of waste is being generated and collected in Bahawalpur, most of it is being dumped in open dumping sites. These open dumping sites are openly accessible to scavengers that search through and collect items of a

recyclable nature i.e. paper, metals, plastic. These items they then either sell to scrap dealers or bring to their specific warehouses to be sold onwards.

Currently, there is not any properly designed bioreactor landfill site for waste disposal in the town. No proper solid waste plan has been developed. 60% of the waste generated is being collected and disposed off. This situation will worsen with the increasing population. There is no proper solid waste management system in Town that places waste in bioreactor landfills.

An estimated 50-60 warehouses are being operated at different locations on average employing about 50 scavengers. Another estimate places the total number of scavengers, whether employed or operating privately, somewhere between 5000 and 7000, mostly male but an overwhelmingly high proportion lying in the age bracket of 10-20 years.

Studies on a limited scale have tried to assess their socioeconomic conditions, from their mean monthly income figures, to their motivation for this line of work and their working conditions (Alam et al, 2011). Generally, a scavenger on average makes between PKR 2000 and 3000 per month (Dawn, 2017). In most cases, this income supports the primary income source in the household, but there are cases where the scavenger's income is the primary or even sole income of the household (Alam et al, 2011). The major concern observed within this line of work is the overall health and safety risk that scavengers are under, as they constantly have to deal with sharp or dangerous objects with usually no protective measures or gear. Scavenging activities are observed to be mostly concentrated in commercial market areas of the city, with not as much outreach into residential neighbourhoods.

There is a considerable potential to positively channelize the work that these scavengers put in towards waste reduction and recycling, possible immediately after door-to-door collection takes place as well as at a Material Recovery Facility (MRF). The informal networks of scavengers can be brought on board by the BWMC operations by subcontracting them these waste sorting activities. This is likely to significantly secure both their livelihoods and their working conditions. Some level of vocational training will be required to ensure a uniform basic skill level, however, it is expected that these workers will bring to the job considerable experience from having performed it in an informal and unregulated sector.

There is much tendency in the scavenging industry to employ young children. Once under a formalized umbrella, care will be taken to ensure that Child Labour Laws and best practices are fulfilled. Examples of global brands like Levi's and Nike (Dawn, 2017) retaining their underage workforce in Bangladesh, investing in their education and bringing them to work once they were of legal age, is a good precedent to look up to, determined ultimately by financial feasibility in addition to ethical considerations.

A study places the present rate of recovering recyclables from Bahawalpur's total waste at 30%, which is predominantly done by these scavengers. Making use of their service in a formal, regulated system of operation which emphasizes can improve this rate to as high as 90% (Asma et al, 2017).

Considering all these factors, it is clear that an overall positive effect is anticipated from SWM system on scavenging and recycling. In addition, detailed consultations with scavengers, scrap dealers and personnel involved in the waste management business were conducted and the details are provided in **Chapter 8 (Stakeholder Consultations)**.

5. ANALYSIS OF ALTERNATIVES

5.1 OVERVIEW

Project alternatives have been studied as a part of this EIA process. The environmental, economic, and social impacts of each alternative have been thoroughly examined. This chapter also provides an overview of the various commercially available technologies for the environmentally sustainable treatment and processing of waste that are successfully operating in developed countries in particular, and recommends the most appropriate set of options for Bahawalpur city in light of its waste generation and composition.

Project alternatives have been studied keeping in view number of parameters including; waste quantum, physio-chemical properties of waste, suitability for mixed waste handling, land requirements, technical complexities, social acceptability, environmental and legal compliance, and OPEX & CAPEX requirements. The development of the proposed landfill is based on detailed feasibility assessments focusing on assessing the city requirements with regards to SWM and then determining the most suitable and effective technology and location for development of the required infrastructure.

This procedure of analysing different choices for landfill site development ensures that a well-informed decision is made regarding the selection of the most preferred option among the potential alternatives that are brought into consideration.

5.2 ALTERNATIVES TYPES

Types of alternatives considered for detailed analysis for Bahawalpur SWM facility are given below;

- No Project Option
- Site Selection Alternatives
- Landfill Type Alternatives and Landfill Construction Alternatives
- Waste Disposal Alternatives
- Technological Alternatives for AD and Material Recovery Facility (MRF)
- Scenario Analysis for all possible treatment options for Bahawalpur
- Economic Analysis
- Closure/Post Closure Plan

5.3 'NO PROJECT' OPTION

The current waste disposal system has been through controlled dumpsites. These dumpsites often characterized by an area where garbage is simply transported, unloaded, and at times levelled by a bulldozer. Nearly all these sites operate with no protection against soil and groundwater contamination.

The situation is further exacerbated by operators' seldom attempt to control pungent smoke, objectionable odor and vermin. Sorting is only achieved through scavenging, which at times tolerated, with no checks in place for the health and safety. Such dumpsites are inexpensive operate, but pose serious damage to the land, water, air, aesthetics, and the health of the surrounding population. These dumpsites are also difficult to rehabilitate after they are filled and abandoned. Failure to implement the project or a "No-Action alternative" will result to allocation of land only to be subjected to the existing practice.

Alternatives in this context will mean the establishment of the SLF at alternative sites or the project not pushing through. Although what is obvious is such alternatives shall

not negate the disadvantages of allocating land for disposal purposes only to be subjected to the existing dumping practice.

On the other hand, if the project is implemented, it will result in improved SWM system services and improved urban environment quality. Furthermore, project implementation will also create job opportunities during construction, thereby improving the socioeconomic condition of the local people and help in improving their quality of life. Thus, the 'no project' option is not a viable option.

5.4 SITE SELECTION ALTERNATIVES

There are many different, often inter-related, criteria that go into the selection of an appropriate site for a landfill. These include technical, environmental, geological-hydrogeological, operational, economic, social and political factors. Environmental Sensitivity (Hydrology, Climate, Fault/fractures, Soil/topography, flora/fauna, and agriculture/nature conservation) is one of criteria which plays critical role while making decision with respect to landfill site selection. Keeping in view this set of considerations, the sites initially considered were:

Yazman - located at Marot Yazman Road Bahawalpur next to the Malot Machinery Store. No nearby human settlements are located within 1000 metres of the project site. Total area of the site is 56 acres. **Figure 5.1** shows the location of Yazman landfill site.

- The landfill operation is actually a biological method of waste treatment. This process is very slow and may still be going on as long as 25 years after the landfill closes. The proposed site is found not adequate for the waste treatment till 25 years. The surroundings of the site are as follows:

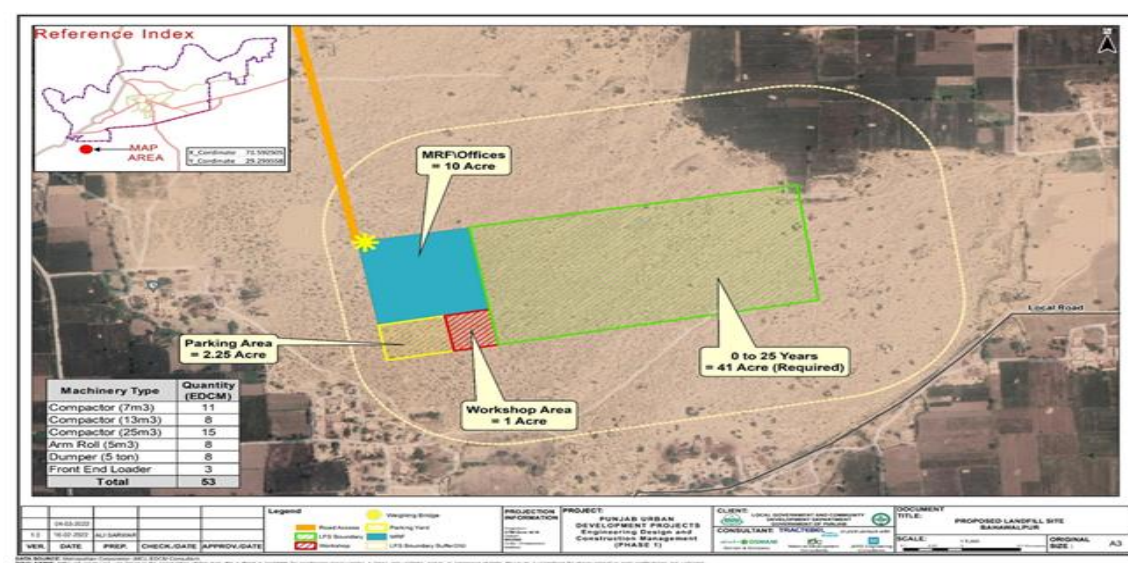
East: Barren land, agricultural Fields and human settlements

West: Barren land

North: Barren land, agricultural Fields and human settlements

South: Agricultural fields and human settlements

Figure 5.1: Yazman Landfill Site



Khanu Wali– The site is located at 0.5 km from the Sutlej River and the nearest human settlement is located within 350-400 metres radius from the project site. The proposed site area is adequate for 25 years of useable life. Location of Khanu Wali proposed landfill site is shown in **Figure 5.2**.

- Buffer zone also acts as barrier, absorber and to some extent as remedial measure against the fugitive emissions of pollutants emitted during handling of waste, storage, transportation and movements of traffics.
- Cell locations of the Khanu Wali landfill site does not meet the buffer zone requirement to ensure that potential effects of the landfilling operation may not any unacceptable impact outside the site. Also the proposed site plan does not maintain the safe distance of nearby settlements from the waste processing facilities. The surroundings of the site are as follows:

East: Agricultural fields

West: Agricultural fields and Sutlej river

North: Agricultural fields and human settlements

South: Agricultural fields and human settlements

Figure 5.2: Khanu Wali



Mari Sheikh Shijra - located near Basti Yar Muhammad, mouza Nouabad Bahawalpur. Total area of the site is 110 acres. Proposed site is mostly surrounded by agricultural fields and located at a safe distance from the nearby human settlements.

Figure 5.3 shows the location map of Mari Sheikh Shijra landfill site.

- Cell locations of the proposed landfill site meet the buffer zone requirement to ensure that potential effects of the landfilling operation may not any unacceptable impact outside the site. The surroundings of the site are as follows:

East: Agricultural fields and human settlements

West: Barren land, agricultural fields and human settlements

North: Barren land and agricultural fields

South: Barren land and agricultural fields

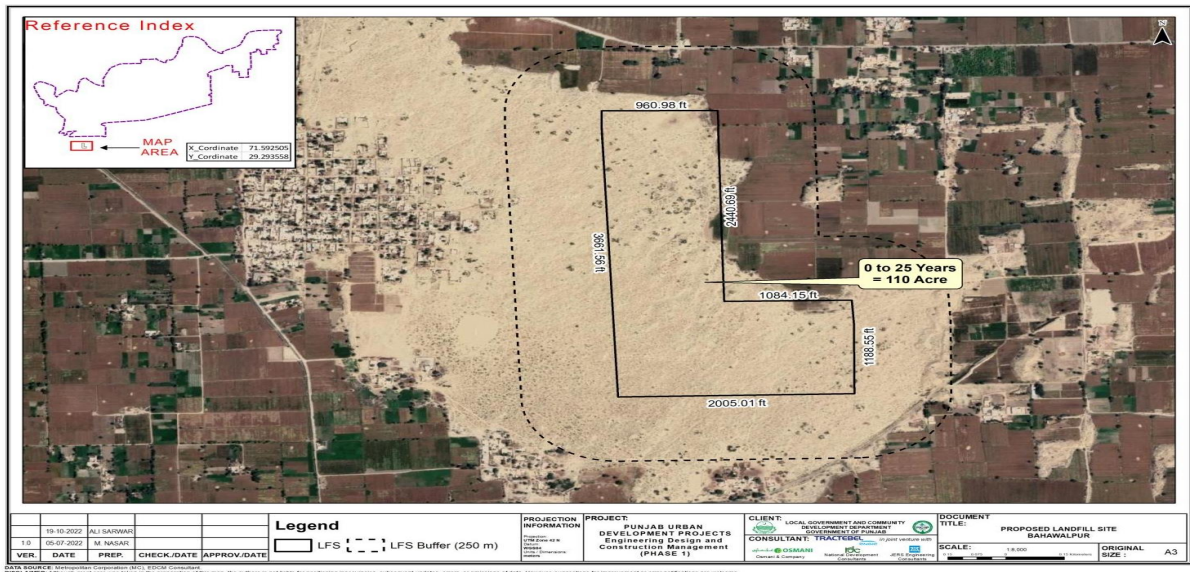


Figure 5.3: Mari Sheikh Shijra mouza Nouabad

These sites are collectively shown in the **Figure 5.4** below and the comparison of these different site alternatives is provided in **Table 5.1** below.

Figure 5.4: Location map of site alternatives

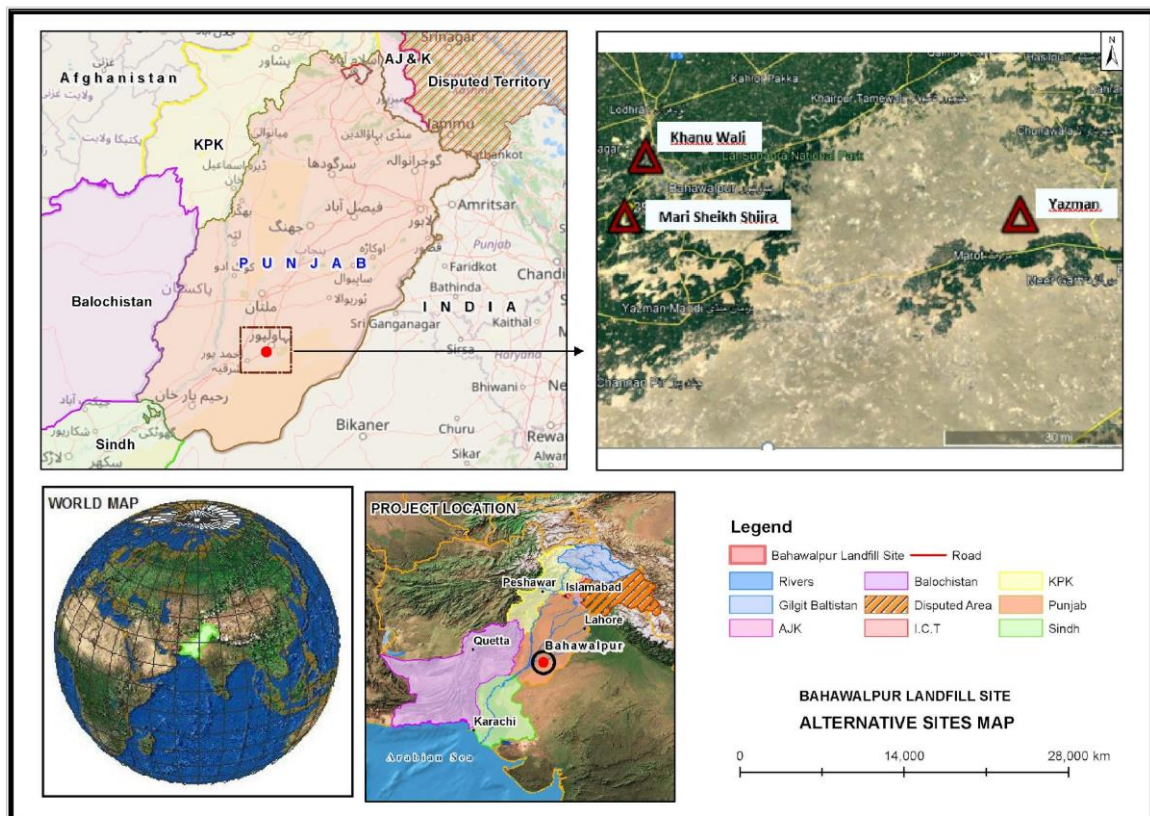


Table 5.1: Comparison of Site Alternatives

Parameters	Site Alternatives		
	Yazman	Khanu Wali	Mari Sheikh Shijra
Environmental Sensitivity	Very low due to less domestic, commercial and agricultural activity	Moderate to high as sparse agricultural activity in the outskirt of proposed site	Very low due to less domestic, and agricultural activity
Infrastructure	Accessible on Marot Yazman Road	Congested right of way for waste carrying transport	Accessible via main roads Mari Sheikh Sijra and Bhatti Dari road
Site capacity	56 Acres, will trigger the land acquisition and high social safeguard activities.	80 Acres	110 Acres
Land Acquisition	56 Acres owned by BWMC which is not sufficient for 25 years' period. Therefore more land acquisition and high social safeguard activities will be required. This will cause additional financial burden to the total project	Existing dumpsite. Area already More land acquisition required and high social safeguard activities. Will cause additional financial burden to the total project Could be problematic due to nearby agricultural and domestic activities	110 Acres area is sufficient already owned by BWMC. Hence no financial burden
Social Acceptability	Easily possible as present use of the location also deals with waste management	Not possible as the existing dumpsite is severely impacting agricultural activity	Easily possible due to safe distance from the nearby settlements and low agricultural, domestic and commercial activity
Distance from City Centre (km)	80	10	11

An alternative site at 13-solang at Yazman Road was also considered. This site was rejected on the basis of some technical points related to the nearby locations of Bahawalpur airport in term of high chance of bird's strike with the flying aircrafts. The site area of 56 Acres is not adequate for the waste treatment till 25 years and more land acquisition will be required which will create financial burden to the project. Another reason of rejection was a clear more than three times distance of the

alternative site which will entail comparatively huge cost of fuel and vehicles maintenance.

The site at Khanu Wali was immediately eliminated primarily due to its proximity to the city. The location lies very much within the urban built-up area. One option which this site provides is the setting up of a transfer station, a point of convergence for waste originating from various parts of the city, possibly coupled with a Material Recovery Facility (MRF) and/or a composting facility. Establishing facilities in such proximity to the city will separate the waste not meant to be disposed in the landfill, thereby making more efficient use of the heavy equipment, compactors and large arm-roll trucks, which will travel to the landfill site.

The site of Khanu wali is fairly vacant but is in quite a close proximity to nearby settlements and agricultural fields. The site is also close to the city center and its adverse impacts on the population will be comparatively greater than Yazman Landfill Site.

The site at Mari Sheikh Shujra fulfilled most of the criteria listed above. It is far enough away from the city. The population is sparse and although there are a few sensitive receptors, proper environmental assessments are being carried and resettlement plans are being prepared to minimize both environmental and socioeconomic impacts. Most of the surrounding area is barren and agricultural. Given the locations of other alternative sites, all were either agricultural or semi-urban areas, which at least places this site as the most ideal among the rest.

No land acquisition is required as land area of 110 acre is already owned by BWMC and cell locations meet the buffer zone requirements which ensures that potential effects of the landfilling operation may not cause any unacceptable impact outside the site. The social acceptability of the project is enhanced by educating the nearby population on the merits of a bioreactor landfill.

The climatic and hydrological factors will have to be addressed by a sound technical plan, particularly during the operation phase where environmental monitoring.

5.5 LANDFILL TYPE ALTERNATIVES

Landfills are vital components of any well designed MSW management system. They are ultimate repositories of a city's MSW after all other MSW management options have been exercised. In many cases, landfill is the only MSW management options available after the MSW is collected. The safe and effective operation of landfill depends on sound planning, administration, and management of the entire MSW management system.

There are three types of landfills viz, Sanitary landfill, Bioreactor landfill, Secured landfill (for inert waste). Various types of landfills are designed and constructed worldwide to manage MSW like sanitary landfill, bio-reactor landfill and secured landfill. The safe and effective operation of landfill depends on sound planning, administration, and management of the entire MSW management system and selection of appropriate landfill type.

5.5.1 Sanitary Landfill

Sanitary landfill is the process of dumping of solid waste in a scientifically designed land area spreading waste in thin layers, compacting to the smallest volume and covering with soil on daily basis. Sanitary landfill would be good option for disposal of existing/mixed waste which cannot be segregated. Landfill gas such as methane from the anaerobic conditions prevailing in the landfill due to the presence of organic material in mixed waste can be recovered. The facilities at the sanitary landfill include

leachate collection and treatment system, storm water management system avoiding ground and surface water pollution.

5.5.2 Bioreactor Landfill

Bioreactor landfill is one idea that has gained significant attention now days. A bioreactor landfill is a sanitary landfill that uses enhanced microbiological processes to transform and stabilize the readily and moderately decomposable organic waste constituents within 5 to 10 years of bioreactor process implementation. The bioreactor landfill significantly increases the extent of organic waste decomposition, conversion rates and process effectiveness over what would otherwise occur within the landfill. The “bioreactor landfill” provides control and process optimization, primarily through the addition of leachate or other liquid amendments, the addition of sewage sludge or other amendments, temperature control, and nutrient supplementation. Beyond that, bioreactor landfill operation may involve the addition of air. Based on waste biodegradation mechanisms, different kinds of “bioreactor landfills” including anaerobic bioreactors, aerobic bioreactors, and aerobic-anaerobic (hybrid) bioreactors have been constructed and operated.

5.5.3 Secured Landfill

Secured landfill is a carefully engineered depression in the ground (or built on top of the ground) into which wastes are dumped to avoid pollution to the surrounding environment. Secured MSW landfill should be restricted to non-biodegradable, inert waste and other waste not suitable for recycling or for biological processing. The important features that should be considered before designing a landfill are given in Schedule III - “Specifications for Landfill sites” of MSW rules 2000. These include:

- Site Selection
- Facilities at the site
- Specifications for land filling
- Pollution prevention
- Water quality monitoring
- Plantation at landfill site
- Closure of landfill site and post care
- Special provisions for hilly areas

Based on above information, the project design consultant suggested to construct a sanitary landfill for Bahawalpur as it is relatively low in cost and requires less technical and operational maintenance as compared to other options.

5.6 LANDFILL CONSTRUCTION ALTERNATIVES

5.6.1 Lining

The liner system's goal is to prevent migration of leachate from landfill and prevent contamination of groundwater and soil beneath the landfill. Leachate collecting facilities serve the following purposes: controlling and reducing leachate heads within the landfill; protecting the liner system; and removing leachate contained within the landfill by the liner system for treatment and disposal. The drainage layer is made up of granular soil with the right amount of permeability. Also appropriate thickness of geomembrane and compacted clay layer is essential to safeguard the soil and water.

The alternative of concrete lining is not as favourable as the HDPE (high density polyethylene) geo-membrane due to its higher erosion factor, indirectly amounting to a higher maintenance cost and greater harm to the environment.

5.6.2 Leachate Collection and Treatment

The best option is to reapply the daily leachate to the surface of the solid waste dumped at the landfill. This is a cost-effective and environmentally friendly method of handling leachate. If the volume of leachate produced exceeds the spraying capacity, leachate treatment will be required.

The alternatives regarding leachate management itself are:

- Discharge to lined drains
- Discharge to waste water treatment system
- Recirculation
- Evaporation of leachate
- Treatment of leachate

There are various benefits and drawbacks to each option being researched and tested, including one in which recirculation acts as a catalyst for increased gas production (Kumar et al. 2011) to aid in energy recovery.

A combination of leachate management options, including leachate spraying and leachate treatment, has been chosen for Bahawalpur. Leachate will be primarily used for waste spraying, with the remainder collected and sent to preliminary treatment in three stage open ponds and anaerobic bio digestion system for final treatment.

By integrating additional technology in the form of remote monitoring equipment into the leachate management system and the gas management system, it is possible to reduce the need for round-the-clock security to only being necessary in emergency situations. Remote sensors can be installed on pumps and storage tanks to transmit real-time data and alerts to an online system.

The use of control technologies within these systems will allow facility operators and supervisors to be able to remotely address routine or emergency issues, whenever notified, without physically being present at the site.

5.6.3 Gas collection and Treatment

Landfill gas can migrate laterally and potentially cause explosions. Landfills are therefore provided with gas collection and processing facilities. The rate of gas production varies depending on the operating procedure. The rate and quantity of gas generation with time, is difficult to predict. Typical generation rates reported in literature vary from 1.0 to 8.0 litres/kg/year. Gas production rates of 60 m³ per hour have been reported from landfill sites in India having an area of 8 hectares and a depth of 5 to 8 m (Dutta et al. 2012). The decision to use horizontal or vertical gas recovery wells depends on the design and capacity of the landfill. The decision to flare or to recover energy from the landfill gas is determined by the capacity of the landfill site and the opportunity to sell power produced.

Gas outputs of 10 to 20 m³ per hour (corresponding to 50 to 100 KW of energy) have been recorded in wells of 15 to 20 cm diameter drilled 10 m into waste at spacing of 30 to 70 m. For 1 MW output from a landfill site, 15 to 20 such wells are required.

Alternative plans for gas management can be one of the following:

- Uncontrolled release
- Controlled passive venting
- Controlled collection and treatment/reuse

Controlled passive venting is proposed for the first years of landfill operation in Bahawalpur, followed by flaring for landfill gas management. Initially a 1000 m³ flaring system is proposed in the project plan.

The organic waste will be used as a resource in bioreactor landfill to maximize and regulate the landfill gas recovery system and conversion of methane component of the gas into CNG. The conversion of organic waste into LFG and Methane component conversion will generate a high revenue and contribute to the substantially of the project.

The organic waste will be beneficially utilized when it is deposited in the bio reactor landfill where it will generate regular and increased quantity of landfill gas which will contain 55-60 percent of Methane. The methane can be converted into electricity or CNG. The CNG option is a much better option as the electricity tariff for green energy is very low in Pakistan and the CNG rates are quite high.

5.7 TECHNOLOGICAL ALTERNATIVES FOR ANAEROBIC DIGESTION SYSTEM (AD SYSTEM)

The Anaerobic Digestion System (AD system) is controlled biological conversion and treatment of organic material by bacteria and other microbes in the absence of oxygen. Oxygen is toxic to anaerobic bacteria and other micro-organisms (anaerobes). The AD process produces biogas (about 50-60% methane or natural gas, 40-45% carbon dioxide and traces of other gases), liquid effluent and a solid, partially stabilized organic material known as digestate which is generally sent for further aerobic composting to yield a stabilized product (compost).

Many AD system designs are available in the marketplace. AD system vendors/EPC contractors will choose between:

- Wet or dry AD
- Single or two stage ADS
- Thermophilic or mesophilic AD
- Continuous, plug flow or batch AD

The design decisions would need to be combined with pre-treatment decisions to create an overall AD design which would best meets the needs of the Bahawalpur landfill depending upon the waste characterization. Project design consultant advised not to prescribe or limit the design options at the pre-feasibility stage of the assessment. AD vendors/EPC contractors may provide customized approaches to AD and pre-treatment options.

5.8 TECHNOLOGICAL ALTERNATIVES FOR MATERIAL RECOVERY FACILITY (MRF)

Having already discussed their site selection criteria above, the analysis of technological specifications within MRF or composting facilities within the ISWMS will also determine how effectively they operate from both a financial as well an environmental point of view. The facilities for the proposed landfill can range from labour-intensive, lower initial costs but lower efficiencies, to machine-intensive, higher initial costs but greater efficiencies.

5.9 WASTE DISPOSAL ALTERNATIVES

There are various technical methods for intermediate municipal waste treatment. However, some of them are only suitable for small-scale systems, while others are technically sophisticated. Taking into account the waste characteristics, the amount of waste for treatment, and the technologies that are practical for developing countries, the following technical options, including composting, MRF, and waste to energy (incineration & RDF), were selected for further investigation as potential intermediate treatment facilities for Bahawalpur, Punjab.

5.9.1 Waste as a Fuel

Waste collection is typically the most expensive aspect of solid waste management in cities and municipalities. As a result, municipal leaders are very interested in Waste to Energy (WtE) options to potentially (and partially) cover waste collection costs. Utilities typically view their solid waste as a resource that can be used to attract private-sector investment for waste-to-energy projects under the right institutional and financial conditions. However, caution should be exercised when applying off-the-shelf solutions to projects—each project should be evaluated on its own merits. These solutions should be sized to accommodate non-recyclable, non-recoverable, and non-upcyclable materials, as well as any landfill mining that may occur during the project's life cycle. It should not be assumed that all municipal waste can be used for waste to energy projects. The viability of any MSW incineration facility depends highly, and most importantly, on the quantity and calorific value of the waste. The economic state of the country/area is highly correlated to the calorific value of the waste. Following is waste to energy conversion techniques applicable to the waste available in Bahawalpur, Punjab:

Table 5.2: Conversion Techniques to utilize waste as fuel

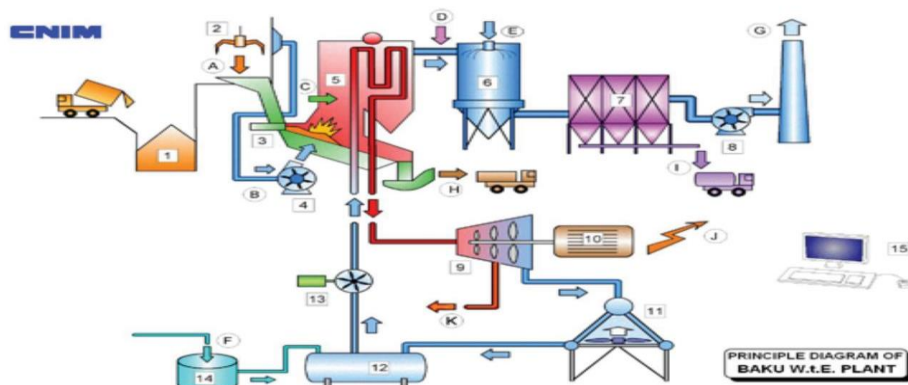
Item	Technology	Output
Thermal	Combustion	Heat, Electricity, Bottom Ash and Fly Ash
Mechanical-thermal	Mechanical Biological Treatment	Biogas, Electricity, RDF, compost like material
	Landfill gas capture	Biogas, heat, electricity,
Thermo-chemical	Gasification	Syn Gas, Bottom Ash
	Pyrolysis	Syngas, char, oil

5.9.2 Municipal Solid Waste Incineration/ Mass Burning Option:

Incineration is a process of controlled combustion for burning of waste and residue containing combustible material. The emissions from incineration of solid waste are of health concern, and the waste for incineration should be free from chlorinated plastics, hence this process is not proposed in the proposed project.

Direct combustion is the oldest technology for biomass conversion, especially for generating heat and steam. The combustion technologies to convert MSW to heat and electricity use similar processes if using fossil fuels. The MSW is burned in a boiler to produce high-pressure steam that flows through a series of turbine blades, causing the turbine to rotate. The turbine is connected to an electric generator that produces electricity. Dumping grate-type boilers are the preferred choice for MSW.

Figure 4.3: Principal Diagram for Waste to Energy Plant



Legend: EQUIPMENT: 1- Waste bunker, 2- Traveling crane and grab, 3- CNIM/MARTIN GmbH combustion grate, 4- Combustion air supply, 5- CNIM recovery boiler, 6- LAB Semi-dry type reactor, 7- Fabric filter, 8- Induced draft fan, 9- Steam turbine, 10- Alternator, 11- Air cooled condenser, 12- Deaerator and feed water tank, 13- Feed water pumps, 14- Feed water treatment and demineralized water tank, 15- Operation and control unit in control room.
 INPUT: A- Waste; B- Air, C- Urea solution, D- Activated carbon, E- Lime slurry, F- Raw water.
 OUTPUT: G- Clean flue gas, H- Coarse ash (clinker) to storage and maturation area, I- Fly ash and flue gas treatment by-products, J- Electricity, K- Steam to district heating network (future possibility).
 Source: Constructions Industrielles de la Méditerranée (CNIM) Group.

Mass burning aims to reduce MSW volume and mass and make it chemically inert in a combustion process without the need for additional fuel (autothermic combustion). There are always about 25% residues from incineration in slag (bottom ash) and fly ash. Bottom ash is made up of fine particulates that fall to the bottom of the incinerator during combustion, whilst fly ash refers to fine particulates in exhaust gases that must be removed in flue gas treatment. These residues need further attention and a secure place for final disposal in the case of hazardous fly ash. Incinerate the waste and convert the heat derived from the process to generate electricity. The energy recovered from incineration produces power and/or steam, depending on local infrastructure and needs. One ton of waste can be converted to approximately 2 MWh of heat and 2/3 MWh of electricity for combined heat and power plants.

The energy content of Bahawalpur can be seen in **Table 5.3**. In general, the average (year- wide) and recommended lower calorific value of waste should be at least 7 MJ/kg or 1671 kcal/kg and must never fall below 6 MJ/kg or 1433 kcal/kg. Without this value, there would be a need to constantly supply auxiliary fuel, which would decrease the viability of an MSW incineration facility.

The average energy content of Bahawalpur meets the minimum energy requirement. According to GIZ guidelines for Waste to Energy, the plant capacity should be preferably higher than 100,000 tons per year to achieve optimal economies of scale together with average collection distances (GIZ, 2017). Presently, Bahawalpur is generating 176,295 tons of solid waste per year, which fulfils GIZ criteria for waste to energy.

Table 5.3: Energy content of Bahawalpur

Waste Source		High-Income Area (kcal/kg)	Middle Income Area (kcal/kg)	Low Income Area (kcal/kg)	Average (kcal/kg)	Average (Collective)
Gross Calorific Value	Day 1	5300	4800	2302	4134	4360.85
	Day 2	5503	4660	3600	4588	
Net Calorific	Day 1	4657.02	4081.15	1686.46	3474.88	3708.39

Waste Source		High-Income Area (kcal/kg)	Middle Income Area (kcal/kg)	Low Income Area (kcal/kg)	Average (kcal/kg)	Average (Collective)
Value ³⁴	Day 2	4868.2	3983.14	2974.42	3941.9	
Calorific Content		Meets Requirement				

Source: WACS Report, 2022

5.9.3 RDF via Mechanical Biological Treatment Option:

Pellets are formed from the combustible portion of MSW. Pelletization initially involves segregation of waste into high and low calorific value materials and then shredded and compacted into pellets with the required bulk density and later can be dried to get the appropriate heat value. These pellets so produced have a calorific value of 4000 Kcal/kg of the product which is quite close to that of coal and therefore is a good substitute for coal, wood, etc. to RDF plant. Comparatively, pellets have advantages over coal and are clean, energy efficient, eco-friendly fuel for coal based industries, power generating industries. Additional advantage of Pellets is easy storage and transportation.

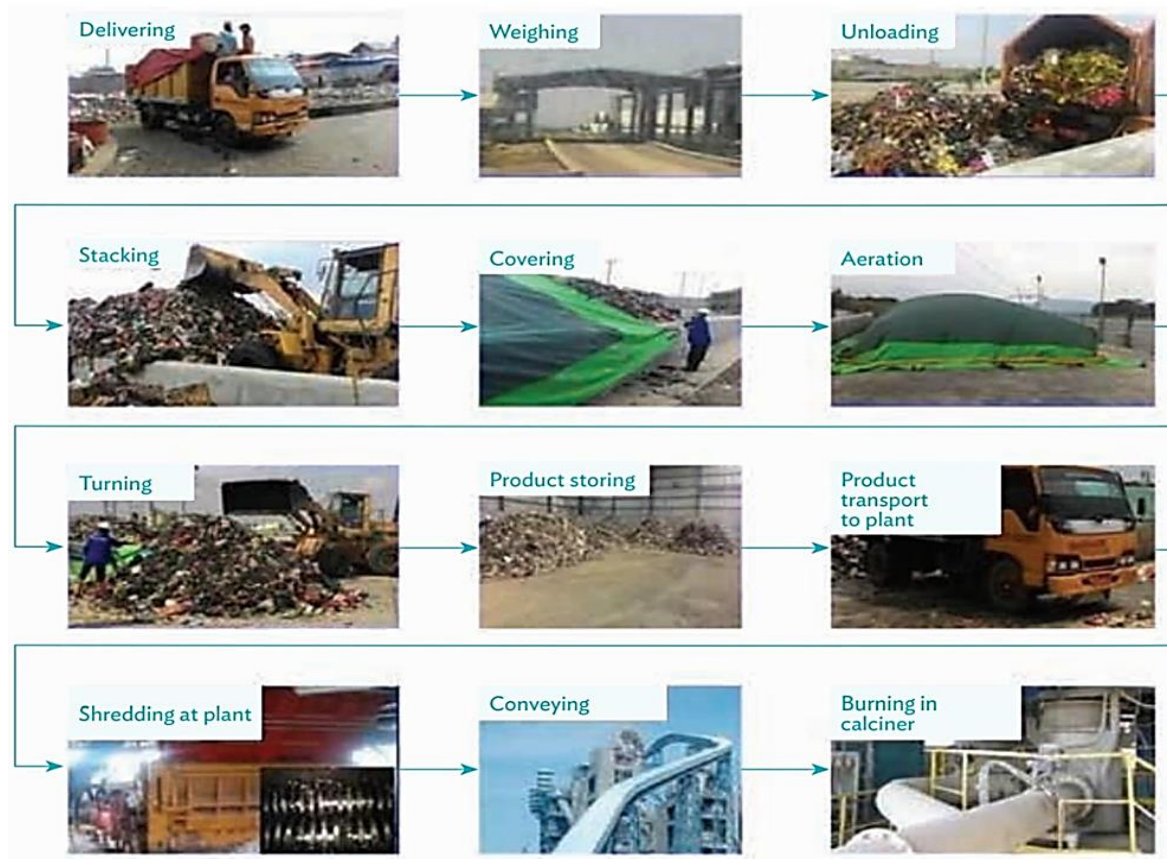
RDF consists largely of combustible components of municipal waste, such as plastics and biodegradable waste. Co-processing of RDF in cement plants has also become a widespread waste management system in several developing and emerging countries.

Mechanical biological treatment (MBT)²² involves the combination of various processes such as mechanical (e.g., sorting, shredding, milling, separating, or screening) and biological components (drying, composting, or anaerobic digestion) to create solid recovered fuel or RDF and divert organic materials for fertilizer and energy. This fuel can be further processed as pellets or briquettes and can be used as feedstock in energy facilities as a replacement for fossil fuels. MBT consists of different treatment processes and has four types of outputs:

1. RDF – has a high calorific value due to its high paper and plastic content.
2. Stabilized organic waste – produced from the biological treatment of the organic portion of the waste.
3. Ferrous and non-ferrous metals – for potential recycling; and
4. inert wastes – scraps/residues that are disposed of in landfills.

²² F. Fe, Z. Wen, and S. Huang. 2018. Mechanical Biological Treatment of Municipal Solid Waste: Energy Efficiency, Environmental Impact and Economic Feasibility Analysis. <https://doi.org/10.1016/j.jclepro.2018.01.060>

Figure 4.4: RDF Via Mechanical biological treatment



For RDF to be successful, a high percentage of the waste streams needs to have a high calorific value. According to GIZ Waste-to-Energy Options in Municipal Solid Waste Management, the minimum pre-sorted waste required is 50,000 tons per year. Presently, Bahawalpur City generates a minimum of 176,295 tons of pre-sorted per year. Furthermore, GIZ calculates the net operating cost of using RDF to treat waste in developing countries as 19-40 Euro per ton.

Refuse Derived Fuel is suitable for Bahawalpur, Punjab, due to its high waste quantity. MSW of Bahawalpur has 24% material that can be used for RDF production.

5.9.4 Composting Option for Bahawalpur:

Composting is an organic method of producing compost manure by decomposition and stabilization of organic matter. Composting process is commonly used method and results in the production of stable compost product reduced in size (when compared to initial size) and free from offensive odors. Compost is particularly useful as organic manure which contains plant nutrients (nitrogen, phosphorous and potassium) as well as micro nutrients which can be utilized for the growth of plants. Composting can be carried out in two ways - aerobically (with the presence of oxygen) or anaerobically (without the presence of oxygen) or vermin composting or by any other biological mechanism.

High moisture content suggests the applicability of wet treatment options, including composting and anaerobic digestion, which are more feasible options for the segregated organic stream of municipal waste. This could prove to be a feasible option because, during waste generation, a high amount of organic waste (more than 50%) with high moisture content (41.83%) was obtained that could be incorporated into compost successfully with the high percentage of biodegradable waste, at 52.69% of

municipal waste in Bahawalpur, composting will be the most practical means for intermediate treatment.

Carbon and Nitrogen are of utmost importance for compost values as their correct ratio favors waste to be used as a fertilizer. The present study's average calculated C/N value of household waste is 16.81%, which is within the recommended range. GIZ guidelines indicate that a Carbon Nitrogen Ratio should be in the range of 16-25. High C/N ratios can lead to prolonged composting duration. The C/N ratio can be regulated by selecting the most suitable combination of compost materials and adding bulking agents to ensure a final ratio within the optimum range. **Table 5.4** below shows the chemical characterisation of waste in Bahawalpur.

Table 5.4: Chemical characterization based composting potential of waste components in Bahawalpur, Punjab

City	Moisture (%)	Carbon (%)	Carbon/ Nitrogen
Bahawalpur, Punjab	41.83	26.50	16.81

Source: WACS Report, 2022

5.9.5 Material Recovery Facility (MRF) for Bahawalpur:

Suitable waste input for MRF includes sorted waste for recycling metal, glass, paper, plastics, and other valuables. The recyclables are stored in open spaces or small-scaled houses. Recyclables are sold to junkshops, recyclable shops, etc.

The waste characterisation study indicated a total of 24 % recyclable items in the waste stream. The potential of recycling in Bahawalpur is, therefore, 24%. Based on the waste characterisation survey, it is concluded that the Material Recovery Facility can be installed at the Transfer Station or at the Landfill site.

An example of the Philippines includes establishing a materials recovery facility (MRF), which is mandated to the local barangays (villages) under the Ecological Solid Waste Management Act of 2000 as the Centre for recovery of recyclable waste. Accordingly, the MRF shall have the role of a core facility of 3R activities operated by the villages with the participation of community residents. However, in most cases, the MRF facilities in the Philippines are operated mainly for the community-level composting of organic wastes since the recovery of valuable wastes by private junkshops is very active. The valuable wastes brought to the MRFs are very few.

Another example of MRF in Thailand includes waste banks establishing segregated recyclable wastes such as paper, glass, plastics, and metal recovered directly from the waste generation sources by the residents and/or community activities. The recovered recyclables are sold at the bank. The junk shops or the recyclers purchase the recovered waste from the bank. According to the report "Waste Minimization in Thailand: Experience and Trend" by Mr Rangsan Pinthong, Pollution Control Department, MONRE, Thailand, nowadays, more than 500 waste recyclable bank systems have been established in 30 provinces.

5.9.6 Biomethanation

Bio methanation is the process of conversion of organic matter in the waste (liquid or solid) to biomethane (biogas) and manure by microbial action in the absence of air, known as "anaerobic digestion".

The solid waste and the slaughterhouse waste is first mixed with raw sewage and conveyed to the primary digester. Effluent from the primary digester is sent to the secondary digester after stabilization. The raw gas generated from the primary and the

secondary digester is then sent to the gas storage/WTE plant. The excess effluent from the secondary digester will be re-circulated back to the primary digester for further generation of gas. The gas thus stored in the gas balloon is passed through a scrubber where gases like H₂S and SO₂ and moisture are removed from the gas. This clean gas is conveyed under pressure to the Power Plant to produce power. The excess sludge from the secondary digester is conveyed to the centrifuge to separate the liquid and solids for further disposal.

Biogas can be used as vehicle fuel or for generating electricity. It can also be burned directly for cooking, heating, lighting, process heat and absorption refrigeration.

In Pakistan, biomass is readily available in most areas of the country, particularly in rural areas. Biomass energy uses natural materials such as trees, plants, and wastes to make electricity and biofuel. It is also environmentally friendly. Since 1974, more than 1,700 biogas plants have been installed under a nationwide program funded by the Government of Pakistan.

NRSP provides the research to access the design, maintenance, usage and sustainability of biogas plants as an energy source at the household level. "Evaluation of Biogas Initiative in Punjab", National Rural Support Program (NRSP), August 2011.

The full cost of biogas plants in Punjab, Pakistan, is in ranges from Rs. 40,000 to Rs. 80,000 and above, depending on the size.²³ Based on the economic analysis conducted in the US, the total cost for a biogas plant, including all essential installations but not including land, is between 50-75 US \$ per m³ capacity. 35 - 40% of the total costs are for the digester.²⁴

Table 5.5 :Daily requirements of biogas plant by size

Plant Size(m ³)	Daily dung requirements (kgs)	Livestock requirements (cow/bullocks)	Daily water requirements (litres)	Gas Production (M ³ /day)
4	30	2-3	30	4
6	45	4-5	45	5-6
8	60	5-6	60	6-8
10	75	7+	75	8-10

5.10 PROPOSED SOLUTION FOR BAHAWALPUR CITY

Engineered bioreactor landfills store and compress the waste without neutralizing toxins or pathogens, but have in place stronger controls against soil, water and air pollution than dumpsites. Moreover, bioreactor landfills allow the recovery of methane gas, a byproduct of anaerobic decomposition of organic matter, which can be used for power generation. Well sited and operated bioreactor landfills provide the best option in waste management in view of their relatively low construction and operating costs and the type of wastes they are expected to handle. SLF is the best option considering

²³ <http://www.nrsp.org.pk/publications/Evaluation-Assessment-Studies/Renewable-Energy-Evaluation-of-Biogas-Initiative-in-Punjab.pdf>

²⁴ https://energypedia.info/wiki/Costs_of_a_Biogas_Plant#Production_Costs

the environmental, social and economic circumstances. Further, this can be complemented and enhanced by waste minimization and recycling strategies.

Based on the Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for Bahawalpur given under **Table 5.6**, the most suitable technological option for handling the municipal waste generated in Bahawalpur, Punjab, is the combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the Landfill. A centralized waste management facility will be handling MSW in the following steps:

- The most suitable technological option for handling 470 tpd combination of mechanical and biological treatment options enabling around 95% of the organics, recyclables and combustibles from the landfill and saving landfill airspace for longer time, recovering the economic potential of the waste and improving environment through reducing the methane emission from the landfill. Organic waste generated from sorting facility will be diverted to composting plant and Biodigester.
- Limited composting from source segregation waste from commercial waste generators that is animal dropping (dung), green waste and wood waste from nurseries, vegetable and fruit market and restaurants. Remaining organic waste will be utilized in Bioreactor landfill site in order to produce gas for recovery and revenue generation.
- A state-of-the-art MRF facility will be created to recover the recoverable recycles from mixed MSW. Initially the recovery will be less but it will increase gradually as primary waste collection incorporates confining of waste at point of waste generation and door to door waste collection system is implemented.
- The MRF area is located at existing dumpsite. The sorting area will be constructed with steel structures for roof with a ceiling height reaching approximately two stories' high. Dedicated machinery will be provided for sorting and segregation area such as a front-end loader and fork lifter. The operations involved in MRF are as follows:
- Waste will be off-loaded on a tipping floor at the MRF. The floor is divided into three chambers to ease the operations on first-in, first-out basis. The overall area can cater for 'two days' offloads, keeping a safety cushion for routine maintenance shutdowns. From tipping floor, front end loader will carry waste in batches and load into hopper. A bag opener is installed at the beginning of the segregation process. It will be used to open the closed bags. It will also work as a metering input device to control the throughput.
- After passing the bag opener, the waste will pass through a small horizontal conveyor belt, where larger components of the waste will be removed manually before entering other sorting equipment. The removal of large items from sorting line will not only safeguard the facility against unnecessary loading of bulk waste, but it will also save the mechanical equipment from avoidable wear and tear. At the end of pre-sorting conveyor belt, a magnet will be installed to recover ferrous metals.
- A Trommel screen with two distinct opening sizes of <90 mm and <6 mm is incorporated afterwards. Material below 90 mm is mostly organic, which will be dropped into trolleys placed right underneath the trommel. Once filled, the trolleys will be transported by tractors for further processing. As for the material < 6 mm which is primarily inert or fines, it will also be collected in a trolley and taken to landfill cells. This reject from MRF can be used as cover soil in waste cells.
- Waste stream after the trommel screen will pass from a Ballistic Separator and separated into two main streams: a) 3D or rolling fraction where all PET, HDPE, PP and other heavy fractions tend to jump towards the lower end of the system and b) 2D or flat fraction where all film and flat material tends to move upwards. During this

process, material is continuously shaken and consequently the dust and 'fines' are screened by the perforated surface of the blades.

- Another chamber separates non-ferrous metals with the help of Eddy-Current technique of aluminium sorting. Afterwards, the material is fed onto a manual sorting conveyor belt located inside the picking station where plastics, glass, paper, cloth and other materials are picked before non-ferrous metals. Waste sorting manually will be collected in containers placed beneath the chutes, which will be emptied in their designated areas within the sorting facility. These materials can then be consolidated with the help of baler for ease of transportation.
- Recyclables and RDF materials are fed onto a baler automatically to be packed in the shape of blocks. These are then stored for transportation to market. Industrial size shredder is proposed for reducing the size of larger waste components. The whole facility will have ventilation installed for creating a comfortable environment for the waste picking team. Recyclables will be sorted, which may be sold to the recycling industry. The remaining inert waste will be landfilled.

Table 5.6: Qualitative Evaluation Matrix of Intermediate Waste Treatment Options for Bahawalpur, Punjab

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF		Option 6: Bio-gas
Waste Type	Mixed waste	Biodegradable waste	Sorted waste for recycling	Combustible	Combustible (plastic, paper)		Biodegradable
Cost of Facility	No cost due to no facility	Cheaper	Cheaper	Very expensive	Expensive		Moderate
	-	A	A	B	A		A
Environmental Aspect	Need to acquire 100% collection efficiency	Odour if mishandled	Odour if mishandled	Need removal of pollutants from combustion gas emission. However, Incineration has additional environmental benefits as well.	Need removal of pollutants from combustion gas emission		Odour if mishandled
	B	A	A	A	A		A
Applicability	-	Small towns to large cities	Small communities to middle cities	For Large Cities	Medium to large cities		Villages /small towns in rural areas
	A	A	A	A	A		A
Actual Practical Experiences in Pakistan	Present	There is the Lahore Compost Company.	Not present (Few projects are underprocessed) ⁴¹	Not present	RDF as fuel in D.G. Khan Cement Company and Lafarge/Fauji Cement companies.		Present (Installed by NRSP)

Evaluation Items	Option 1: No Treatment (Current condition)	Option 2: Composting	Option 3: MRF	Option 4: Incineration	Option 5: RDF	Option 6: Bio-gas
	B	A	A	B	A	A
Recommendations for application to Bahawalpur solid waste intermediate treatment facilities	-	Highly Applicable	High potential/ proportion (27%), but if the compost plant is established, MRF is viable as both activities are interdependent.	Sufficient volume and adequate energy content but need seasonal data to decide	Not-suitable as a sufficient amount of combustibles is not present.	Organic matter was comparatively less as compared to other Cities
	-	A	A	B	A	A
Recommendation as per solid waste policies applicable to Bahawalpur, Punjab	Recommended options for waste utilization and recovery are Option 2: Composting, Option 3: Material Recovery Facility in Bahawalpur, Punjab					
	-	A	A	B	A	A
Evaluation Results		A	A	B	A	A

Legend: **A- Suitable**; **B- Not suitable**

Source: JICA Project Team, GWMC

Note:* NRSP stands for National Rural Support Programme (NGO).

** NRSP, Monitoring, Evaluation & Research Section, "Renewable Energy: Evaluation of Biogas Initiative in Punjab" August 2011

5.11 ECONOMIC ASPECT ANALYSIS

Economic analyses of various waste treatment methods have been conducted, revealing that bioreactor landfilling is the most economically viable option for low-income countries such as Pakistan. **Table 5.7** show the estimated total waste cost per tonne for various waste treatment methods.

Table 5.7: Economic aspect analysis of waste treatment methods²⁵ (UNEP, 2015)

World Bank Project Data	Low Income Countries	Lower Middle Income	Upper Middle Income	High Income Countries
Total Cost in US\$/ton				
Sanitary landfilling	10-30	15-40	25-65	40-100
Composting	5-30	10-40	20-75	35-90
Waste-to-energy incineration	NA	40-100	60-150	70-200
Anaerobic digestion	NA	20-80	50-100	65-150

Disclaimer: All estimates are for comparative purposes only and are not indicative of actual costs at any particular local site. Costs for reduction, reuse and recycling are not captured in this table.

²⁵ Incineration of Municipal Solid Waste February 2013, DEFRA UK

6. POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

6.1 INTRODUCTION

This chapter provides screening of potential environmental impacts of the proposed project, discusses the stakeholders' views, assesses the significance of the potential impacts, and recommends mitigation measures to minimize if not eliminate the potentially adverse impacts of the proposed activities. These include effects on the physical, biological, and socioeconomic surroundings.

The section provides details on the impacts related to the design, construction, operation, and closure/post closure phases of landfill components such as landfill cells, leachate collection network and treatment system, landfill gas collection and flaring system, AD and composting plant, material recovery facility, admin building, BWMC office building and associated road network. The Punjab EPA Rules and Regulations-2020, the Punjab EPA-(Amendment Act, 2017), and the ADB SPS, 2009 were all followed in carrying out the impact assessment of the Bahawalpur landfill.

Impact-screening matrices during each of the landfill development phases i.e. project design, construction, operation and closure/post closure are presented below.

6.2 METHODOLOGY FOR IMPACT SCREENING

Determining the significance of potential environmental impacts and their effects enables the identification of necessary mitigation and benefit enhancement measures as well as an estimation of the related financial costs associated with the impacts of a project. An impact can be either beneficial or adverse and is assessed by comparing the quality of the baseline conditions with the predicted quality once the project is under implementation or in place.

The procedure for determining the level of risk associated with each potential impact is described below.

The likelihood that the activity will have an effect on the environment, as well as the consequence of the effect occurring, are used to assess risk. It is frequently described as follows:

$$\text{Risk} = \text{Likelihood} \times \text{Consequence}$$

Likelihood Scale

Likelihood	Definition	Scale
Certain	Will certainly occur during the activity at a frequency greater than every week if preventative measures are not applied	5
Likely	Will occur more than once or twice during the activity but less than weekly if preventive measures are not applied	3
Unlikely	May occur once or twice during the activity if preventive measures are not applied	2
Rare	Unlikely to occur during the project	1

Consequence Scale

Consequence	Definition	Score
Catastrophic	The action will cause unprecedented damage or impacts on the environment or surrounding communities	5
Major	The action will cause major adverse damage on the environment or surrounding communities.	3
Moderate	No or minimal adverse environmental or social impacts	2
Minor	No or minimal adverse environmental or social impacts	1

Risk Score Table

Likelihood	Consequence				
		Catastrophic	Major	Moderate	Minor
	Certain	25	15	10	5
	Likely	15	9	6	3
	Unlikely	10	6	4	2
	Rare	5	3	2	1

Risk: Significant: 15-25

Medium: 6-10

Low 1-5

Any 'Medium' to 'Significant' risk requires an environmental management measure to manage the potential environmental risk. Judgment will be required concerning the application of an environmental management measure to mitigate low risk situations.

6.3 DESIGN/PRE-CONSTRUCTION PHASE

The impacts associated with the project location (sitting) are those which relate to its location at the designated site. These impacts are different from those which are associated with the project's construction and operational phases. The construction and operational impacts are associated with the activities such as land clearing, waste disposal, whereas the sitting impacts relate to the mere presence of a facility at the given location.

For the proposed project, the aspect of the project site, land use and design have been considered

Impact Screening Matrix

The 'activity wise' screening of potential impacts during the design/pre-construction phase is provided in **Table 6.1** below.

Table 6.1: ‘Activity Wise’ screening of possible Impacts during Design/Pre-Construction phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Landfill Site Selection	Likely	Moderate	Medium	Long Term
2	Integration of EIA/EMP requirements in construction bid documents	Likely	Moderate	Medium	Short Term
3	EMP implementation	Likely	Moderate	Medium	Short Term
4	Land acquisition and resettlement impacts	Likely	Moderate	Medium	Short Term
5	Impacts due to natural hazards	Likely	Moderate	Medium	Long Term

	Critical Risk Level
	Significant Risk Level
	Medium Risk Level
	Low Risk Level

6.3.1 Landfill Site Selection

Impacts

The IFC Guidelines contain specific criteria related to site selection for landfill sites that have been developed to ensure any potential Impacts resulting from landfill operation are minimized as far as possible. In case these Guidelines are not strictly implemented for the development of the proposed landfill, it could result in considerable irreversible, diverse or unprecedented impacts.

Proposed landfill site should be selected on the basis that it must comply basic Punjab government regulations, IFC EHS guidelines for waste management facilities and ADB SPS 2009.

Proposed selection of landfill site must take into accounts impacts from leachate, litter, dust, vector and odors on surrounding environment.

Mitigation Measures

The following mitigation measures will be implemented:

- The proposed landfill site has been selected in accordance with international landfill development standards and guidelines, including but not limited to the IFC Guidelines on Waste Management Facilities for Landfills.
- All parameters including site capacity, accessibility, acceptability, stability, environmental sensitivity, land use, socioeconomic receptors, and climate hazards have been considered, and the site has been selected accordingly.

- Site for Bahawalpur Landfill has been selected keeping in view environmental and social sensitive receptors and necessary design considerations have been provided to manage impacts related to leachate, litter, dust, vector and odors on surrounding environment.

6.3.2 Integration of EIA/EMP requirements in construction bid documents

Impacts

The bidding documents must reflect the requirement to select a qualified and experienced Contractor from the perspective of ensuring implementation of required safeguards during project development.

Mitigation Measures

- The proposed 'Safeguards unit' that will be developed at the PMU will be assigned the task to check that design and bid documents are responsive to key environmental, social and safety considerations, and that the proposed method of work reflects the boundaries defined in the EMP. The bid documents must include the EMP and its implementation cost must be reflected in the BoQ.
- EIA/EMP implementation and monitoring requirements must be part of bidding documents and necessary contractual binding must be agreed by project contractors before award of contract.
- Project contractors shall have qualified and experienced environmental staff to plan, arrange, implement, monitor and report EIA/EMP requirements.

6.3.3 EMP implementation

Impacts

Lack of contractor's environmental safeguard capacity or selection of environment non-responsive contractors may result in failure of EMP implementation and may be a source of number of non-compliances.

The responsibility of the PMU Punjab LG &CDD in collaboration with the focal agencies is to review and finalize the bidding documents relating to environmental issues.

Contractors that do not possess the required capacity for safeguards management must not be pre-qualified and selected.

Mitigation Measures

PMU Punjab LG &CDD shall review the contractor capacity with respect to safeguard management and contracts shall be awarded accordingly.

The Contractor will be required to define an Occupational and Environmental Health and Safety procedure for all work, including work camp operation, management of cement dust, and use of Personal Safety Equipment. These procedures should be developed and approved by the PMU in collaboration with the focal agencies before the Contractor commences any physical works on ground.

PMU Punjab LG&CDD shall ensure the project contractors are selected on merit and necessary funds has been allocated in the contract documents for EMP implementation and monitoring.

6.3.4 Land Acquisition and Resettlement Impacts

Impacts

The field visits for social safeguard assessment by PMU and EDCM team has been carried out in October and November to identify any sensitive receptors falling within 250 meters distance from landfill cells. None of the receptors is falling within 250 metres from the project site. Although, clusters of settlements are located near the project site, the nearest settlement is located at a distance of 520 metres from the boundary of the project site.

No land acquisition and resettlement impacts are anticipated as project will be constructed on state land already under possession by BWMC and being already used for dumping.

Mitigation Measures

The PMU Punjab LG&CDD shall ensure the following:

- Pending payment to all land owners must be paid before mobilization of construction contractors.
- Social safeguard unit shall ensure that project affected people has been paid following appropriate procedures and there are no grievances about land acquisition process of the site.

6.3.5 Impacts due to Natural hazards

Impacts

Site is located outside of seismically active area as it falls in Zone 2A on seismic map of Pakistan with moderate seismic risk. No fault lines or significantly fractured geologic structure is present within 500 meters of the perimeter of the proposed landfill cell development that may allow unpredictable movement of gas or leachate.

Site is located outside of flood plain, however, in case of high precipitation, there are chances of urban flooding. Surface drainage network will be provided in detailed design of landfill site to avoid risk of surface runoff and contamination.

Furthermore, extreme rainfall events in Bahawalpur do not show changing trends and also surface water drainage/diversion work is included in the project design to avoid percolation of rain water into the landfill cells.

Mitigation Measures

The PMU Punjab LG&CDD shall ensure the following:

- Bahawalpur Landfill infrastructure shall be designed keeping in view the seismic zone 2 A building considerations.
- Surface water diversion shall be included in the design to protect landfill from urban/flash flooding.
- Extreme precipitation events analysis shall be performed for landfill life i.e. 25 years, to predict and manage impacts of flash flooding.
- On site waste storage at loading bay shall be kept to minimum during high precipitation events.
- Emergency response plan shall be prepared by construction and operation phase contractors and will be submitted to PMU for approval to manage impacts of natural hazards such as earth quakes and floods.

6.4 CONSTRUCTION PHASE

Impact Screening Matrix

The screening of potential impacts during the construction phase is provided in **Table 6.2** below.

Table 6.2: Screening of Possible Impacts during Construction Phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Soil and Water Contamination	Likely	Major	Medium	Long Term
2	Air Quality Degradation	Likely	Moderate	Medium	Short Term
3	Loss of Vegetation	Likely	Moderate	Medium	Short Term
4	Damage to Wildlife	Likely	Moderate	Medium	Short Term
5	Health and Safety Hazard	Likely	Moderate	Medium	Short Term
6	Noise and Vibration	Likely	Moderate	Medium	Short Term
7	Hazardous and Non Hazardous Waste Disposal	Likely	Moderate	Medium	Short Term
8	Waste Effluent Disposal	Likely	Moderate	Medium	Short Term
9	Soil Erosion and Sedimentation	Likely	Moderate	Medium	Short Term
10	Soil Contamination	Likely	Moderate	Medium	Short Term
11	Employment Conflicts	Likely	Moderate	Medium	Short Term
12	Communicable diseases	Likely	Moderate	Medium	Short Term
13	Historical/Archaeological Sites	Unlikely	Moderate	Low	No Residual Impact
14	Impacts associated with Construction of Administration and BWMC office Buildings and Other Infrastructure	Likely	Moderate	Medium	Short Term
15	Impacts associated with Construction/Widening of Access Road	Likely	Moderate	Medium	Short Term



Critical Risk Level



Significant Risk Level
Medium Risk Level
Low Risk Level

6.4.1 Soil and Water Contamination

Impacts

If the proposed landfill is not developed in accordance with the finalized design and its corresponding design parameters, it could lead to a number of unanticipated impacts such as groundwater contamination due to inadequate liner installation etc.

Mitigation measures

The following mitigation measures will be implemented:

- Method statements must be prepared by the Contractor and approved by the Construction Supervision Consultant (CSC) prior to commencement of construction works.
- The CSC must closely monitor the construction works being conducted by the Contractor to ensure the finalized design is implemented in full and the landfill design is developed completely in compliance of the approved finalized designs.
- Any deviation by the Contractor from following the finalized design must be immediately highlighted and corrective measures must be implemented to ensure full compliance with the finalized design of the landfill.
- PMU Punjab LG &CDD shall ensure that construction activities are being carried out in compliance to project design following best international practices. It will closely review and monitor the activities of CSC and contractors involved in construction activities.

Water Quality (Surface and Groundwater)

Impacts

The project activities that can contaminate soil may also contaminate the surface water and groundwater. These include.

- Solid waste disposal
- Sewerage disposal
- Equipment/ vehicles maintenance
- Spillage/ leakage of fuels, oils and chemicals
- Campsite sanitation facilities

Preparation of designated area of land for subsequent development activities involves levelling of the ground surface, removal of vegetation, stockpiling and generation of construction waste. Construction of temporary infrastructure such as drainage culverts may be required.

The site formation may produce large quantities of run-off with high suspended solids loading in the absence of appropriate mitigation measures. This potential problem may be aggravated during rainy season.

The used engine oil and lubricants, and their storage as waste materials as the potential to create impacts if spillage occurs.

Waste oil may infiltrate into the surface soil layers, or runoff into local watercourses, increasing hydrocarbon levels.

Proper precautionary measures should be taken to prevent any spillage of the above materials and their subsequent runoff into the water bodies

During construction, impacts from the workers include waste and wastewater generated from eating areas, and sewage from temporary sanitary facilities.

Sewage is characterized by high levels of BOD, ammonia and E. Coli. Significant water quality impact will happen only if the sewage is discharged directly into the receiving waters without any prior treatment.

Mitigation Measures

During site development necessary precautions will be taken, so that the runoff water from the site gets collected to working pit and if any over flow is, will be diverted to near by greenbelt/ plantation area.

During construction activity all the equipments washed water will be diverted to working pit to arrest the suspended solids if any and the settled water will be reused for construction purposes, and for sprinkling on roads to control the dust emission, etc.

Sewage will be discharged into receiving water bodies after treatment

There are no nearby existing irrigation channels near the project site which will be affected during project establishment. There is least possibility that groundwater and surface water will be affected during the construction phase of the project.

Consideration shall be given to the stability of the sub-grade, the base liner system, the waste mass and the capping system. The sub-grade and the base liner will be sufficiently thick as per international standards and stable to prevent excessive settlement or slippage.

Bottom and cap lining system for each landfill cell must be designed for the protection of soil, groundwater and surface runoff.

An efficient leachate collection system must be provided to ensure leachate accumulation at the base of the landfill and keep it to a minimum.

6.4.2 Air Quality Degradation

Impacts

The impact to air and noise will be significant during the progress of the construction phase. The proposed landfill development will involve large scale earth works and transporting and dumping large quantities of dry material. This will likely lead to an increase in SPM (Suspended Particulate Matter) in and around the construction zones.

Potential sources of particulate matter emission during construction activities include earthworks (dirt or debris pushing and grading), exposed surfaces, exposed storage piles, truck dumping, hauling, vehicle movement on unpaved roads, combustion of liquid fuel in equipment and vehicles, land excavation, and concrete mixing and batching.

Vehicles carrying construction material are expected to result in increased Suspended Particulate Matter (SPM) levels near the haul roads. This can be of potential importance if the vehicles pass through the areas with a high concentration of sensitive receptors, such as residential areas, in this particular case.

The construction machinery and project vehicles will release exhaust emissions containing Carbon Monoxide (CO), Oxides of Sulfur (SOx), Oxides of Nitrogen (NOx)

and Particulate Matter (PM). These emissions can deteriorate the ambient air quality in the immediate vicinity of the project site.

Impacts of air emissions may be carried over long distances depending upon the wind speed, direction, temperature of the surrounding air and atmospheric stability.

At the construction yard, the dust levels are also expected to increase due to unloading of construction materials. It shall be ensured that most of the excavated material will be used within the project, with minimal cut and fill material to come from outside the site.

Poor air quality due to the release of contaminants into the workplace can result in possible respiratory irritation, discomfort, or illness to workers. Employers should take appropriate measures to maintain air quality in the work area.

The quantity of dust that will be generated on a particular day will depend on the magnitude and nature of activity and the atmospheric conditions prevailing on the day. Due to the uncertainty in values of these parameters, it is not possible to calculate the quantity from a 'bottom-up' approach, that is, from adding PM₁₀ emissions from every activity on the construction site separately. Typical and worst-case PM₁₀ emissions from construction sites have been estimated²⁶ as 0.27 megagram per hectare per month of activity (Mg/ha-month) and 1.04 Mg/ha-month, respectively.

Dust management plan for the project is prepared and provided as **Appendix A.8**.

Mitigation Measures

The following mitigation measures will be adopted for preservation of the environment:

- At the landfill site and the immediately adjoining areas, water will be sprinkled every three hours and at a higher frequency if felt necessary, at all construction sites to suppress dust emissions.
- For the proposed project site levelling and grading will be carried out, where ever possible to maintain the natural elevations
- Temporary tin sheets of sufficient height (3m) will be erected around the site of dust generation or all around the project site as barrier for dust control.
- Tree plantations around the project boundary will be initiated at the early stages by plantation of 2 to 3 years old saplings, regular watering will be done, so that the area will be moist for most part of the day.
- All heavy equipment and machinery shall be fitted in full compliance with the national and local regulations.
- Stockpiled soil and sand shall be slightly wetted before loading, particularly in windy conditions.
- Fuel-efficient and well-maintained haulage trucks shall be employed to minimize exhaust emissions.
- Vehicles transporting soil, sand and other construction materials shall be covered

²⁶ Gaffney, G. and Shimp, D. 1997. *Improving PM₁₀ Fugitive Dust Emission Inventories*. Sacramento, CA. California Air Resource Board. <www.arb.ca.gov/emisinv/pubs/pm10tmp.pdf>

with tarpaulin.

- Limitations to speeds of such vehicles as felt necessary. Transport through densely populated area should be avoided.
- Concrete plants to be controlled in line with statutory requirements and shall not be close to sensitive receptors.
- Stack height of generators will be at least 3 meters above the ground.
- Project traffic will maintain maximum speed limit of 20 km/hr on all unsealed roads within project area.
- A minimum distance of 300 meters will be ensured between batching plant(s) and the nearest community.
- The need for large stockpiles shall be minimized by careful planning of the supply of materials from controlled sources. Stockpiles should not be located within 50 m of schools, hospitals or other public amenities and shall be covered with tarpaulin when not in use and at the end of the working day to enclose dust. If large stockpiles (>25m³) of crushed materials are necessary, they should be enclosed with side barriers and also covered when not in use.
- Dust emissions due to road travel shall be minimized through good construction practices (such as keeping stock piles down wind and away from communities) and sprinkling water over the access road.
- Maintaining levels of contaminant dusts, vapors and gases in the work environment at concentrations below those recommended as TWA-TLV's (threshold limit value)—concentrations to which most workers can be exposed repeatedly (8 hours/day, 40 hrs/week, week-after week), without sustaining adverse health effects. .
- Developing and implementing work practices to minimize release of contaminants into the work environment including:
 - Direct piping of liquid and gaseous materials
 - Minimized handling of dry powdered materials; Enclosed operations
 - Local exhaust ventilation at emission/release points
 - Vacuum transfer of dry material rather than mechanical or pneumatic conveyance
 - Indoor secure storage, and sealed containers rather than loose storage
- Where ambient air contains several materials that have similar effects on the same body organs (additive effects).

Fugitive Dust Control

The source wise fugitive control measures are provided in **Table 6.3** below.

Table 6.3: Control measures for Fugitive Dust emissions

Source	Control Measures
Earth Moving	For any earth moving that is to take place in the immediate vicinity from the site boundary, watering must be conducted as required to prevent visible dust emissions
Disturbed Surface Areas	Apply dust suppression measures (clear vegetation only from areas where work is to commence, plant or mulch areas that will not receive traffic, construct artificial wind breaks or wind screens) frequently to maintain a stabilized surface. Areas that cannot be stabilized, such as wind driven dust, must have an application of water at least twice a day
Inactive Disturbed Surface Areas	Apply dust suppressants (clear vegetation only from areas where work is to commence, plant or mulch areas that will not receive traffic, construct artificial wind breaks or wind screens) in sufficient quantity and frequency to maintain a stabilized surface
Unpaved Roads	Periodic sprinkling on all roads used for any vehicular traffic at least twice per day during active operations and restrict vehicle speed to 20 kmph.
Open Storage Piles	Apply water to at least 80 percent of the surface areas of all open storage piles on a daily basis when there is evidence of wind driven fugitive dust or install an enclosure all along the storage piles Tarpaulin sheet should be provided on the storage piles to avoid dust emissions.
Track-out Control	Wash down of construction vehicles (particularly tyres) prior to departure from site.

Vehicular & Equipment Emissions

It shall be ensured that the following measures are taken to control emissions from vehicles being used in the construction activity:

- Periodically check and conduct maintenance of the construction machinery and haul vehicles. Generators, compressors and vehicles used during construction works will be maintained in a good condition to ensure that emissions are kept to a minimum level.
- Regularly change the engine oil and use new engines/machinery/equipment having good efficiency and fuel burning characteristics.
- Controlled technology generator and batching plants will be used to avoid excessive emissions.
- Burning of wastes at any site will not be allowed.
- The stack height of generators will be at least 3 meters above the ground.
- Training of the technicians and operators of the construction machinery and drivers of the vehicles.
- All type of machinery and generator must comply with the PEQS. Vehicles, which are not in compliance with PEQS are not allowed to use.

- Periodic emission monitoring of vehicles, generator and batching plants is proposed.
- Project activities should be planned to avoid harsh weather conditions.

6.4.3 Loss of vegetation

Impacts

The project site preparation and construction activities may necessitate the removal of the natural vegetation which will deteriorate the environmental quality. As landfill site is barren land comprised of sand dunes therefore no significant vegetation loss is anticipated from the project.

Mitigation Measures

Endeavours will be made to enhance the environment through a plantation of trees.

All preventive measures will be adopted to control the spill-over of chemicals and other effluents on the ground to protect the soil.

Ornamental trees and bushes will be planted in the project area, which will improve the scenic and aesthetic value of the area.

A buffer zone of indigenous plantation will be maintained along the Landfill site through plantation along the boundary.

6.4.4 Damage to Wildlife

Impacts

The project site is small and inhibits no wildlife, while smoke, chemicals, dust particles, and noise generated by construction machinery during the construction period are the scary factor for biota. Rodents and insects would lose their abode.

Impacts on wildlife may arise from the following project activities:

- Noise generated from project activities,
- Movement of personnel and vehicles,
- Lights used at the project facilities,
- Clearing of vegetation, and
- Improper disposal of wastes
- Endeavours will be made to enhance the environment through a plantation of trees.

Mitigation Measures

Following mitigation measures will be adopted to reduce the impact on wildlife:

- Special measures will be adopted to minimize impacts on birds, such as avoiding noise-generating activities.
- The measures to enhance natural vegetation in the area will benefit the area's fauna as well.
- The project staff will not be allowed to indulge in any hunting or trapping activities.
- Appropriate diffusers will be used to restrict the illumination within the project site.
- Nighttime construction works will not be undertaken.
- No off tracking will be practiced. Work area will be minimized and movement will be restricted to designated routes.

6.4.5 Health and Safety

a) Community Health and Safety

Impacts

The landfill development will involve the use of considerable heavy machinery at the project site along with posing the risk of community members falling into trenches. In addition, the risk to commuters on the road during the construction works will be significant and thus a number of precautionary measures will be necessary to minimize the risk of possible accidents. Community Health & Safety may be compromised during road travel particularly in night hours if adequate barriers and lighting is not provided at construction sites.

Land development and civil works can generate substantial amount of dusts particularly from excavations and dirt roads. Air emissions from hauling trucks and heavy equipment can also be pervasive. These particulates (especially PM10) and emissions from exhausts vehicles may pose some levels of health hazards to workers at the site.

Mitigation Measures

The following mitigation measures will be implemented:

- Work areas outside the project site, especially where machinery is involved, will be barricaded and will be constantly monitored to ensure that local residents, particularly children stay away while excavated areas being prepared for landfill related infrastructure will also be cordoned off. Also, no machinery will be left unattended, particularly in running condition.
- Local communities in the project area will be briefed on traffic safety, especially women who are the main care providers to children.
- Speed limit of 20 km/hr will be maintained by all project related vehicles and nighttime driving of project vehicles will be limited where possible.
- Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport.
- Contractor must take proper safety measures (placing warning tapes around excavations) to avoid people, especially children, accidentally falling into excavations.
- All the working platforms must be cordoned off with special care by well-trained skilled workers.
- Contractor will prepare construction management plan which will include the hazard prevention and safety plan, which will address health and safety of the people in the project area.
- PMU Punjab LG&CDD should ensure the contractor staff working in the the project are well trained and educated in the Health, Safety and Environment (HSE) hazards associated with their duties, and that of the public, in the project area.

b) Occupational Health and Safety (OHS)

Impacts

There is invariably an OHS risk when construction works for the landfill are conducted, and precautions will be needed to ensure the safety of the workers.

The major OHS hazards expected during the proposed activities are as follows:²⁷

Accident Hazards

- Falls from height, especially when standing/working on ladders;
- Slips, trips and falls, especially while carrying heavy or bulky loads;
- Cuts and injuries caused by sharp instruments and tools;
- Hazard of suffocation from asphyxiant gases released or from oxygen deficiency, during maintenance and cleaning operations;
- Burns caused by hot parts of equipment, steam lines etc, by release of hot water or steam;
- Electric traumas, caused by defective installations and equipment, especially portable;
- Musculoskeletal injury (especially of back), resulting from lifting and moving of heavy loads;

Physical Hazards

- Exposure to cold and/or heat stress, as a result of rapid movement between cold and hot areas;
- Exposure to UV radiation during welding operations;

Chemical Hazards

- Exposure to various chemicals, such as: adhesives, caulking compounds, fluxes (solder), hydrochloric acid, zinc chloride, tar and solvents, various greases and inorganic lead;

Biological Hazards

69. Exposure to parasites, such as hookworm, ascaris, and various mites, chiggers and ticks;

Ergonomic, psychosocial and organizational factors

- Psychological stress due to dissatisfaction at work due to issues with peers, superiors etc.;
- General ill feeling as a result of work in confined spaces and development of 'sick

²⁷ https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/publication/wcms_192256.pdf

building syndrome’;

Mitigation Measures

General

The Contractor will be required to prepare and implement an effective OHS Plan that is supported by trained OHS personnel and emergency response facilities. Construction contracts will include standard OHS measures and contractors will be bound to implement these fully.

Monitoring will be required to ensure that the health and safety plan based on contract specifications is followed.

- Cement feed hopper areas will be inspected daily to ensure compliance with the requirement of dust masks.
- Surfaces (including flooring and work surfaces) in camps, kitchens, dining areas and workshops should be solid and easy to clean. Flooring for work camps must be float finished concrete or better.
- All drivers engaged by Contractors must hold a valid license for the vehicle they are operating.
- Work in confined space shall be executed with available safety standards. Adequate monitoring and equipment shall be available to detect deficient oxygen levels.
- The Contractor shall submit to the Engineer for approval an emergency evacuation plan and practice the procedure annually.
- The Contractor shall submit to the Engineer for approval a site layout plan, identifying work areas, accommodation, kitchen, dining area, sanitary facilities, location of generators, plant and vehicle parking, transport routes through the camp, pedestrian routes through the camp, evacuation routes, emergency exits, batching plants, storage areas, waste facilities etc.
- Fire extinguishers should be provided throughout camps and work sites. Fire extinguishers should be inspected monthly and maintained as necessary.
- An adequate and reliable supply of safe drinking water shall be made available at readily accessible and suitable places including at all camps.
- The Contractor shall take samples from each supply of drinking water and arrange for analysis of these samples at EPA certified laboratory prior to its use by the Contractor's staff. The results of these tests for each supply must be submitted to the Engineer and must demonstrate that each water supply meets national and World Health Organization standards for drinking water.
- The Contractor shall provide and maintain adequate hygienic kitchens which are sheltered and separated from the living quarters. Kitchens shall include raised and washable surfaces suitable for food preparation.
- The Contractor shall provide and maintain adequate hygienic dining areas for staff. Work places and camps should be provided with both natural & artificial light. Artificial lighting should be powered by generator in the event of power cuts.

- Public sensitization training should be provided to workers to avoid social conflicts between residents and the construction contractor, Occurrence of any such impacts can be avoided by community sensitive project planning and implementation and through effective involvement of local administration.
- All OHS protocols should be implemented in true letter and spirit.
- Contractor must appoint an OHS resource to implement, monitor and report the HSE management plan to concerned authorities.
- Contractor must ensure the provision of first aid facility at construction site and camps through hiring medics and establishing a dispensary at the campsite.
- Reasonable number of first aid kits should be available on construction sites and within contractor camps.
- Site personnel will be provided appropriate type of personal protective equipment (PPEs). Contractor will ensure consistent use of PPEs.

Based on the type of hazard applicable during the proposed works at site, the mitigation measures as per IFC guidelines for Occupational Health and Safety (OH&S) must be implemented:²⁸

Emergency response plan to provide measures and guidance for the establishment and implementation of emergency preparedness plans during project execution is provided as **Appendix A.6.**

Mitigation Measures for Physical Hazards

Rotating and Moving Equipment

Injury or death can occur from being trapped, entangled, or struck by machinery parts due to unexpected starting of equipment or unobvious movement during operations. Mitigation measures related to rotating and moving equipment on workers are provided below:

- Designing machines to eliminate trap hazards and ensuring that extremities are kept out of harm's way under normal operating conditions.
- Where a machine or equipment has an exposed moving part or exposed pinch point that may endanger the safety of any worker, the machine or equipment should be equipped with, and protected by, a guard or other device that prevents access to the moving part or pinch point. Guards should be designed and installed in conformance with appropriate machine safety standards.
- Turning off, disconnecting, isolating, and de-energizing (Locked Out and Tagged Out) machinery with exposed or guarded moving parts, or in which energy can be stored (e.g. compressed air, electrical components) during servicing or maintenance.
- Designing and installing equipment, where feasible, to enable routine service, such

²⁸ <https://www.ifc.org/wps/wcm/connect/1d19c1ab-3ef8-42d4-bd6b-cb79648af3fe/2%2BOccupational%2BHealth%2Band%2BSafety.pdf?MOD=AJPERES&CVID=Is62x8I>

as lubrication, without removal of the guarding devices or mechanisms.

Vibration

Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits, should be controlled through choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure. Limits for vibration and action values. Exposure levels should be checked on the basis of daily exposure time and data provided by equipment manufacturers.

Other sources of vibration at construction site are rollers, compactors or any loose part of machinery exposure which may cause serious injury or workplace sickness. No equipment and machinery with loose or vibratory parts will be allowed to work. Such issues will be fixed through maintenance of the machinery on periodic basis. Use of rollers for land grading will be carried out during day times and with intermittent intervals to reduce the impacts of vibration on surrounding environment.

Considering the project setting, which is not in a congested urban environment and instead is a rural open setting, there is no potential risks with regards to vibration.

Electrical

Exposed or faulty electrical devices, such as circuit breakers, panels, cables, cords and hand tools, can pose a serious risk to workers. Overhead wires can be struck by metal devices, such as poles or ladders, and by vehicles with metal booms. Vehicles or grounded metal objects brought into close proximity with overhead wires can result in arcing between the wires and the object, without actual contact. Recommended actions include:

- Marking all energized electrical devices and lines with warning signs; ·
- Locking out (de-charging and leaving open with a controlled locking device) and tagging-out (warning sign placed on the lock) devices during service or maintenance;
- Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools; ·
- Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits; ·
- Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas; ·
- Conducting detailed identification and marking of all buried electrical wiring prior to any excavation work.

Eye Hazards

Solid particles from a wide variety of industrial operations, and/or a liquid chemical spray may strike a worker in the eye causing an eye injury or permanent blindness. Recommended measures include:

- Use of machine guards or splash shields and/or face and eye protection devices, such as safety glasses with side shields, goggles, and/or a full-face shield. Specific Safe Operating Procedures (SOPs) may be required for use of sanding and

grinding tools and/or when working around liquid chemicals. Frequent checks of these types of equipment prior to use to ensure mechanical integrity is also good practice. Machine and equipment guarding should conform to standards published by organizations such as CSA, ANSI and ISO.

Welding/Hot Work

Welding creates an extremely bright and intense light that may seriously injure a worker's eyesight. In extreme cases, blindness may result. Additionally, welding may produce noxious fumes to which prolonged exposure can cause serious chronic diseases. Recommended measures include:

- Provision of proper eye protection such as welder goggles and/or a full-face eye shield for all personnel involved in, or assisting, welding operations. Additional methods may include the use of welding barrier screens around the specific work station (a solid piece of light metal, canvas, or plywood designed to block welding light from others). Devices to extract and remove noxious fumes at the source may also be required.
- Special hot work and fire prevention precautions and Standard Operating Procedures (SOPs) should be implemented if welding or hot cutting is undertaken outside established welding work stations, including 'Hot Work Permits, stand-by fire extinguishers, stand-by fire watch, and maintaining the fire watch for up to one hour after welding or hot cutting has terminated. Special procedures are required for hot work on tanks or vessels that have contained flammable materials.

Industrial Vehicle Driving and Site Traffic

Poorly trained or inexperienced industrial vehicle drivers have increased risk of accident with other vehicles, pedestrians, and equipment. Industrial vehicles and delivery vehicles, as well as private vehicles on-site, also represent potential collision scenarios. Industrial vehicle driving and site traffic safety practices include:

- Training and licensing industrial vehicle operators in the safe operation of specialized vehicles such as forklifts, including safe loading/unloading, load limits.
- Ensuring drivers undergo medical surveillance.
- Ensuring moving equipment with restricted rear visibility is outfitted with audible back-up alarms.
- Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures (e.g. prohibiting operation of forklifts with forks in down position), and control of traffic patterns or direction.
- Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to 'one-way' circulation, where appropriate.

Ergonomics, Repetitive Motion, Manual Handling

Injuries due to ergonomic factors, such as repetitive motion, overexertion, and manual handling, take prolonged and repeated exposures to develop, and typically require periods of weeks to months for recovery. These OHS problems should be minimized or eliminated to maintain a productive work environment. Controls may include:

- Facility and workstation design with 5th to 95th percentile operational and maintenance workers in mind.

- Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi-person lifts if weights exceed thresholds.
- Selecting and designing tools that reduce force requirements and holding times and improve postures. ·
- Providing user adjustable workstations.
- Incorporating rest and stretch breaks into work processes and conducting job rotation.
- Implementing quality control and maintenance programs that reduce unnecessary forces and exertions.
- Taking into consideration additional special conditions such as left-handed persons.

Working at Heights

Fall prevention and protection measures should be implemented whenever a worker is exposed to the hazard of falling more than two meters; into operating machinery; into water or other liquid; into hazardous substances; or through an opening in a work surface. Fall prevention / protection measures may also be warranted on a case-specific basis when there are risks of falling from lesser heights. Fall prevention may include:

- Installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area. ·
- Proper use of ladders and scaffolds by trained employees. ·
- Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area, or fall protection devices such as full body harnesses used in conjunction with shock absorbing lanyards or self-retracting inertial fall arrest devices attached to fixed anchor point or horizontal life-lines. ·
- Appropriate training in use, serviceability, and integrity of the necessary PPE. ·
- Inclusion of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall.

These include:

Fire and Explosions

Fires and or explosions resulting from ignition of flammable materials or gases can lead to loss of property as well as possible injury or fatalities to project workers. Prevention and control strategies include:

- Fuel storage areas and generators will have secondary containment in the form of concrete or brick masonry bunds. The volume of the containment area should be equal to 120% of the total volume of fuel stored.
- Storing flammables away from ignition sources and oxidizing materials. Further, flammables storage area should be:

- Remote from entry and exit points into camps
 - Away from facility ventilation intakes or vents
 - Have natural or passive floor and ceiling level ventilation and explosion venting
 - Use spark-proof fixtures
 - Be equipped with fire extinguishing devices and self-closing doors, and constructed of materials made to withstand flame impingement for a moderate period of time .
- Defining and labeling fire hazards areas to warn of special rules (e.g. prohibition in use of smoking materials, cellular phones, or other potential spark generating equipment). .
 - Providing specific worker training in handling of flammable materials, and in fire prevention or suppression.

Corrosive, oxidizing, and reactive chemicals

Corrosive, oxidizing, and reactive chemicals present similar hazards and require similar control measures as flammable materials. However, the added hazard of these chemicals is that inadvertent mixing or intermixing may cause serious adverse reactions. This can lead to the release of flammable or toxic materials and gases, and may lead directly to fires and explosions. These types of substances have the additional hazard of causing significant personal injury upon direct contact, regardless of any intermixing issues. The following controls should be observed in the work environment when handling such chemicals: .

- Corrosive, oxidizing and reactive chemicals should be segregated from flammable materials and from other chemicals of incompatible class (acids vs. bases, oxidizers vs. reducers, water sensitive vs. water based, etc.), stored in ventilated areas and in containers with appropriate secondary containment to minimize intermixing during spills. .
- Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, face shield or goggles, etc).
- Where corrosive, oxidizing, or reactive chemicals are used, handled, or stored, qualified first-aid should be ensured at all times. Appropriately equipped first-aid stations should be easily accessible throughout the place of work, and eye-wash stations and/or emergency showers should be provided close to all workstations where the recommended first-aid response is immediate flushing with water.

Mitigation Measures for Biological Hazards

Biological agents represent potential for illness or injury due to single acute exposure or chronic repetitive exposure. Biological hazards can be prevented most effectively by implementing the following measures: .

- The contractor should review and assess known and suspected presence of biological agents at the place of work and implement appropriate safety measures, monitoring, training, and training verification programs.

- Project contractor must provide good working and sanitation conditions at camp and work sites. Disease surveillance should be carried out to identify any exposure to parasites, such as hookworm, ascaris, and various mites, chiggers, ticks and dengue.
- Measures to eliminate and control hazards from known and suspected biological agents at the place of work should be designed, implemented and maintained in close co-operation with the local health authorities and according to recognized international standards.

6.4.6 Noise and Vibration

Impacts

The impact of noise will be significant during the progress of the construction phase. The sources of impacts mostly are the vehicles and equipment that will be moving around the construction site, entering and leaving the project site.

Noise disturbance during the construction phase is inevitable due to the operation of typical construction equipment and machineries. This equipment typically has average noise levels of 70 – 105 dB at 15m.

The noise to be generated by these equipment and machines are expected to be confined within a radius of 500 meters up to 1 kilometer from the construction site. Any distance further than 1 kilometer will no longer experience the impact of the construction activities.

The detailed mapping of sensitive receptors has been conducted and the types of receptors and their respective distances from the work sites are provided earlier. However, any required mitigation measures that shall be proposed will be to control potential impacts on noise to prevent any long-term impacts within the project area.

The assessment of the noise impacts on the sensitive receptors that have been identified at various locations in the project area depends upon:

- Characteristics of noise source (instantaneous, intermittent or continuous in nature)
- Time of day at which noise occurs, and
- Location of noise source

Each construction activity has its unique noise characteristics due to use of different equipment items. The potential sources of noise during the preparation, construction, and worksite closure phases for the landfill works include equipment, machinery, and transportation used for the construction activities. The equipment used for construction will be the major source of noise.

The construction activities will include use of a large number of trucks, generators, excavators etc., which can generate significant noise.

Since various modern machines are acoustically designed to generate low noise levels, any high noise levels that might be generated will only be for a short duration during the construction phase.

Depending on the construction equipment used and its distance from the receptors, the community and the workers may typically be exposed to intermittent and variable noise levels. During the day, such noise results in general annoyance and can interfere with sleep during the night. In general, human sound perception is such that a change

in sound level of 3 dB is just noticeable, a change of 5 dB is clearly noticeable, and a change of 10 dB is perceived as a doubling or halving of sound level.

Due to the various construction activities, there will be temporary noise impacts in the immediate vicinity of the project site. The movement of heavy vehicles, loading, transportation and unloading of construction materials produces significant noise during the construction stage. However, these increased noise levels will prevail only for a short duration during the construction phase.

The **Table 6.4** below represents typical noise levels from various construction equipment items. It should be noted that the values indicated in the table may differ depending on the brand and age of machinery provided/used by construction contractors.

Table 6.4: Construction Equipment Noise Ranges, dB(A)

Equipment	Peak Noise Range at 15 m	Typical Peak Sound Level in a Work Cycle ^a at 15 m	Typical 'Quieted Equipment' Sound Level ^b at 15 m	Construction Phase		
				Earthworks	Structures	Installation
Batching plant	82-86	84	81		Y	
Concrete mixers	76-92	85	82		Y	
Cranes	70-94	83	80		Y	Y
Excavators	74-92	85	82	Y		
Front loader	77-94	85	82	Y	Y	Y
Water bowzers	85-93	88	85	Y	Y	Y
Graders	72-92	85	82	Y		
Bulldozers	65-95	85	80	Y		
Pavers	87-89	88	80	Y		
Pumps	68-72	76	75	Y	Y	Y
Diesel generators	72-82	81	77		Y	Y
Drilling machines	82-98	90	87		Y	Y
Compressors	74-88	81	71		Y	
Dumpers	77-96	88	83	Y	Y	
Dump/flatbed Truck	75-85	80	77	Y	Y	Y

Sources: USEPA, 1971; <http://www.waterrights.ca.gov/EIRD/text/Ch11-Noise.pdf>;
http://www.lacsd.org/LWRP%202020%20Facilities%20Plan%20DEIR/4_6_Noise.pdf;
<http://newyorkbiz.com/DSEIS/CH18Construction.pdf>

Notes:

- a. Where typical value is not cited in literature, mean of the peak noise range is assumed
- b. Quieted equipment can be designed with enclosures, mufflers, or other noise-reducing features. Where data is not available, a 3 dB reduction is assumed

Precise information on the type, quantity and location of equipment to be used during the construction phase is not available at this stage and will be dependent on the working methods of the selected contractors. However, preliminary calculations have been conducted to provide a general magnitude of the noise levels during various construction phases.

The mitigation measures listed below shall be implemented to minimize noise levels during the construction activity as far as possible.

Mitigation Measures

The following mitigation measures will be implemented:

- Equipment noise will be reduced at source by proper design, maintenance and repair of construction machinery and equipment. Noise from vehicles and power generators will be minimized by use of proper silencers and mufflers.
- Excessive noise emitting equipment will not be allowed to operate and will be replaced.
- Blowing of horns will be prohibited on access roads to work sites.
- As a rule, the operation of heavy equipment shall be conducted in daylight hours.
- Construction equipment, which generates excessive noise, shall be enclosed or fitted with effective silencing apparatus to minimize noise.
- Well-maintained haulage trucks will be used with speed controls.
- Use of ear plug and ear muffs must be ensured during construction. No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C).
- Prior to the issuance of hearing protective devices as the final control mechanism, use of acoustic insulating materials, isolation of the noise source, and other engineering controls should be investigated and implemented, where feasible.
- Periodic medical hearing checks should be performed on workers exposed to high noise levels.
- All the equipment and machinery used during construction phase should be well maintained and in compliance with PEQS.
- Grievance redress mechanism to deal any public complaints related to noise is established.

6.4.7 Hazardous and Non-Hazardous Waste Disposal

Impacts

During construction/civil works potential sources of waste will include spoils generated during landfill cells excavation, excavation waste for other civil works, domestic wastes

(solid & wastewater), fuel or oil leakages or spills, onsite effluents from vehicle wash & cleaning, and cement spills.

Waste disposal of materials containing contents of both hazardous and non-hazardous nature such as scrap wood, bricks, concrete, asphalt, plumbing fixtures, piping, insulation (asbestos and non-asbestos), metal scraps, oil, electrical wiring and components, chemicals, paints, solvents etc. can potentially become a serious environmental issue, particularly with the local contractors. To avoid any potential issue, the PMU in collaboration with focal agencies will need to impose adequate internal controls.

Domestic wastes generated during construction Bahawalpur SWF will include sewage, grey water (from kitchen, laundry, and showers), kitchen wastes, combustible wastes and recyclable wastes from contractor camps.

Mitigation measures

A waste management plan will be developed prior to the start of construction. This plan will cater to sorting of hazardous and non-hazardous materials prior to disposal, placing of waste bins at the project sites for waste disposal and an onsite hazardous waste storage facility i.e. designated area with secondary containment.

Licensed waste contractors will be engaged to dispose off all non-hazardous waste material that cannot be recycled or reused.

- Excavated material from landfill cells will be stored at site and it will be used as daily cover within landfill cells.
- All types of combustible and non-combustible waste including plastic or glass bottles and cans will be temporarily stored on site and later sold/handed over to a waste/recycling contractor who will utilize these wastes for recycling purposes.
- Waste management training for all site staff to be included in Contractor's training plan.
- Fuel storage areas and generators will have secondary containment in the form of concrete or brick masonry bunds. The volume of the containment area should be equal to 120% of the total volume of fuel stored.
- Fuel and hazardous material storage points must be included in camp layout plan to be submitted for approval. Hazardous material storage areas shall include a concrete floor to prevent soil contamination in case of leaks or spills. Fuel tanks will be checked daily for leaks and all such leaks will be plugged immediately.
- Designated vehicles/plant wash down and refueling points must be included in camp layout plan to be submitted for approval.
- Hazardous waste will be initially stored on site at designated area and then handed over to EPA certified contractor to final disposal.
- Record of waste generation and transfer shall be maintained by project contractors.
- Spill kits, including sand buckets (or other absorbent material) and shovels must be provided at each designated location.
- At the time of restoration, septic tanks will be dismantled and backfilled with at least 1m of soil cover keeping in view landscape of surrounding natural surface.

- It will be ensured that after restoration activities, the campsite is clean and that no refuse has been left behind.
- Clinical wastes will be temporarily stored onsite separately and will be handed over to approved waste contractor for final disposal.
- Training will be provided to personnel for identification, segregation and management of waste.
- The structure of a Framework waste management plan has been prepared for the project and attached as **Appendix A.13** and contractors will be required to prepare waste management plan for the site in light of guidelines provided in the waste management plan and submit to PMU LG&CDD for approval.

6.4.8 Waste Effluent Disposal

Impacts

The staff and labor camps for the construction of the proposed landfill will be a source of wastewater generated from the toilets, washrooms and the kitchen. The wastewater will not meet the national environmental standards and will therefore need treatment prior to disposal.

The project sites where construction is being conducted must not be treated by the project staff and/or labor as a public toilet or for disposal of camp effluent.

Mitigation measures

- It will be ensured that no untreated effluent is released to the environment.
- A closed sewage treatment system including soak pits and septic tank will be constructed to treat the effluent from the construction/labor camps.
- Sewage treatment system will be installed at each respective labor camp based on the number of laborers residing at the respective camp.
- Wastewater from laundry, kitchen washings and showers will be disposed-off into soak pits or septic tank (where soak pit cannot be constructed) and after treatment it will be disposed of in TMA provided drains in the project area.
- Soak pits will be built in absorbent soil and shall be located 300 m away from a water well, hand pump or surface water body. Soak pits in non-absorbent soil will not be constructed.
- Ensure that the soak pits remain covered all the time and measures are taken to prevent entry of rainwater into them.
- Sprinkling of grey water or sewage will not be allowed; in case the septic tank gets filled with sludge, septic tank shall be emptied through vacuum truck and material shall be transferred to treatment facility or approved municipal drain.
- Water being released from any batching plant(s) must be treated as per requirements of PEQS prior to release to sewerage system/any other water body.
- Sewage at the end of construction period to be disposed of in nearest municipal drains after getting approval from concerned municipal authorities.

6.4.9 Soil Erosion and Sedimentation

Impacts

The majority of the works proposed for development of the landfill may result in soil erosion and sedimentation. Spoils will be generated from the excavation activities, particularly during construction of landfill cells. Potential impacts from spoils and their disposal are (i) land for disposal of spoil, (ii) potential erosion from the spoil areas and spoil material reaching the waterways, and (iii) aesthetic impacts. Excavated soil will be stored at site and will be used as daily cover during landfill operations.

Mitigation measures

Any drainage structures, culverts or pipes crossing the project site may need to be modified or protected and the detailed designs must make provisions to protect or re-provision all infrastructure that may be affected by the construction works.

6.4.10 Soil Contamination

Impacts

During the project construction, spills of fuel, lubricants and chemicals can take place while transferring from one container to another or during refueling. Also, during maintenance of equipment and vehicles, through leakages from equipment and containers and as a result of traffic accidents.

Depending on the nature of the material, location of spill and quantity of spill, the soil can get contaminated.

Mitigation measures

- It will be ensured that spill prevention trays are provided and used during refueling. Also, on-site maintenance of construction vehicles and equipment will be avoided as far as possible. In case on-site maintenance is unavoidable, tarpaulin or other impermeable material will be spread on the ground to prevent contamination of soil.
- Regular inspections will be carried out to detect leakages in construction vehicles and equipment and all vehicles will be washed in external commercial facilities.
- Fuels, lubricants and chemicals will be stored in covered bounded areas, underlain with impervious lining. Appropriate arrangements, including shovels, plastic bags and absorbent materials will be available near fuel and oil storage areas.

6.4.11 Employment Conflicts

Impacts

The proposed construction of Bahawalpur Landfill is not likely to create any significant permanent job opportunities. Even unskilled and semi-skilled employment opportunities that are likely to be created will be for a short period, while the landfill project is constructed. As persons with relevant skills may be available locally, people from the project area are likely to fill a significant number of the semi-skilled and skilled jobs.

This issue of provision of jobs can become particularly problematic if it is perceived by the local population that a significant number of construction-related jobs opportunities are not given to people from the local community. This can result in friction between local residents and construction workers from outside of the community.

Mitigation measures

- The Construction Contractor will adopt a transparent hiring policy. Prior to the

commencement of the construction activity, the local communities in the project area will be informed of the employment policy in place and number of people that can be employed for this project.

- It will be ensured that maximum number of unskilled and semi-skilled jobs will be provided to the residents of the project area.
- The PMU Punjab LG & CDD will ensure a balanced process of employment of the communities in the project area with preference given to those most directly affected by the project.

6.4.12 Historical/Archaeological Sites

Impacts

No historical/archaeological sites have been identified in the project area or project site.

Mitigation measures

If evidence of any archaeological remains is found during the construction activities, the excavation work will be stopped immediately, and necessary next steps taken to identify the archaeological discovery based on the 'Chance Find' procedures provided as **Appendix A.7**.

6.4.13 Impacts associated with Construction of BWMC Office and Administration Buildings and other infrastructure

Impacts

Bahawalpur LFS will have proper facilities like administration building, waste reception areas, weigh bridge, waste inspection area, wheel wash area, site services and security fencing and professionally trained workers to operate and supervise.

An Administration building will be constructed within landfill to house administration staff and manage the facility operations within Bahawalpur landfill. It is planned such that it can accommodate landfill operations team, has a laboratory for quality control and MIS monitoring room for data acquisition and transfer to head office. The building also contains a conference room for meetings at landfill, an inventory room for storing supplies for repair and maintenance of landfill machinery and vehicles. There are showers, prayer area, rest rooms and a kitchen in the building. A car park outside the building will be constructed for personnel's vehicles. The area of the administrative building is surrounded by landscaping and greenery.

Roads inside the premises will be constructed. Road 10 m wide with two lanes each 4 m for two-way traffic of waste carrying vehicles will be constructed. Access roads within cells (8 meters wide) will be constructed at 1:10 longitudinal slope. Vehicle parking shed for waste vehicles, a workshop for routine repair and maintenance work will be constructed.

BWMC office building will be constructed on already owned land (1.12 acres) of BWMC located at Hasilpur road. Building will comprise of ground floor plus 4 storeys. Building will be used for office of BWMC and other floors are rented out to commercial parties in order to generate revenue for the company.

Soil erosion is main impact during construction of admin and BWMC office buildings and associated infrastructure. Construction of roads or other facilities has also been historically perceived and in some cases has actually led to soil erosion. The possibility of soil erosion has been assessed in detail in the following paragraphs.

The possibility of soil erosion from a human activity increases when soil particles are detached from the soil mass. This is true for agricultural lands where a certain landscape is changed and the area is left exposed to wind and water erosion and also for dirt tracks which are developed through continual use by vehicles and the soil surface is subject to continual erosion for as long as the track is used. However, these cases are different from scenarios in which the soil surface initially disturbed is sealed or compacted by engineering means. For example, metalled roads are not subject to soil erosion, similarly neither would the gravel-topped roads which will be compacted to sustain loads.

Other environmental impacts from construction of administration and BWMC office buildings includes construction debris, unattended concrete and cement waste, brick waste, littering and empty cement bags which required to be disposed off as per waste management plan. Flooring works will add to slurry waste resulting from grinding activities. Noise from mixing plants, steel fixing works, wood works is another source of environmental nuisance which need to be managed. Use of generators, vehicles and machinery may be source of air pollution if not managed.

All the identified sensitive receptors are located at safe distance from administration building and BWMC office building and impacts associated with construction of buildings are limited to construction sites only and also of short duration which can be managed through good construction management practices.

On the basis of the above it can be assessed that on a macro level environmental impacts from construction of admin building within landfill site, BWMC office building at Hasilpur road and associated infrastructure will not be a significant issue as all these impacts will be managed through implementation of site specific EMMP prepared by contractors and approved by CSC/PMU.

Mitigation measures

Following are the mitigations measures that will be employed to manage impacts from construction of BWMC office building at Hasilpur road, administration building within landfill site and associated infrastructure.

- Water will be sprinkled regularly to suppress dust emissions. Off road travelling of vehicles will be prohibited.
- Stock piles will be appropriately located and out of wind to avoid dust emissions. Dry dusty materials should be sprinkled with water and properly covered to avoid dust emissions.
- No cement and concrete waste will be left unattended. Construction debris will not be thrown from height to avoid dust emissions. Return unpaved areas to original or improved contours following construction.
- Solid waste generated from construction of admin and BWMC office buildings will be managed through site specific EMMP and no waste will be stored at site to improve housekeeping at site and to avoid environmental nuisance.
- Set protocols for proper and regular maintenance of construction machinery, vehicles and generators working at building sites. Generators that will be used will be placed at suitable locations in order to avoid nuisance.
- Contractor will not be allowed to store bulk quantities of fuel or hazardous material at building sites.
- Any fuel or chemicals stored at building sites (in small quantities) will be stored at designated site and containers/storage vessels be properly marked for their contents. Storage area will be provided with hard impervious surface and secondary containment.

- Equipment and machinery with loose vibratory parts will not be allowed to use. Used equipment and machinery will be in compliance to PEQS.
- Waste bins will be provided at appropriate places to manage waste. Daily housekeeping of the construction area will be carried out.

6.4.14 Impacts associated with Construction of Access Roads

Impacts

Following approach roads will be constructed as part of Bahawalpur ISWMS.

- The TS+MRF location at the current waste dumpsite will require new road construction of about 05 km. Out of this 2.5km will be extension of single road to double lane and 2.5km new two-way road.
- The access road to new landfill site will require 2.5km new road from the main access road and improvement of the main access road for about 10km.
- Road construction may impact physical and chemical soil conditions, water flow and air and water quality, as well as plants and animals.
- Major activities of road works will include preparation of sub-grade, sub-base, base and wearing course. Major equipment to be involved in road widening works are tractor, bulldozer, roller, compactor, shovel, grader, dumper, aggregate distributor and spreader, asphalt mixer, bitumen boiler and sprayer, concrete mixer and paver, batching plant and finisher.
- The development of the access road will involve earth works and transporting and dumping large quantities of debris material. This will likely lead to an increase in SPM (Suspended Particulate Matter) at the road construction site. Construction of roads has been historically perceived and, in some cases, has actually led to soil erosion. The landfill development will involve the use of considerable heavy machinery at the project site along with posing the risk to commuters on the road during the construction works.
- Main impacts associated with road widening are noise, dust and vibrations and construction waste. Noise mainly occurs during road construction phases but it can also occur to a lesser degree during maintenance operations. Dust is created during the construction of roads and unbound aggregate layers. Dust is an almost inevitable consequence of roadwork. Gravel and crushed gravel and hard rock aggregates always contain a proportion of fines, and if the material is dry, a fairly heavy dust cloud can be raised when it is mobilized. The resulting dust can disturb both the population and the local environment.
- Excess dust production can be treated by a range of measures such as watering, use of alternative materials and by using dust binders near houses. Vibration can be caused by uneven road surfaces and can pose significant impacts and problems to houses close to the source. Vibrations disturb people close to roads but they may also cause damage to buildings and sensitive equipment. Scarification, material cutting, formworks and foundation works and poor material management are the sources of waste generation during widening of roads.

Mitigation Measures

The following mitigation measures will be implemented during construction of the proposed access road:

- The road widening will be to a standard that is suitable for movement of high-capacity waste carrying vehicles.
- BWMC/PMU will maintain close coordination with the residents falling close to road widening works, project information leaflet will be distributed to them and awareness with respect to impacts (noise, dust and vibrations) associated with construction will be provided. If people are notified, their acceptance of the disturbance is usually higher.
- BWMC/PMU will arrange community consultation session before commencement of construction works to make public sensitization which will facilitate smooth execution of project activities.
- Compaction with heavy vibration rollers should be avoided or minimized in built-up areas.
- Work areas outside the project site, especially where machinery is involved, will be barricaded and will be constantly monitored to ensure that local residents, particularly children stay away.
- Local communities in the project area will be briefed on traffic safety, especially women who are the main care providers to children.
- Traffic diversions will be planned in such way that it does not create traffic congestion during road widening works. Road closure for the works will be avoided.
- Proper drainage system will be provided in order to achieve sustainability.
- Off-road travel will be strictly prohibited and observance of this will be monitored during execution of the project.
- Vehicle speed will be regulated and monitored to avoid excessive dust emissions.
- Blowing of horns will be prohibited on access roads to work sites.
- Periodic sprinkling on access road at least twice per day during construction phase and restrict vehicle speed to 20 kmph.
- Project traffic will maintain maximum speed limit of 20 km/hr on all unsealed part within project area.
- Traffic is not disrupted by labor camps being set up roadside next to the construction sites.
- Contractor will prepare construction management plan which will include the hazard prevention and safety plan, which will address health and safety of the people in the project area.
- PMU Punjab LG&CDD should ensure the contractor staff working in the project are well trained and educated in the Health, Safety and Environment (HSE) hazards associated with their duties, and that of the public, in the project area.
- Record of waste generation and transfer shall be maintained by project contractor.
- Periodic water sprinkling will be carried out during widening works to suppress dust.

- Fuel-efficient and well-maintained equipment and machinery shall be employed to minimize exhaust emissions.
- The need for large stockpiles shall be minimized by careful planning of the supply of materials from controlled sources. Stockpiles should not be located within 50 m of schools, hospitals or other public amenities and shall be covered with tarpaulin when not in use and at the end of the working day to enclose dust. If large stockpiles ($>25\text{m}^3$) of crushed materials are necessary, they should be enclosed with side barriers and also covered when not in use.
- Prior to starting of work, the contractor should prepare a method statement for water supply pipeline works. This should be simple and explain the contractor's work process that is actually conducted on site, with safety and safeguard concerns.
- Method Statement is very important, particularly for the road widening works.
- Method Statement can be prepared for each stretch (say 1 km) /specific site based on the project area.
- Method Statement should be in a Table format with appended site layout map and cover the following:
 - Work description
 - No. of workers (skilled & unskilled)
 - Details of Plant, equipment & machinery, vehicles
 - Work duration (total, and activity-wise, for example for preparation of sub grade, sub-base, base and wearing coarse
 - PPE (helmet, gloves, boots, etc.) details for each type of work
 - Details of materials at each site (type & quantity)
 - Risks/hazards associated with the work
 - Construction waste/debris generated (details & quantity)
 - Detail the sequence of work process (step-by-step) including specific details of each work
 - Contractor's supervision & management arrangements for the work
 - Emergency: Designate (i) responsible person on site, and (ii) first aider
 - Typical site layout plan including placement of material, excavated earth, barricading etc.
- The following should be included in the site layout plan:
 - Provide barricading/security personnel at the site to prevent entry/trespassing of pedestrian/vehicles into the work zone.
 - Location of temporary stockpiles and provision of bunds
 - Separation of stockpiles areas with workers/vehicle movement paths to avoid

disturbing the stockpiled soil

- Wetting of soil to arrest dust generation by sprinkling water
- Waste/surplus soil utilization and disposal plan – indicate expected duration of temporary stockpiling along the road and identify final surplus soil utilization/disposal site in consultation with PMU.
- PMU Punjab will ensure the identification of disposal sites for unsuitable excavated material in consultation with BWMC.
- PMU will inspect and monitor the borrow material areas prior to procurement to ensure that it is being used in sustainable way and no significant disfiguration of landscape is going on at quarry site.
- Stock piling of excavated material at places that are congested will be avoided as these piles can create traffic issues and public nuisance.
- Already available quarry sites for additional backfill material will be utilized. Development of new quarry site will be discouraged.
- Record of borrow materials will be maintained including details of quarry site, agreement and necessary approvals from concerned government authorities.

6.5 IMPACTS ASSOCIATED WITH OPERATION OF LANDFILL

70. The potential impacts from operation of the Landfill are provided as **Table 6.5** below.

Operation Phase

Table 6.5: Screening of Possible Impacts during Operation Phase

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
1	Leachate Generation	Likely	Major	Medium	Long Term
2	Soil and Groundwater Contamination	Likely	Major	Medium	Long Term
3	Landfill Gas Generation	Likely	Major	Medium	Long Term
4	Air Quality Deterioration	Likely	Major	Medium	Long Term
5	Disease Vector Generation and Vermin Attraction	Likely	Major	Medium	Long Term
6	Occupational Health and Safety	Likely	Major	Medium	Long Term
7	Waste Collection and Hauling Impacts	Likely	Major	Medium	Long Term

S/No.	Potential Impacts	Likelihood (Certain, Likely, Unlikely, Rare)	Consequence (Catastrophic, Major, Moderate, Minor)	Risk Level (Significant, Medium, Low)	Residual Impact (Short term, Long term)
8	Wind Blown Litter	Likely	Major	Medium	Long Term
9	Medical Waste Management	Likely	Major	Medium	Long Term
9	Solid waste & health and sanitation	Positive impacts expected			Long Term positive residual impact
10	Public Health	Positive impacts expected			Long Term positive residual impact
11	Aesthetic aspects	Positive impacts expected			Long Term positive residual impact
12	Construction and Demolition Waste Disposal	Positive impacts expected			Long Term positive residual impact
13	Medical Waste Disposal	Positive impacts expected			Long Term positive residual impact

	Critical Risk Level
	Significant Risk Level
	Medium Risk Level
	Low Risk Level
	Positive Impacts

6.5.1 Leachate Generation

Impacts

The general risks from leachate generated from wastes are due to its normally high organic contaminant concentrations and high ammonia nitrogen. Pathogenic microorganisms and hazardous substances that might be present in it are often cited as most dangerous, but pathogenic organism counts have been found to reduce rapidly with time in the landfill, so this only applies to fresh leachate.

The generation of leachate is inevitable in most landfill areas. Leachate generation rates are completely dependent on the amount of liquid the waste originally contains and the amount of rainfall in the area. Some factors that can influence leachate generation are the following:

- Climate;
- Site topography;

- Final landfill cover material;
- Vegetative cover;
- Site phasing and operating procedures;
- Type of waste materials in the landfill

The climate at the site will significantly influence the rate of leachate generation in the landfill. Since the site is located in an area of low precipitation, it can be expected that leachate generation is relatively low, although plans to handle and treat even these minute quantities are incorporated in the design.

A significant quantity of leachate is produced from a landfill's 'active' phases under operation during the monsoon season. The daily leachate amount generated from the proposed Bahawalpur Landfill site is calculated under the following conditions.

- All the rainwater outside the landfill site is expelled and does not enter the disposal section.
- Daily precipitation is taken as 1.88 mm/day, based on August monthly average precipitation, the highest throughout the year.

The Peak Leachate flow will be 6.06 m³/d for Master Plan (2025-2050)

Finally, it is a given that vegetation will, by evapotranspiration, re-direct a portion of the infiltrating precipitation back into the atmosphere. The presence of vegetation in the landfill can also influence the generation of leachate in the landfill.

Mitigation measures

- Leachate generated during active phase of LFS will be treated through Three stage open leachate treatment system and potable Anaerobic digestion treatment system for leachate. Anaerobic Digestion treatment system is potable arrangement for treatment of leachate and can be operationalized during monsoon for 24/7 basis. During monsoon season, recirculation of leachate will be increased to avoid operational constraints of leachate collection, storage and treatment system at landfill site.
- Operate the landfill in accordance with applicable internationally recognized standards to minimize leachate generation, including the use of low-permeability landfill liners to prevent migration of leachate as well as landfill gas, a leachate drainage and collection system, and landfill cover (daily, intermediate, and final) to minimize infiltration;
- Minimize the daily exposed working face and use perimeter drains and landfill cell compaction, slopes and daily cover materials to reduce infiltration of rainfall into the deposited waste;
- Leachate collection will be augmented by a leachate recirculation system in the landfill design.
- The operators of the landfill must ensure that an effective and efficient leachate control and monitoring system is maintained. This may be complimented by establishment of groundwater monitoring wells and regularly collecting samples for laboratory analysis. Results of the analysis could aid the operators to determine the final fate of the collected leachate and/detect any potential leakages. Final decision rests with the landfill operator on the final number of wells as well as the frequency of sampling for groundwater quality.

- The final vegetative cover plays an integral part in leachate production control. Its basic functions are to limit infiltration by intercepting precipitation directly, thereby improving evaporation from the surface, and to reduce percolation through the cover material by taking up soil moisture and transpiring it back to the atmosphere. Preferred plant species should be of those that do not have deep roots in order to protect the surface sealing. Further, these species should require minimal maintenance and human intervention.
- Landfill operators must be properly and adequately trained to operate and maintain the installed control system.
- A procedure for the rapid repair of leaks in the pipes, pumps and other equipment must be part of landfill operations.
- An inventory of spare parts and repair equipment must be continuously in place to ensure immediate remedial action against breakdowns.
- Strict quality assurance and construction guidelines during the installation of the HDPE liner should be strictly implemented.

6.5.2 Soil and Groundwater Contamination

Impacts

Contamination of the groundwater resources is among the most recognized impact of landfill development. In cases of leakages, the contaminated leachate will percolate into the ground and may find its way into existing groundwater resources.

However, in the case of the proposed landfill site, the groundwater resources appear to be deep (greater than 25 meters) with a substrate that acts as a natural barrier. Also, there is no water extraction locations such as wells in close proximity to the proposed SWM site. The closest well for water abstraction is located 0.7 km from the boundary of the proposed site.

The likelihood of the liner bursting for a new landfill site is quite remote since high quality liner will be installed and in addition, it will be ensured that all countermeasures in terms of liner design are in place to prevent breakage of liner. Furthermore, active life of landfill cell is about 4-5 years and after that Final capping will be placed. After that, there are minimal chances of percolation of water in the landfill cell and hence limited leachate production.

Four 04 storage cells are proposed by the designer of LFS in Bahawalpur. A leachate leak from any of the storage cells may result in the contamination of the water table below the LFS. The ground comprises of Lean clay and Silty Sand with very high permeability.

Project design consultant has estimated the leachate leaking effect on ground water quality of Bahawalpur LFS. The quantity of leachate generated in a landfill is strongly dependent on the quantity of infiltrating water. This, in turn, is dependent on weather and operational practices. The amount of rain falling on a landfill largely controls the leachate quality generated. Precipitation depends on geographical location. A significant quantity of leachate is produced from a landfill's 'active' phases under operation during the monsoon season. The daily leachate amount generated from the proposed Bahawalpur Landfill site is calculated under the following conditions. Table 6.6 below shows the average rainfall data of Bahawalpur.

- All the rainwater outside the landfill site is expelled and does not enter the disposal section.

- Daily precipitation is taken as 1.23 mm/day, based on August monthly precipitation, the highest throughout the year.

Table 6.6: Average rainfall data Bahawalpur

Month	Average Rainfall mm/Month	Average Daily mm/d
January	7.2	0.23
February	11.6	0.41
March	12.7	0.41
April	9.8	0.33
May	9.3	0.30
June	21.9	0.73
July	33.8	1.09
August	38.3	1.23
September	26.1	0.87
October	7.0	0.22
November	1.3	0.04
December	5.6	0.18

It is assumed that the peak leachate flow will generate during the activation of phase 3. Hence till that time, two phases of 4,461 m² each will be completely filled and covered with the intermediate cover. So the total covered area of phase one and two will be 8,922 m², and the area of the operational phase will be 4,461 m². So the Coefficient of leachate generation for the landfilled area (8,922 m²) will be 0.3, and for the active area (4,461 m²) will be 0.5.

The following is the mathematical formula used to calculate the design leachate amount during master plan (2025-2050).

$$Q_j = 1/1000 \times I_j \times (C1A1 + C2A2)$$

Q_j: Design leachate generation amount (m³ /day) for the day (j) in a given year.

I_j : Rainfall amount (mm/day) for the day (j) in a given year.

C1 : Leachate generation coefficient from the area of current landfill operation (0.5)

C2 : Leachate generation coefficient from the landfilled area (0.3)

A1 : Area of current landfill operation (m²)

A2 : Landfilled area (m²)

$$Q = 1/1000 \times 1.23 \times (0.5 \times 4461 + 0.3 \times 8922)$$

The Peak Leachate flow will be 6.06 m³/d for Master Plan (2025-2050)

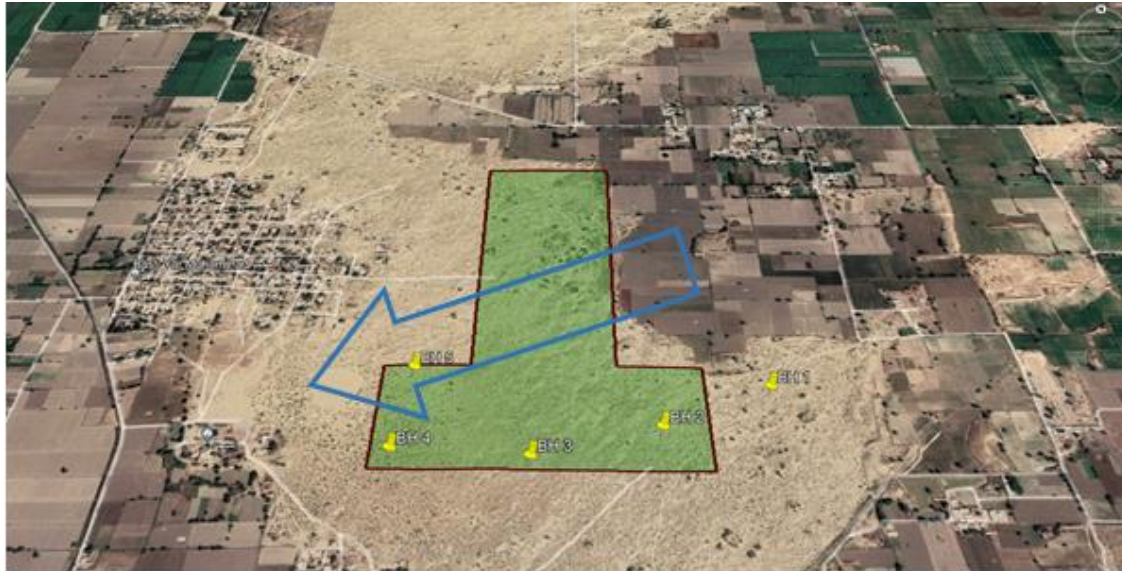
In this case, fifty percent of the leachate that is circulated to the disposal site by the pump will evaporate, and the rest is assumed to return to the regulation pond from the disposal site as part of the design leachate generation amount.

A detailed hydrological analysis was carried out for estimation of leachate leaking effect on ground water quality. Leachate leak from any of the storage cells may result in the contamination of the water table below the LFS. The geology of the site is Sandy

Silt (Moderately High Permeability) with occasional bands of Lean Clay of low permeability.

The water table, based on actual data from site as well as the surroundings of LFS, shows that the water table is sloping towards nearby mosque and a few households. Below figure shows the community location and the ground water flow from North-East towards South West in the surrounding of the LFS.

Figure 4.2: Location of tube wells and groundwater levels showing underground flow direction

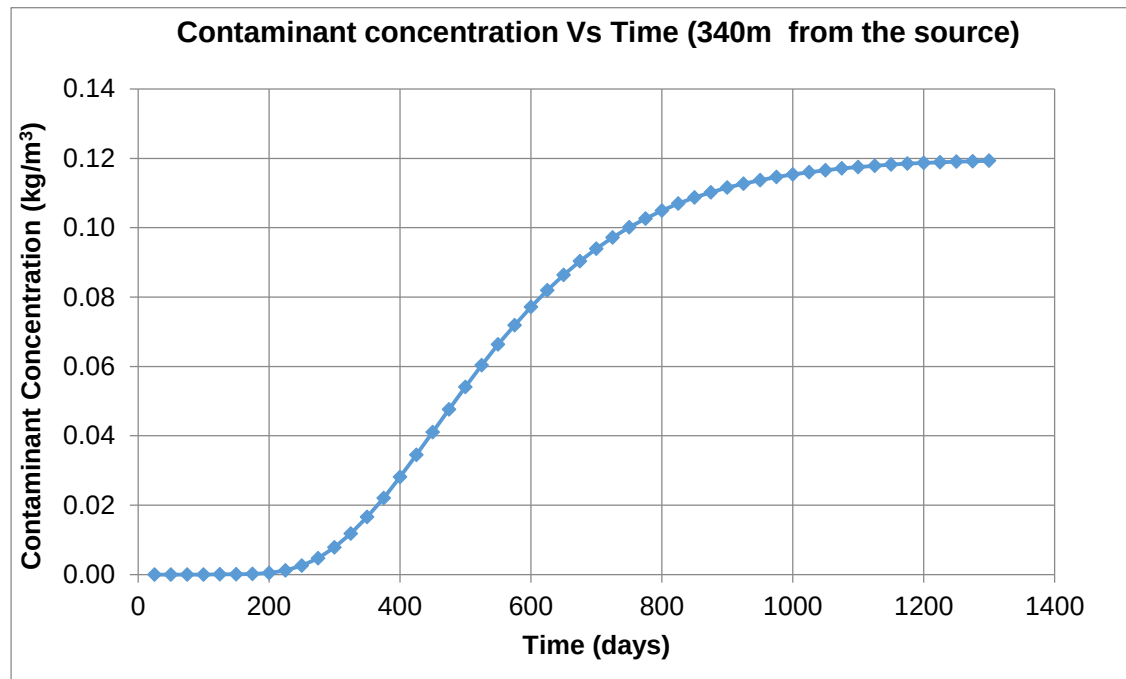


The nearest communities with respect to the proposed LFS is at risk in the direction of the flow are residential houses (Distance 340m), and a Mosque (Distance 320m). The risk analysis indicates that the contamination of groundwater from possible leakage of a storage cell may result in the uptake of contamination by the nearby community.

Key points of hydrological analysis are highlighted below

- Nearest well is located at the local community 340m away from the landfill site The hydrogeological analysis was based on a very conservative estimate of contaminant movement through strata considering no bio decay, diffusion or retardation is occurring to model worst-case scenario.
- Based on analysis, it will take a total of **310 Days** for contamination to start appearing at the nearest tube. Time required to reach the full concentration of 0.12 kg/m³ will be 1010 days
- Once the contamination start appearing in the water supply from the tube well it will take about 700 more days to reach full concentration.
- Under part 2a of section 57 (Environmental Protection Act 1990, UK Guidance) as the amount of contamination is below the guidelines values for contamination the part of the land cannot be described as contaminated land here.
- However, there is a significant chance of harm if the amount of groundwater flow reduces or the contamination level increases above the current levels. Therefore,

it is recommended to use observation boreholes to monitor groundwater quality and also additional checks should be made on monthly basis by collecting water samples from the nearest tube well for detection of any contamination. If any contamination is detected, then the necessary action to plug the breach should be completed with 310 days. Breakthrough curve of Contaminant concentration at local community location with time is shown in below figure.



- The leachate discharge should be measured on regular basis to indicate barrier breach from loss of leachate.
- Detailed hydrological analysis is attached as **Appendix A-18** of the report

Mitigation measures

The following measures will be implemented:

- Appropriate liner and collection systems in compliance with international guidelines/criteria are part of the design and will be installed.
- An efficient leachate collection and treatment system has been provided to ensure leachate accumulation at the base of the landfill and keep it to a minimum.
- The leachate system will consist of a leachate collection layer of either natural granular (sand, gravel) or synthetic drainage material (e.g. geonet or geo-composite) with pipe network to convey the leachate to treatment facility.
- Leachate collection pond shall be in opposite direction from nearest surface water
- Bottom lining will be comprised of compacted sub-grade base, geo-synthetic clay liner (GCL) topped by 2 mm HDPE layer.
- Silty sand or geotextile (500 GSM) will be covered for the protection of the HDPE on the side slopes. Above geotextile gravel layer (30 cm thick) will be placed which will be topped up with sand layer (50 cm thick).

- Thick top soil layer (6 inches) capable of supporting vegetation in order to protect the landfill surface from wind and water erosion.
- Drain Layer (18 inches) of at bottom to maximize runoff of precipitation while minimizing infiltration and preventing ponding of water on the landfill.
- Compacted soil layer or barrier of low permeability (1×10^{-5} cm/sec) to limit and control the amount of precipitation that enters the waste.
- Vent layer of reasonable thickness comprised of sand and gravel
- The Leachate treatment system can comprise of a three stage clarifier with aeration with diffusers or enclosed leachate treatment system utilizing anaerobic digestion system.
- Three Stage Clarifier with aeration and diffusers utilizing Anaerobic digestion will be used for leachate treatment. Slope of the landfill site shall be away from nearest surface water body.
- Cut-off drains around active landfill site and peripheral drains around landfill site should be provided
- Ground water monitoring wells should be dug keeping in view of the flow of ground water on both upstream and downstream of the disposal site and monitor the ground water quality of the upper strata for any contamination for disposal site every month.
- In the worst case scenario, if leachate contamination is detected during ground water monitoring after few years of landfill operation, detailed ground water modelling to determine possible contamination of leachate will be carried out and necessary design changes will be implemented.
- Detailed ground water quality baseline will be developed during operation phase of the project to trace any ground water contamination from landfill operations.
- Waste hauling vehicles shall be covered during transport of waste to landfill site
- Hauling vehicles shall not wash at the surface water bodies along the route as the wash water shall drain into the canal and will pollute the surface water source which is used by the animals of the nearby communities and for agriculture purpose.
- Domestic sewerage of Bahawalpur facility shall not be discharged untreated in open area and drains,
- Waste water generated from vehicle wash area shall be contained and treated before final discharge
- In order to augment this system, regular quality control checks on the equipment /accessories of landfill site will be implemented and incorporated during operations.

6.5.3 Landfill Gas Generation

Impacts

Studies and research indicate that landfill gas is approximately 40-60% methane (CH₄) and the remaining being mostly carbon dioxide (CO₂). There is another group of chemicals, called non-methane organic compounds (NMOCs), which may be present in the air near a landfill, though they are not likely to reach harmful levels. They are nitrogen, oxygen, water vapor, sulfur and hundreds of other contaminants. NMOCs

may occur naturally, or be formed by chemical processes. There is concern that long-term exposure to high levels of NMOCs could lead to health problems, but health studies have been largely inconclusive. The Table 6. Shows a list of the various components of a typical landfill gas.

Though NMOCs usually make up only less than 1% of landfill gas, many of these are hazardous chemicals like benzene, toluene, chloroform, vinyl chloride, carbon tetrachloride and 1,1,1 trichloroethane. At least 41 of these are halogenated compounds. Many others are non-halogenated toxic chemicals. More exhaustive test for contaminants in landfill gas has found hundreds of different NMOC contaminants.

Table 6.7: Typical Landfill Gas Components

Component	Percent Volume	by	Characteristics
Methane	45-60		Methane is a naturally occurring gas. It is colourless and odourless. Landfills are the single largest source of U.S. man-made methane emissions
Carbon Dioxide	40-60		Carbon dioxide is naturally found at small concentrations in the atmosphere (0.03%). It is colourless, odourless, and slightly acidic.
Nitrogen	2-5		Nitrogen comprises approximately 79% of the atmosphere. It is odourless, tasteless, and colourless.
Oxygen	0.1-1		Oxygen comprises approximately 21% of the atmosphere. It is odourless, tasteless, and colourless
Ammonia	0.1-1		Ammonia is a colourless gas with a pungent odour
NMOCs (non-methane organic compounds)	0.01-0.6		NMOCs are organic compounds (i.e., compounds that contain carbon). (Methane is an organic compound but is not considered an NMOC.) NMOCs may occur naturally or be formed by synthetic chemical processes. NMOCs most commonly found in landfills include acrylonitrile, benzene, 1, 1-dichloroethane, 1, 2-cis dichloroethylene, dichloromethane, carbonyl sulphide, ethyl-benzene, hexane, methyl ethyl ketone, tetrachloroethylene, toluene, trichloroethylene, vinyl chloride, and xylenes
Sulphides	0-1		Sulfides (e.g., hydrogen sulfide, dimethyl sulfide, mercaptans) are naturally occurring gases that give the landfill gas mixture its rotten egg smell. Sulphides can cause unpleasant odours even at very low concentrations
Hydrogen	0-0.2		Hydrogen is an odourless, colourless gas
Carbon Monoxide	0-0.2		Carbon monoxide is an odourless, colourless gas

Source: Tchobanoglous, Theisen, and Vigil; EPA 2015

These landfill gases are released into the atmosphere. Whenever unabated, these gases might affect the general environment, including the welfare of its employees and host community in general. Landfill gas is the main carrier of landfill generated odor, which is classified to be objectionable.

Landfill gas may cause temporary discomfort, but it is not likely to cause permanent health effects. At extremely high concentrations, persons exposed may experience eye irritation, headaches, nausea, and soreness of the nose and throat. People with respiratory ailments such as asthma are especially sensitive to these effects. However, these temporary conditions are reversed as soon as the gases are reduced or eliminated. Engineered Bioreactor Landfills normally have landfill gas capture systems.

Project design consultant has initially proposed flaring of landfill gas management. A 1000 m³ flaring system is proposed for landfill site for initial years. Keeping in view the volume of gas generated after few years of operations LFG will be converted to CNG for final reuse/disposal.

Mitigation Measures

Landfill gas capture and 1000m³ flaring systems will be in place as part of the landfill design and thus no significant impacts on occupational or community health and safety are envisaged from landfill gas exposure.

Landfill gas will be collected through installation of perforated pipes within the cells. This gas will initially be flared through 1000 m³ flaring system at start of landfill operations. Keeping in view the volume of gas generated after few years of operations feasibility for gas reuse including conversion into CNG will be carried out and accordingly design changes will be executed. Both Horizontal and Vertical gas collection systems will be implemented in the landfill. The gabion of the gas collection wells will be filled with gravel and these will be constructed with iron mesh. There will be a perforated HDPE pipe with pressure class in the center of the gas collection wells. The gap between the iron mesh and the perforated pipe will be filled with pebble stone.

The organic waste will be used as a resource in bioreactor landfill to maximize and regulate the landfill gas recovery system and conversion of methane component of the gas into CNG. The conversion of organic waste into LFG and Methane component conversion will generate a high revenue and contribute to the substantially of the project.

The organic waste will be beneficially utilized when it is deposited in the bio reactor landfill where it will generate regular and increased quantity of landfill gas which will contain 55-60 percent of Methane. The methane can be converted into electricity or CNG. The CNG option is a much better option as the electricity tariff for green energy is very low in Pakistan and the CNG rates are quite high.

The landfill gas recovery must be designed from bottom up to avoid emission during landfill operation and drilling through the garbage when the cell is filled with waste. When two meters of waste layer will deposit in the first cell, a 30m x 30m or 50m x 50m grid of perforated gas recovery pipes will be installed over a 15cm layer of gravel under the pipe and another layer of 15cm gravel will be placed on top of the gas grid. The 30m length of the pipe will be joined with the second pipe with a "T" joint and vertical gas well is installed. When desired height 20-30m of the fill achieved the ring main will be installed and connected to final LFG to power generation.

As part of closure plan of existing dumping site, GHG monitoring will be carried out and necessary gas flaring system will be done.

As part of closure plan of existing dumping site, GHG monitoring will be carried out and necessary gas flaring system will be done.

Periodic GHG monitoring will be carried out during operation phase of the project and accordingly, necessary design changes will be incorporated, if required.

6.5.4 Air Quality Deterioration

Impacts

Objectionable odour is expected at the landfill site from landfill cells, composting facility and material recovery facility depending on various factors. Some of which are the types of wastes being handled, humidity, temperature and moisture content, among others. Uncontrolled composting and poor housekeeping at site will be the source of objectionable odour. Furthermore, ambient dust may be generated from sorting lines of MRF which need to be managed through proper ventilation and necessary arrangements for dust collection/suppression. Haphazard waste tipping at unloading bay and weighbridge will create nuisance and objectionable odor, if not attended at frequent intervals.

At composting plant, odours originate with the incoming ingredients, which may have been stored anaerobically (without oxygen) for a week or more before transport to the site. Once these ingredients are incorporated into the composting system, subsequent odour problems are usually a result of low oxygen or anaerobic conditions. Anaerobic odours include a wide range of compounds, most notoriously the reduced sulphur compounds (e.g. hydrogen sulphide, dimethyl sulphide, dimethyl disulphide, and methane thiol), volatile fatty acids, aromatic compounds and amines. Ammonia is the most common odour that can be formed aerobically as well as anaerobically, and thus has its own set of management options.

The closest receptors will be the personnel who will be onsite monitoring the status of the facility. Some of the anticipated problems that may be raised during the operation of the landfill are as follows:

- Discomfort of working with offensive odours; and
- Concerns for the mental or psychological welfare of exposed communities

The Wind Rose for Bahawalpur City shows that dominant wind direction of Bahawalpur is from North to South with an average speed of 6 km/hr. As a result, the potential impact on the households from any airborne related impacts, particularly during landfill operations. Since most of the houses which are being used for residential purposes are located at a minimum distance of 500 meters from the proposed landfill, therefore, no significant impacts from objectionable odour are anticipated.

Daily cover will be provided at end of each day to avoid risk of fire, wind littering, odour, vector breeding and dust hazards in the landfill. Working surface of waste will be covered with a soil layer called "daily cover" at the end of each working day. Amount of soil to be used in daily cover will be about 10% of the waste volume. Suitable quality of excavated material will be used as daily cover material.

The special dispersion of the pollution levels around the project site was modeled for ground level concentration through Lakes Environmental Software AERMOD. Dispersion of maximum pollutants is found in the north east direction driven by the south-westerly wind. Models for dispersion of NO_x, and PM based 24-Hour Averages for proposed facilities have been recorded. Contour maps of average concentration are shown in below figures.

The results of modeling show that the 24-hour average highest ground level concentration of CO from the flare remains $0.347\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) NOx from the flare remains $0.417\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) and PM₁₀ from the plant remains $0.00463\mu\text{g}/\text{m}^3$ at 1000 meters (75°14'63.19N, 3244037.28E) when flare operating at its normal conditions.

The color contours maps plotted by the model for the proposed emissions effect of the proposed flare display the extent of dispersion of the pollutants. The dispersion plumes shown in above figures show that the plant is located at 1000 meters from the origin set at top left corner of the map. Contours maps expand to 5000 meters from the flare site. The contours show that the emissions disperse in north-east-north direction. Pertinent to mention that all the emissions are well in compliance with the WHO and national ambient air quality standards.

Air dispersion modelling report is attached as **Appendix A 19** of the report.

Mitigation measures

Best management practices and good housekeeping measures will be implemented to minimize the release of objectionable odours. Potential odours impacts can be minimized or eliminated by adopting the following measures:

- Daily cover will be placed on working surface of waste in order to reduce the risk of fire, wind littering, odour, vector breeding and dust hazards in the landfill.
- Suitable amount of daily cover will be stocked at the landfill site.
- Final capping of landfill cells will be carried out in order to limit and control the amount of precipitation that enter the waste and to limit wind and water erosion and burrowing animal activity. This will not only prevent the odor of decaying waste from escaping from the landfill but also protect the site against intrusion of vermin and pests.

The top cover system consists of following arrangements.

- Thick top soil layer (6 inches) capable of supporting vegetation in order to protect the landfill surface from wind and water erosion.
- Drain Layer (18 inches) of at bottom to maximize runoff of precipitation while minimizing infiltration and preventing ponding of water on the landfill.
- Compacted soil layer or barrier of low permeability (1×10^{-5} cm/sec) to limit and control the amount of precipitation that enters the waste.
- Vent layer of reasonable thickness comprised of sand and gravel
- Appropriate and regular housekeeping (i.e. cleaning) will be done in all areas
- Strict use of Personal Protective Equipment (PPE) by all personnel (e.g. inspectors at the Weigh Bridge, MRFs, material handler and waste compactor operators) must be ensured.
- All the incoming ingredients that are anaerobic will be converted to aerobic state through combining them with a coarse, dry bulking amendment to increase the porosity and allow oxygen penetration.
- Air should be thoroughly dispersed throughout the organic waste. This is done by frequently turning and mixing the wastes.
- Oxidizing chemicals like hydrogen peroxide, potassium permanganate, and

chlorine will be used by the wastewater treatment industry for odor control.

- Organic waste lot which is creating objectionable odor will be attended immediately and introduced in the composting system on priority basis.
- Controlled composting conditions will be maintained throughout the operation.
- Mandatory health and medical check-ups for all employees especially workers working at MRF as they may be exposed to general airborne dust above the level where it is considered a substance hazardous to health (10 mg/m³ as an 8-hr TWA). This should ideally be complemented by obtaining an Insurance Policy for Workmen's especially engaged in the daily activities of the landfill;
- Control of inhalation exposure to hazardous substances by the effective use of general ventilation within MRF and Local Exhaust Ventilation (LEV) the appropriate use of respiratory protective equipment (RPE);
- Where solid waste will be processed (i.e. weigh bridge area). This will prevent the reproduction of flies, generation of obnoxious odors, scattering of plastic and papers, etc.

6.5.5 Disease Vector Generation

Impacts

The operation of the landfill may attract presence of pests such as rats, cockroaches, flies, ants and other pests in the immediate area along with various other vectors such as foxes, feral cats and dogs, birds and other animals. These pests can freely move around the area and may find their way to buildings and areas adjacent to the landfill. Since these pests are known to be carriers of diseases, they may trigger the sudden occurrence of illnesses and unacceptable conditions among people of weak resistance and children.

Each type of vector can live and multiply at a landfill and is potentially of concern to site operators, regulators, public health professionals and the general public. Fortunately, vectors are controllable and should rarely, and even then only intermittently, be present on a well-controlled landfill.

Mitigation measures

The most important control measure used to minimize vector problems at landfills is the application of daily cover. Cover should be present on all solid waste at all times, except the tipping face while it is being worked. Daily cover of at least 150mm of compacted soil or similar material or an effective layer of alternate daily cover (ADC) should be applied on finished portions of the daily cell during operation and at the conclusion of daily operations, and not less frequently than once per day. Alternative daily cover materials such as tarpaulins, foams, granular waste, etc, can be effective as vector control after careful site-specific evaluation.

Intermediate cover of 300mm (minimum) compacted soil should be used on all areas not at finished levels, but not to be further landfilled for a period of 30 days or more.

Final cover is typically applied as each area is brought to finished level through the operational life of the landfill.

There should be no uncontrolled or uncovered (stockpiled) waste, including litter, tyres, brush, appliances, construction/demolition waste or even inert industrial waste on the landfill property. The only exception is compactable soil-like inert wastes, such as ash, but even this waste must be graded and compacted to avoid ponding water.

There should be no ponding water on the landfill property except as designed for runoff storage or leachate treatment ponds. Such storage ponds can, however, aid vector reproduction if not designed and controlled properly so as to minimise stagnant water, nutrient build-up and plant growth.

Finally, the waste must be compacted and graded at reasonable maximum slopes (see the Working Face Guideline) to minimise voids within the waste that can harbour rodents in particular. Rodents and foxes can readily dig into cover soil, but have much more difficulty digging into compacted solid waste.

On-site landfill site personnel must be trained and must monitor the levels of key vectors on a daily basis as part of daily management. A simple monthly site walk-over can provide a baseline of vector activity so changes can be noted and translated into action. Observations of various droppings, sightings, tracks, insect counts, etc are useful indicators of activity. Written reports from regular walk-over assessments should be kept on file so changes that occur over time and in response to control measures can be assessed.

6.5.6 Occupational Health and Safety

Impacts

There are considerable risks associated with the operation of the proposed landfill site from an occupational health and safety perspective, keeping in view the scope of work to be conducted on a daily basis and the use of heavy machinery to be involved in the daily operations. Moreover, Organic dust which may lead to exposure to airborne microorganisms and their toxic by-products exposure cause work-related symptoms and effects among waste recycling workers in Materials Recovery Facilities (MRFs) are also a concern.

The equipment in a MRF is likely to expose employees to excessive noise levels. Unless suitable precautionary protocols in accordance with international good practices are put in place, there is a high risk of injury and accidents taking place at the landfill site during its day-to-day operations. Draft Occupational Health and Safety Plan has been attached as **Appendix A.5**.

Mitigation Measures

In order to ensure a safe and healthy working environment for the employees of the landfill and all its auxiliary facilities, the following measures have to be strictly enforced, implemented and monitored:

- OHS management system will be prepared and implemented prior to commencement of operation of the Landfill.
- Designation of an Environment, Health and Safety (EHS) officer dedicated to the site;
- All employees must be able to reach their work stations safely. All path, walkways, staircases, ladders and platforms must be stable and suitable for the tasks to be undertaken;
- Strict use of Personal Protective Equipment (PPE) by all personnel (e.g. inspectors at the Weigh Bridge, material handler and waste compactor operators) must be ensured.
- Mandatory health and medical check-ups for all employees, especially workers working at MRF as they may be exposed to general airborne dust above the level where it is considered a substance hazardous to health (10 mg/m³ as an 8-hr TWA).

This should ideally be complimented by obtaining an Insurance Policy for Workmen's especially engaged in the daily activities of the landfill;

- Develop a written program (i.e. health information, instruction and training) which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards of working in a landfill and its auxiliary facilities;
- Mandatory monitoring of air quality and noise levels in the working stations i.e MRFs, compactors and bailer etc to maintain the same within local standards and whenever possible near ambient levels;
- Control of inhalation exposure to hazardous substances by the effective use of general ventilation within MRF and Local Exhaust Ventilation (LEV) the appropriate use of respiratory protective equipment (RPE);
- Accidental fires must be addressed immediately. Appropriate operational procedures involving the spreading and smothering of burning waste, rather than the use of water, must be implemented;
- Emergency plan (including fire management) must be developed and implemented;
- Availability of first-aid kits and vehicles that can be used to bring any injured employee to the nearest doctor in cases of accidents;
- Mandatory reporting of all accidents or incident of near misses of accidents and immediate adoption of corrective measures; and
- Management must provide all the necessary financial and manpower resources for the implementation and enforcement of all health and safety programs and activities of the project;
- Regular training and orientation on safety practices will be implemented to impart knowledge of safe and efficient working environment. Furthermore, regular health checkups of all employees including contract workers will be conducted. Effective and proper housekeeping is recommended to reduce dust exposures to its direct vicinity. Heat levels must be monitored as well. Spot checks should be done to ensure that workers' welfare is addressed especially during summer months.

6.5.7 Waste Collection and Hauling Impacts

Impacts

The operation of the proposed landfill will result in the movement of a higher volume of trucks and heavy vehicles in general, transporting solid waste between Bahawalpur city and the proposed landfill site. The movement of these heavy vehicles could result in a higher risk of accidents along with the risk of increased congestion events taking place along the route of these vehicles, particularly during the times of peak traffic, such as during the morning and evening times of the day.

Increased traffic volume of waste carrying vehicles will result in increased noise levels and dust issues if such impacts are not managed properly. Waste hauling through mechanically unfit vehicles will result in increased noise levels in the project area. Waste transport without purpose built vehicles or waste transport on dirt roads will result in increased dust levels.

There is general practice by citizens to throw waste on streets instead of communal bins. BWMC workers need to collect all scattered waste manually. There are multiple transactions of waste till disposal site resulting in poor waste management.

Communal storage constraints include shortage of containers, lack of financial resources leading to broken and ill maintained bins; Lack of planning for waste storage depots or temporary storage locations and Inaccessible areas and narrow lanes that do not allow sufficient space for container. If such constraints are not addressed it will result in poor waste management and environmental/public nuisance.

Currently BWMC is under capacity with respect to daily manual sweeping and waste collection on Sunday and public holiday resulting in poor waste collection and environmental nuisance.

There is lack of public/civic sense with respect to waste management at source, segregation of recyclables and waste collection system. Public don't practice responsible behavior and throw litter outside their premises in open streets, along roads, canals and other places which is resulting in operational constraints for BWMC towards solid waste management.

Mitigation measures

The following measures will be implemented to ensure that no traffic related issues take place due to the landfill operation:

- Capacity of BWMC will be increased through increase in its collection fleet. It will be done through procurement of both solid waste and non-solid waste carrying machinery under this project.
- Door to Door collection of waste will be enhanced through media campaigns. Communication programs would be developed to encourage better management of waste. Proper PPEs will be provided to waste handlers. Key performance indicators will be developed to monitor improvements in the system.
- All type of waste hauling will be carried out in purpose built vehicles to avoid scattering of waste at hauling routes. Drivers of waste carrying vehicles will be trained with respect to environmental sensitization. Drivers are allowed to commute only on designated routes through purpose built vehicles for waste hauling.
- Multiple transactions of waste will be avoided through use of main and mobile transfer stations. Improved segregation practices will be introducing once door to door collection desired efficiency achieved. Necessary legal bindings with respect to waste storage by Public will be introduced.
- A comprehensive traffic management plan (TMP) must be developed and implemented. Traffic management plan is provided as **Appendix A.11**.
- As part of the TMP, it will be ensured that the movement of heavy vehicles related to landfill operations is minimized during the peak traffic hours of the day in order to prevent congestion and accidents as far as possible;
- Furthermore, the movement of heavy vehicles within Bahawalpur city related to landfill operations must be restricted to specific routes containing least number of sensitive receptors and low traffic volumes.
- Waste hauling through dirt tracks will be strictly prohibited. Waste hauling through mechanically unfit vehicles or noisy vehicles will not be allowed.

- Waste transporters will be directed to use designated routes and follow recommended speed limit for waste hauling and such routes will be metaled roads instead of dirt tracks.

6.5.8 Wind Blown Litter

Impacts

One of many operational concerns in the management of a landfill is the control and management of litter. Litter includes blowing papers and other solid materials that may become airborne and carried by the wind away from the working face where solid waste is being deposited.

The control of litter is an integral part of the daily operations of the facility. The goal of the facility operations is to implement best management practices and have all blowing litter contained at the working face. However, due to the type of facility operation and waste materials received, total containment of litter at the working face may be difficult to achieve. The secondary goal of the facility is to strive to pick up all blowing litter that has escaped the working face at the end of each operating day.

Mitigation measures

The facility operator, as necessary, will implement the following procedures and techniques to control litter:

- All trucks must be tarped upon entering and exiting the facility. They should only untarp and tarp at the active area. This policy will be strictly enforced.
- Daily waste entering the landfill site will be subject to immediate compaction to minimize the area and debris subject to the impacts of wind.
- If possible, on windy days, the daily fill face tipper locations shall be selected for its protection to minimize effects of wind.
- Waste that is more susceptible to windblown distribution may, on windy days, be worked immediately into the fill face and covered with a layer of daily cover, as needed, or the waste may be excluded from the site.
- Portable skid-mounted litter fences may be provided for deployment downwind as close as practical to the working area, as needed.
- Semi-permanent fencing may be provided around the fill area as an additional barrier to the migration of litter off-site when litter has not been contained by the portable litter fences. (Examples of additional barriers include but not limited to, a four-foot minimum temporary construction fence and/or a ten-foot or higher semi-permanent fence.) The utilization will be continually evaluated and the fence will be relocated or added as needed.
- Permanent fencing (ten-foot high with an additional three-foot kicker) may be constructed with possibility of placement on an eight-foot high berm.
- On very windy days, when all other procedures are not successful in controlling blowing litter, the operator may apply cover material more frequently or immediately to the incoming waste load.
- Buffer zones resulting from required facility setbacks along the site's perimeter should provide some protection of adjacent properties.

- As a final control measure, personnel will be dispatched, as needed or daily if conditions require, to collect any litter that has escaped the above control measures.
- Portable litter vacuums may be used to collect litter that has accumulated on litter fences. If fences are positioned properly, this can be a very efficient method of collecting litter.
- The main highway leading to the site will be routinely inspected for litter. If the highway has litter associated with the trucks entering the facility, then the litter will be picked up on a routine basis. All necessary safety precautions must be followed.
- Before and after photos of any litter removal effort may be taken in the event anyone questions the level of effort spent on litter collection.
- Site management's cell phone numbers may be provided to community/neighbors.
- The management of litter at the landfill is a daily activity. In most instances the above procedures and techniques should properly manage litter effectively. However, there will be occasions and situations when litter will be distributed by the wind in such a manner that the above procedures will not totally manage the litter and contain the litter on-site. In these situations, the facility operator may not be able to collect all litter within the day the litter problem occurred. However, the facility operator should proceed with collecting the litter off site and complete the retrieval of wind-blown litter at the earliest practicable time.

6.5.9 Solid Waste Disposal & Health and Sanitation

Impacts

The landfill development will greatly improve solid waste management system in Bahawalpur city and the project area and improve overall aesthetic value and quality of urban area of Bahawalpur city.

Community development programs that may be undertaken, including health and hygiene education, reduction, reuse and recycling of solid waste, skill training of low income people would be of great benefit to local community. The magnitude of the impact shall be high, local, long term and impact is very significant.

Mitigation measures

No measures required.

6.5.10 Public Health

Impacts

The operation of the proposed landfill will result in solid waste management in a way resulting in fixing issues like odor, vector borne diseases from open dumped waste, poor sanitation and ground water contamination in the area.

The operation of the proposed landfill will limit risk of vector spread, fire and explosion of dump site gas.

It will result in an overall positive impact on the public health by preventing issues such as infectious diseases, disease vector generation, groundwater aquifer contamination etc.

Specifically, successful operation of Bahawalpur landfill site will limit the child scavenging activity who are directly at risk as they are not using any PPEs.

Further, it will provide promising opportunities to people involved in scavenging activity in terms of jobs and other economic incentives to accelerate recycling potential at the facility.

Mitigation measures

No measures required.

6.5.11 Aesthetic Aspects

Impacts

Open dumping of solid waste creates poor aesthetics in the project area. However, landfill site shall be walled and the aesthetic impacts will be far less as compared to open dumping. However, due to the movement of the waste truck on the streets will create a little aesthetic nuisance.

Mitigation measures

- The boundary walls shall be constructed alongside the facility.
- The indigenous plants shall be planted alongside the access road and around the landfill site which will act as buffer zone.
- The waste transfer vehicles shall be covered.
- Reasonable area will be allocated for plantation within and at boundary of facility to improve aesthetic appeal of the area.
- Plantation will start as one of the earliest activities of site development. Once the design of landfill is approved and necessary funds mobilized, plantation activity can be started in collaboration with Bahawalpur Development Authority or BWMC can outsource the activity separately.

6.5.12 Construction and Demolition Waste Disposal

Impacts

Dumping of construction wastes/excavated material in Bahawalpur City create poor aesthetics and may limit the use of land in the project area. The solid waste may be generated due to different construction activities, and it will mainly include surplus excavated and construction material.

The indiscriminate disposal of solid waste may cause dust emissions due to the wind blowing, thereby affecting the health of the community.

Mitigation measures

- All components of construction & Demolition Waste shall be processed, recycled and reused.
- All Concrete, PCC and RCC will be processed to Produce Class II and Class III recycled Sub-Base and Base materials.
- Recovered Asphalt Concrete will be mixed in Recycled concrete or reused by mixing with fresh Asphalt concrete.
- All metal will be recovered and recycled.
- Wood component will be Processed and used as Mulch or raw materials for compost.

- Processed waste will be used as Cover material for landfills.

6.5.13 Medical Waste Management

Impacts

- Treatment and disposal of healthcare waste may pose health risks indirectly through the release of pathogens and toxic pollutants into the environment.
- The disposal of untreated health care wastes at dumpsites can lead to the contamination of drinking, surface, and ground waters.
- The treatment of health care wastes with chemical disinfectants can result in the release of chemical substances into the environment if those substances are not handled, stored and disposed in an environmentally sound manner.

Mitigation measures

- A dedicated medical waste management system will be established including segregation at source of medical waste in designated waste containers and its treatment as per prevailing PEQS regulations.
- The treatment of waste will be through autoclave or Incineration. The incineration of medical waste is simpler and cost-effective option and is recommended in the FS.

6.6 Closure and Post Closure Impacts

Impacts

Even after closure, landfills required long-term care, including maintenance of the cap system, collection and treatment of leachate, collection and flaring or utilization of landfill gas, and monitoring of groundwater so that the waste remains isolated.

Impacts associated with closure and post closure phase of the landfill include poor aesthetics of the area, runoff issues, leachate/odors issues, uncontrolled gases and long term environmental nuisance. There is need of routine inspection of the facility infrastructure particularly landfill cells and gas/leachate collection system to avoid and monitor any contamination released to environment. There is need to manage leachate and gas continues after landfill closure, which should be an integral component of the total landfill management together with restoration and surveillance

As moisture enters the landfill through an ineffectively maintained cover after the landfill has been closed, leachate will also again be generated. If the leachate collection and removal system is no longer functioning to collect and remove from the landfill all the leachate generated, and/or the landfill operator is no longer operating/maintaining the such system, the leachate will accumulate in the landfill, leading to increased potential for leachate to penetrate through the liner and potentially begin to pollute groundwater.

Mitigation measures

- Appropriate selection of soil type for final cover will be ensured to prevent water infiltration and minimize infiltration of precipitation into the waste and the subsequent generation of leachate; control landfill gas migration; and minimize long term maintenance needs.
- Appropriate selection of soil type for final cover will be ensured to prevent direct or indirect contact of living organisms with the waste materials and their constituents;
- Application of final cover components that are consistent with post closure use and

local climatic conditions.

- Necessary environmental objectives and controls (including technical specifications) will be defined and implemented.
- Necessary surveillance protocols for final capping, leachate and gas monitoring will be established and implemented.
- Future Land use of the site will be defined in consultation with local communities and government agencies.
- It will be ensured that financial resources, and monitoring arrangements are in place for closure and post closure activities.
- PMU Punjab LG&CDD will ensure that financial instruments are in place to cover the costs of closure and post-closure care and monitoring.
- Long term integrity and security of the site will be maintained.

6.7 CUMULATIVE IMPACTS

Based on the scoping exercise of the site and based on discussions with the public sector agencies responsible for development in the project area, no other infrastructure works are planned to be conducted in the landfill project area while these project works shall be conducted. Thus, no cumulative impacts are expected.

6.8 INDIRECT AND INDUCED IMPACTS

The potential impact of development of the landfill in the project area has been examined, which indicated that the existing and planned infrastructure such as water supply, wastewater collection and treatment, municipal solid waste collection and disposal would be adequate to accommodate any potential population intake as a result of the proposed landfill development. Impacts on the environment from air emissions, traffic and community noise have also been assessed and have found to be acceptable and within the carrying capacities of the environmental media.

Thus, negative indirect and induced impacts from the proposed landfill works are not expected.

7. ENVIRONMENTAL MANAGEMENT PLAN & INSTITUTIONAL REQUIREMENTS

7.1 INTRODUCTION

The EIA has identified potential impacts that are likely to arise during development of Bahawalpur landfill in detail, both negative and positive impacts at each stage of the project. To minimize the effects of adverse impacts the EIA has recommended mitigation measures in the EMP. The proposed mitigation measures have been based on the understanding of the sensitivity and behavior of environmental receptors in the project area, the legislative controls that apply to the project and a review of good industry practices for projects of similar nature. For residual impacts (impacts remaining after applying the recommended mitigation measures) and for impacts in which there can be a level of uncertainty in prediction at the EIA stage, monitoring measures have been recommended to ascertain these impacts during the course of the project activities.

The Environmental Management Plan (EMP) is developed to eliminate and/or mitigate the impacts envisaged at the design, construction and operation stages.

The detailed EMP provided in this document as **Table 7.1** ensures that development of Bahawalpur landfill has no detrimental effect on the surrounding environment. The Plan shall act as a guideline for incorporating environmental measures to be carried out by the contractors engaged for the proposed project. It shall also be used for other parties concerned for mitigating possible impacts associated with each project and will form part of the Contract documents to be considered alongside the specifications. This Plan shall act as the Environmental Management and Monitoring Plan during the construction and operation phase of the project and will allow for prompt implementation of effective corrective measures.

7.2 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The EMP attached with this report ensures the following:

- Delivery of the prescribed environmental outcomes during all phases of this sub-project;
- Formulating a system for compliance with applicable legislative requirements and obligations and commitments for this sub-project;
- Ensure that project design process incorporates best practice environmental design and sustainability principles to minimize potential impacts of construction on the environment and community.
- Ensure that the construction work procedures minimize potential impacts on the environment and community.
- Develop, implement and monitor measures that minimize pollution and optimize resource use.

7.3 OBJECTIVES OF EMP

The EMP provides a delivery mechanism to address potential impacts of the project activities, to enhance project benefits and to outline standardized good practice to be adopted for all project works. The EMP has been prepared with the objectives of:

- Defining the roles and responsibilities of the project proponent for the implementation of EMP and identifying areas where these roles and responsibilities can be shared with other parties involved in the execution and monitoring of the

project;

- Outlining mitigation measures required for avoiding or minimizing potential negative impacts assessed by environmental study;
- Developing a monitoring mechanism and identifying requisite monitoring parameters to confirm effectiveness of the mitigation measures recommended in the study;
- Defining the requirements for communication, documentation, training, monitoring, management and implementation of the mitigation measures.

7.4 ENVIRONMENTAL MANAGEMENT/MONITORING AND REPORTING

During the construction phase, the overall responsibility for the implementation and monitoring of the EMP rests with the Project Director (PD), Project Management Unit (PMU), LG&CDD, Punjab. The PD at the PMU, using the Construction Supervision Consultant (CSC), will supervise the implementation of the proposed mitigation measures and monitor the implementation progress in the field.

During the operation phase, the overall responsibility for the implementation and monitoring of the EMP rests with Managing Director, BWMC. For initial two years of LFS operation, relevant Contractor will be responsible for running of relevant plant (e.g. AD compositing vendor, MRF Vendor, Leachate treatment plant vendor etc.) and also responsible for implementation of EMP. This requirement will be reflected in the bidding document of such Contractors/Suppliers. Furthermore, these Contractors will train designated staff of BWMC with respect to technical matters as well as EMP requirements.

The specific roles and responsibilities for environmental management and monitoring are provided in **Table 7.1** below. The expected costs for implementing any required mitigation measures are provided in **Table 7.7** below.

7.4.1 Inclusion of EMP in Contract documents

In order to make Contractors fully aware and responsible of the implications of the EMP and to ensure compliance, it is recommended that mitigation measures be treated separately in the tender documentation and that payment milestones should be linked to performance, measured by execution of the prescribed mitigation measures. Such a procedure would help ensure adequate management of project impacts is carried out during the construction and operation phases, where a consistent approach will be expected on behalf of the Contractor and its sub-contractors so that data and information collected from monitoring programs is comparable with baseline monitoring data.

The Contractor shall be made accountable through contract documents and/or other agreements for fulfilling the environmental safeguard obligations and delivering on the environmental safeguard components of the Project. Contractors shall be prepared to co-operate with the executing agency and supervising consultants and local population for the mitigation of adverse impacts. After the EMP's inclusion in the contract documents, the Contractor will be bound to implement the EMP and will engage appropriately trained environmental and social management staff to ensure the implementation and effectiveness of the mitigation measures.

The Contractor is required to bid for executing the EMP, including the recommended mitigation measures and monitoring programs, as part of its Bill of Quantities (BoQ).

7.5 INSTITUTIONAL ARRANGEMENTS

The environmental management plan will require involvement of the following organizations for its implementation during construction and operation phases of the project:

7.5.1 Role of PMU/CIU, PUNJAB LG &CDDD

The PMU will:

- Provide support to ADB missions;
- Coordinate activities with all stakeholders, review consultants, proposals, and provide overall guidance during various stages of project preparation;
- Manage and ensure safeguard due diligence and disclosure requirements including resettlement and environmental safeguards in accordance with ADB's Safeguard Policy Statement (2009) and PUNJAB government requirements;
- Manage and ensure effective implementation of the gender action plan;
- Ensure submission of all EIA requirements as per law by responsible entities; and
- Monitoring of activities of the entire project.

7.5.2 Role of the ADB

The ADB will:

- Support the coordination and administration of the project;
- Provide guidance to PMU and BWMC on implementation issues and project design;
- Disclose all safeguards documents, and monitor safeguards implementation;
- Monitor and report project performance;
- Conduct periodic review of the project;
- Develop TORs for third party monitor

7.5.3 Role of Construction Supervision Consultant (CSC)

The CSC will be responsible for the following items:

- Incorporates into the project design the environmental protection and mitigation measures identified in the EMP for the design stage;
- Assists PMU to ensure that all environmental requirements and mitigation measures from the EIA and EMP are incorporated in the bidding and contracts documents
- Prior to construction, reviews the updated SSEMPs prepared by the contractor.
- Undertakes environmental management capacity building activities for relevant project focal staff.

7.5.4 Role of PUNJAB EPA

The Punjab EPA will have the following responsibilities with regards to this landfill project:

- Provides regulatory compliance works for the project.
- Reviews and approves environmental assessment report of landfill, submitted by PMU.
- Issues environmental clearance certification for the project based on their mandate and regulations.

- Undertakes monitoring of the project's environmental performance based on their mandate.

7.5.5 Role of Project Contractor

The project contractor will be responsible for following items:

- Implementation of, or adherence to, all provisions of the EIA and EMP;
- Preparation of site specific EMPs (SSEMPs) as required. SSEMPs will be prepared by Contractor's Environment Specialist, site incharge, HSE staff and project technical team before their mobilization and it will be submitted to Engineer of construction supervision consultant/PMU for review and approval. Site specific EMP template for guidance of contractors is provided as **Appendix A.9**.
- Contractor's environmental performance will rest with the person holding the highest management position within the contractor's organization. Reporting to their management, the contractor's site managers will be responsible for the effective implementation of the EMP.
- The Contractor will be required to have qualified Environmental Specialists in their team to ensure all mitigation measures are implemented during the different development phases of the project.

7.5.6 Role of BWMC

The BWMC will be responsible for following items:

- Implementation of, or adherence to, all provisions of the EIA and EMP
- Preparation of site specific EMPs for operations phase
- BWMC would be responsible to ensure that contractors engaged during operation phase of landfill site are executing activities in compliance to EIA/EMP.
- BWMC will be required to have qualified Environmental Specialist designated for LFS to ensure all mitigation measures are implemented in true letter and spirit.

7.5.7 Role of Third Party Monitor

The Third party monitor will be responsible for following items:

- Monitoring and reporting of all provisions of the EIA and EMP.
- Periodic environmental monitoring during operation phase.
- Reporting of environmental non-compliances to project stakeholders including ADB, PMU, BWMC and Supervision consultants.
- Suggest corrective actions for close out of EMP non compliances.
- Train the contractors and project stakeholder toward EMP implementation.

General TORs for third party monitoring are provided as **Appendix A.10** of this EIA report.

7.6 MONITORING PARAMETERS

A monitoring plan for the construction phase of the project, indicating environmental parameters, frequency and applicable standards is provided below as **Table 7.3** below.

During the procurement/pre-construction period, the monitoring activities will focus on (i) checking the contractor's bidding documents, particularly to ensure that all necessary environmental requirements have been included; and (ii) checking that the contract documents' references to environmental mitigation measures requirements

have been incorporated as part of contractor's assignment and making sure that any advance works are carried out in good time.

During the construction period, the monitoring activities will focus on ensuring that any required environmental mitigation measures are implemented to address possible impacts.

In general, the construction impacts will be manageable, and no insurmountable impacts are predicted, provided that the EMP is implemented to its full extent as required in the Contract documents. However, experience suggests that some Contractors may not be familiar with this approach or may be reluctant to carry out some measures. For the proposed project, in order that the Contractor is fully aware of the implications of the EMP and to ensure compliance, environmental measures must be costed separately in the tender documentation and listed as BoQ items, and that payment milestones must be linked to environmental performance, vis a vis the carrying out of the EMP.

The effective implementation of the EMP will be audited as part of the loan conditions by ADB, and as part of regulatory/NOC compliance by Punjab EPA. In this regard, the PMU will guide the design engineers and Contractors on the environmental aspects and necessary EMP documentation. Monitoring during operation phase will be carried out by BWMC with support from PMU.

7.7 ENVIRONMENTAL TRAINING

7.7.1 Capacity Building and Training

Capacity building and training programs are necessary for the project staff in order to control the negative impacts resulting from the project construction and during its operation phase. They will also require trainings on monitoring and inspecting of such a project for environmental impacts and for implementation of mitigation measures.

The details of this capacity building and training program are presented in the **Table 7.7** below.

7.8 ENVIRONMENTAL STAFFING AND REPORTING REQUIREMENTS

EMP implementation would be responsibility of all project stakeholders including PMU, BWMC, Project Construction contractors, O&M contractor and other suppliers involved in the project. Requirement of environmental staffing will be part of bidding documents and necessary cost will be allocated as BOQ item by the bidder. PMU will maintain environmental safeguard staffing (Environmentalist/Environment Associate) for construction and operation phase of the project to monitor and supervise EMP implementation and performance. Environment expert will also be part of CSC technical time and will produce bi-weekly and monthly environmental compliance reports during construction phase. Environment expert of CSC will be responsible to monitor the implementation of EMP during construction phase by project contractors. Project contractors will also hire sufficient environmental officers to implement the EMP requirements and prepare necessary EMP documentation. Project contractor EMP staff will prepare daily environmental reports and submit to CSC for approval and record. BWMC will hire qualified environmental specialist during operation phase of the project who will be responsible for EMP implementation and reporting by BWMC and its O&M contractors during operation. Monthly environmental compliance report will be prepared by BWMC and circulated to concerned authorities. Further third party environmental monitoring consultant will be hired on intermittent basis to monitor the EMP implementation and to report environmental non-compliances.

Table 7.1: Environmental Management Plan

Project Activities	Section	Impact	Mitigation Measures Recommended	Responsibility		Timing
				Execution	Monitoring	
Design/Pre-Construction Phase	1.1	Landfill Site Selection	Site selection for the proposed landfill site must be conducted in accordance with international standards and guidelines for landfill development, including but not limited to the IFC Guidelines on Waste Management Facilities for Landfills. Factors such as site capacity, accessibility, acceptability, stability, environmental sensitivity, land use, socio-economic receptors and climate hazards shall be assessed and evaluated at the time of site selection Proposed selection of landfill site must take into account impacts from leachate, litter, dust, vector and odors on surrounding environment.	EDCM	PMU	BC: during detailed designing of the sub-project
	1.2	Integration of EIA/EMP requirements into bidding documents	The proposed 'Safeguards unit' that will be developed at the PMU will be assigned the task to check that design and bid documents are responsive to key environmental, social and safety considerations, and that the proposed method of work reflects the boundaries defined in the EMP. The bid documents must include the EMP and its implementation cost must be reflected in the BOQ. EIA/EMP implementation and monitoring requirements must be part of bidding documents and necessary contractual binding must be agreed by project contractors before award of contract. Project contractors shall have qualified and experienced environmental staff to plan, arrange,	PMU	-	BC: during detailed designing of the sub-project

			implement, monitor and report EIA/EMP requirements.			
	1.3	EMP Implementation	PMU Punjab LG &CDD shall review the contractor capacity with respect to safeguard management and contracts shall be awarded accordingly. The Contractor will be required to define an Occupational and Environmental Health and Safety procedure for all work, including work camp operation, management of cement dust, and use of Personal Safety Equipment. These procedures should be developed and approved by the PMU in collaboration with the focal agencies before the Contractor commences any physical works on ground. PMU Punjab LG&CDD shall ensure the project contractors are selected on merit and necessary funds has been allocated in the contract documents for EMP implementation and monitoring.	PMU	PMU	BC: during detailed designing of the sub-project
	1.4	Land Acquisition and Resettlement Impacts	Pending payment to all land owners must be paid before mobilization of construction contractors. Social safeguard unit shall ensure that project affected people has been paid following appropriate procedures and there are no grievances about land acquisition process of the site.	EDCM	PMU	BC: during detailed designing of the sub-project
	1.5	Impacts due to Natural Hazards	Bahawalpur Landfill infrastructure shall be designed keeping in view the seismic zone 2 A building considerations. Surface water diversion shall be included in the design to protect landfill from urban/flash flooding.	PMU	-	BC: during detailed designing of the sub-project

			Extreme precipitation events analysis shall be performed for landfill life i.e. 25 years, to predict and manage impacts of flash flooding. On site waste storage at loading bay shall be kept to minimum during high precipitation events. Emergency response plan shall be prepared by construction and operation phase contractors and will be submitted to PMU for approval to manage impacts of natural hazards such as earth quakes and floods.			
Construction Phase	2.1	Landfill Design	Method statements must be prepared by the Contractor and approved by the Construction Supervision Consultant (CSC) prior to commencement of construction works; The CSC must closely monitor the construction works being conducted by the Contractor to ensure the finalized design is implemented in full and the landfill design is developed completely in compliance of the approved finalized designs. Any deviation by the Contractor from following the finalized design must be immediately highlighted and corrective measures must be implemented to ensure full compliance with the finalized design of the landfill. PMU PUNJAB LG&CDD shall ensure that construction activities are being carried out in compliance to project design following best international practices. It will closely review and monitor the activities of CSC and contractors involved in construction activities.	Contractors	CSC, PMU	DC
	2.2	Air Quality Degradation	At the landfill site and the immediately adjoining areas, water will be sprinkled every three hours and at a higher frequency if felt necessary, at all construction sites to suppress dust emissions.	Contractors	CSC, PMU	DC

			All heavy equipment and machinery shall be fitted in full compliance with the national and local regulations. Stockpiled soil and sand shall be slightly wetted before loading, particularly in windy conditions. Fuel-efficient and well-maintained haulage trucks shall be employed to minimize exhaust emissions. Vehicles transporting soil, sand and other construction materials shall be covered with tarpaulin. Limitations to speeds of such vehicles as felt necessary. Transport through densely populated area should be avoided. Concrete plants to be controlled in line with statutory requirements and shall not be close to sensitive receptors. Stack height of generators will be at least 3 meters above the ground. Project traffic will maintain maximum speed limit of 20 km/hr on all unsealed roads within project area. A minimum distance of 300 meters will be ensured between batching plant(s) and the nearest community. The need for large stockpiles shall be minimized by careful planning of the supply of materials from controlled sources. Stockpiles should not be located within 50 m of schools, hospitals or other public amenities and shall be covered with tarpaulin when not in use and at the end of the working day to enclose dust. If large stockpiles (>25m³) of crushed materials are necessary, they should be enclosed with side barriers and also covered when not in use.			
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			Dust emissions due to road travel shall be minimized through good construction practices (such as keeping stock piles down wind and away from communities) and sprinkling water over the access road. Maintaining levels of contaminant dusts, vapors and gases in the work environment at concentrations below those recommended as TWA-TLV's (threshold limit value)—concentrations to which most workers can be exposed repeatedly (8 hours/day, 40 hrs/week, week-after week), without sustaining adverse health effects. · Developing and implementing work practices to minimize release of contaminants into the work environment including: Direct piping of liquid and gaseous materials Minimized handling of dry powdered materials; Enclosed operations Local exhaust ventilation at emission/release points Vacuum transfer of dry material rather than mechanical or pneumatic conveyance Indoor secure storage, and sealed containers rather than loose storage Where ambient air contains several materials that have similar effects on the same body organs (additive effects) Vehicular & Equipment Emissions It shall be ensured that the following measures are taken to control emissions from vehicles being used in the construction activity: Periodically check and conduct maintenance of the construction machinery and haul vehicles.			
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			Generators, compressors and vehicles used during construction works will be maintained in a good condition to ensure that emissions are kept to a minimum level. Regularly change the engine oil and use new engines/machinery/equipment having good efficiency and fuel burning characteristics. Controlled technology generator and batching plants will be used to avoid excessive emissions. Burning of wastes at any site will not be allowed. The stack height of generators will be at least 3 meters above the ground. Training of the technicians and operators of the construction machinery and drivers of the vehicles. All type of machinery and generator must comply with the PEQS. Vehicles, which are not in compliance with PEQS are not allowed to use. Periodic emission monitoring of vehicles, generator and batching plants is proposed. Project activities should be planned to avoid harsh weather conditions.			
	2.3	Health and Safety Hazard	Work areas outside the project site, especially where machinery is involved, will be barricaded and will be constantly monitored to ensure that local residents, particularly children stay away while excavated areas being prepared for landfill related infrastructure will also be cordoned off. Also, no machinery will be left unattended, particularly in running condition. Local communities in the project area will be briefed on traffic safety, especially women who are the main care providers to children.	Contractors	CSC, PMU	DC

			Speed limit of 20 km/hr will be maintained by all project related vehicles and nighttime driving of project vehicles will be limited where possible. Educate drivers on safe driving practices to minimize accidents and to prevent spill of hazardous substances and other construction materials during transport. Contractor must take proper safety measures (placing warning tapes around excavations) to avoid people, especially children, accidentally falling into excavations. All the working platforms must be cordoned off with special care by well-trained skilled workers. Contractor will prepare construction management plan which will include the hazard prevention and safety plan, which will address health and safety of the people in the project area. PMU PUNJAB LG&CDD should ensure the contractor staff working in the project are well trained and educated in the Health, Safety and Environment (HSE) hazards associated with their duties, and that of the public, in the project area.			
			General The Contractor will be required to prepare and implement an effective OHS Plan that is supported by trained first aid personnel and emergency response facilities. Construction contracts will include standard OHS measures and contractors will be bound to implement these fully. Monitoring will be required to ensure that the OHS plan based on contract specifications is followed.	Contractors	CSC, PMU	DC

			Cement feed hopper areas will be inspected daily to ensure compliance with the requirement of dust masks. Surfaces (including flooring and work surfaces) in camps, kitchens, dining areas and workshops should be solid and easy to clean. Flooring for work camps must be float finished concrete or better. All drivers engaged by Contractors must hold a valid license for the vehicle they are operating. Work in confined space shall be executed with available safety standards. Adequate monitoring and equipment shall be available to detect deficient oxygen levels. The Contractor shall submit to the Engineer of CSC for approval an emergency evacuation plan and practice the procedure annually. The Contractor shall submit to the Engineer of CSC for approval a site layout plan, identifying work areas, accommodation, kitchen, dining area, sanitary facilities, location of generators, plant and vehicle parking, transport routes through the camp, pedestrian routes through the camp, evacuation routes, emergency exits, batching plants, storage areas, waste facilities etc. Fire extinguishers should be provided throughout camps and work sites. Fire extinguishers should be inspected monthly and maintained as necessary. An adequate and reliable supply of safe drinking water shall be made available at readily accessible and suitable places including at all camps. The Contractor shall take samples from each supply of drinking water and arrange for analysis			
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			of these samples at EPA certified laboratory prior to its use by the Contractor's staff. The results of these tests for each supply must be submitted to the Engineer of CSC and must demonstrate that each water supply meets national and World Health Organization standards for drinking water. The Contractor shall provide and maintain adequate hygienic kitchens which are sheltered and separated from the living quarters. Kitchens shall include raised and washable surfaces suitable for food preparation. The Contractor shall provide and maintain adequate hygienic dining areas for staff. Work places and camps should be provided with both natural& artificial light. Artificial lighting should be powered by generator in the event of power cuts. Public sensitization training should be provided to workers to avoid social conflicts between residents and the construction contractor, Occurrence of any such impacts can be avoided by community sensitive project planning and implementation and through effective involvement of local administration. All HSE protocols should be implemented in true letter and spirit. Contractor must appoint an HSE resource to implement, monitor and report the HSE management plan to concerned authorities. Contractor must ensure the provision of first aid facility at construction site and camps through hiring medics and establishing a dispensary at the campsite.			
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			Reasonable number of first aid kits should be available on construction sites and within contractor camps. Based on the type of hazard applicable during the proposed works at site, the following mitigation measures as per IFC guidelines for Occupational Health and Safety (OH&S) must be implemented:²⁹ <u>Mitigation Measures for Physical Hazards</u> <i>Rotating and Moving Equipment</i> Designing machines to eliminate trap hazards and ensuring that extremities are kept out of harm's way under normal operating conditions. Where a machine or equipment has an exposed moving part or exposed pinch point that may endanger the safety of any worker, the machine or equipment should be equipped with, and protected by, a guard or other device that prevents access to the moving part or pinch point. Guards should be designed and installed in conformance with appropriate machine safety standards. Turning off, disconnecting, isolating, and de-energizing (Locked Out and Tagged Out) machinery with exposed or guarded moving parts, or in which energy can be stored (e.g. compressed air, electrical components) during servicing or maintenance.			
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²⁹<https://www.ifc.org/wps/wcm/connect/1d19c1ab-3ef8-42d4-bd6b-cb79648af3fe/2%2BOccupational%2BHealth%2Band%2BSafety.pdf?MOD=AJPERES&CVID=ls62x8l>

			Designing and installing equipment, where feasible, to enable routine service, such as lubrication, without removal of the guarding devices or mechanisms. <i>Vibration</i> Exposure to hand-arm vibration from equipment such as hand and power tools, or whole-body vibrations from surfaces on which the worker stands or sits, should be controlled through choice of equipment, installation of vibration dampening pads or devices, and limiting the duration of exposure. Limits for vibration and action values. Exposure levels should be checked on the basis of daily exposure time and data provided by equipment manufacturers. <i>Electrical</i> Marking all energized electrical devices and lines with warning signs; Locking out (de-charging and leaving open with a controlled locking device) and tagging-out (warning sign placed on the lock) devices during service or maintenance; Checking all electrical cords, cables, and hand power tools for frayed or exposed cords and following manufacturer recommendations for maximum permitted operating voltage of the portable hand tools; · Double insulating / grounding all electrical equipment used in environments that are, or may become, wet; using equipment with ground fault interrupter (GFI) protected circuits; ·			
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			Protecting power cords and extension cords against damage from traffic by shielding or suspending above traffic areas; · Conducting detailed examination and marking of all buried electrical wiring prior to any excavation work. Appropriate labeling of service rooms housing high voltage equipment ('electrical hazard') and where entry is controlled or prohibited; · Eye Hazards Use of machine guards or splash shields and/or face and eye protection devices, such as safety glasses with side shields, goggles, and/or a full-face shield. Specific Safe Operating Procedures (SOPs) may be required for use of sanding and grinding tools and/or when working around liquid chemicals. Frequent checks of these types of equipment prior to use to ensure mechanical integrity is also good practice. Machine and equipment guarding should conform to standards published by organizations such as CSA, ANSI and ISO. Welding/Hot Work Provision of proper eye protection such as welder goggles and/or a full-face eye shield for all personnel involved in, or assisting, welding operations. Additional methods may include the use of welding barrier screens around the specific work station (a solid piece of light metal, canvas, or plywood designed to block welding light from others). Devices to extract and remove noxious fumes at the source may also be required. · Special hot work and fire prevention precautions and Standard Operating Procedures (SOPs) should be implemented if welding or hot cutting is			
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			undertaken outside established welding work stations, including 'Hot Work Permits, stand-by fire extinguishers, stand-by fire watch, and maintaining the fire watch for up to one hour after welding or hot cutting has terminated. Special procedures are required for hot work on tanks or vessels that have contained flammable materials. <i>Industrial Vehicle Driving and Site Traffic</i> Training and licensing industrial vehicle operators in the safe operation of specialized vehicles such as forklifts, including safe loading/unloading, load limits. · Ensuring drivers undergo medical surveillance. · Ensuring moving equipment with restricted rear visibility is outfitted with audible back-up alarms. · Establishing rights-of-way, site speed limits, vehicle inspection requirements, operating rules and procedures (e.g. prohibiting operation of forklifts with forks in down position), and control of traffic patterns or direction. · Restricting the circulation of delivery and private vehicles to defined routes and areas, giving preference to 'one-way' circulation, where appropriate. <i>Ergonomics, Repetitive Motion, Manual Handling</i> Facility and workstation design with 5th to 95th percentile operational and maintenance workers in mind. Use of mechanical assists to eliminate or reduce exertions required to lift materials, hold tools and work objects, and requiring multi-person lifts if weights exceed thresholds.			
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			Selecting and designing tools that reduce force requirements and holding times and improve postures. Providing user adjustable workstations. Incorporating rest and stretch breaks into work processes and conducting job rotation. · Implementing quality control and maintenance programs that reduce unnecessary forces and exertions. · Taking into consideration additional special conditions such as left-handed persons. Working at Heights Installation of guardrails with mid-rails and toe boards at the edge of any fall hazard area. · Proper use of ladders and scaffolds by trained employees. · Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard area, or fall protection devices such as full body harnesses used in conjunction with shock absorbing lanyards or self-retracting inertial fall arrest devices attached to fixed anchor point or horizontal life-lines. · Appropriate training in use, serviceability, and integrity of the necessary PPE. · Inclusion of rescue and/or recovery plans, and equipment to respond to workers after an arrested fall. Fire and Explosions Storing flammables away from ignition sources and oxidizing materials. Further, flammables storage area should be:			
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			Remote from entry and exit points into camps Away from facility ventilation intakes or vents Have natural or passive floor and ceiling level ventilation and explosion venting Use spark-proof fixtures Be equipped with fire extinguishing devices and self-closing doors, and constructed of materials made to withstand flame impingement for a moderate period of time. Defining and labeling fire hazards areas to warn of special rules (e.g. prohibition in use of smoking materials, cellular phones, or other potential spark generating equipment). · Providing specific worker training in handling of flammable materials, and in fire prevention or suppression. <i>Corrosive, oxidizing, and reactive chemicals</i> Corrosive, oxidizing and reactive chemicals should be segregated from flammable materials and from other chemicals of incompatible class (acids vs. bases, oxidizers vs. reducers, water sensitive vs. water based, etc.), stored in ventilated areas and in containers with appropriate secondary containment to minimize intermixing during spills. · Workers who are required to handle corrosive, oxidizing, or reactive chemicals should be provided with specialized training and provided with, and wear, appropriate PPE (gloves, apron, splash suits, face shield or goggles, etc). · Where corrosive, oxidizing, or reactive chemicals are used, handled, or stored, qualified first-aid should be ensured at all times. Appropriately equipped first-aid stations should be easily			
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			accessible throughout the place of work, and eye-wash stations and/or emergency showers should be provided close to all workstations where the recommended first-aid response is immediate flushing with water. <u>Mitigations for Biological Hazards</u> The Contractor should review and assess known and suspected presence of biological agents at the place of work and implement appropriate safety measures, monitoring, training, and training verification programs. Project contractor must provide good working and sanitation conditions at camp and work sites. Disease surveillance should be carried out to identify any exposure to parasites, such as hookworm, ascaris, and various mites, chiggers, ticks and dengue. Measures to eliminate and control hazards from known and suspected biological agents at the place of work should be designed, implemented and maintained in close co-operation with the local health authorities and according to recognized international standards.			
	2.5	Noise and Vibration	Equipment noise will be reduced at source by proper design, maintenance and repair of construction machinery and equipment. Noise from vehicles and power generators will be minimized by use of proper silencers and mufflers. Excessive noise emitting equipment will not be allowed to operate and will be replaced. Blowing of horns will be prohibited on access roads to work sites.	Contractors	CSC, PMU	DC

			As a rule, the operation of heavy equipment shall be conducted in daylight hours. Construction equipment, which generates excessive noise, shall be enclosed or fitted with effective silencing apparatus to minimize noise. Well-maintained haulage trucks will be used with speed controls. Use of ear plug and ear muffs must be ensured during construction. No employee should be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day without hearing protection. In addition, no unprotected ear should be exposed to a peak sound pressure level (instantaneous) of more than 140 dB(C). Prior to the issuance of hearing protective devices as the final control mechanism, use of acoustic insulating materials, isolation of the noise source, and other engineering controls should be investigated and implemented, where feasible. Periodic medical hearing checks should be performed on workers exposed to high noise levels. All the equipment and machinery used during construction phase should be well maintained and in compliance with PEQS.			
	2.6	Hazardous and non-hazardous waste disposal	A waste management plan will be developed prior to the start of construction. This plan will cater to sorting of hazardous and non-hazardous materials prior to disposal, placing of waste bins at the project sites for waste disposal and an onsite hazardous waste storage facility i.e. designated area with secondary containment.	Contractors	CSC, PMU	DC

			Licensed waste contractors will be engaged to dispose off all non-hazardous waste material that cannot be recycled or reused. Excavated material from landfill cells will be stored at site and it will be used as daily cover within landfill cells. All types of combustible and non-combustible waste including plastic or glass bottles and cans will be temporarily stored on site and later sold/handed over to a waste/recycling contractor who will utilize these wastes for recycling purposes. Waste management training for all site staff to be included in Contractor's training plan. Fuel storage areas and generators will have secondary containment in the form of concrete or brick masonry bunds. The volume of the containment area should be equal to 120% of the total volume of fuel stored. Fuel and hazardous material storage points must be included in camp layout plan to be submitted for approval. Hazardous material storage areas shall include a concrete floor to prevent soil contamination in case of leaks or spills. Fuel tanks will be checked daily for leaks and all such leaks will be plugged immediately. Designated vehicles/plant wash down and refueling points must be included in camp layout plan to be submitted for approval. Hazardous waste will be initially stored on site at designated area and then handed over to EPA certified contractor to final disposal. Record of waste generation and transfer shall be maintained by project contractors.			
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			Spill kits, including sand buckets (or other absorbent material) and shovels must be provided at each designated location. At the time of restoration, septic tanks will be dismantled and backfilled with at least 1m of soil cover keeping in view landscape of surrounding natural surface. It will be ensured that after restoration activities, the campsite is clean and that no refuse has been left behind. Clinical wastes will be temporarily stored onsite separately and will be handed over to approve waste contractor for final disposal. Training will be provided to personnel for identification, segregation and management of waste.			
	2.7	Waste Effluent Disposal	It will be ensured that no untreated effluent is released to the environment. A closed sewage treatment system including soak pits and septic tank will be constructed to treat the effluent from the construction/labor camps. Sewage treatment system will be installed at each respective labor camp based on the number of laborers residing at the respective camp. Wastewater from laundry, kitchen washings and showers will be disposed-off into soak pits or septic tank (where soak pit cannot be constructed) and after treatment it will disposed of in TMA provided drains in the project area. Soak pits will be built in absorbent soil and shall be located 300 m away from a water well, hand pump or surface water body. Soak pits in non-absorbent soil will not be constructed.	Contractors	CSC, PMU	DC

			Ensure that the soak pits remain covered all the time and measures are taken to prevent entry of rainwater into them. Sprinkling of grey water or sewage will not be allowed; in case the septic tank gets filled with sludge, septic tank shall be emptied through vacuum truck and material shall be transferred to treatment facility or approved municipal drain. Water being released from any batching plant(s) must be treated as per requirements of PEQS prior to release to sewerage system/any other water body. Sewage at the end of construction period to be disposed of in nearest municipal drains after getting approval from concerned municipal authorities.			
	2.8	Soil Erosion and Sedimentation	Any drainage structures, culverts or pipes crossing the project site may need to be modified or protected and the detailed designs must make provisions to protect or re-provision all infrastructure that may be affected by the construction works.	Contractors	CSC, PMU	DC
	2.9	Soil Contamination	It will be ensured that spill prevention trays are provided and used during refueling. Also, on-site maintenance of construction vehicles and equipment will be avoided as far as possible. In case on-site maintenance is unavoidable, tarpaulin or other impermeable material will be spread on the ground to prevent contamination of soil. Regular inspections will be carried out to detect leakages in construction vehicles and equipment and all vehicles will be washed in external commercial facilities.	Contractors	CSC, PMU	DC

			Fuels, lubricants and chemicals will be stored in covered bounded areas, underlain with impervious lining. Appropriate arrangements, including shovels, plastic bags and absorbent materials will be available near fuel and oil storage areas.			
	2.10	Employment Conflicts	The Construction Contractor will adopt a transparent hiring policy. Prior to the commencement of the construction activity, the local communities in the project area will be informed of the employment policy in place and number of people that can be employed for this project. It will be ensured that maximum number of unskilled and semi-skilled jobs will be provided to the residents of the project area. The PMU will ensure a balanced process of employment of the communities in the project area with preference given to those most directly affected by the project.	Contractors	CSC, PMU	DC
	2.11	Communicable diseases	A communicable diseases prevention program will be prepared for construction workers or residents near the construction sites.	Contractors	CSC, PMU	DC
	2.12	Vegetation and Wildlife Loss	Necessary plantation will be carried out, which will act as buffer zone from surrounding environment. Reasonable area has been allocated for plantation within and at boundary of facility to improve landscape of the area. Indigenous tree plantation will be carried out, which will serve as the buffer zone. For the landfill, to present a clean and aesthetically pleasing view, buffer zone with tree plantation and landscaped berms will be done. Plantation will start as one of the earliest activities of site development. Once the design of landfill is approved and necessary funds	Contractors	CSC, PMU	DC

			mobilized, plantation activity can be started in collaboration with Bahawalpur Development Authority (BDA) or BWMC can outsource the activity separately. Camp/s will be located in existing clearings; as much as possible. Off-road travel will be strictly prohibited and observance of this will be monitored during execution of the project Vehicles speed will be regulated and monitored to avoid excessive dust emissions. No hunting or killing of animals will be permitted. No cutting down of vegetation or using vegetation or trees as firewood will be permitted.			
	2.13	Impacts on Historical/Archaeological Sites	If evidence of any archaeological remains is found during the construction activities, the excavation work will be stopped immediately and necessary next steps taken to identify the archaeological discovery based on the 'Chance Find' procedures.	Contractor	CSC, PMU	DC
	2.14	Impacts associated with Construction of office and Administration Building and Other Infrastructure	Water will be sprinkled regularly to suppress dust emissions. Off road travelling of vehicles will be prohibited. Stock piles will be appropriately located and out of wind to avoid dust emissions. Dry dusty materials should be sprinkled with water and properly covered to avoid dust emissions. No cement and concrete waste will be left unattended. Construction debris will not be thrown from height to avoid dust emissions. Return unpaved areas to original or improved contours following construction.	Contractor	CSC, PMU	DC

			Solid waste generated during construction of BWMC office and admin buildings will be managed through SSEMP. Set protocols for proper and regular maintenance of construction machinery, vehicles and generators at building sites. Generators that will be used will be placed at suitable locations. Contractor will not be allowed to store bulk quantities of fuel or hazardous material at building sites Any fuel or chemicals stored at building sites (in small quantities) will be stored at designated site and containers/storage vessels be properly marked for their contents. Storage area will be provided with hard impervious surface and secondary containment. Equipment and machinery with loose vibratory parts will not be allowed to use. Used equipment and machinery will be in compliance to PEQS. Waste bins will be provided at appropriate places to manage waste. Daily housekeeping of the construction area will be carried out.			
	2.15	Impacts associated with Construction of Access Roads	The road widening will be to a standard that is suitable for movement of high-capacity waste carrying vehicles. BWMC/PMU will maintain close coordination with the residents falling close to road widening works, project information leaflet will be distributed to them and awareness with respect to impacts (noise, dust and vibrations) associated with construction will be provided. If people are notified,	Contractor	CSC, PMU	DC

			their acceptance of the disturbance is usually higher. BWMC/PMU will arrange community consultation session before commencement of construction works to make public sensitization which will facilitate smooth execution of project activities. Compaction with heavy vibration rollers should be avoided or minimized in built-up areas. Work areas outside the project site, especially where machinery is involved, will be barricaded and will be constantly monitored to ensure that local residents, particularly children stay away. Local communities in the project area will be briefed on traffic safety, especially women who are the main care providers to children. Traffic diversions will be planned in such way that it does not create traffic congestion during road widening works. Road closure for the works will be avoided. Proper drainage system will be provided in order to achieve sustainability. Off-road travel will be strictly prohibited and observance of this will be monitored during execution of the project. Vehicle speed will be regulated and monitored to avoid excessive dust emissions. Blowing of horns will be prohibited on access roads to work sites. Periodic sprinkling on access road at least twice per day during construction phase and restrict vehicle speed to 20 kmph.			
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			Project traffic will maintain maximum speed limit of 20 km/hr on all unsealed part within project area. Traffic is not disrupted by labor camps being set up roadside next to the construction sites. Contractor will prepare construction management plan which will include the hazard prevention and safety plan, which will address health and safety of the people in the project area. PMU Punjab LG&CDD should ensure the contractor staff working in the project are well trained and educated in the Health, Safety and Environment (HSE) hazards associated with their duties, and that of the public, in the project area. Record of waste generation and transfer shall be maintained by project contractor. Periodic water sprinkling will be carried out during widening works to suppress dust. Fuel-efficient and well-maintained equipment and machinery shall be employed to minimize exhaust emissions. The need for large stockpiles shall be minimized by careful planning of the supply of materials from controlled sources. Stockpiles should not be located within 50 m of schools, hospitals or other public amenities and shall be covered with tarpaulin when not in use and at the end of the working day to enclose dust. If large stockpiles (>25m³) of crushed materials are necessary, they should be enclosed with side barriers and also covered when not in use. Prior to starting of work, the contractor should prepare a method statement for water supply pipeline works. This should be simple and explain the contractor's work process that is actually			
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			conducted on site, with safety and safeguard concerns. Method Statement is very important, particularly for the road widening works. Method Statement can be prepared for each stretch (say 1 km) /specific site based on the project area. Method Statement should be in a Table format with appended site layout map and cover the following: Work description 1.No. of workers (skilled & unskilled) 2. Details of Plant, equipment & machinery, vehicles 3. Work duration (total, and activity-wise, for example for preparation of sub grade, sub-base, base and wearing coarse 4. PPE (helmet, gloves, boots, etc.) details for each type of work 5. Details of materials at each site (type & quantity) 6. Risks/hazards associated with the work 7. Construction waste/debris generated (details & quantity) 8.Detail the sequence of work process (step-by-step) including specific details of each work 9. Contractor's supervision & management arrangements for the work 10.Emergency: Designate (i) responsible person on site, and (ii) first aider			
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			11. Typical site layout plan including placement of material, excavated earth, barricading etc. 12. The following should be included in the site layout plan: Provide barricading/security personnel at the site to prevent entry/trespassing of pedestrian/vehicles into the work zone. Location of temporary stockpiles and provision of bunds Separation of stockpiles areas with workers/vehicle movement paths to avoid disturbing the stockpiled soil Wetting of soil to arrest dust generation by sprinkling water Waste/surplus soil utilization and disposal plan – indicate expected duration of temporary stockpiling along the road and identify final surplus soil utilization/disposal site in consultation with PMU. PMU Punjab will ensure the identification of disposal sites for unsuitable excavated material in consultation with BWMC. PMU will inspect and monitor the borrow material areas prior to procurement to ensure that it is being used in sustainable way and no significant disfiguration of landscape is going on at quarry site. Stock piling of excavated material at places that are congested will be avoided as these piles can create traffic issues and public nuisance. Already available quarry sites for additional backfill material will be utilized. Development of new quarry site will be discouraged.			
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			Record of borrow materials will be maintained including details of quarry site, agreement and necessary approvals from concerned government authorities.			
Operation Phase	3.1	Leachate Generation	Operate the landfill in accordance with applicable internationally recognized standards to minimize leachate generation, including the use of low-permeability landfill liners to prevent migration of leachate as well as landfill gas, a leachate drainage and collection system, and landfill cover (daily, intermediate, and final) to minimize infiltration; Leachate generated during active phase of LFS will be treated through Three stage open leachate treatment system and potable Anaerobic digestion treatment system for leachate. Anaerobic Digestion treatment system is potable arrangement for treatment of leachate and can be operationalized during monsoon for 24/7 basis. During monsoon season, recirculation of leachate will be increased to avoid operational constraints of leachate collection, storage and treatment system at landfill site. During monsoon, recirculation of leachate will be increased to avoid operational constraints of leachate collection, storage and treatment system at landfill site. Minimize the daily exposed working face and use perimeter drains and landfill cell compaction, slopes and daily cover materials to reduce infiltration of rainfall into the deposited waste; Leachate collection will be augmented by a leachate recirculation system in the landfill design. The operators of the landfill must ensure that an effective and efficient leachate control and	O&M Contractor/BWMC	BWMC, PMU	DO

			monitoring system is maintained. This may be complimented by establishment of groundwater monitoring wells and regularly collecting samples for laboratory analysis. Results of the analysis could aid the operators to determine the final fate of the collected leachate and/detect any potential leakages. Final decision rests with the landfill operator on the final number of wells as well as the frequency of sampling for groundwater quality. The final vegetative cover plays an integral part in leachate production control. Its basic functions are to limit infiltration by intercepting precipitation directly, thereby improving evaporation from the surface, and to reduce percolation through the cover material by taking up soil moisture and transpiring it back to the atmosphere. Preferred plant species should be of those that do not have deep roots in order to protect the surface sealing. Further, these species should require minimal maintenance and human intervention. Landfill operators must be properly and adequately trained to operate and maintain the installed control system. A procedure for the rapid repair of leaks in the pipes, pumps and other equipment must be part of landfill operations. An inventory of spare parts and repair equipment must be continuously in place to ensure immediate remedial action against breakdowns. Strict quality assurance and construction guidelines during the installation of the HDPE liner should be strictly implemented. In worst case, if leachate contamination is detected during ground water monitoring after few years of landfill operation, ground water modelling to determine possible contamination of leachate			
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			will be carried out and necessary design changes will be done. Detailed ground water quality baseline will be developed during operation phase of the project to trace any ground water contamination from landfill operations.			
	3.2	Contamination of Soil and Groundwater	Bottom lining will be comprised of compacted sub-grade base, geo-synthetic clay liner (GCL) topped by 2 mm HDPE layer. Silty sand or geotextile (500 GSM) will be covered for the protection of the HDPE on the side slopes. Above geotextile gravel layer (30 cm thick) will be placed which will be topped up with sand layer (50 cm thick). An efficient leachate collection and treatment system will be provided to ensure leachate accumulation at the base of the landfill and keep it to a minimum. Thick top soil layer (6 inches) capable of supporting vegetation in order to protect the landfill surface from wind and water erosion. Drain Layer (18 inches) of at bottom to maximize runoff of precipitation while minimizing infiltration and preventing ponding of water on the landfill. Compacted soil layer or barrier of low permeability (1×10^{-5} cm/sec) to limit and control the amount of precipitation that enters the waste. Vent layer of reasonable thickness comprised of sand and gravel. The leachate system will consist of a leachate collection layer of either natural granular (sand, gravel) or synthetic drainage material (e.g. geonet or geo-composite) with pipe network to convey the leachate to treatment facility.	O&M Contractor/BWMC	BWMC, PMU	DO

			Leachate collection pond shall be in opposite direction from nearest surface water body. Three Stage Open Pond Leachate Treatment System and Anaerobic digestion will be used for leachate treatment. Anaerobic digestion is fully enclosed and environmental much better options which is incorporated in the FS. Slope of the landfill site shall be away from nearest surface water body. Cut-off drains around active landfill site and peripheral drains around landfill site should be provided Detailed analysis of leachate leakage detection on ground water quality will be carried out and necessary design changes/improvements will be done. Ground water monitoring wells should be dug keeping in view of the flow of ground water on both upstream and downstream of the disposal site and monitor the ground water quality of the upper strata for any contamination for disposal site every month. Waste hauling vehicles shall be covered during transport of waste to landfill site Hauling vehicles shall not wash at the surface water bodies along the route as the wash water shall drain into the canal and will pollute the surface water source which is used by the animals of the nearby communities and for agriculture purpose. Domestic sewerage of Bahawalpur facility shall not be discharged untreated in open area and drains,			
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			Waste water generated from vehicle wash area shall be contained and treated before final discharge In order to augment this system, regular quality control checks on the equipment /accessories will be implemented and incorporated during construction and operations.			
	3.3	Landfill Gas generation	Landfill gas capture and 1000m3 flaring systems will be in place as part of the landfill design and thus no significant impacts on occupational or community health and safety are envisaged from landfill gas exposure. Landfill gas will be collected through installation of perforated pipes within the cells. This gas will initially flared through 1000 m3 flaring system at start of landfill operations. Keeping in view the volume of gas generated after few years of operations feasibility for gas reuse including conversion into CNG will be carried out and accordingly design changes will be executed. Both Horizontal and Vertical gas collection systems will be implemented in the landfill. The gabion of the gas collection wells will be filled with gravel and these will be constructed with iron mesh. There will be a perforated HDPE pipe with pressure class in the center of the gas collection wells. The gap between the iron mesh and the perforated pipe will be filled with pebble stone. The organic waste will be beneficially utilized when it is deposited in the bio reactor landfill where it will generate regular and increased quantity of landfill gas which will contain 55-60 percent of Methane. The methane can be converted into electricity or CNG. The CNG option is a much better option as	O&M Contractor/BWMC	BWMC, PMU	DO

			the electricity tariff for green energy is very low in Pakistan and the CNG rates are quite high. The landfill gas recovery must be designed from bottom up to avoid emission during landfill operation and drilling through the garbage when the cell is filled with waste. When two meters of waste layer will deposit in the first cell, a 30m x 30m or 50m x 50m grid of perforated gas recovery pipes will be installed over a 15cm layer of gravel under the pipe and another layer of 15cm gravel will be placed on top of the gas grid. The 30m length of the pipe will be joined with the second pipe with a "T" joint and vertical gas well is installed. When desired height 20-30m of the fill achieved the ring main will be installed and connected to final LFG to power generation. PMU PUNJAB LG&CDD shall ensure that during operation phase of the project, if there are changes in the baseline ambient air quality, then a quantitative assessment will be carried out for flaring and necessary design changes will be incorporated to avoid air quality impacts from flaring. As part of closure plan of existing dumping site, GHG monitoring will be carried out and necessary gas flaring system will be done. Periodic GHG monitoring will be carried out during operation phase of the project.			
	3.4	Air quality Deterioration	Best management practices and good housekeeping measures will be implemented to minimize the release of objectionable odors. Potential odors impacts can be minimized or eliminated by adopting the following measures: Daily cover will be placed on working surface of waste in order to reduce the risk of fire, wind	O&M Contractor/BWMC	BWMC/PMU	DO

			littering, odor, vector breeding and dust hazards in the landfill. Suitable amount of daily cover will be stocked at the landfill site. Final capping of landfill cells will be carried out in order to limit and control the amount of precipitation that enter the waste and to limit wind and water erosion and burrowing animal activity. This will not only prevent the odor of decaying waste from escaping from the landfill but also protect the site against intrusion of vermin and pests. The top cover system consists of following arrangements. Thick top soil layer (6 inches) capable of supporting vegetation in order to protect the landfill surface from wind and water erosion. Drain Layer (18 inches) of at bottom to maximize runoff of precipitation while minimizing infiltration and preventing ponding of water on the landfill. Compacted soil layer or barrier of of low permeability (1×10^{-5} cm/sec) to limit and control the amount of precipitation that enters the waste. Vent layer of reasonable thickness comprised of sand and gravel. Appropriate and regular housekeeping (i.e. cleaning) will be done in all areas where solid waste will be processed (i.e. weigh bridge area). This will prevent the reproduction of flies, generation of obnoxious odors, scattering of plastic and papers, etc. Strict use of Personal Protective Equipment (PPE) by all personnel (e.g. inspectors at the Weigh			
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			Bridge, MRFs, material handler and waste compactor operators) must be ensured. All the incoming ingredients that are anaerobic will be converted to aerobic state through combining them with a coarse, dry bulking amendment to increase the porosity and allow oxygen penetration. Air should be thoroughly dispersed throughout the organic waste. This is done by frequently turning and mixing the wastes. Oxidizing chemicals like hydrogen peroxide, potassium permanganate, and chlorine will be used by the wastewater treatment industry for odor control. Organic waste lot which is creating objectionable odor will be attended immediately introduced in the composing system on priority basis. Controlled compositing conditions will be maintained throughout the operation. Mandatory health and medical check-ups for all employees especially workers working at MRF as they may be exposed to general airborne dust above the level where it is considered a substance hazardous to health (10 mg/m³ as an 8-hr TWA). This should ideally be complimented by obtaining an Insurance Policy for Workmen's especially engaged in the daily activities of the landfill; Control of inhalation exposure to hazardous substances by the effective use of general ventilation within MRF and Local Exhaust Ventilation (LEV) the appropriate use of respiratory protective equipment (RPE);			
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	3.5	Disease vector generation and vermin attraction	The most important control measure used to minimize vector problems at landfills is the application of daily cover. Cover should be present on all solid waste at all times, except the tipping face while it is being worked. Daily cover of at least 150mm of compacted soil or similar material or an effective layer of alternate daily cover (ADC) should be applied on finished portions of the daily cell during operation and at the conclusion of daily operations, and not less frequently than once per day. Alternative daily cover materials such as tarpaulins, foams, granular waste, etc, can be effective as vector control after careful site-specific evaluation. Intermediate cover of 300mm (minimum) compacted soil should be used on all areas not at finished levels, but not to be further landfilled for a period of 30 days or more. Final cover is typically applied as each area is brought to finished level through the operational life of the landfill. There should be no uncontrolled or uncovered waste, including litter, tyres, brush, appliances, construction/demolition waste or even inert industrial waste on the landfill property. The only exception is compactable soil-like inert wastes, such as ash, but even this waste must be graded and compacted to avoid ponding water. There should be no ponding water on the landfill property except as designed for runoff storage or leachate treatment ponds. Such storage ponds can, however, aid vector reproduction if not designed and controlled properly so as to minimise stagnant water, nutrient build-up and plant growth. Finally, the waste must be compacted and graded at reasonable maximum slopes (see the Working	O&M Contractor/BWMC	BWMC, PMU	DO
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			Face Guideline) to minimize voids within the waste that can harbor rodents in particular. Rodents and foxes can readily dig into cover soil, but have much more difficulty digging into compacted solid waste. On-site landfill site personnel must be trained and must monitor the levels of key vectors on a daily basis as part of daily management. A simple monthly site walk-over can provide a baseline of vector activity so changes can be noted and translated into action. Observations of various droppings, sightings, tracks, insect counts, etc are useful indicators of activity. Written reports from regular walk-over assessments should be kept on file so changes that occur over time and in response to control measures can be assessed.			
	3.6	Occupational Health and Safety	OHS management system will be prepared and implemented. Designation of an Environment, Health and Safety (EHS) officer dedicated to the site; All employees must be able to reach their work stations safely. All path, walkways, staircases, ladders and platforms must be stable and suitable for the tasks to be undertaken; Strict use of Personal Protective Equipment (PPE) by all personnel (e.g. inspectors at the Weigh Bridge, material handler and waste compactor operators) must be ensured. Mandatory health and medical check-ups for all employees especially workers working at MRF as they may be exposed to general airborne dust above the level where it is considered a substance hazardous to health (10 mg/m³ as an 8-hr TWA). This should ideally be complimented by obtaining an Insurance Policy for	O&M Contractor/BWMC	BWMC, PMU	DO

			Workmen's especially engaged in the daily activities of the landfill; Develop a written program (i.e. health information, instruction and training) which sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards of working in a landfill and its auxiliary facilities; Mandatory monitoring of air quality and noise levels in the working stations to maintain the same within local standards and whenever possible near ambient levels; Control of inhalation exposure to hazardous substances by the effective use of general ventilation within MRF and Local Exhaust Ventilation (LEV) the appropriate use of respiratory protective equipment (RPE); Accidental fires must be addressed immediately. Appropriate operational procedures involving the spreading and smothering of burning waste, rather than the use of water, must be implemented; Emergency plan (including fire management) must be developed and implemented; Availability of first-aid kits and vehicles that can be used to bring any injured employee to the nearest doctor in cases of accidents; Mandatory reporting of all accidents or incident of near misses of accidents and immediate adoption of corrective measures; and Management must provide all the necessary financial and manpower resources for the implementation and enforcement of all health and safety programs and activities of the project; Regular training and orientation on safety practices will be implemented to impart knowledge of safe			
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			and efficient working environment. Furthermore, regular health checkups of all employees including contract workers will be conducted. Effective and proper housekeeping is recommended to reduce dust exposures to its direct vicinity. Heat levels must be monitored as well. Spot checks should be done to ensure that workers' welfare is addressed especially during summer months.			
	3.7	Waste Collection and Hauling Impacts	Capacity of BWMC will be increased though increase in its collection fleet. It will be done through procurement of both solid waste and non-solid waste carrying machinery under this project. Door to Door collection of waste will be enhanced through media campaigns. Communication programs would be developed to encourage better management of waste. Proper PPEs will be provided to waste handlers. Key performance indicators will be developed to monitor improvements in the system. All type of waste hauling will be carried out in purpose built vehicles to avoid scattering of waste at hauling routes. Drivers of waste carrying vehicles will be trained with respect to environmental sensitization. Drivers are allowed to commute only on designated routes through purpose built vehicles for waste hauling. Multiple transactions of waste will be avoided through use of main and mobile transfer stations. Improved segregation practices will be introducing once door to door collection desired efficiency achieved. Necessary legal bindings with respect to waste storage by Public will be introduced. A comprehensive traffic management plan (TMP) must be developed and implemented;	O&M Contractor/BWMC	BWMC, PMU	DO

			As part of the TMP, it will be ensured that the movement of heavy vehicles related to landfill operations is minimized during the peak traffic hours of the day in order to prevent congestion and accidents as far as possible; Furthermore, the movement of heavy vehicles within Bahawalpur city related to landfill operations must be restricted to specific routes containing least number of sensitive receptors and low traffic volumes. Waste hauling through dirt tracks will be strictly prohibited. Waste hauling through mechanically unfit vehicles or noisy vehicles will not be allowed. Waste transporters will be directed to use designated routes and follow recommended speed limit for waste hauling and such routes will be metaled roads instead of dirt tracks.			
	3.8	Wind Blown Litter	The facility operator, as necessary, will implement the following procedures and techniques to control litter: All trucks must be tarped upon entering and exiting the facility. They should only untarp and tarp at the active area. This policy will be strictly enforced. Daily waste entering the landfill site will be subject to immediate compaction to minimize the area and debris subject to the impacts of wind. If possible, on windy days, the daily fill face tipper locations shall be selected for its protection to minimize effects of wind. Waste that is more susceptible to windblown distribution may, on windy days, be worked immediately into the fill face and covered with a	O&M Contractor/BWMC	BWMC, PMU	DO

			layer of daily cover, as needed, or the waste may be excluded from the site. Portable skid-mounted litter fences may be provided for deployment downwind as close as practical to the working area, as needed. Semi-permanent fencing may be provided around the fill area as an additional barrier to the migration of litter off-site when litter has not been contained by the portable litter fences. (Examples of additional barriers include but not limited to, a four-foot minimum temporary construction fence and/or a ten-foot or higher semi-permanent fence.) The utilization will be continually evaluated and the fence will be relocated or added as needed. Permanent fencing (ten-foot high with an additional three-foot kicker) may be constructed with possibility of placement on an eight-foot high berm. On very windy days, when all other procedures are not successful in controlling blowing litter, the operator may apply cover material more frequently or immediately to the incoming waste load. Buffer zones resulting from required facility setbacks along the site's perimeter should provide some protection of adjacent properties. As a final control measure, personnel will be dispatched, as needed or daily if conditions require, to collect any litter that has escaped the above control measures Portable litter vacuums may be used to collect litter that has accumulated on litter fences. If fences are positioned properly, this can be a very efficient method of collecting litter. The main highway leading to the site will be routinely inspected for litter. If the highway has			
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			litter associated with the trucks entering the facility, then the litter will be picked up on a routine basis. All necessary safety precautions must be followed. Before and after photos of any litter removal effort may be taken in the event anyone questions the level of effort spent on litter collection. Site management's cell phone numbers may be provided to community/neighbors. The management of litter at the landfill is a daily activity. In most instances the above procedures and techniques should properly manage litter effectively. However, there will be occasions and situations when litter will be distributed by the wind in such a manner that the above procedures will not totally manage the litter and contain the litter on-site. In these situations, the facility operator may not be able to collect all litter within the day the litter problem occurred. However, the facility operator should proceed with collecting the litter off site and complete the retrieval of wind-blown litter at the earliest practicable time.			
	3.9	Aesthetic Aspects	The boundary walls shall be constructed alongside the facility. The indigenous plants shall be planted alongside the access road and around the landfill site which will act as buffer zone. The waste transfer vehicles shall be covered. Reasonable area will be allocated for plantation within and at boundary of facility to improve aesthetic appeal of the area. Plantation will start as one of the earliest activities of site development. Once the design of landfill is approved and necessary funds mobilized, plantation activity can be started in collaboration	O&M Contractor/BWMC	BWMC/PMU	DO

			with Bahawalpur Development Authority or BWMC can outsource the activity separately.			
	3.10	Management of Construction and Demolition Waste	All components of construction & Demolition Waste shall be processed, recycled and reused. All Concrete, PCC and RCC will be processed to Produce Class II and Class III recycled Sub-Base and Base materials. Recovered Asphalt Concrete will be mixed in Recycled concrete or reused by mixing with fresh Asphalt concrete. All metal will be recovered and recycled. Wood component will be Processed and used as Mulch or raw materials for compost. Processed waste will be used as Cover material for landfills	O&M Contractor/BWMC	BWMC/PMU	DO
	3.11	Medical Waste management	A dedicated medical waste management system will be established including segregation at source of medical waste in designated waste containers and its treatment as per prevailing PEQS regulations. The treatment of waste will be through autoclave or Incineration. The incineration of medical waste is simpler and cost-effective option and is recommended in the FS.	O&M Contractor/BWMC	BWMC/PMU	DO
Closure & Post Closure Phase	4.1	Closure and Post Closure Impacts	Appropriate selection of soil type for final cover will be ensured to prevent water infiltration and minimize infiltration of precipitation into the waste and the subsequent generation of leachate; control landfill gas migration; and minimize long term maintenance needs.	BWMC	BWMC	During Closure & Post Closure

			Appropriate selection of soil type for final cover will be ensured to prevent direct or indirect contact of living organisms with the waste materials and their constituents; Application of final cover components that are consistent with post closure use and local climatic conditions. Necessary environmental objectives and controls (including technical specifications) will be defined and implemented. Necessary surveillance protocols for final capping, leachate and gas monitoring will be established and implemented. Future Land use of the site will be defined in consultation with local communities and government agencies. It will be ensured that financial resources, and monitoring arrangements are in place for closure and post closure activities. PMU PUNJAB LG&CDD will ensure that financial instruments are in place to cover the costs of closure and post-closure care and monitoring. Long term integrity and security of the site will be maintained.			
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: Construction Supervision Consultant

: Before Construction

: During Construction

: Project Management Unit

During Operation

: Bahawalpur Waste Management Company

Table 7.2: 'Pre-Construction' Environmental Monitoring Plan for Baseline Development

Parameter to be measured	Objective of Monitoring	Parameters to be Monitored	Measurements	Location	Frequency	Responsibility
Ambient Air Quality	To establish baseline air quality levels	CO,NO ₂ , SO ₂ , O ₃ & PM ₁₀ (particulate matter smaller than 10 microns) concentration at receptor level	1-hr and 24-hr concentration levels	At three random receptor locations in the project area, both upwind and downwind	Once	CSC
Ambient Noise	To establish baseline noise levels	Ambient noise level near receptors in project area	A-weighted noise levels – 24 hours, readings taken at 15 s intervals over 15 min. every hour, and then averaged	At three random receptor locations in the project area	Once	CSC
Groundwater Quality in vicinity of landfill site	To establish groundwater quality in project area	Groundwater quality in project area	Water samples for comparison against PEQS parameters	At five locations around the landfill site in the project area	Once	CSC

Table 7.3: Construction Phase Monitoring Requirements

Project Activity and Potential Impact	Objective of Monitoring	Parameters to be Monitored	Measurements	Location	Frequency	Responsibility
Noise Disturbance due to noise from construction activity	To determine the effectiveness of noise abatement measures on sound pressure levels	Ambient noise level at different locations in project area	A-weighted noise levels – 24 hours, readings taken at 15 s intervals over 15 min. every hour at 15 m from receptors, and then averaged	At three random receptor locations in project area	Quarterly basis on a typical working day	Contractor's Environmental officer, CSC
Air Quality Dust emissions from construction vehicles and equipment	To determine the effectiveness of dust control program on dust at receptor level	CO, NO ₂ , SO ₂ , O ₃ & PM ₁₀ (particulate matter smaller than 10 microns) concentration at receptor level	1-hr and 24-hr concentration levels	At three random receptor locations in project area	Quarterly basis on a typical working day	Contractor's Environmental officer, CSC
		Visible dust	Visual observation of size of dust clouds, their dispersion and the direction of dispersion	Construction site	Once daily during peak construction period	Contractor's Environmental officer, CSC

Project Activity and Potential Impact	Objective of Monitoring	Parameters to be Monitored	Measurements	Location	Frequency	Responsibility
Safety precautions by Safety workers	To prevent accidents for workers and general public	Number of near miss events and accidents taking place	Visual inspections	Construction site	Once Daily	Contractor's Environmental officer, CSC
Soil Contamination	To prevent contamination of soil from oil and toxic chemical spills and leakages	Incidents of oil and toxic chemical spills	Visual inspections	At construction site and at vehicle and machinery refuelling & maintenance areas	Once a month	Contractor's Environmental officer, CSC
Solid Waste & Effluent disposal Insufficient procedures for waste collection, storage, transportation and disposal	To check the availability of waste management system and implementation	Inspection of solid and liquid effluent generation, collection, segregation, storage, recycling and disposal will be undertaken at all work sites in project area	Visual inspections	At work sites in project area	Once daily.	Contractor's Environmental officer, CSC

Table 7.4: 'Operation Phase' Environmental Monitoring Plan

Parameter to be measured	Objective of Monitoring	Parameters to be Monitored	Measurements	Location	Frequency	Responsibility
Groundwater Quality in vicinity of landfill site	To assess whether landfill operation is causing any seepage into the groundwater aquifers in project area and contaminating it.	Groundwater quality in project area	Water samples for comparison against PEQS parameters	At five locations around the landfill site in the project area	Quarterly	BWMC
Ambient Air Quality in vicinity of Landfill site	To assess whether landfill operation is causing deterioration of ambient air due to flaring	Ambient air quality in project area	Ambient air quality monitoring against PEQS parameters	At three locations around the landfill site in the project area	Quarterly	BWMC

Solid Waste Management Plan	To assess that solid waste generated from Landfill operation is managed as per EIA/EMP requirements	Solid waste inventory is being maintained Only MSW is reaching the Landfill	Solid waste inventory audit	Each component of Landfill	Monthly	BWMC
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Table 7.5: Capacity Development and Training Programme

Provided by	Organized by	Contents	No. of training events	Duration	Cost (PKR)
Pre-construction Phase Monitoring Consultants/Organizations offering specialized services in environmental management and monitoring	CSC & PMU	Short seminars and courses on: Environmental Management Plan and Environmental Monitoring Plan	Two seminars for Contractor management staff and project staff	1 day	300,000/Training
Construction Phase Monitoring Consultants/Organizations offering specialized services in	CSC & PMU	Short seminars on Environmental risks associated with construction phase.	Two seminars for Contractor management staff and project staff dealing in	1 day	300,000/Training

environmental management and monitoring		Development of Environmental Performance Indicators Occupational Health and Safety (OHS) issues	environment and social issues		
Operation Phase Landfill Facility Operator authorized representative or 3rd party trainer	Landfill Facility Operator	Short seminars on Environmental risks associated with operation phase. Development of Environmental Performance Indicators/ Occupational Health and Safety (OHS) issues	Bi-annual seminars	1-2 Day	800,000/Year
Total			14,00,000 (PKR 1.4 million)		

7.9 ENVIRONMENTAL MANAGEMENT COSTS

The **Table 7.6** below provides cost estimates for 'Pre-Construction phase' monitoring while **Tables 7.7** and **7.8** provides cost estimates for 'Construction phase' and 'Operation phase' monitoring of key environmental parameters.

The costs associated with implementation of the EMP and the necessary mitigation measures are provided as **Table 7.9** below. The **Table 7.10** below provides the 'Capacity development and training programme' for project contractors for the proposed landfill development.

Table 7.6: Cost Estimates for 'Pre-Construction Phase' Environmental Monitoring³⁰

Monitoring Component	Parameters	Quantity	Amount PKR	Details
Air Quality	CO, NO ₂ , SO ₂ , O ₃ PM ₁₀	3 (Once only at 3 locations)	150,000	3 readings @ PKR 50,000 per sample
Noise Levels	dB(A)	3 (Once only at 3 locations)	90,000	3 readings @ PKR 30,000 per reading
Ground Water Quality	PEQS	5 (Once only at 5 locations)	150,000	5 readings @ PKR 30,000 per sample
Contingencies			19,500	5% of monitoring cost
Total (PKR)			409,500	

Table 7.7: Annual Cost Estimates for 'Construction Phase' Environmental Monitoring³¹

Monitoring Component	Parameters	Quantity	Amount PKR	Details
Air Quality	CO, NO ₂ , SO ₂ , O ₃ PM ₁₀	12 (Quarterly basis at 3 locations)	600,000	12 readings @ PKR 50,000 per sample
Noise Levels	dB(A)	12 (Quarterly basis at 3 locations)	360,000	12 readings @ PKR 30,000 per reading
Contingencies			48,000	5% of monitoring cost
Total (PKR)			1,008,000	

³⁰ For air quality monitoring: 'Passive samplers' such as test tubes can be used or 'Active samplers' with sorbent tubes can also be used.

³¹ For noise monitoring: sampling equipment with duration greater than 1 hour can be used

Table 7.8: Annual Cost Estimates for 'Operation Phase' Environmental Monitoring³²

Monitoring Component	Parameters	Quantity	Amount PKR	Details
Surface Water Quality	PEQS	2 (bi-annual basis)	60,000	2 readings @ PKR 30,000 per sample
Groundwater Quality in vicinity of landfill site	PEQS	5 (Quarterly basis @ 5 locations)	600,000	20 readings @ PKR 30,000 per reading
Ambient Air Quality Monitoring	PEQS	3 (Quarterly basis @ 3 locations)	600,000	12 readings @ PKR 50,000 per reading
Contingencies			63,000	5% of monitoring cost
Total (PKR)			1,323,000	

Table 7.9: Estimated Costs for EMP Implementation

Item	Sub-Item	Estimated Total Cost (PKR)
Staff, audit and monitoring cost³³	1 person for 24 months (@ 100,000 per month)	24,00,000
Monitoring Activities	Provided separately in Tables 7.7 and 7.8.	-
Mitigation Measures	As prescribed under EMP and EIA.	40,00,000
(i) Water sprinkling	To suppress dust emissions	800,000
(ii) Solid waste collection & disposal	From construction sites (based on initial estimates)	700,000
(iii) Plantation around project boundary to control odor levels	To plant vegetation all along the landfill boundary to limit odor emissions	15,00,000
(iv) Chemicals/pesticides to prevent/minimize disease vector generation	Chemicals to be injected into the influent streams in order to minimize/prevent disease vector generation	10,00,000
Third party monitoring and evaluation expert	1 person for third party monitoring and evaluation (@ 8 00,000 per evaluation)	48,00,000

³² To cover staff cost and expenses of Environmental Specialist for Contractor

³³ To cover staff cost and expenses of Environmental Specialist for Contractor

Contingencies	5% of EMP implementation cost	560,000
Total Estimated Cost (PKR)		11,760,000

Table 7.10: Capacity Development and Training Programme for Project Contractor(s)

Provided by	Organized by	Contents	Target Audience	Venue	Duration
Pre-construction Phase PMC offering specialized services in environmental management and monitoring	CSC & PMU	Short seminars and courses on: Environmental Management Plan and Environmental Monitoring Plan	Contractor staff	PMU Office, Bahawalpur	One day long training seminar
Construction Phase PMC offering specialized services in social management and monitoring	CSC & PMU	Short seminar on Environmental risks associated with construction phase. Development of Environmental Performance Indicators Occupational Health and Safety (OHS) issues	Contractor staff	PMU Office, Bahawalpur	One day long training seminar

8. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

This section describes the process and outcomes of the consultations carried out with various groups of stakeholders as part of the environmental and social assessment. It includes a brief discussion on the concerns expressed by the stakeholders during the consultation meetings and responses provided in order to address the concerns through necessary mitigation measures.

The specific objectives of the consultation were: (i) obtaining local and indigenous knowledge about the environment and people living in the project area; (ii) interaction with the project affected population and other stakeholders for the collection of primary and secondary data on environment and people; and (iii) engaging stakeholders for maximization of the project benefits.

Two rounds of comprehensive stakeholders' consultations were organized with a total of over 104 different stakeholders consulted. The first round of public consultations was conducted in the month of first week of November, 2022, while the second round of public consultation was completed in the month of December, 2022. Information on positive and negative impacts associated with constructional and operational stage and proper mitigation of adverse impacts were shared at these consultations.

Details on the public consultations conducted are provided below with the pictorial evidences and list of persons consulted provided as **Appendix A.3**.

8.1 IDENTIFICATION OF STAKEHOLDERS

There are three types of stakeholders for the proposed landfill site development as described below.

8.1.1 Primary Stakeholders

The primary stakeholders are primarily the Project Affected Persons (PAPs) and general public including women residing in the project area - for example, people living in the project area particularly those affected by the footprint of the Mari Sheikh Shijra mouza Nouabad Landfill site, Bahawalpur. These are the people who are directly exposed to the project's impacts, though in most cases they may not be receiving any direct benefit from the project. The local community and women of the area were also consulted.

8.1.2 Secondary Stakeholders

The secondary stakeholders are typically institutional stakeholders – for instance, related government department/agencies, local government, and organizations that may not be directly affected by the project; however, they may influence the project and its design. In the case of the proposed landfill site development, the secondary stakeholders are as follows:

- Bahawalpur Waste Management Company (BWMC)
- Environment Protection Agency (EPA), Government of Punjab, Divisional Office Bahawalpur and Head Office in Lahore.
- Wildlife Departments, Government of Punjab
- The ADB (The Financing Agency)

- Tehsil Municipal Authority (TMA), Bahawalpur
- Agricultural Department, Bahawalpur.

8.1.3 Representatives of local communities

- Irrigation Department, Government of Punjab, Bahawalpur.
- Revenue Department, Government of Punjab, Bahawalpur
- Social Welfare and Baitul-Mall, Bahawalpur.
- Al-Fatah Development (Non-government organization)
- Public at large

8.1.4 Key stakeholders

The stakeholders considered to possess the ability to significantly influence a project, or who are critical to the success of a project are considered key stakeholders. Key stakeholders may be from the primary and/or secondary stakeholder groups. In this context of the proposed landfill site development, these are considered to be local leaders, influential community members and other local representatives including Imams of mosques and teachers of local schools.

8.2 INFORMATION DISCLOSURE AND CONSULTATION

8.2.1 Scope of Consultations

The consultations were conducted and recorded by Mr. Saeed (Sr. Sociologist), Mr. Adnan Shareef (Sociologist), Mr. Ali Hassan (Sociologist) and Mr. Sher Zaman (Environmentalism). The stakeholders were also briefed by PMU Project Infrastructure Engineer Mr. Rizwan Jabbar and Ms. Zunaira. During these consultations, the primary and secondary stakeholders were briefed on the project components in detail and all their concerns and feedback was recorded.

All consultations were carried out in accordance with the 'meaningful consultation' guidelines of ADB's SPS 2009 and their outcome is discussed in the proceeding sections. Consultations were also held with the PMU, Local Government Board and the design consultants.

As part of the present environmental and social assessment, detailed consultations with over 160 different stakeholders were conducted through village meetings and focus group discussions (FGDs) with the communities, including women in the project area. Separate meetings were held with the institutional stakeholders in the form of one-to one meetings i.e. with EPA, BWMC, etc. Specially, prepared consultation performa was used during the data collection. Details of this consultation process are described in the **Table 8.1** below and the locations of the Public consultations are provided in **Figure 8.1** below. Photographs of institutional stakeholders are provided in **Figure 8.2**. Photographs of FGDs are provided in **Figure 8.3**.

Figure 8.1: Map of Public Consultation Locations

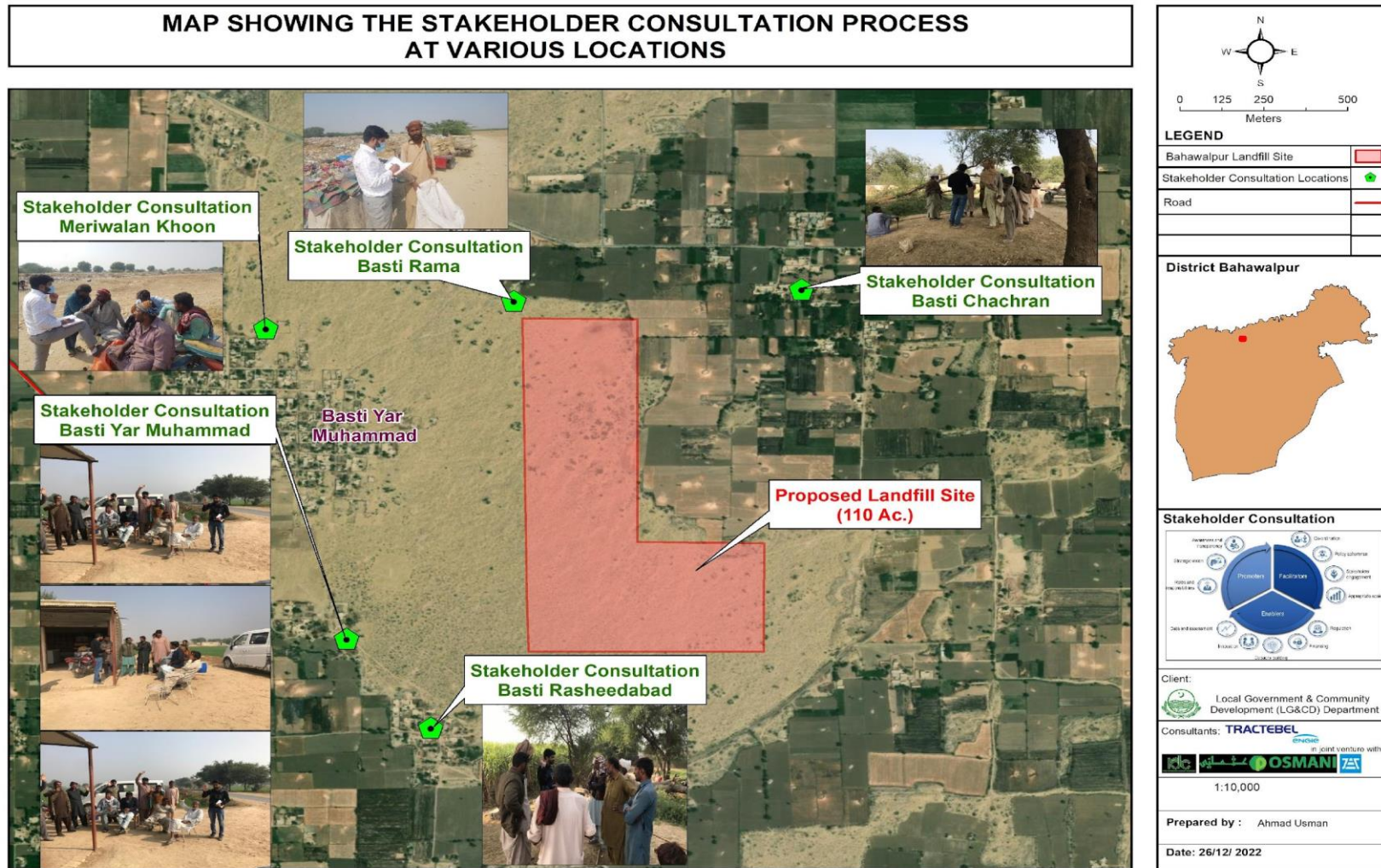


Table 8.1: List of Stakeholder Consultation and Concerns

Sr. No.	Date	Location of Consultation	Total No. of Participants	Comments/Concerns	Consultant Response
1	07/11/22	Basti Yar Muhamamd	14	- Jobs should be provided to the locals - Odor issue during landfill operation will cause the inconvenience to locals especially in summer season - Skin diseases, and dengue can be boosted in the area.	- People were briefed regarding Waste Management current and proposed practices and anticipated issues - Provided briefings on the landfill technology which will eliminate disease and odor related issues - Implementation of EMP i.e. spraying of fleas and mosquito killer reagents at site. - Locals will be preferred for Jobs
2	08/11/22	Basti Chachran	22	- Transportation of Waste may cause the smell issues - Odor and smell issues in the waste storage area (cell area) - Diseases, such as skin allergies, dengue, typhoid	- People were briefed regarding Waste Management current and proposed practices and anticipated issues - Educating about the landfill technology to be implemented, which will eliminate disease and odor related issues - Implementation of EMP i.e. spraying of fleas and use of mosquito killer reagents at site - Preparation of buffer zone along the boundary limits of the landfill site
2	08/11/22	Meriwalan Khoon	10	- People were in favor of the project - Some persons also demanded the jobs.	- Waste Management and transportation plan will be properly implemented. - Educating about the landfill technology to be implemented, - The concept of no waste touches the ground will be implemented

Sr. No.	Date	Location of Consultation	Total No. of Participants	Comments/Concerns	Consultant Response
3	08/11/22	Basti Rama	14	• People were not well aware about the land fill sites and its process, details were provided during the one to one meetings • People were in favor of the project • Some persons also demanded the jobs and infrastructure development.	• A media news will be advertise once the project is approved. • Educating about the landfill technology to be implemented, • The concept of no waste touches the ground will be implemented • Locals should be preferred for jobs
4	09/11/22	Basti Marian wala Khoon	10	• People were not well aware about the land fill sites and its process, details were provided during the one to one meetings • People were in favor of the project • Some persons also demanded the jobs and infrastructure development.	• A media news will be advertise once the project is approved. • Educating about the landfill technology to be implemented, • The concept of no waste touches the ground will be implemented • Locals should be preferred for jobs
5	06/12/22	Basti Dera Mastee	6	• People were not well aware about the land fill sites and its process, details were provided during the one to one meetings • People were in favor of the project • Some persons also demanded the jobs and infrastructure development.	• A media news will be advertise once the project is approved. • Educating about the landfill technology to be implemented, • The concept of no waste touches the ground will be implemented • Locals should be preferred for jobs
6	06/12/22	Basti Rasheedabad	13	• Jobs should be provided to the locals • Odor issue during will cause the inconvenience to locals especially in summer season and during the transportation • Skin diseases, and dengue can be boosted in the area.	• People were briefed regarding Waste Management current and proposed practices and anticipated issues • Provided briefings on the landfill technology which will eliminate disease and odor related issues

Sr. No.	Date	Location of Consultation	Total No. of Participants	Comments/Concerns	Consultant Response
					• Implementation of EMP i.e. spraying of fleas and mosquito killer reagents at site. • Locals will be preferred for Jobs
7	07/12/22	Basti Kumharan wali	15	• Jobs should be provided to the locals • People were not interested to leave the government land, however, they were also briefed that no dislocation is required for the proposed project.	• People were briefed regarding Waste Management current and proposed practices and anticipated issues. • Provided briefings on the landfill technology which will eliminate disease and odor related issues • Implementation of EMP i.e. spraying of fleas and mosquito killer reagents at site. • Locals will be preferred for Jobs • No land acquisition is involved

Table 8.2: Consultations with Government Stakeholders

Sr. No.	Date	Department of Consultation	Name/Designation of Person	Comments/Concerns	Consultant Response
1	11-11-22	Bahawalpur Waste Management Company (BWMC)	Irfa Mehmood (Head-BWMC)	He expressed an interest in facilitating the necessary fulfillment of the environmental and social safeguard criteria. Along with need assessment of the Regional Waste Management Practices. He emphasized on early execution of the project d obtain	After the detail design and all mandatory financial arrangement related with project, proponent will make also consider the regional landfill option in liaison with PMU.

Sr. No.	Date	Department of Consultation	Name/Designation of Person	Comments/Concerns	Consultant Response
				the approval before to start any activity at site.	
2	11-11-22	City Implementation Unit (CIU)- Bahawalpur	Rizwan Jabbar (Infrastructure Engineer)	He expressed about the project as the most demanding activity in Bahawalpur.	The design will be finalized and all Codal formalities will be completed in due timelines.
3	11-11-22	Agricultural Department	Sohail Shanee (Agricultural Officer)	He desired that during the production of compost (if any) the agricultural department may be taken on board for its utilization.	During the implementation of project Agricultural Department of Bahawalpur should be taken on board for regular consultation and compost utilization.
4	11-11-22	Environment Protection Department - Bahawalpur	Ansar Abbas (Assistant Director) - Bahawalpur	He suggested that for disposal of hazardous waste a separate cell may be designated, he further emphasized that regular monitoring may be conducted to ascertain the GHG emissions.	Regular monitoring as per environment monitoring plan will be conducted to ascertain the GHG emissions.
5	11-11-22	Social Welfare Department	Rizwan Ullah (Social Welfare officer)- Bahawalpur	He appreciated the project and added that this will uplift the environmental sustainability in the project area in general and district Bahawalpur as whole.	Project implementation should be in compliance with ADB SPS 2009.
6	11-11-22	Irrigation Department	Junaid Iqbal (SDO-Irrigation)	He appreciated the project and asked about the leaching disposal measurements in the project design.	The design must cater the leaching treatment facility at the landfill site.

Sr. No.	Date	Department of Consultation	Name/Designation of Person	Comments/Concerns	Consultant Response
7	11-11-22	Environment Protection Agency- Punjab	Nasim ur Rehman (Director-EPA-Punjab)	He appreciated the project and added that environmental should obtained before the commencement of the project.	Project implementation should be in compliance with ADB SPS 2009.
8	11-11-22	Wild Life Department (WLD) -Bahawalpur	Mir Yaqoob (AD-WLD)	He appreciated the project and mentioned that in or around the proposed site no threatened species are there.	Project implementation should be in compliance with ADB SPS 2009.
9	11-11-22	Civil Society Representative	Jamshaid Karim Khan	He appreciated the project and offered if the NGO can do something for the proposed project.	During the project implementation all the stakeholders must be taken on board.

Figure 8.2: Consultations with Institutional Stakeholders



8.2.2 Social Safeguard Focused Group Discussions

After initial survey by Social Safeguard team, the overall number of directly affected people from the proposed landfill site was known. Every affected person was reached out and interviewed by social safeguard team as per ADB requirements. These people were interviewed about the land area they share in the project area and their entire social status including details of their income, food expenditure, basic life amenities, living background etc. Till date, 80% of those people including both men and women

have been interviewed and their observations have been noted down while the rest is in progress.

Consultation with the affectees was conducted within their settlements to encourage and facilitate their participation. 66% men and 34% women were interviewed. Separate sessions were arranged for the women. During the consultation process, a verbal detailed description of the Project activities was provided to those interviewed.

Figure 8.3: Focus Group Discussions (FGDs) for Bahawalpur Landfill



8.2.3 Findings of the Public Consultations/Focal Group Discussions

No major land acquisition and resettlement issues were expressed by the local as land is already under possession of BWMC.

All the Indirectly affected people included the population living in the vicinity of the project area. Those people complained about the smell issues and spreading of different diseases in the project area due to open dumping of untreated solid waste in the proposed landfill site. Due to variation in direction and flow of wind in summers, the odor problem was observed to be increased and hence causing the spread of fever and skin diseases.

Power load shedding is adversely affecting the daily lives of residents as the only source of power in the vicinity of the project area is through solar panels which the locals have installed on their own finances.

Health, education, and drinking water facilities should be provided, following the Project development.

There are no public tube wells and pipeline structure to facilitate water source for the people in the vicinity of the project area. The locals have installed private tube wells to keep up with the water resources.

8.2.4 Response from Social Safeguards Team

Our team made sure that the affected people were given full surety regarding their demands.

The people indirectly affected from the project were told about the new technological installation in the project area as installation of new engineered landfill would reduce the odor issue and hence reduction in spreading of different diseases.

There is a big opportunity for the installation of solar powered panels in the surroundings of the project area.

The people were made sure that their demands reach to the higher authorities and that the basic life amenities be provided to them once work on project gets initiated.

Women Consultation in the Project Area





8.2.5 Consultations with Scavengers and Scrap Dealers

During the scoping of environmental and socioeconomic studies of the project area, these groups were identified as important stakeholders which will be influenced in some form or another. To gather more information on the nature and extent of this influence, a data collection and analysis strategy was devised by the environmental experts, relevant literature consulted and compiled (included previously our project data), questionnaires drafted and site visits conducted. All these activities are described below.

The process of consultation was planned to begin with contacting the workers collecting waste door-to-door every morning, and progressing step by step through scrap collection and sorting facilities of various capacities, possibly including the transporters associated along the way, up till the larger scrap recycling or management facilities.

The initial few visits conducted by the environmental team, covering most of the aforementioned groups, yielded some useful data which projects a picture of the current operations within the informal waste management system structure. Details of their operations, income levels and their opinions, particularly concerns, are given in at the end of this section. The summary of the consultation data is provided in the **Table 8.3** below. Photographs of scavenger's consultations are provided in **Figure 8.4**.

Based on these consultations, some general conclusions can be derived regarding the prevailing scavenging and informal waste recycling system in operation, as well as its scope of potential involvement in the proposed ISWM system, which are summarized below:

- Majority of stakeholders consulted expressed the need for some form of government formalization, management or oversight is needed in order to better manage the operation of the landfill site, once developed, regardless of their position or significance in the system's chain.
- Improvements in physical equipment and facilities made available to the operators will serve to improve their working conditions and income levels.
- The reason that most scavengers and waste-pickers adopt this line of work is due to necessity born out of a lack of employment opportunities of any other kind.
- Those stakeholders in the waste management business doing well financially appear to have been involved in this line of work for a longer period, pointing to the benefits of persistence and experience in this business. In their position, they are

no longer limited by work options and do this type of business more by choice and in anticipation of significant profits.

Table 8.3: Consultations with Scavengers and Scrap Dealers

Sr. No.	Date	Location of Consultation	Total No. of Participants	Comments/Concerns
1	12/12/2022	Khan Gah Shreef (Scrap Dealer)	5	The scrap business generates a reasonable money depending on availability of the scrape. The rates remain variable in the market based on demand and supply working principle. Scrap business does generate a relatively stable income, although low, as the owner and employees have gotten accustomed to the market.
2	12/12/2022	Main Victoria Bazar- Bahawalpur	3	The scrap dealer informed that due of proper disposal system and non-availability of smelting furnaces in the area they sale metal scrap in multan and other large scale dealers. they informed that substantial amount of income is involved once the sufficient scrape is available.
3	12/12/2022	Shahi Bazar Bahawalpur	6	Highly informal income source, necessitated due to lack of education, employment options and government support or supervision of any kind. They feel that their young children who should be in schools also have no option but to assist in their work to generate enough income to survive.
4	12/12/2022	Fareed Bazar - Bahawalpur	3	(Small intermediate scrap dealer) For them, this is a steady source of income generation. Their waste sorting activity is not as labour intensive since the waste they receive has already undergone some preliminary sorting. The employee and owner consulted were generally satisfied with their working conditions.

Table 8.4: Responses from Scavengers based on Survey Questions

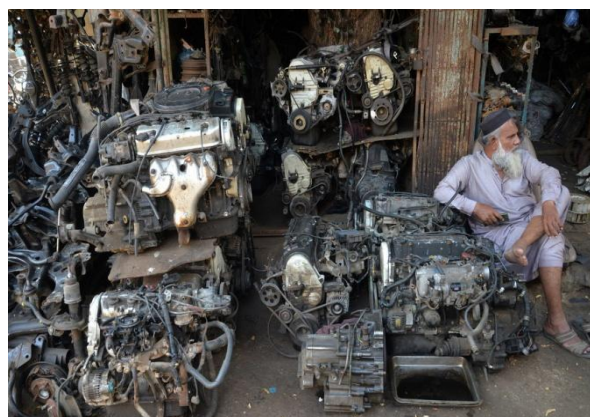
Name, Details	Responses
Shahi Bazar –Bahawalpur	Amount of waste collected/day: Waste quantity varies from 1.5tonne to 05 tonnes depending on availability of scrape Usefulness of that waste: The waste is sorted out on spot and the recyclable material is sold to further scrape dealer Procedure for collection: The waste is brought to the store by several small waste pickers and sold in this store. The waste is normally not sorted before. Usual cost and time spent: It takes the entire day in sorting out the waste. The usual cost depends on quantity of waste brought to the store. 60,000 rent monthly for the godown space. 5 employees, 2 for waste collection and 2 for handling facility operations and 1 for office. Amount of income generated: It varies from 300,000-500,000 rupees/day (depending on waste) Source of income: This is their only source of income End use of waste: The waste is further sold to bigger waste collecting dealers. Motivation/reason for this job: Lack of job opportunities. Working relationship with any government authority: Private business Expected improvements in the system: Mode of transportation for waste picking should be improved
Fareed Bazar - Bahawalpur	Amount of waste collected/day: Waste quantity varies from 1.5 tonne to 08 tonnes depending on availability of scrape

Name, Details	Responses
	Usefulness of that waste: The waste is sorted out on spot and the recyclable material is sold to further scrape dealer. Procedure for collection: The waste is brought to the store by several small waste pickers and sold in this store. The waste is normally not sorted before. Usual cost and time spent: It takes the entire day in sorting out the waste. The usual cost depends on quantity of waste brought to the store. 100,000 rent monthly for the godown space. 8 employees, 4 for waste collection and 3 for handling facility operations and 1 for office. Amount of income generated: It varies from 500,000-800,000 rupees/day (depending on waste) Source of income: This is their only source of income End use of waste: The waste is further sold to bigger waste collecting dealers. Motivation/reason for this job: Lack of job opportunities. Working relationship with any government authority: Private business Expected improvements in the system: Mode of transportation for waste picking should be improved

Name, Details	Responses
- Asim BWMC employee, Bahawalpur - Shahid BWMC employee, Bahawalpur - Zafar BWMC employee, Bahawalpur	These workers are hired by BWMC for dumping of solid waste across the city. They dump the waste in places designated by BWMC and put soil layers over the dumped waste. These workers demanded that more jobs should be generated in this sector and that the system should be regulated and made centralized and networks be developed among different waste picking private community, so that the waste picking process is made efficient, clean and productive.
- Sami 52, owner of scrap business, Ring Road Bahawalpur - Anwar 35, co-owner of scrap business, Bahawalpur	Amount of waste collected: Amount of waste generated varies widely every day. But according to a rough estimate, they collect approximately 70-100 kg waste every day Usefulness of that waste: The waste after its sorting is sent to different industries to make ready-to-use products from it. The waste is then melted/molded according to desired end product. Procedure for collection: Usually the waste is bought from small scale waste pickers and then sorted out in separate categories at store. Usual cost and time spent:

Name, Details	Responses
	The time spent on the process depends on the waste brought to the store. But normally it takes 5-6 hours every day to sort out the waste and set them. Amount of income generated: The income normally generate from selling the waste is Rs 10,000-15,000 per day Source of income: This is the only source of income of these people End use of waste: The waste is finally sent to different recycling plants in the outskirts of District Bahawalpur, to convert the scrap material into useful raw material or products Motivation/reason for this job: This business provides a greater profit margin as compared to most small scale businesses. Working relationship with any government authority: This is a private run company Expected improvements in the system: The waste collection process should be made systematic and regulated by the government. Priority should be given to waste delivery system as most of the waste is left untouched on the dump sites because of lack of transportation to the targeted scrap stores.

Figure 8.4: Consultations with Scavengers/Scrap Dealers



9. Consultation Plan for Construction and Operation Phase

Consultation plan for construction and operation phase of Bahawalpur Landfill site will be prepared in order to take response of project stakeholders and general public about the project during its implementation.

Periodic meaningful consultations and community feedback surveys will be carried out following ADB SPS, 2009 consultation requirements to develop positive perception about the project. In this regards city implementation unit as well as project construction contractor and supervision consultant will play a key role to involve all the stakeholders for such consultations during the implementation.

Record of such consultations will be maintained at PMU/BWMC/CIU offices and necessary changes in operational modalities will be introduced in the system in light of the response provided by the consultees.

9. PUBLIC DISCLOSURE AND INFORMATION

A ADB Disclosure Requirements

The purpose of disclosure is to engage all stakeholder through disclosure process aims to: establish a systematic and inclusive approach to stakeholder engagement; build and maintain a constructive relationship with stakeholders; incorporate stakeholders' views and concerns into project design/implementation; mitigate negative social and environmental impacts of the project; and, enhance project acceptance and socio-environmental sustainability.

As per ADB disclosure requirement, the EIA report after finalization by the resident mission and safeguard section shall be disclosed on the project web page after the period of 120 days.

The Periodic consultations and community feedback surveys will also be carried out to develop positive perception about the project. In this regards city implementation unit as well as project construction contractor and supervision consultant will play a key role to involve all the stakeholders for such consultations during the implementation.

Record of such consultations will be maintained at PMU/BWMC/CIU offices and necessary changes in operational modalities will be introduced in the system in light of the response provided by the consultees.

B Provincial EPA Disclosure Requirements

Under Punjab EPA EIA/IEE Regulation 2021 during the EIA review and approval process disclosure will be carried out to all stakeholders and general public. The following will be the procedure of EIA disclosure.

Provincial Agency shall cause to be published in any English or Urdu national newspaper and in a local newspaper of general circulation in the area affected by the project, a public notice mentioning the type of project, its exact location, the name and address of the proponent and the places at which the EIA of the project can be accessed.

The date fixed shall not be earlier than 07 days from the date of publication of the notice.

The Provincial Agency shall also ensure the circulation of the EIA to the concerned Government Agencies and solicit their comments thereon.

All comments received by the Provincial Agency from the public or any Government Agency shall be collated, tabulated and duly considered by it before decision on the EIA.

Public Hearing

A public hearing will be conducted as part of the EIA review and approval process wherein all the general public and all stakeholders will be invited for their views.

During the public hearing the summary of the project translated in Urdu will be distributed among the participant. Appenx-16 shows a translated version in Urdu of the executive summary.

C EIA Report disclosure

The final EIA report will be disclosed on i) ADB project website. ii) PICIIP project website iii) EPA website.

As per ADB right to information any person can request any type of project related information from the project web.

10. GRIEVANCE REDRESSAL MECHANISM

10.1 GENERAL

The ADB Policy (SPS 2009) requires establishment of a local grievance redress mechanism to receive and facilitate resolution of the Displaced/Affected Persons concerns and grievances regarding the project's social and environment performance. The measures have been identified to mitigate any potential environmental and social impacts to be caused due to implementation of the landfill works.

However, in spite of best efforts, there is chance that the individuals / households affected by the project or other stakeholders are dissatisfied with measures adopted to address adverse environmental impacts of the project. To address, such situation an effective Grievance Redress Mechanism (GRM) will be established to ensure timely and successful implementation of the project. It will also provide a public forum to the aggrieved to raise their objections and the GRM would address such issues adequately. It will receive, evaluate and facilitate the resolution of displaced persons' concerns, complaints and grievances about the social and environmental performance at the level of the project.

The GRM will aim to investigate charges of irregularities and complaints receive from any displaced persons and provide a time-bound early, transparent and fair resolution to voice and resolve social and environmental concerns link to the project.

The PMU LG&CDD shall make the public aware of the GRM through public awareness campaigns. The name of contact person(s) and his/her phone number, PMU contact numbers will serve as a hotline for complaints and shall be publicized through the media and placed on notice boards outside their offices, construction camps of contractors, and at accessible and visible locations in the project area. The project information brochure will include information on the GRM and shall be widely disseminated throughout the project area. Grievances can be filed in writing, via web-based provision or by phone with any member of the PMU.

First tier of GRM. The PMU is the first tier of GRM which offers the fastest and most accessible mechanism for resolution of grievances. The PMU staff for environment and social safeguards will be designated as the key officers for grievance redressal. Resolution of complaints will be completed within seven (7) working days. Investigation of grievances will involve site visits and consultations with relevant parties (e.g., affected persons, contractors, traffic police, etc.). Grievances will be documented and personal details (name, address, date of complaint, etc.) will be included, unless anonymity is requested. A tracking number will be assigned for each grievance, including the following elements:

- Initial grievance sheet (including the description of the grievance), with an acknowledgement of receipt handed back to the complainant when the complaint is registered;
- Grievance monitoring sheet, mentioning actions taken (investigation, corrective measures);
- Closure sheet, one copy of which will be handed to the complainant after he/she has agreed to the resolution and signed-off.
- The updated register of grievances and complaints will be available to the public at the PMU office, construction sites and other key public offices in the project area. Should the grievance remain unresolved, it will be escalated to the second tier.

Second Tier of GRM. The PMU will activate the second tier of GRM by referring the unresolved issue (with written documentation) to the Bahawalpur Waste Management Company (BWMC), who will pass unresolved complaints upward to the Grievance Redress Committee (GRC). The GRC will be established by BWMC before start of site works. The GRC will consist of the following persons: (i) Project Director; (ii) representative of District

government; (iii) representative of the affected person(s); (iv) representative of the local Deputy Commissioners office (land); and (v) representative of the Punjab EPA (for environmental-related grievances). A hearing will be called with the GRC, if necessary, where the affected person can present his/her concerns/issues. The process will facilitate resolution through mediation. The local GRC will meet as necessary when there are grievances to be addressed. The local GRC will suggest corrective measures at the field level and assign clear responsibilities for implementing its decision within fifteen (15) working days. The contractor will have observer status on the committee. If unsatisfied with the decision, the existence of the GRC will not impede the complainant's access to the Government's judicial or administrative remedies.

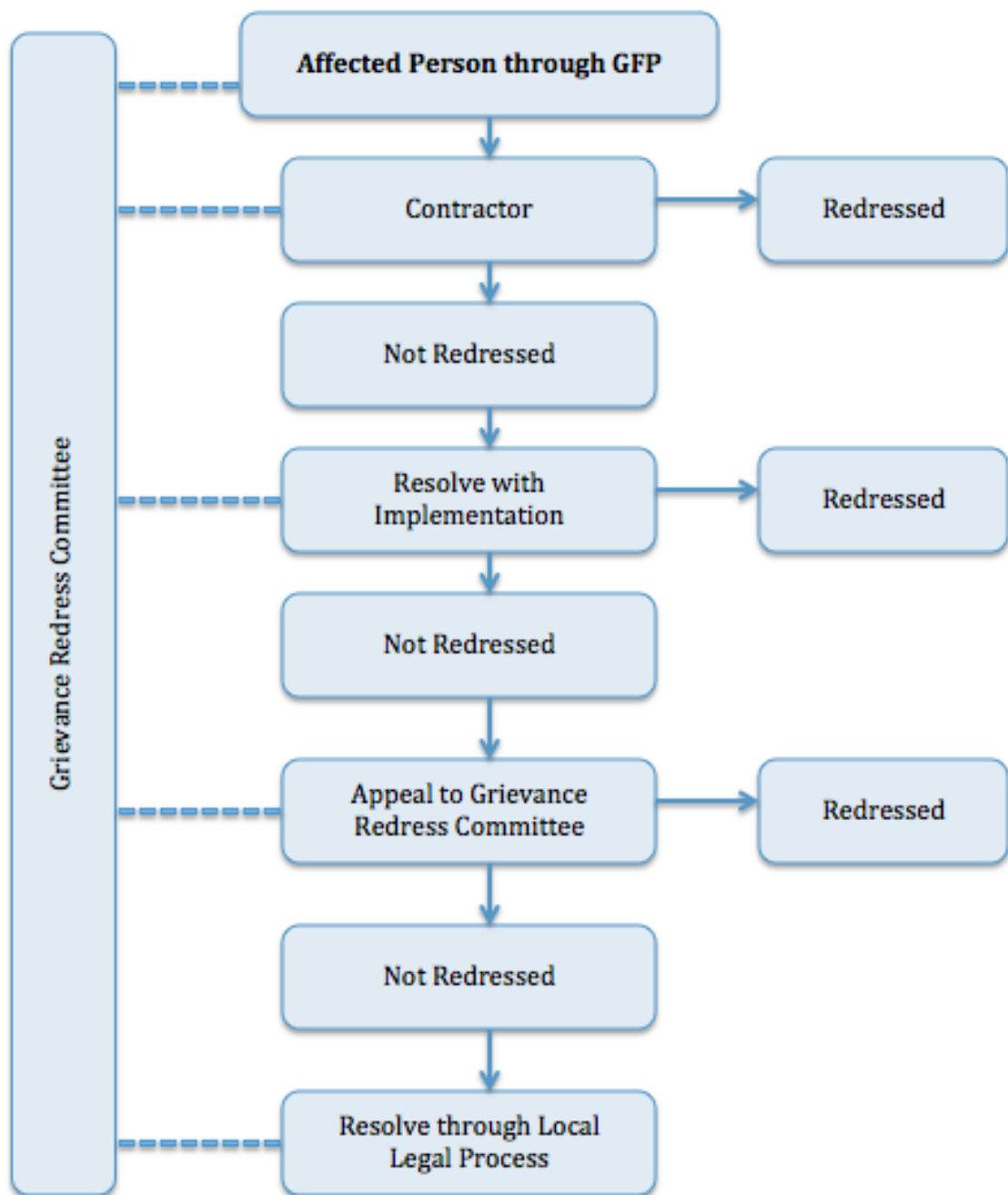
The functions of the local GRC are as follows: (i) resolve problems and provide support to affected persons arising from various environmental issues and including dust, noise, utilities, power and water supply, waste disposal, traffic interference and public safety as well as social issues and land acquisition (temporary or permanent); asset acquisition; and eligibility for entitlements, compensation and assistance; (ii) reconfirm grievances of displaced persons, categorize and prioritize them and aim to provide solutions within a month; and (iii) report to the aggrieved parties about developments regarding their grievances and decisions of the GRC.

The BWMC officers will be responsible for processing and placing all papers before the GRC, maintaining a database of complaints, recording decisions, issuing minutes of the meetings and monitoring to see that formal orders are issued and the decisions carried out.

Third tier of GRM. In the event that a grievance cannot be resolved directly by the PMU (first tier) or GRC (second tier), the affected person can seek alternative redressal through the district or sub-district committees as appropriate. The PMU or GRC will be kept informed by the district, municipal or national authority. The grievance redress mechanism and procedure are depicted in the Figure 9.1 below. The monitoring reports of the EMP implementation will include the following aspects pertaining to progress on grievances: (i) Number of cases registered with the GRC, level of jurisdiction (first, second and third tiers), number of hearings held, decisions made, and the status of pending cases; and (ii) lists of cases in process and already decided upon may be prepared with details such as Name, ID with unique serial number, date of notice, date of application, date of hearing, decisions, remarks, actions taken to resolve issues, and status of grievance (i.e., open, closed, pending).

In order to provide greater clarity, the pictorial description of the GRM is provided in **Figure 10.1** below.

Figure 10.1: Grievance Redressed Mechanism



12. CONCLUSION AND RECOMMENDATIONS

The development of the proposed IWMS in Bahawalpur is of high significance considering the urgent need for improving the SWM system of Bahawalpur city.

Primary and secondary data has been collected and used to assess the environmental impacts of the Project. This EIA report highlights all potential environmental impacts associated with the project and recommends mitigation measures. Any environmental impacts associated with the project need to be properly mitigated, through the existing institutional arrangements described in this report. IBAT screening of project site is conducted, Estimation of leachate leaking effect on ground water quality and air pollution dispersion modelling of emissions from landfill flaring system are carried out and findings are detailed in the EIA report.

The majority of the environmental impacts are associated with the operation phase of the project since these will be long term, such as Generation of objectionable Odor and impact on air quality, Attraction of Vermin and disease vector generation, Leachate generation, Possible contamination of Soil and Groundwater, Generation of Landfill Gas etc. An efficient Leachate Collection and Removal System (LCRS) is included in the design to manage leachate impacts. Landfill gas recovery system and its reuse through conversion into CNG is part of project design in order to manage and maximize utilization of Landfill gas. A dedicated MRF and compost plant will be established to manage organic waste and recyclables. C&D waste will also be recycled in order to maximize beneficial use. The storage, segregation of medical waste and its treatment is also recommended in the design for revenue generation.

During the construction phase, the overall responsibility for the implementation and monitoring of the EMP rests with the Project Director (PD), Project Management Unit (PMU), PICIIP LG&CDD, Punjab. The PD at the PMU, using the Construction Supervision Consultant (CSC), will supervise the implementation of the proposed mitigation measures and monitor the implementation progress in the field. During the operation phase, the overall responsibility for the implementation and monitoring of the EMP rests with Managing Director, BWMC.

The environmental mitigation measures will have to be clearly defined in the bidding and contract documents, and appropriately qualified environmental staff retained by the Consultant to supervise the implementation process. The EMP includes measures to minimize project impacts due to noise and air pollution, waste generation etc.

The EMP contained within this EIA document is considered sufficient for issuance as part of the Contracts to the successful bidder(s) and for subsequent use during the project works. It should be mentioned that prior to the commencement of works, this EMP must be further updated by the Contractor into site specific EMPs (SSEMPs) for review and approval of ADB. In these SSEMPs, aspects such as a detailed traffic management plan, identification of locations for disposal of debris and spoil and any other details which shall become available later must be included for efficient implementation of all proposed mitigation measures and the subsequent monitoring of these measures.

This project has been assigned environmental category 'A' in accordance with the ADB's Safeguard Policy Statement (SPS) 2009 and in Schedule II, Category G-Waste Storage and Disposal (Rule 1) as per Punjab EPA Review of IEE and EIA Regulations, 2022; Thus, a comprehensive EIA report has been prepared for the proposed project.

This EIA report will be reviewed and approved by ADB and after completion it will be disclosed on ADB and PMU PICIIP websites in compliance to ADB SPS, 2009.

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Appendix A.1 Rapid Environmental Assessment (REA) Checklist

BAHAWALPUR: LANDFILL SITE

Country/Project Title:	PAKISTAN/ Punjab Urban Development Projects
Sector Division:	Urban Development - Waste Management

Screening Questions	Yes	No	Remarks
A. Project Siting			
Is the project area adjacent to or within the following environmentally sensitive areas?			
Cultural Heritage Site		No	• There are not any such sites within 500 m of the radius
Protected Area		No	• There are not any such sites within 500 m of the radius
Wetland		No	• There are not any such sites within 500 m of the radius.
Mangrove		No	• Not applicable
Estuarine		No	• There are not any such sites in 500 m of the radius.
A buffer zone of protected area		No	• There are not any such sites within 500 m of the radius
A particular area for protecting biodiversity		No	• There are not any such sites within 500 m of the radius
B Potential Environmental Impacts			
• Will the Project cause...			
Impacts associated with transport of wastes to the disposal site or treatment facility		Yes	• Although the specific route for transport of the wastes to the landfill site is yet to be finalized, however, considering the proximity of the site to the populated areas, it is expected that the vehicles will collect and transport the wastes by moving through highly populated areas and result in significant community health and nuisance impacts such as odor, vector generation along with traffic congestion, accident risks from heavy vehicle movement, etc.
Encroachment on historical/cultural areas; disfiguration of the landscape by road embankments, cuts, fills, and quarries?		No	• No such acts are anticipated during construction or operations as site is located away from historical/cultural areas.
Encroachment on precious ecology (e.g. sensitive or protected areas)?		No	• No such acts are anticipated during construction or operations as site is located away from protected areas.
Alteration of surface water hydrology of waterways crossed by roads, resulting in increased sediment in streams affected by increased soil erosion at the construction site?		No	• No such acts are anticipated during construction or operations. However, the excavated soil from the landfill site constructions will be handled appropriately.
Deterioration of surface water quality due to silt runoff and sanitary wastes from worker-based camps and chemicals used in construction?	Yes		• Construction camps generate solid and liquid wastes therefore they should be built appropriately and away from settlements.

Screening Questions	Yes	No	Remarks
Degradation of aesthetic and property value loss?	Yes		The development of the proposed landfill site is expected to significantly affect the aesthetics of the project area as well as significantly diminish the property value of the land in this area considering the nuisance effects such as odor as well as possible health impacts from disease vector generation, groundwater contamination etc.
Nuisance to neighboring areas due to foul odor and influx of insects, rodents, etc.?	Yes		The proposed landfill site is expected to result in high levels of foul odor in the project area along with the generation of disease vectors such as mosquitoes, flies, rodents etc.
Dislocation or involuntary resettlement of people?	Yes		No dislocation or involuntary resettlement of people is expected as per now.
Disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?	Yes		No such impacts are expected on the poor while no indigenous peoples are located in the project area that would be impacted.
Risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation during project construction and operation?	Yes		Significant occupational health and safety hazards will exist at the site considering the waste and toxic gases present at the site during the landfill site operation.
Public health hazards from odor, smoke from fire, and diseases transmitted by flies, insects, birds and rats?	Yes		These public health hazards do exist from the operation of the landfill site such as odor, generation of disease vectors, etc.
Deterioration of water quality as a result of contamination of receiving waters by leachate from land disposal system?	Yes		No surface water bodies are located in the project area and thus no contamination in this regard is possible.
Contamination of ground and/or surface water by leachate from land disposal system?	Yes		A high risk exists of contamination of ground water by the production of leachate from landfill site operation.
Land use conflicts?		No	The selected land is already in use for solid waste disposal therefore no or limited conflicts are expected.
Pollution of surface and ground water from leachate coming from sanitary landfill sites or methane gas produced from decomposition of solid wastes in the absence of air, which could enter the aquifer or escape through soil fissures at places far from the landfill site?	Yes		A high risk exists of contamination of ground water by the production of leachate from landfill site operation.
Inadequate buffer zone around landfill site to alleviate nuisances?		No	Based on the sensitive receptor mapping of the site there are no sensitive receptors within 250m radius.
Road blocking and/or increased traffic during construction of facilities?	Yes		While no roadblocks are expected, however, a significant increase in heavy vehicles/trucks transporting the waste to the landfill site is expected.

Screening Questions	Yes	No	Remarks
Other social concerns relating to inconveniences in living conditions in the project areas may trigger upper respiratory problems and stress?	Yes		The selected land is already in use for solid waste disposal therefore no or limited conflicts are expected.
Noise and dust from construction activities?	Yes		During the development of the infrastructure at the site during the construction phase, significant noise and dust emissions are expected from the movement of construction vehicles and equipment.
Temporary silt runoff due to construction?		No	No silt run-off is expected.
hazards to public health due to inadequate management of landfill site caused by inadequate institutional and financial capabilities for the management of the landfill operation?	Yes		A high risk exists considering the limited institutional and financial capacities in the country along with limited experience and expertise with regards to the operation and management of landfill sites.
Emission of potentially toxic volatile organics from land disposal site?	Yes		Toxic emissions such as landfill gas from the site are possible.
Surface and ground water pollution from leachate and methane gas migration?	Yes		A high risk exists of contamination of ground water by the production of leachate from landfill site operation.
Loss of deep-rooted vegetation (e.g. trees) from landfill gas?	Yes		It is possible that over time, the landfill gas generated could damage and cause loss of trees etc.
Explosion of toxic response from accumulated landfill gas in buildings?	Yes		Accumulation of landfill gas over time from landfill site operation could result in explosions of toxic gas.
Contamination of air quality from incineration?	Yes		In case incineration is planned at the site and emissions are not well managed significant air pollution is expected due to the landfill site operation specifically in close proximity. Uncontrolled venting and flaring will also result in air quality degradation.
Health and safety hazards to workers from toxic gases and hazardous materials in the site?	Yes		Significant occupational health and safety (OSH) hazards will exist at the site considering the waste and toxic gases during construction as the landfill will be developed near an existing landfill site. OHS hazards will also be present at the site during the landfill site operation.
Social conflicts if workers from other regions or countries are hired?		No	No such impacts are expected.
Does a large population influx cause an increased burden on social infrastructure and services (such as water supply and sanitation systems)?		No	No such conflicts are expected since local labor will be utilized as far as possible.
Risks to community health and safety due to the transport, storage, use, and disposal of materials such as explosives, fuel, and other chemicals during construction and operation?	Yes		The risks to community health and safety exist, particularly during the construction phase, considering the proximity of the project site to the

Screening Questions	Yes	No	Remarks
Community safety risks due to both accidental and natural causes, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation, and decommissioning.	Yes		- residential settlements in the project area. - The risks to the community exist, particularly during the operation of the landfill site, considering the proximity of the site to residential settlements.
Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g., by encouraging settlement in areas more affected by floods in the future or encouraging settlement in earthquake zones)?		No	

Recommendations

The proposed project is recommended to be categorized as Category 'A' based on the potential impacts related with lactates, transportation of waste and its nuisance and operations related potential impacts.

Thus, severity of expected impacts to be potential and irreversible especially land use of the landfill area.

Project Category Recommendation

It is recommended that based on the available project information and subsequent analysis, the project should be placed in:

Cate: ☒ 'A' Category 'B' ☐ Category 'C' ☐

Please provide an explanation to justify the Categorization above:

Severity of expected impacts as evident from above table are adverse and irreversible and as per ADB Safeguard Policy, a project may be classified as Category A if it is likely to have adverse environmental impacts

Screening & Categorization Conducted by: Endorsed by:

Environment Officer, PIU

Head of PIU

Approved by: Endorsed by:

ADB Environment Safeguards Focal Point

Project Officer, ADB

Appendix A.2 Questionnaires for Conducting FGDs & Surveys

Focal Group Discussion (FGDs)

Project Name: _____

Venue: _____

Sr no _____

Date: _____

Sr no	Name	Profession	CNIC	Moza/Village UC, Tehsil & District	Signature/Thumb
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

SOCIO-ECONOMIC AND RESETTLEMENT SURVEY FOR KPCIP RUP PROJECTS

Date: _____

Sr No. _____

1. Identification

1.1 Name of Respondent _____

1.2 Father's Name _____

1.3 Respondent CNIC No: _____

1.4 Tribe _____

1.5 Address: Village: _____

Town: _____

Tehsil: _____

District: _____

Province: _____

1.6 Demographic Profile of Respondent (Children up to 10 yrs (#): M FM T)

Sr. No.	Relationship with Respondent (See codes)	Sex Male=1 Female=2	Age (Yrs.)	Education (See Codes)	Name of Business/ Occupation (See Codes)		Income From Business/ Occupation (Rs./ Annum)		Diseases During Last Year (See codes)
					Main	Secondary	Main	Secondary	
1	SELF								
2									
3									
4									
5									
6									
7									
8									
9									
10									

*Other: Rent from property, remittances, net sale of items during a year, net income from agriculture etc.

Demographic Codes:

Relationship: 1=Self, 2=Wife, 3=Son, 4=Daughter, 5=Father, 6=Mother, 7=Brother, 8=Sister, 9=Grand Father, 10=Grand Mother, 11=Bhabhi, 12=Nephew, 13=Father-in-Law, 14=Mother-in-Law, 15=Others

Sex: 1=Male, 2=Female

Education: 1= Primary 2= Middle 3= Matric, 4= Intermediate, 5= BA/BSc, 6= MA/MSc, 7=LLB, 8=Engineer, 9=MBBS, 10=Technical Diploma, 11=Dars-e-Nizami, 12=CanRead Quran, 13= Can Insert Signatures, 14= Illiterate,

Occupations: 1=Agriculturist, 2=Shopkeeper, 3= Trader, 4= Govt. Servant, 5=Private Servant, 6=Timber Labour, 7=General Labour, 8=Livestock, 9=Fishing, 10=8=Driver, 11=Health Related, 12=Educator/Teacher, 13=House-Maid, 14= House Wife, 15=Gone Abroad, 16=Gone out City within Pakistan

Diseases: 1=Diarrhea, 2=Measles, 3=Hepatitis, 4=Typhoid, 5=HIV/AIDS, 6=Polio, 7=Cholera, 8=Tuberculosis, 9=Heart Disease, 10=No Disease,

1.7 Are you member of any village Community organization ____ 1. Yes ☐ 2. No ☐

1.8 If yes, which of the following organizations?

- i. Religion ii. Political iii. Law & Order
 iv. Educational (formal/informal)
 v. Community Organization vi. Local Jirga
 vii. Youth Organization viii. Any other

2. Land Utilization

Land	Acre	Kanal	Marla
Total Area owned			
Total Cultivated Area			
Area Under Rabi (winter) Crops			
Area Under Kharif (summer) Crops			
Uncultivated Area			
Waste land			
Area Under Farm Houses			
Barren Land			

2.1 Cropping Pattern, Yield and Cost

Sr. No.	Major Crops	Area Sown		Average. Production (Kgs)	Price/40 kgs (Rs.)	Total Cost Incurred (Rs.)
		Acre	Kanal			
1.	Wheat					
2	Maize					
3	Cotton					
4	Rice					
5	Sugarcane					
6	Orchards					
7	Other ()					
8	Grand Total:					

2.2 Land Tenure Status: ☐ Owner ☐ Tenant ☐ Share Cropper ☐ Leaser

2.3 Land Rent (Rs. / acre) _____

3. Possession of Household Goods

Item	No.	Value (Rs.)	Item	No.	Value (Rs.)
Television			Car		
Washing machine			Van/Pickup		
Geyser			Gas Cylinder		
Electric fan			VCR/DVD Player		
Electric iron			Dish Antenna/Cable Connection		

Item	No.	Value (Rs.)	Item	No.	Value (Rs.)
Sewing machine			Telephone/Mobile		
Radio/tape recorder			Electric Water Pump		
Motor cycle/ scooter			Computer		
Other			Other		
Total:			Total:		

4. Average Monthly Expenditure on Food and Non-Food Items

4.1 Monthly Expenditure on Food & Non-Food Items (Rs.)

a) Expenditures on Food Items

Sr. No.	Item	Qty. / Month	Expenditure (Rs.)
1.	Wheat / Atta (Flour)		
2.	Maize Flour		
3.	Ghee		
4.	Sugar		
5.	Legumes		
6.	Vegetables		
7.	Tea Leaves		
8.	Milk		
9.	Other Specify		
10.	Total:		

b) Exp. On Non-Food Items:

1.	Fire wood		
2.	Gas Cylinder		
3.	Kerosene Oil		
4.	Washing Material		
5.	Other Specify		
6.	Total:		

4.2 Expenditure on clothes and shoes during last year: Rs.

4.3 Occasional expenses during last year (such as meeting social obligation expenditure) Rs.

4.4 Av. Monthly utility bills for: Electricity (Rs.)

Communication (Rs.) Water (Rs.)

4.5 Annual Expenditure on Health Care (Rs.):

5. Social Organizations

5.1 Specify the existing village/social organizations in your area and state their functional status?

Sr. No.	Name of Organization	Category	Registered/ Unregistered	Functions
1		Religious		
2		Educational		
3		Skill Development		
4		Social Welfare		
5		Women Organization		
6		Other		

6. Leadership Pattern

6.1 Which type of people is influential in village matters and how they decide these matters?

Sr. #	Person / Status	Decision Pattern
1	MPA / MNAs	
2	Head of Tribe	
3	Spiritual / Religious Leader	
4	Land Lord / Lumber Dar	
5	School Teacher	
6	Community Leader	
7	Government Official	
8	Retd. Government Official	
9	Any other (specify)	

6.2 Were their decisions considered final and implemented successfully? ☐ 1. Yes
☐ 2. No

i) Level of acceptability (%) _____ ii) Successful implementation (%) _____

6.3 Are the general relationship among people in the locality essentially based upon?

1. Competition _____ 2. Conflict _____
3. Co-operation _____ 4. Don't Know _____

6.4 Were you involved in any dispute in the past 5 years? ☐ 1. Yes ☐ 2. No

6.5 If yes, what was the nature of dispute and how was it resolved
Nature of Dispute _____ Method of Resolution _____

1. _____
2. _____
3. _____

7. Credit

7.1 Have you obtained credit during last year? Yes [], No. [], if yes, source of credit: Formal [], Informal []

7.2 Please write the name of relevant source

Formal source (s) _____

Informal source (s) _____

Percentage of interest _____

7.3 Purpose of Loan (Tick)

Purchase House ☐ Rs. _____
 Business ☐ Rs. _____
 Repair of House ☐ Rs. _____
 Medicare of Family Member ☐ Rs. _____
 Family/ Social matters ☐ Rs. _____
 Farm inputs ☐ Rs. _____
 Livestock ☐ Rs. _____
 Other (specify) ☐ Rs. _____

7.4 Mode of repayment (Tick the relevant)

1) One time [] 2) Through installments []

i) Quarterly installments [] ii) Six monthly []
 iii) Annual [] iv) Other (specify) _____

7.5 How much repayment has been made so far? a) 100% [], b) 75% [], c) 50% [], d) 25% [], Less than 25 % []

8. Housing Conditions

8.1 Do you have your own house?

1) Yes _____ 2) No. _____

If yes then

8.2 Total Area of the house: square ft. Present Value (Rs) _____

Type of Room	No. of Room	Katcha (tick)	Pacca (tick)	Semi Pacca (tick)
Living rooms				
Animal shed				
Other shed				
Bathroom				
Latrine				
- Open				
- Flush				

Other

8.3 Other Assets

Area (Ft.)

Shop(Sq. ft): L W

Khokha:

Electric Pump / Hand Pump (No.):

Hydropower Generator:

Other () (No.):

8.4 Trees

- Mature Fruit Trees (No.):

- Mature Shade Trees (No.):

9. Access to Social Amenities (tick)

Social Amenities	Available	Satisfactory	Non-Satisfactory	No Access
Electricity				
Sui Gas				
Water Supply				
Telephone				
Sewerage/Drainage				
BHU				
School				
Others				

10. Livestock Inventory

Livestock	No.	Present Value (Rs.)
Buffaloes		
Cows		
Horse		
Donkey		
Mule		
Sheep		
Goat		
Poultry		
Other		

11. Women's Participation and Decision Making in Different Activities

11.1 Women participation in different household activities:

Activities	Participation (%)	Decision Making (%)
Household activities		

Child caring	☐	☐
Farm/Crop activities	☐	☐
Livestock rearing	☐	☐
Sale & Purchase of properties	☐	☐
Social obligations (marriage, birthday & other functions)	☐	☐
Local representation (councilor/ political gathering)	☐	☐
Others	☐	☐

11.2 Women issues in the project area

11.3 Women views about the project

12. Perceptions of Respondents for Action Associated with the Project

	Increase	Decrease
Employment opportunities	☐	☐
Marketing facilities opportunities	☐	☐
Living standard	☐	☐
Unemployment	☐	☐
Income generating activities	☐	☐
Mobility (Access to Resources)	☐	☐
Quality of drinking water	☐	☐
Agriculture water	☐	☐
Trend of fish farm	☐	☐
Other specify		

13. General Remarks of the Respondents

14. Resettlement Part

14.1 Do you feel any displacement impact?

Yes

No

If yes then

Category	Area Acre	Kanal	Value of Land (Rs.)	Remarks
Cultivated				
Uncultivated				
Crazing				
Barren Land				
Waste Land				
Other				
Total				

14.2 Affected Cropping Area

Yes

No

If yes then

Name of Crop	Acre	Kanal	Value (Rs.)
Rabi			
Kharif			
Total:			

14.3 Affected residential structures

Name of Structure	Types of Structures			Area		Value of Structure
	Kacha	Pacca	Semi Pacca	Sq. ft.	Rft.	
Houses						
Boundary Wall						
Other						

14.4 Impact on Farm House

Yes

No

If yes then

Name	Type of Farm House			Area		Value (Rs.)
	Kacha	Pacca	Semi Pacca	Sq.ft	Rft.	
Rooms						
Cattle Shed						
Boundary Wall						
Other						

14.5 Impact of Tube wells

Yes

No

If yes then

Types of Tube wells	No.	Value (Rs.)
Electric		
Diesel		
Turbine		
Other		
Total:		

14.6 Impact on Utility

Yes

No

If yes then

Types	Nos. / Area
Electric poles	
Transformer	
Transmission line	
Telephone	
Other	
Total:	

14.7 Impact on Community Structure

Name	Yes	No	Value (Rs.)
Schools			
Mosque			
Graveyard			
Health Centre			
Shrine			
Others			
Total:			

14.8 How to shift shrines / graveyards?

14.9 Miscellaneous Impacts of the Project

14.10 Do you have any alternate residence place?

Yes ☐ No ☐

If yes then (tick relevant)

Own Land / House	Yes/No	Location	Distance from current residence (km)
Tenancy			
Relative			
Other			

14.11 Mode of Payment

Land for land _____
Cash compensation _____
Kind _____
Other _____

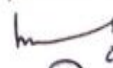
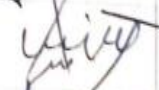
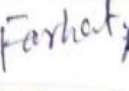
15. Project

16. Views / Comments of Interviewers

Name & Signature of Interviewer: _____ Date: _____

- 1) Name:
- 2) Occupation:
- 3) Age:
- 4) Residence City:
 - -----
- 5) How much waste do you normally collect in a day?
- 6) Is all of the waste you collect useful, or do you have to sort it after collection as well?
- 7) What is the procedure you normally follow in your waste collection activity?
- 8) What is the usual cost (money) and time (man-hours) you put in the waste collection activity every day or every month?
- 9) What is the amount of (daily or monthly) income you generate from your activity?
- 10) Is this your only income source?
- 11) If no to Q10, what is your other occupation?
- 12) If no to Q10, what is your total income, and what percentage income is from waste collection?
- 13) Where does the waste go after you have processed it?
- 14) What is your motivation (reason) to do this activity?
- 15) Do you feel a sense of satisfaction that your work makes a positive difference to the cleanliness of the area?
- 16) What is your working relationship, if any, with any government department or authority (BWMC etc.) of your city?
- 17) What kind of improvements would you like to see in your work? Any kind of assistance from government?

Appendix A.3 Details of public consultations

 PUNJAB INTERMEDIATE CITIES IMPROVEMENT INVESTMENT PROGRAM (PICIP) DISTRICT BAHAWALPUR 			
<u>ATTENDANCE SHEET</u>			
Venue:..... <u>BWMC</u>, Bahawalpur			
Date:..... <u>11-11-2020</u> Time:..... <u>11:00</u>			
Sr. #	Name	Designation & Organization	Signature & Contact No.
1.	Rizwan Jubbar	Infrastructure Egt. CIU - BWP	 0321-6974585
2.	ANSAR ABBAS	AD (Environnement)	 0300-7505254
3.	Rizwan Ullah	Social Welfare officer	 0303-8897169
4.	Sohail Shamee	Agriculture officer BWP	 0333-600571
5.	Jawid Jhal	Investigation department SDD/BGD	 03017770827
6.	M. Farid Mahmood	Mayor M.I.S Bwmc	 0345-4634444
7.	M. Naveem Abbas	Chief Financial Officer	 0345-9564444
8.	Jamshid Khan/Chauhan	Civil Society Representative	 03009683824. Liaison Katah Development for
9.	M. Imtiaz ulah	MO Bwmc	
10.	Zunisa Tahir	MFO PICIP	
11.	Farhat Abbas	PSO PICIP	 Farhat Abbas
12.	Alteham Raza	Env. Expert (EDCM)	 0308462412
13.	Sanaat Hussain	Special Reps. Expert (Tractebel)	 Sanaat Hussain

Sr. No.	Name	Address	Contact Number.	Signature
32.	Ali Raza	Dera Hashi	0301-4307889	aliraza
33.	Asbab Ali	Dera Hashi	0324-853236	Asbab Ali
34.	YOUSAF Ali	"	03101414945	Yousaf
35.	Zohaib Hassan	"	0303-4426938	Zohaib
36.	Shazaib Khan	"	03234103455	Shazaib
37.	M. Waqas	"	0308-4423409	M. Waqas
38.	Uzame Akshad	"	0304-8438385	Uzame
39.	Muhamamd Tameed Anif	Rasheedabad	0302-162870	Muhamamd
40.	Ali Raza	Rasheedabad	03004562380	Ali Raza
41.	M. Shakeel	"	0345459006	M. Shakeel
42.	Muzlim Hussain	"	03604443342	Muzlim
43.	Waqas Ali	"	03091147237	Waqas
44.	Suban Ali	"	0324493378	Suban
45.	Asif Ali	"	03234576674	Asif
46.	Amir Ali	"	0305-701952	Amir
47.	Haider	"	304-761476	Haider
48.	Rizwan	"	0305-2571028	Rizwan
49.	Uzair	"	0302-4528772	Uzair

Sr. No.	Name	Address	Contact Number.	Signature
50.	M. Junaid	6	0309-7726204	M. Junaid
51.	M. Awaiz	6	0309-4868737	M. Awaiz
52.	Zee Khan	6	0314-820 7979	Zee Khan
53.	Aamir Shujaat	Village Khushnagar	0300-6546531	Aamir
54.	Yasir Sindhvi	Village Khushnagar	0321-4510988	Yasir
55.	Fahad Mahmood	6	0323-8401150	Fahad
56.	Naveed Akram	6	0312-6234980	Naveed
57.	Nauman Afzal	6	0333-5615637	Nauman
58.	Ashim	6	0322-4081508	Ashim
59.	Umar Siddique	-	0308-4144601	Umar
60.	Taimoor	-	0335-4344994	Taimoor
61.	Fahad Sabarwan	-	03111234572	Fahad
62.	Reif Ali	-	0323-4576674	Reif
63.	Abrar Ahmad	-	0324-4029733	Abrar
64.	Ali Hussain	-	0308-5735208	Ali
65.	Usman Ali Butt	-	0302-2512630	Usman
66.	M. Shahzaib	-	0324-5056098	M. Shahzaib
67.	Ali Raza	-	0300-2221718	Ali Raza

Sr. No.	Name	Address	Contact Number.	Signature
68.	M. Qaisar	1	03211655389	M. Qaisar
69.	Raza	4	0333-4092203	Raza
70.	Raza	مسٹر / 190	0314 7564100	Raza
71.	Raza	1	0301 4578203	Raza
72.	Raza	1	0322 4089825	Raza
73.	M. Kram-ul-Haq	1	0300 4704011	M. Kram-ul-Haq
74.	Mahid Akhtar Abbas	4	0321 4601344	Mahid Akhtar Abbas
75.	Akbar Ali	4	0301 4127716	Akbar Ali
76.	Azam	4	0302-432524	Azam
77.	Zafar	1	0315 4117457	Zafar
78.	Waqar	4	0322 4470102	Waqar
79.	Faisal	5	0300-8102231	Faisal
80.	Hassan Hassan	1	0321 4478083	Hassan
81.	Akbar	1	0324-7896738	Akbar
82.	IRfan	-	0310-9876728	IRfan
83.	TANVEER ASHRAF	-	0312-2200312	TANVEER ASHRAF
84.	Khalid Hussain	-	0315-4289714	Khalid Hussain
85.	Alif Rasheed	-	0324 4816081	Alif Rasheed

Sr. No.	Name	Address	Contact Number.	Signature
	فرانک		0304500517	Frank
86.	SATIAL	Yad Muhammud	0315-4155078	Satial
87.	USAD PANIZ	,	0309-2680192	USAD
88.	Adeel mahzoo8	,	0323-4436195	Adeel
89.	Raza Zatt	,	03211151986	Raza
90.	Zohaib	,	03014250228	Zohaib
91.	ADIL	,	03014250228	Adil
92.	Awaris	,	0301-6584174	Awaris
93.	Hussain	,	03076129869	Hussain
94.	Sulman	,	03014785303	Sulman
95.	Shafiq	,	0301278593	Shafiq

Appendix A.4 Environmental Baseline Monitoring

Air Quality



AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	30-11-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring Instrument:	ACMS 65
Location	East Rama		

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
		Units			
	Hours	($\mu\text{g}/\text{m}^3$)	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	21.2	71.97	14.93 ($\mu\text{g}/\text{m}^3$)	64.03 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	18.93	72.84		
3.	11:00 A.M	17.01	71.29		
4.	12:00 P.M	16.26	74.58		
5.	01:00 P.M	16.29	73.03		
6.	02:00 P.M	16.65	72.32		
7.	03:00 P.M	16.59	69.79		
8.	04:00 P.M	16.19	68.57		
9.	05:00 P.M	15.09	65.35		
10.	06:00 P.M	13.86	63.83		
11.	07:00 P.M	13.09	62.1		
12.	08:00 P.M	13.49	63.58		
13.	09:00 P.M	13.99	60.85		
14.	10:00 P.M	14.36	60.13		
15.	11:00 P.M	12.1	59.61		
16.	12:00 A.M	13.98	56.88		
17.	01:00 A.M	13.12	56.35		
18.	02:00 A.M	14.69	57.64		
19.	03:00 A.M	13.99	58.07		
20.	04:00 A.M	13.57	56.38		
21.	05:00 A.M	13.16	57.23		
22.	06:00 A.M	12.29	59.51		
23.	07:00 A.M	13.97	60.42		
24.	08:00 A.M	14.49	64.41		
PEQSAA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEQSAA: Punjab Environmental Quality Standards for Ambient Air

WHO: World Health Organization $\mu\text{g}/\text{m}^3$: Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Signature

Incharge Environmental Monitoring:

AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	01-12-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring	ACMS 65
Location	Basti Yar Muhammad	Instrument:	

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
		Units			
		Hours	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	18.61	67.31	12.34 ($\mu\text{g}/\text{m}^3$)	59.37 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	16.34	68.18		
3.	11:00 A.M	14.42	66.53		
4.	12:00 P.M	13.67	69.92		
5.	01:00 P.M	13.7	68.37		
6.	02:00 P.M	14.06	67.55		
7.	03:00 P.M	14	65.13		
8.	04:00 P.M	13.6	63.91		
9.	05:00 P.M	12.5	60.59		
10.	06:00 P.M	11.27	59.17		
11.	07:00 P.M	10.5	57.44		
12.	08:00 P.M	10.9	58.92		
13.	09:00 P.M	11.4	56.2		
14.	10:00 P.M	11.77	55.47		
15.	11:00 P.M	9.51	54.95		
16.	12:00 A.M	11.39	52.22		
17.	01:00 A.M	10.53	51.59		
18.	02:00 A.M	12.1	52.98		
19.	03:00 A.M	11.4	53.41		
20.	04:00 A.M	10.98	51.72		
21.	05:00 A.M	10.57	52.57		
22.	06:00 A.M	9.7	54.85		
23.	07:00 A.M	11.38	55.75		
24.	08:00 A.M	11.9	59.75		
PEQSAA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEQSAA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Signature
Incharge Environmental Monitoring

AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	02-12-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring Instrument:	ACMS 65
Location	Basti Karim Bukhsh		

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
		Units			
		Hours	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	22.12	76.3	15.85 ($\mu\text{g}/\text{m}^3$)	68.36 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	19.85	77.17		
3.	11:00 A.M	17.93	75.62		
4.	12:00 P.M	17.18	78.91		
5.	01:00 P.M	17.21	77.35		
6.	02:00 P.M	17.57	76.65		
7.	03:00 P.M	17.51	74.12		
8.	04:00 P.M	17.11	72.9		
9.	05:00 P.M	16.01	69.68		
10.	06:00 P.M	14.78	68.15		
11.	07:00 P.M	14.01	66.43		
12.	08:00 P.M	14.41	67.91		
13.	09:00 P.M	14.91	65.19		
14.	10:00 P.M	15.28	64.45		
15.	11:00 P.M	13.02	63.94		
16.	12:00 A.M	14.9	61.21		
17.	01:00 A.M	14.04	60.68		
18.	02:00 A.M	15.61	61.97		
19.	03:00 A.M	14.91	62.4		
20.	04:00 A.M	14.48	60.71		
21.	05:00 A.M	14.08	61.55		
22.	06:00 A.M	13.21	63.84		
23.	07:00 A.M	14.89	64.75		
24.	08:00 A.M	15.41	68.74		
PEQSAA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEQSAA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring



AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	03-12-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring	AGMS 65
Location	Basti Merwala Khoon	Instrument:	

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
		Units			
		Hours	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	15.66	60.87	9.39 ($\mu\text{g}/\text{m}^3$)	52.93 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	13.39	61.74		
3.	11:00 A.M	11.47	60.19		
4.	12:00 P.M	10.72	63.48		
5.	01:00 P.M	10.75	61.93		
6.	02:00 P.M	11.11	61.22		
7.	03:00 P.M	11.06	58.69		
8.	04:00 P.M	10.65	57.47		
9.	05:00 P.M	9.55	54.25		
10.	06:00 P.M	8.32	52.73		
11.	07:00 P.M	7.55	51		
12.	08:00 P.M	7.96	52.48		
13.	09:00 P.M	8.45	49.76		
14.	10:00 P.M	8.82	49.03		
15.	11:00 P.M	6.56	48.51		
16.	12:00 A.M	8.44	45.78		
17.	01:00 A.M	7.58	45.25		
18.	02:00 A.M	9.15	46.54		
19.	03:00 A.M	8.45	46.97		
20.	04:00 A.M	8.03	45.28		
21.	05:00 A.M	7.62	46.13		
22.	06:00 A.M	6.75	48.41		
23.	07:00 A.M	8.43	49.32		
24.	08:00 A.M	8.95	53.31		
PEGSAA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEGSAA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
 - Quality was assured through self calibration of the instrument.
 - The values were representing of monitoring conditions prevailing during the monitoring hours.
 - The measurements were carried out on client request.
 - The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	04-12-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring	AQMS 65
Location	East Rasheedabad	Instrument:	

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
	Hours	($\mu\text{g}/\text{m}^3$)	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	20.88	65.87	14.61 ($\mu\text{g}/\text{m}^3$)	57.95 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	18.61	66.74		
3.	11:00 A.M	16.69	65.19		
4.	12:00 P.M	15.94	68.48		
5.	01:00 P.M	15.97	66.93		
6.	02:00 P.M	16.33	66.22		
7.	03:00 P.M	16.27	63.69		
8.	04:00 P.M	15.87	62.47		
9.	05:00 P.M	14.77	59.25		
10.	06:00 P.M	13.54	57.73		
11.	07:00 P.M	12.77	56		
12.	08:00 P.M	13.17	57.48		
13.	09:00 P.M	13.67	54.76		
14.	10:00 P.M	14.04	54.03		
15.	11:00 P.M	11.78	53.51		
16.	12:00 A.M	13.66	50.78		
17.	01:00 A.M	12.8	50.25		
18.	02:00 A.M	14.37	51.54		
19.	03:00 A.M	13.67	51.97		
20.	04:00 A.M	13.25	50.28		
21.	05:00 A.M	12.84	51.13		
22.	06:00 A.M	11.97	53.41		
23.	07:00 A.M	13.65	54.32		
24.	08:00 A.M	14.17	58.31		
PEQSAA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEQSAA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring



AMBIENT PARTICULATE MATTER MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	05-12-2022	Reporting Date:	13-12-2022
Source	Ambient Air	Monitoring	AQMS 65
Location	Basti Chachran	Instrument:	

Sr. No	Time	Parameters		Results (Average 24 Hrs)	
		PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀
	Hours	Unit	Unit		
		($\mu\text{g}/\text{m}^3$)	($\mu\text{g}/\text{m}^3$)		
1.	09:00 A.M	17.24	62.39	10.97 ($\mu\text{g}/\text{m}^3$)	54.49 ($\mu\text{g}/\text{m}^3$)
2.	10:00 A.M	14.97	63.25		
3.	11:00 A.M	13.05	61.71		
4.	12:00 P.M	12.3	65		
5.	01:00 P.M	12.33	63.45		
6.	02:00 P.M	12.69	62.74		
7.	03:00 P.M	12.63	60.21		
8.	04:00 P.M	12.23	58.99		
9.	05:00 P.M	11.13	55.77		
10.	06:00 P.M	9.9	54.25		
11.	07:00 P.M	9.13	52.52		
12.	08:00 P.M	9.53	54		
13.	09:00 P.M	10.03	51.28		
14.	10:00 P.M	10.4	50.55		
15.	11:00 P.M	8.14	50.03		
16.	12:00 A.M	10.02	47.3		
17.	01:00 A.M	9.16	46.77		
18.	02:00 A.M	10.73	48.05		
19.	03:00 A.M	10.03	48.49		
20.	04:00 A.M	9.61	46.8		
21.	05:00 A.M	9.2	47.55		
22.	06:00 A.M	8.33	49.93		
23.	07:00 A.M	10.01	50.84		
24.	08:00 A.M	10.53	54.83		
PEQ&AA				35 ($\mu\text{g}/\text{m}^3$)	150 ($\mu\text{g}/\text{m}^3$)
WHO				15 ($\mu\text{g}/\text{m}^3$)	45 ($\mu\text{g}/\text{m}^3$)

PEQ&AA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization $\mu\text{g}/\text{m}^3$ = Micrograms per Cubic Meter

Note:

- Selected measurement units were $\mu\text{g}/\text{m}^3$ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	30-11-2022	Reporting Date:	13-12-2022
Source	Ambient Air Gases	Monitoring	AGMS 65
Location	East Rama	Instrument:	

Sr. No	Time	Parameters			
		CO	NO	NO ₂	SO ₂
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.34	5.46	8.06	7.28
2.	10:00 A.M	0.39	6.31	8.24	7.15
3.	11:00 A.M	0.31	6.38	8.51	6.42
4.	12:00 P.M	0.42	7.13	7.42	6.55
5.	01:00 P.M	0.45	6.53	7.29	5.7
6.	02:00 P.M	0.34	6.71	7.4	5.78
7.	03:00 P.M	0.32	7.25	7.75	6.4
8.	04:00 P.M	0.27	6.39	7.91	7.59
9.	05:00 P.M	0.23	5.55	7.43	5.42
10.	06:00 P.M	0.29	5.32	7.55	5.91
11.	07:00 P.M	0.15	6.1	8.13	7.34
12.	08:00 P.M	0.21	6.43	7.24	7.01
13.	09:00 P.M	0.17	7.24	7.67	6.58
14.	10:00 P.M	0.22	5.52	7.52	6.24
15.	11:00 P.M	0.15	5.09	8.35	7.09
16.	12:00 A.M	0.27	6.27	7.6	7.37
17.	01:00 A.M	0.24	6.34	7.14	6.3
18.	02:00 A.M	0.11	5.59	7.3	6.11
19.	03:00 A.M	0.23	7.38	7.18	5.89
20.	04:00 A.M	0.24	6.59	6.81	6.2
21.	05:00 A.M	0.29	6.35	6.24	6.57
22.	06:00 A.M	0.27	5.88	7.1	6.73
23.	07:00 A.M	0.29	6.63	7.39	7.02
24.	08:00 A.M	0.32	5.87	7.49	6.89
Average Concentration		0.27	6.28	7.68	6.80
PEQSAA		05	40	80	120
WHO		04	—	25	40

PEQSAA: Punjab Environmental Quality Standards for Ambient Air

WHO: World Health Organization µg/m³ = Micrograms per Cubic Meter

Notes:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.


Signature of Analyst


Incharge Environmental Monitoring

AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022				
Client Name:	Local Government and Community Development (LG&CD).	Project Name:	Bahawalpur Landfill Site		
Monitoring Date:	01-12-2022	Reporting Date:	13-12-2022		
Source	Ambient Air Gases	Monitoring	AQMS 65		
Location	Basit Yar Muhammad	Instrument:			

Sr. No	Time	Parameters			
		CO	NO	NO _x	SO _x
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.55	9.47	12.93	12.76
2.	10:00 A.M	0.61	10.32	13.11	12.63
3.	11:00 A.M	0.53	10.39	13.38	11.9
4.	12:00 P.M	0.64	11.14	13.29	12.03
5.	01:00 P.M	0.67	10.54	12.15	12.18
6.	02:00 P.M	0.56	10.72	12.27	11.26
7.	03:00 P.M	0.54	11.25	12.63	11.88
8.	04:00 P.M	0.49	10.4	12.78	13.07
9.	05:00 P.M	0.45	9.56	12.3	10.9
10.	06:00 P.M	0.51	9.33	12.42	11.39
11.	07:00 P.M	0.37	10.11	13	12.82
12.	08:00 P.M	0.43	10.44	12.11	12.49
13.	09:00 P.M	0.39	11.25	12.54	12.06
14.	10:00 P.M	0.44	9.63	12.39	11.72
15.	11:00 P.M	0.37	9.1	13.22	12.57
16.	12:00 A.M	0.49	10.29	12.47	12.85
17.	01:00 A.M	0.46	10.35	12.01	11.78
18.	02:00 A.M	0.33	9.6	12.17	11.59
19.	03:00 A.M	0.45	11.39	12.05	11.37
20.	04:00 A.M	0.46	10.6	11.68	11.68
21.	05:00 A.M	0.51	10.35	11.11	12.05
22.	06:00 A.M	0.49	9.89	11.97	12.21
23.	07:00 A.M	0.51	10.64	12.25	12.5
24.	08:00 A.M	0.54	9.88	12.35	12.37
Average Concentration		0.48	10.27	12.40	12.68
PEQ&AA		06	40	80	120
WHO		04	—	26	40

PEQ&AA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization µg/m³ = Micrograms per Cubic Meter

Note:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022				
Client Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site		
Monitoring Date:	02-12-2022	Reporting Date:	13-12-2022		
Source	Ambient Air Gases	Monitoring	AQMS 65		
Location	East Karim Bukhsh	Instrument:			

Sr. No	Time	Parameters			
		CO	NO	NO _x	SO _x
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.8	12.42	14.87	16.63
2.	10:00 A.M	0.85	13.27	15.05	16.5
3.	11:00 A.M	0.77	13.34	15.32	15.77
4.	12:00 P.M	0.88	14.09	14.23	15.9
5.	01:00 P.M	0.91	13.49	14.1	16.06
6.	02:00 P.M	0.8	13.67	14.21	15.13
7.	03:00 P.M	0.78	14.21	14.57	15.75
8.	04:00 P.M	0.73	13.35	14.72	16.94
9.	05:00 P.M	0.69	12.91	14.34	14.77
10.	06:00 P.M	0.75	12.28	14.36	15.26
11.	07:00 P.M	0.61	13.06	14.94	16.68
12.	08:00 P.M	0.67	13.39	14.05	16.36
13.	09:00 P.M	0.63	14.2	14.48	15.93
14.	10:00 P.M	0.68	12.48	14.33	15.59
15.	11:00 P.M	0.61	12.05	15.15	16.44
16.	12:00 A.M	0.73	13.23	14.41	16.72
17.	01:00 A.M	0.7	13.3	13.95	15.66
18.	02:00 A.M	0.57	12.55	14.11	15.46
19.	03:00 A.M	0.69	14.34	13.99	15.24
20.	04:00 A.M	0.7	13.55	13.62	15.55
21.	05:00 A.M	0.75	13.31	13.05	15.92
22.	06:00 A.M	0.73	12.84	13.91	16.08
23.	07:00 A.M	0.75	13.59	14.2	16.37
24.	08:00 A.M	0.78	12.83	14.3	16.24
Average Concentration		0.73	13.22	14.34	15.86
PEQ&AA		06	40	80	120
WHO		04	—	25	40

PEQ&AA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization µg/m³ = Micrograms per Cubic Meter

Note:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.

The report is not valid for court.

Signature of Analyst

Signature

Incharge Environmental Monitoring

AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022			
Client Name:	Local Government and Community Development (LG&CD).	Project Name:	Bahawalpur Landfill Site	
Monitoring Date:	03-12-2022	Reporting Date:	13-12-2022	
Source	Ambient Air Gases	Monitoring	ACMS 65	
Location	Basti Meriwala Khoon	Instrument:		

Sr. No	Time	Parameters			
		CO	NO	NO ₂	SO ₂
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.46	6.21	8.97	9.1
2.	10:00 A.M	0.51	7.06	9.15	8.97
3.	11:00 A.M	0.43	7.13	9.42	8.24
4.	12:00 P.M	0.54	7.88	8.33	8.37
5.	01:00 P.M	0.57	7.28	8.2	8.52
6.	02:00 P.M	0.46	7.46	8.31	7.6
7.	03:00 P.M	0.44	8	8.67	8.22
8.	04:00 P.M	0.39	7.14	8.82	9.41
9.	05:00 P.M	0.35	6.3	8.34	7.24
10.	06:00 P.M	0.41	6.07	8.46	7.73
11.	07:00 P.M	0.27	6.85	9.04	9.16
12.	08:00 P.M	0.33	7.18	8.15	8.83
13.	09:00 P.M	0.29	7.99	8.58	8.4
14.	10:00 P.M	0.34	6.27	8.43	8.06
15.	11:00 P.M	0.27	5.84	9.26	8.91
16.	12:00 A.M	0.39	7.02	8.51	9.19
17.	01:00 A.M	0.36	7.09	8.05	8.12
18.	02:00 A.M	0.23	6.34	8.21	7.93
19.	03:00 A.M	0.35	8.13	8.09	7.71
20.	04:00 A.M	0.36	7.34	7.72	8.02
21.	05:00 A.M	0.41	7.1	7.15	8.39
22.	06:00 A.M	0.39	6.63	8.01	8.55
23.	07:00 A.M	0.41	7.38	8.3	8.84
24.	08:00 A.M	0.44	6.62	8.4	8.71
Average Concentration		0.38	7.01	8.44	8.42
PEQ&AA		06	40	80	120
WHO		04	—	26	40

PEQ&AA: Punjab Environmental Quality Standards for Ambient Air
WHO: World Health Organization µg/m³= Micrograms per Cubic Meter

Note:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring



AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022			
Client Name:	Local Government and Community Development	Project Name:	Bahawalpur Landfill Site	
Monitoring Date:	04-12-2022	Reporting Date:	13-12-2022	
Source	Ambient Air Gases	Monitoring	ACMS 65	
Location	Basir Rasheedabad	Instrument:		

Sr. No	Time	Parameters			
		CO	NO	NO _x	SO _x
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.45	8.66	10.77	11.75
2.	10:00 A.M	0.5	9.51	10.95	11.62
3.	11:00 A.M	0.42	9.58	11.22	10.89
4.	12:00 P.M	0.53	10.33	10.13	11.02
5.	01:00 P.M	0.55	9.73	10	11.17
6.	02:00 P.M	0.45	9.91	10.11	10.25
7.	03:00 P.M	0.43	10.45	10.47	10.87
8.	04:00 P.M	0.38	9.59	10.62	12.06
9.	05:00 P.M	0.34	8.75	10.14	9.89
10.	06:00 P.M	0.4	8.52	10.25	10.38
11.	07:00 P.M	0.26	9.3	10.84	11.81
12.	08:00 P.M	0.32	9.63	9.95	11.48
13.	09:00 P.M	0.28	10.44	10.38	11.05
14.	10:00 P.M	0.33	8.72	10.23	10.71
15.	11:00 P.M	0.25	8.29	11.06	11.56
16.	12:00 A.M	0.38	9.47	10.31	11.84
17.	01:00 A.M	0.35	9.54	9.85	10.77
18.	02:00 A.M	0.22	8.79	10.01	10.58
19.	03:00 A.M	0.34	10.58	9.89	10.36
20.	04:00 A.M	0.35	9.79	9.52	10.67
21.	05:00 A.M	0.4	9.55	8.95	11.04
22.	06:00 A.M	0.38	9.08	9.81	11.2
23.	07:00 A.M	0.4	9.83	10.1	11.49
24.	08:00 A.M	0.43	9.07	10.2	11.36
Average Concentration		0.38	9.48	10.24	11.07
PEQSAA		06	40	80	120
WHO		04	—	25	40

PEQSAA: Punjab Environmental Quality Standards for Ambient Air
 WHO: World Health Organization µg/m³= Micrograms per Cubic Meter

Note:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT AIR GASES MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022			
Client Name:	Local Government and Community Development (LG&CD).	Project Name:	Bahawalpur Landfill Site	
Monitoring Date:	05-12-2022	Reporting Date:	13-12-2022	
Source	Ambient Air Gases	Monitoring	AQMS 65	
Location	Basti Chachran	Instrument:		

Sr. No	Time	Parameters			
		CO	NO	NO _x	SO _x
		Units			
	Hours	(mg/m ³)	(µg/m ³)	(µg/m ³)	(µg/m ³)
1.	09:00 A.M	0.37	8.13	10.95	10.77
2.	10:00 A.M	0.42	8.98	11.13	10.64
3.	11:00 A.M	0.34	9.05	11.4	9.91
4.	12:00 P.M	0.45	9.8	10.31	10.04
5.	01:00 P.M	0.48	9.2	10.18	10.19
6.	02:00 P.M	0.37	9.38	10.29	9.27
7.	03:00 P.M	0.35	9.92	10.65	9.89
8.	04:00 P.M	0.3	9.06	10.8	11.08
9.	05:00 P.M	0.26	8.22	10.32	8.91
10.	06:00 P.M	0.32	7.99	10.44	9.4
11.	07:00 P.M	0.18	8.77	11.02	10.83
12.	08:00 P.M	0.24	9.1	10.13	10.5
13.	09:00 P.M	0.2	9.91	10.56	10.07
14.	10:00 P.M	0.25	8.19	10.41	9.73
15.	11:00 P.M	0.18	7.76	11.24	10.58
16.	12:00 A.M	0.3	8.54	10.49	10.86
17.	01:00 A.M	0.27	9.01	10.03	9.79
18.	02:00 A.M	0.14	8.26	10.19	9.6
19.	03:00 A.M	0.26	10.05	10.07	9.38
20.	04:00 A.M	0.27	9.26	9.7	9.69
21.	05:00 A.M	0.32	9.02	9.13	10.06
22.	06:00 A.M	0.3	8.55	9.99	10.22
23.	07:00 A.M	0.32	9.3	10.28	10.51
24.	08:00 A.M	0.35	8.54	10.38	10.38
Average Concentration		0.30	8.83	10.42	10.08
PEQSAA		06	40	80	120
WHO		04	—	25	40

PEQSAA: Punjab Environmental Quality Standards for Ambient Air

WHO: World Health Organization µg/m³ = Micrograms per Cubic Meter

Notes:

- Selected measurement units were µg/m³ & mg/m³ otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT NOISE MONITORING REPORT

Reference Number:	LG&CD/ENV/161-2022	Project Name:	Bahawalpur Landfill Site
Project Name:	Local Government and Community Development (LG&CD).		
Monitoring Date:	30-11-2022	Reporting Date:	13-12-2022
Source:	Ambient Noise	Monitoring Instrument:	Noise Meter-IEC651-Type-2
Location:	Basti Rama		

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time		dB(A)	Day Time		
1.	09:00 A.M		46.2	48.5	47.3
2.	10:00 A.M		47.3	49.5	48.4
3.	11:00 A.M		45.3	46.1	45.7
4.	12:00 P.M		45.2	47.8	46.5
6.	01:00 P.M		48.7	51.6	50.1
6.	02:00 P.M		48.7	49.4	49
7.	03:00 P.M		45.1	46.3	45.7
8.	04:00 P.M		47.8	48.2	48
8.	05:00 P.M		50.1	52.3	51.2
10.	06:00 P.M		49.8	50.7	50.2
11.	07:00 P.M		52.3	54.7	53.5
12.	08:00 P.M		46.3	48.2	47.2
13.	09:00 P.M		44.3	45.8	45
14.	10:00 P.M		48.6	50.4	49.5
Night Time			Night Time		
16.	11:00 P.M		46.3	47.5	46.9
18.	12:00 A.M		48.6	49.1	48.8
17.	01:00 A.M		50.3	51.7	51
18.	02:00 A.M		45.8	47.2	46.5
19.	03:00 A.M		48.2	49.7	48.9
20.	04:00 A.M		46.5	48.9	47.7
21.	05:00 A.M		45.3	46.3	45.8
22.	06:00 A.M		44.8	45.7	45.2
Day Time			Day Time		
23.	07:00 A.M		48.6	49.7	49.1
24.	08:00 A.M		48.6	47.6	48.1

Day Time: 06:00 AM – 10:00 PM

Night Time: 10:00 PM – 06:00 AM

PEQS Limit: 65 – 55 dB

WHO Limit: 70 dB

PEQS: Punjab Environmental Quality Standards for Ambient Noise

WHO: World Health Organization Leq: Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT NOISE MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022	Project Name:	Bahawalpur Landfill Site
Project Name:	Local Government and Community Development (LG&CD)	Monitoring Date:	01-12-2022
Monitoring Date:	01-12-2022	Reporting Date:	13-12-2022
Source:	Ambient Noise	Monitoring Instrument:	Noise Meter-EC651-Type-2
Location:	Basti Yar Muhammad		

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time		dB(A)	Day Time		
1.	09:00 A.M		49.3	50.6	49.9
2.	10:00 A.M		49.3	51.9	50.6
3.	11:00 A.M		47.3	48.5	47.9
4.	12:00 P.M		45.8	48.7	47.2
5.	01:00 P.M		50.7	54	52.3
6.	02:00 P.M		51.7	51.8	51.7
7.	03:00 P.M		47.1	48.7	47.9
8.	04:00 P.M		49.8	50.6	50.2
9.	05:00 P.M		52.7	52.9	52.8
10.	06:00 P.M		51.8	53.1	52.4
11.	07:00 P.M		54.3	57.1	55.7
12.	08:00 P.M		48.3	50.6	49.4
13.	09:00 P.M		46.3	48.2	47.2
14.	10:00 P.M		50.6	52.8	51.7
Night Time			Night Time		
15.	11:00 P.M		48.3	49.9	49.1
16.	12:00 A.M		50.6	51.5	51
17.	01:00 A.M		52.3	54.1	53.2
18.	02:00 A.M		46.7	47.2	46.9
19.	03:00 A.M		50.2	52.1	51.1
20.	04:00 A.M		48.5	51.3	49.9
21.	05:00 A.M	47.3	48.7	48	
22.	06:00 A.M	46.8	48.1	47.4	
Day Time		Day Time			
23.	07:00 A.M	50.6	52.1	51.3	
24.	08:00 A.M	49.7	50.7	50.2	

Day Time 06:00 AM – 10:00 PM
Night Time 10:00 PM – 06:00 AM

PEQS limit : 55 – 55 dB

WHO limit: 70 dB

PEQS: Punjab Environmental Quality Standards for Ambient Noise

WHO: World Health Organization Leq: Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT NOISE MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022	Project Name:	Bahawalpur Landfill Site
Project Name:	Local Government and Community Development (LG&CD).	Monitoring Date:	02-12-2022
Monitoring Date:	02-12-2022	Reporting Date:	13-12-2022
Source:	Ambient Noise	Monitoring Instrument:	Noise Meter-EC651-Type-2
Location:	Basti Karim Bukhsh		

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time			Day Time		
1.	09:00 A.M	dB(A)	60.6	63.5	62
2.	10:00 A.M		60.4	63.2	61.8
3.	11:00 A.M		60.1	63	61.5
4.	12:00 P.M		59.9	62.8	61.3
5.	01:00 P.M		59.7	62.6	61.1
6.	02:00 P.M		59.5	62.4	60.9
7.	03:00 P.M		59.3	62.2	60.7
8.	04:00 P.M		59.1	61.9	60.5
9.	05:00 P.M		58.8	61.7	60.2
10.	06:00 P.M		58.6	61.5	60
11.	07:00 P.M		58.4	61.3	59.8
12.	08:00 P.M		58.2	61.1	59.6
13.	09:00 P.M		58	60.9	59.4
14.	10:00 P.M		57.8	60.6	59.2
Night Time			Night Time		
16.	11:00 P.M	dB(A)	47.7	50.6	49.1
18.	12:00 A.M		47.4	50.3	48.9
17.	01:00 A.M		47.2	50.1	48.7
18.	02:00 A.M		47	49.9	48.5
19.	03:00 A.M		46.8	49.7	48.3
20.	04:00 A.M		46.6	49.4	48
21.	05:00 A.M		46.3	49.2	47.8
22.	06:00 A.M		46.1	49	47.6
Day Time			Day Time		
23.	07:00 A.M	dB(A)	45.9	48.8	47.4
24.	08:00 A.M		45.7	48.6	47.2

Day Time 06:00 AM – 10:00 PM

Night Time 10:00 PM – 06:00 AM

PEQS limit : 65 – 55 dB

WHO limit: 70 dB

PEQS: Punjab Environmental Quality Standards for Ambient Noise

WHO: World Health Organization Leq= Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

AMBIENT NOISE MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022	Project Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site
Monitoring Date:	03-12-2022	Reporting Date:	13-12-2022	Monitoring Instrument:	Noise Meter-IEC651-Type-2
Source:	Ambient Noise				
Location	Basti Merhwa Khoon				

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time		dB(A)	Day Time		
1.	09:00 A.M		48.3	49.7	49
2.	10:00 A.M		50.1	51.7	50.9
3.	11:00 A.M		49.8	52.7	51.2
4.	12:00 P.M		46.3	48.5	47.4
6.	01:00 P.M		52.5	53	52.7
8.	02:00 P.M		52.9	53.1	53
7.	03:00 P.M		51.7	53.8	52.7
8.	04:00 P.M		49.8	50.2	50
8.	05:00 P.M		45.8	47.6	46.7
10.	06:00 P.M		50.2	51.7	50.9
11.	07:00 P.M		48.6	50.2	49.4
12.	08:00 P.M		48.2	51.4	49.8
13.	09:00 P.M		48.3	55.8	52
14.	10:00 P.M		52.6	52.9	52.7
Night Time			Night Time		
16.	11:00 P.M		50.3	54.5	52.4
18.	12:00 A.M		52.6	57.1	54.8
17.	01:00 A.M		48.5	49.8	49.1
18.	02:00 A.M		48.7	55.1	51.9
18.	03:00 A.M		52.2	54.3	53.2
20.	04:00 A.M		50.5	51.7	51.1
21.	05:00 A.M		49.3	51.1	50.2
22.	06:00 A.M		48.8	55.1	51.9
Day Time			Day Time		
23.	07:00 A.M		52.6	53.7	53.1
24.	08:00 A.M		51.8	52.4	52.4
Day Time 06:00 AM – 10:00 PM Night Time 10:00 PM – 06:00 AM PEQ8 limit : 55 – 55 dB WHO limit: 70 dB					

PEQ8: Punjab Environmental Quality Standards for Ambient Noise

WHO: World Health Organization Leq= Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible for lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring



AMBIENT NOISE MONITORING REPORT

Reference Number	LG&CD/ENV/161-2022	Project Name:	Bahawalpur Landfill Site
Project Name:	Local Government and Community Development (LG&CD).	Monitoring Date:	04-12-2022
Monitoring Date:	04-12-2022	Reporting Date:	13-12-2022
Source:	Ambient Noise	Monitoring Instrument:	Noise Meter-EC651-Type-2
Location:	Basti Rasheedabad		

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time		dB(A)	Day Time		
1.	09:00 A.M		50.4	53.3	51.9
2.	10:00 A.M		50.2	53.1	51.6
3.	11:00 A.M		50	52.9	51.4
4.	12:00 P.M		49.8	52.7	51.2
5.	01:00 P.M		49.6	52.4	51
6.	02:00 P.M		49.3	52.2	50.8
7.	03:00 P.M		49.1	52	50.6
8.	04:00 P.M		48.9	51.8	50.4
9.	05:00 P.M		48.7	51.6	50.1
10.	06:00 P.M		48.5	51.4	49.9
11.	07:00 P.M		48.3	51.1	49.7
12.	08:00 P.M		48	50.9	49.5
13.	09:00 P.M		47.8	50.7	49.3
14.	10:00 P.M		47.6	50.5	49.1
Night Time			Night Time		
15.	11:00 P.M		47.4	50.3	48.8
16.	12:00 A.M		47.2	50.1	48.6
17.	01:00 A.M		47	49.9	48.4
18.	02:00 A.M		46.8	49.7	48.2
19.	03:00 A.M		46.6	49.5	48
20.	04:00 A.M		46.4	49.2	47.8
21.	05:00 A.M		46.1	49	47.5
22.	06:00 A.M		45.9	48.8	47.3
Day Time			Day Time		
23.	07:00 A.M		45.7	48.6	47.1
24.	08:00 A.M		45.5	48.4	46.9
Day Time 05:00 AM – 10:00 PM Night Time 10:00 PM – 05:00 AM PEQ3 limit : 55 – 55 dB WHO limit: 70 dB					

PEQ3: Punjab Environmental Quality Standards for Ambient Noise
WHO: World Health Organization Leq= Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring



AMBIENT NOISE MONITORING REPORT

HEAD OFFICE: 3rd Floor, Suite # 11, Anwar Tower, 93-Shadman, Lahore, Pakistan
PESHAWAR OFFICE: Suite # 302, Level-II, Albal Appartment, Near Phase-II Chowk, Peshawar

Reference Number	LG&CD/ENV/161-2022	Project Name:	Bahawalpur Landfill Site
Project Name:	Local Government and Community Development (LG&CD).	Monitoring Date:	05-12-2022
Monitoring Date:	05-12-2022	Reporting Date:	13-12-2022
Source:	Ambient Noise	Monitoring Instrument:	Noise Meter-IEC651-Type-2
Location	Basti Chachran		

Sr. No.	Monitoring Time	Unit	Minimum	Maximum	Leq
Day Time		dB(A)	Day Time		
1.	09:00 A.M		56.8	59.1	57.95
2.	10:00 A.M		57.9	60.1	59
3.	11:00 A.M		55.9	56.7	56.3
4.	12:00 P.M		55.8	58.4	57.1
5.	01:00 P.M		59.3	62.2	60.75
6.	02:00 P.M		59.3	60	59.65
7.	03:00 P.M		55.7	56.9	56.3
8.	04:00 P.M		58.4	58.8	58.6
9.	05:00 P.M		60.7	62.9	61.8
10.	06:00 P.M		60.4	61.3	60.85
11.	07:00 P.M		62.9	65.3	64.1
12.	08:00 P.M		56.9	58.8	57.85
13.	09:00 P.M		54.9	56.4	55.65
14.	10:00 P.M		59.2	61	60.1
Night Time			Night Time		
15.	11:00 P.M		56.9	58.1	57.5
16.	12:00 A.M		59.2	59.7	59.45
17.	01:00 A.M		60.9	62.3	61.6
18.	02:00 A.M		56.4	57.8	57.1
19.	03:00 A.M		58.8	60.3	59.55
20.	04:00 A.M		57.1	59.5	58.3
21.	05:00 A.M		55.9	56.9	56.4
22.	06:00 A.M		55.4	56.3	55.85
Day Time		Day Time			
23.	07:00 A.M	59.2	60.3	59.75	
24.	08:00 A.M	59.7	62.4	61.05	
Day Time 06:00 AM – 10:00 PM Night Time 10:00 PM – 06:00 AM					
PEQS limit : 55 – 55 dB					
WHO limit: 70 dB					

PEQS: Punjab Environmental Quality Standards for Ambient Noise

WHO: World Health Organization Leq: Log Equivalent Continuous Sound Level

Note:

- Selected measurement units were dB(A) otherwise stated.
- Quality was assured through self calibration of the instrument.
- The values were representing of monitoring conditions prevailing during the monitoring hours.
- The measurements were carried out on client request.
- The client is responsible lawful usage of reported data in future.
- The report is not valid for court.

Signature of Analyst

Incharge Environmental Monitoring

DRINKING WATER ANALYSIS REPORT

Reference Number	LG&CD/ENV/161-2022		
Client Name:	Local Government and Community Development (LG&CD)	Project Name:	Bahawalpur Landfill Site
Sampling Date:	05-12-2022	Reporting Date:	13-12-2022
Source Location	Tubewell Basti Chachran	Monitoring Instrument:	APHA/USEPA Standard Methods

Sr. No.	Parameters	Analytic Method	Units	NEQS	Results
1	pH	APHA-4500H+ B	—	6.5-8.5	7.6
2	Taste & Odor	In-house	—	Non Objectable	Non Objectable
3	Color	APHA-2120 B/C	TCU	<15	5
4	Turbidity	APHA-2130 B	NTU	<5	3
5	Total Coliform	APHA-9222 B	Number/100 mL	0 Number/100 mL	0
6	E-Coli	APHA-9222 D	Number/100 mL	0 Number/100 mL	0
7	Total Dissolved Solids (TDS)	APHA-2540 C	mg/L	<1000	468
8	Total Hardness	APHA-2340 C	mg/L	<500	121
9	Nitrate	APHA-4500NO3 B	mg/L	≤50	4.9
10	Nitrite	APHA-4500NO2 B	mg/L	≤3	0.035
11	Ammonia	APHA-4500-NH3-B	mg/L	—	0.07
12	Arsenic	APHA-3500As B	mg/L	<0.05	N.D.
13	Antimony	APHA-3500Sb B	mg/L	<0.005	N.D.
14	Barium	APHA-3500Ba B	mg/L	0.7	N.D.
15	Chloride	APHA-4500Cl- B	mg/L	250	82
16	Fluoride	APHA-4500F- C	mg/L	<1.5	0.76

PDWQ3: Funlab Drinking Water Quality Standards N.D. = Not Detected

Note:

- Selected measurement units were mg/L, otherwise stated.
- The measurements were carried out on client request. The client is responsible lawful usage of reported data in future. The report is not valid for court.


Signature of Analyst

Signature
Incharge Environmental Monitoring:

Appendix A.5 Occupational Health and Safety Plan

General

Occupational Health and Safety covers all personnel working under the project and will be in line with the World Bank/IFC EHS guidelines on health and safety.

The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by: addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces.

Some of the risks/hazards associated with workplaces are due to working close to or at sites associated with the various project construction activities. Other risks associated with the project construction phase include risk of increase of vector borne and other different diseases.

The following sections will be implemented during the construction phase to address and ensure workers' health and safety.

a. Screening and regular unannounced checking of workers

As per the procedure for hiring workers, all contractors and labor agencies are required to make all prospective workers undergo medical tests to screen for diseases and sicknesses, prior to selection and employment of any worker. The contractor is also responsible for ensuring that no worker who has a criminal record is employed at the project site. It will be ensured that all workers undergo medical tests to screen diseases at source and at sites in consultation with the designated Health Officer.

In addition to this, the Project Management will also undertake sudden, unannounced checks on workers to look for diseases such as HIV, STDs, and hepatitis and take necessary steps as mandated by the Contractual agreement between the Contractor and the Worker(s).

b. Minimizing hazards and risks at the workplace.

To ensure safety at all work sites, the following will be carried out:

i. Installation of signboards and symbols in risky and hazardous areas, to inform workers to be careful.

ii. Construction of barricades around construction sites and deep excavated pits, to cordon off and deter entry of unauthorized personnel and workers into these areas.

iii. Providing a safe storage site/area for large equipment such as power tools and chains, to prevent misuse and loss.

iv. Proper Housekeeping: Ensuring that materials are all stacked, racked, blocked, interlocked, or otherwise secured to prevent sliding, falling, or collapse. Brick stacks will not be more than 7 feet in height and for concrete blocks they will not be more than 6 feet high.

v. Removing all scrap timber, waste material and rubbish from the immediate work area as the work progresses.

vi. Where scaffolds are required, ensuring that each scaffold or its components shall be capable of supporting its own weight and at least 4 times the maximum intended load applied or transmitted to it. The platform/scaffold plank shall be at least 15 inches wide and 1.5 inches thick. The rope should be capable of supporting at least 6 times the maximum intended load applied or transmitted to that rope. Pole scaffolds over 60 feet in height shall be designed by a registered professional engineer and shall be constructed and loaded in accordance with that design. Where scaffolds are not provided, safety belts/safety nets shall be provided;

- vii. Ensure that all ramps or walkways are at least 6 feet wide, having slip resistance threads and not inclined at more than a slope of 1 vertical and 3 horizontals.
- viii. Stacking away all excavated earth at least 2 feet from the pit to avoid material such as loose rocks from falling back into the excavated area and injuring those working inside excavated sites.
- ix. Constructing support systems, such as bracing to adjoining structures that may be endangered by excavation works nearby.
- x. Only a trained electrician to construct, install and repair all electrical equipment to prevent risks of electrical shocks and electrocution.
- xi. Install fire extinguishers and/or other fire-fighting equipment at every work site to prepare for any accidental fire hazards.

c. Provision of Personal Protective Equipment

Risks to the health and safety of workers can be prevented by provision of Personal Protective Equipment (PPEs) to all workers. This will be included in the construction cost for each Contractor. Depending on the nature of work and the risks involved, contractors must provide without any cost to the workers, the following protective equipment:

- i. High visibility clothing for all personnel during road works must be mandatory.
- ii. Helmet shall be provided to all workers, or visitors visiting the site, for protection of the head against impact or penetration of falling or flying objects.
- iii. Safety belt shall be provided to workers working at heights (more than 20 ft) such as roofing, painting, and plastering.
- iv. Safety boots shall be provided to all workers for protection of feet from impact or penetration of falling objects on feet.
- v. Ear protecting devices shall be provided to all workers and will be used during the occurrence of extensive noise.
- vi. Eye and face protection equipment shall be provided to all welders to protect against sparks.
- vii. Respiratory protection devices shall be provided to all workers during occurrence of fumes, dusts, or toxic gas/vapor.
- viii. Safety nets shall be provided when work places are more than 25 feet (7.5 m) above the ground or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors or safety belts is impractical.

The specific PPE requirements for each type of work are summarized below.

Table E.1 PPE Requirement List

Type of Work	PPE
Elevated work	Safety helmet, safety belt (height greater than 20 ft), footwear for elevated work.
Handling work safety	Helmet, leather safety shoes, work gloves.
Welding and cutting work	Eye protectors, shield and helmet, protective gloves.
Grinding work	Dust respirator, earplugs, eye protectors.

Work involving handling of chemical substances	Dust respirator, gas mask, chemical-proof gloves. Chemical proof clothing, air-lined mask, eye protectors.
Wood working	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Blasting	Hard hat, eye and hearing protection.
Concrete and masonry work	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Excavation, heavy equipment, motor graders, and bulldozer operation	Hard hat, safety boots, gloves, hearing protection.
Quarries	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.

d. Procedures to Deal with Emergencies such as Accidents, Sudden Illness and Death of Workers

First aid kits will be made available at all times throughout the entire construction period by the respective contractors. This is very important, because most work sites will be at some distance from the nearest hospital. In addition to the first aid kits, the following measures should be in place:

- i. Provision of dispensaries by the individual EPC contractor.
- ii. A vehicle shall be on standby from the Project Office so that emergency transportation can be arranged to take severely injured/sick workers to the nearest hospital for immediate medical attention.
- iii. A designated Health Officer/worker for the Project will be identified as a focal person to attend to all health and safety related issues. This employee's contact number will be posted at all work sites for speedy delivery of emergency services. The focal person shall be well versed with the medical system and facilities available at the hospital.
- iv. Communication arrangements, such a provision of radios or mobile communication for all work sites, for efficient handling of emergencies, will be made.

e. Record Maintenance and Remedial action

The Project Management will maintain a record of all accidents and injuries that occur at the work site. This work will be delegated by the contractor to the site supervisor and regularly reviewed every quarter by project management. Reports prepared by the contractor shall include information on the place, date and time of the incident, name of persons involved, cause of incident, witnesses present and their statements. Based on such reports, the management can jointly identify any unsafe conditions, acts or procedures and recommend for the contractor to undertake certain mitigative actions to change any unsafe or harmful conditions.

f. Compensation for Injuries and Death

Any casualty or injury resulting from occupational activities should be compensated as per the local labor laws. Where compensation is sought by the injured party, proper procedures for documentation of the case will be followed, including a detailed report on the accident, written reports from witnesses, report of the examining doctor and his/her recommendation for

treatment. Each individual contractor will be responsible for ensuring compensation for the respective workers.

g. Awareness Programs

The Project management will undertake awareness programs through posters, talks, and meetings with the contractors to undertake the following activities:

- i. Dissemination sessions will clarify the rights and responsibilities of the workers regarding interactions with local people (including communicable disease risks, such as HIV/AIDS), work site health and safety, waste management (waste separation, recycling, and composting), and the illegality of poaching.
- ii. Make workers aware of procedures to be followed in case of emergencies such as informing the focal health person who in turn will arrange the necessary emergency transportation or treatment.

h. Nomination of a Health and Safety Focal Person

Within each site (especially if different sites are being implemented by different contractors), a Health and Safety Focal Person will be appointed. The Terms of Reference for the focal person will mainly be as follows:

- i. Function as the focal person/representative for all health and safety matters at the workplace;
- ii. Responsible for maintaining records of all accidents and all health and safety issues at each site, the number of accidents and its cause, actions taken and remedial measures undertaken in case of safety issues;
- iii. Be the link between the contractor and all workers and submit grievances of the workers to the contractor and instructions/directives on proper health care and safety from the contractors back to the workers;
- iv. Ensure that all workers are adequately informed on the requirement to use Personal Protective Equipment and its correct use;
- v. Also responsible for the first aid kit and making sure that the basic immediate medicines are readily available.

Appendix A.6 Emergency Response Plan

PURPOSE

The purpose of this Emergency Response Procedure is to provide measures and guidance for the establishment and implementation of emergency preparedness plans for the project. The aim of the Emergency Response Procedure is to:

- (i) Ensure all personnel and visitors to the office/job sites are given the maximum protection from unforeseen events.
- (ii) Ensure all personnel are aware of the importance of this procedure to protection of life and property.

EMERGENCY PREPARATION AND RESPONSE MEASURE SCOPE

The emergency management program is applied to all Project elements and intended for use throughout the Project life cycle. The following are some emergencies that may require coordinated response.

- (i) Construction Accident
- (ii) Road & Traffic Accident
- (iii) Hazardous material spills
- (iv) Structure collapse or failure
- (v) Trauma or serious illness
- (vi) Sabotage
- (vii) Fire
- (viii) Environmental Pollution
- (ix) Loss of person
- (x) Community Accident

RESPONSIBILITIES

The detailed roles and responsibilities of certain key members of the Emergency Response team available to assist in emergency are provided in **Table G.1** below.

Table A.6.1 Emergency Response Team

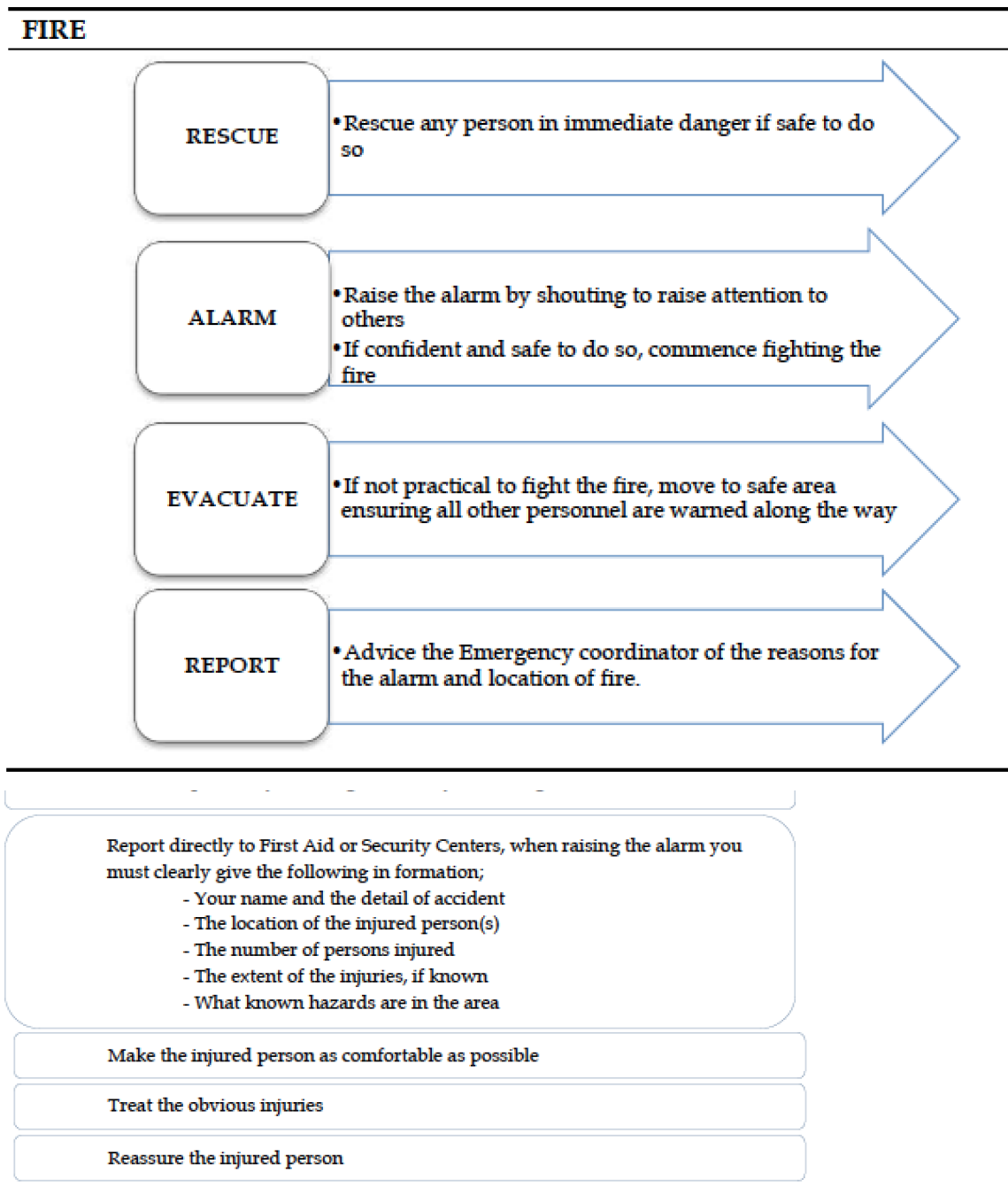
Action Group	Responsibility
Emergency Coordinator	Overall control of personnel and resources. The Emergency Coordinator will support and advise the Site Safety Supervision as necessary. Serves as public relations spokes persons, or delegates to some staff member the responsibility for working with news media regarding any disaster or emergency. Also assure proper coordination of news release with appropriate corporate staff or other designated people.
Site Safety Supervision (Emergency Commander)	Overall responsibility for activating emergency plan and for terminating emergency actions. Be alternative of emergency response chairpersons. Disseminates warnings and information as required to ensure all people in the immediate area have been warned and evacuated either by alarms or by word of mouth. Supervise the actions of the Emergency Response Team to ensure all persons are safe from the danger. Notify outside authorities if assistance is required. Carries the responsibility for coordinating actions including other organizations in accordance with the needs of the situation. Ensure maximum co-operation and assistance is provided to any outside groups called to respond to an emergency. Establish and appoint all emergency organization structure and team. Assures adequate delegation of responsibilities for all key positions of assistants on the Project to assist with any foreseeable emergency. Ensure resources available to purchase needed emergency response equipment and supplies. Assures that all persons on the Emergency Response Team aware and fully understand their individual responsibilities for implementing and supporting the emergency plan. Establish the emergency drill schedule of all identified emergency scenarios, track the status and evaluate the emergency. The Emergency Commander shall ensure that senior management personnel have been reported of the emergency as soon as practical after the event.
Security Team	Ensure that the exit route is regularly tested and maintained in good working order. Maintain station at the security gate or most suitable location to secure the area during any emergency such that only authorized

Action Group	Responsibility
	personnel and equipment may enter, prevent access to the site of unauthorized personnel. Assist with strong/activation of services during an emergency. Ensure vehicles and obstructions are moved to give incoming emergency vehicles access to the scene, if ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct any incoming emergency service to the site of emergency.
Rescue & Medical Team	Protect the injured from further danger and weather. Provide treatment to the victim(s) to the best of their ability by first aid and then transfer to hospital. Remain familiar with the rescue activities and rescue apparatus. Assist outside medical services personnel when they arrive
General Administration Team	Response to support any requested general facilities for assisting Emergency Response Team in their work.
Government Relation Team	Coordinate with local government on a matter of concerned in the emergency response plan to liaise with local officers in their affair for support Emergency Response Team. Coordinate emergency plan with the government authorities, local community.
Environment Team	In case of emergency related to the environmental pollution such as the chemical spill, oil spill into the ambient, the environment team will support the technical advice to control and mitigate the pollution until return to the normal situation.
Department Heads	Call up of personnel into the safe location for protective life and property. Take immediate and appropriate action while Emergency Response Team is being mobilized. Keep in touch with the Emergency Commander Control and supervise operators and contractors on the implementation of this procedure, with consultation with Safety Team as necessary. Provide and maintain emergency equipment of their responsible areas.
Other Staff and Employees	All other staff and employees will remain at their workstations or assembly point unless directed otherwise from Emergency Response Team. Each supervisor will ensure that all members of his work group are accounted for and keep in touch with each of their Department Head.

PROCEDURE

Emergency situation and injuries to person can occur at any time or place either on Project site or elsewhere. The most two common types of emergencies on site are fire and serious accident.

Figure A.6.1 Emergency Procedure for Fire



COMMUNICATION WITH AUTHORITIES / PRESS AT SITE

In the event of an accident or incident, only senior staff is permitted to give factual information to the authorities for resource of liability exposure. The press must be avoided politely, at all costs, with the terse comment that "the matter is under investigation and relevant information when available will be provided by our Head Office" Do not ever give your opinion or story.

First Aid Persons

- Upon advice of medical emergency, make immediate assessment to response required and if necessary, advise security to summon ambulance or medical assistance, the qualified first aid attendant should also,
- Provide treatment to the victim(s) to the best of his/her ability.
- Ensure the safety of victims by ceasing any work activity in the area.
- Protect the injured from further danger and weather.
- Assist medical services personnel when they arrive.

General Administration Team

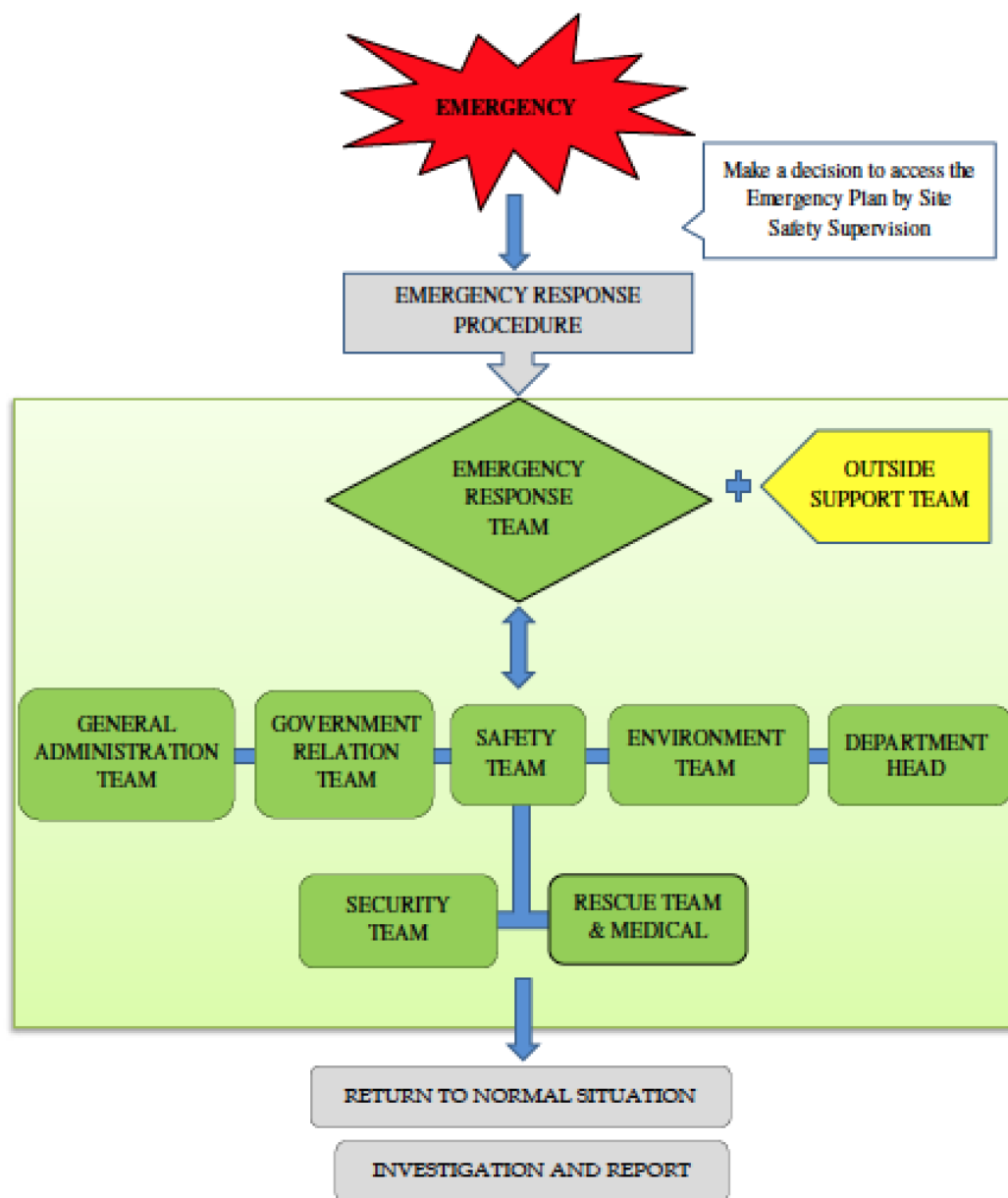
- Upon advice of medical emergency, maintain contact with first aid personnel and summon ambulance if required.

Security Team

- If ambulance or emergency services are attending the site, ensure clear access and personnel are located to direct vehicle closest to the scene.
- Prevent access to the site of unauthorized personnel (press, etc.).

Emergency Coordinator

- The Emergency Coordinator shall assist emergency personnel at the scene as required through allocation of company resources.
- The Emergency Coordinator shall ensure next-of-kin are properly notified as soon as possible and give whatever company support and assistance is necessary to assist them bundle the situation
- The Emergency Coordinator shall ensure that senior management personnel are advised of the emergency as soon as practical after the event.



Note: Name of contact person and call number from Owner/ Contractor to be determined.

Figure A.6.2 INCIDENT AND ACCIDENT REPORT

Section A: Identification Data										
Report No:	Date of Reported:				Reporter:		Sign:			
Job Title:					Company Name:					
Section B: Violence Rate										
Accident Violence: ☐ 01-Death ☐ 02-Serious Injury ☐ 03-Lost Time Injury ☐ 04-First Aid ☐ 05- Not Injury ☐ 06-Near Miss Property Damage Cost: ☐ 1-2,000 USD ☐ 2,001-10,000 USD ☐ 10,001-50,000 ☐ > 50,001										
Section C: Environmental Impact										
Affected area		☐ Construction area			☐ Public area					
Receptor		☐ None			☐ Workers			☐ Community		
Type of pollution		☐ Physical			☐ Chemical			☐ Biological		
Toxicity		☐ Non-toxic			☐ Low - toxic			☐ High - toxic		
Return to Normal		☐ 1 day			☐ 1 day to 1 week			☐ ≥ 1 week		
Cumulative impact		☐ Non-cumulative			☐ Cumulative					
Section D: Injured/Illness Employee										
1.Name:		Sex:	Date of Birth:			Age:	Regular Job Title:		Experience:	
		☐ Male	Month	Day	Year				In this job title	In this Project
		☐ Female							Years	Weeks
Site:		Company:		Reference:			Phone No:		Social Security Number	
Part of Body Injured or Affected:					Nature of Injury or Illness:					
☐ Head ☐ Hands ☐ Face ☐ Nose					☐ Laceration ☐ Amputation ☐ Puncture ☐ Fracture					
☐ Eyes ☐ Legs ☐ Teeth ☐ Neck					☐ Strain & Sprain ☐ Burns ☐ Contusion ☐ Dry Heat Friction					
☐ Trunk ☐ Toes ☐ Elbow ☐ Shoulder					☐ Hernia ☐ Foreign Body ☐ Chemical ☐ Contamination					
☐ Back ☐ Ankle ☐ Wrist ☐ Foot					☐ Skin (Occupationnel) ☐ Rash ☐ Irritation					
☐ Arms ☐ Thump ☐ Fingers ☐ Internal										
Remark:					Remark:					
Section D: Injured/Illness Employee										
2.Name:		Sex:	Date of Birth:			Age:	Regular Job Title:		Experience:	
		☐ Male	Month	Day	Year				In this job title	In this Project
		☐ Female							Years	Weeks
Site:		Company:		Reference:			Phone No:		Social Security Number	
Part of Body Injured or Affected:					Nature of Injury or Illness:					
☐ Head ☐ Hands ☐ Face ☐ Nose					☐ Laceration ☐ Amputation ☐ Puncture ☐ Fracture					
☐ Eyes ☐ Legs ☐ Teeth ☐ Neck					☐ Strain & Sprain ☐ Burns ☐ Contusion ☐ Dry Heat Friction					
☐ Trunk ☐ Toes ☐ Elbow ☐ Shoulder					☐ Hernia ☐ Foreign Body ☐ Contamination ☐ Chemical					
☐ Back ☐ Ankle ☐ Wrist ☐ Foot					☐ Skin (Occupationnel) ☐ Rash ☐ Irritation					
☐ Arms ☐ Thump ☐ Fingers ☐ Internal										
Remark:					Remark:					
Section E: Accidents/incident Details										
Date Accident/Incident Occurred:			Time Accident/Incident Occurred:				Exact Location of the Accident / Incident:			

Details of the actual Job Being done at the time:		
Details of Accident / Incident / What actually happened?		
Section F: Accident Cause (Basic cause mark X / Contributing cause, if any mark O)		
UNSAFE CONDITIONS 1 ☐ Inadequately Guarded 2 ☐ Unguarded 3 ☐ Defective Tools, Equipment, or Substance 4 ☐ Unsafe Design or Construction 5 ☐ Hazardous Arrangement 6 ☐ Unsafe Illumination 7 ☐ Unsafe Ventilation 8 ☐ Unsafe Clothing 9 ☐ Insufficient Instruction 10 ☐ Lack of system of work Why was the unsafe act committed? _____	UNSAFE ACTS 1 ☐ Operating Without Authority / Training 2 ☐ Operating at Unsafe Speed 3 ☐ Marking SHE Device Inoperative 4 ☐ Using Unsafe Equipment or Equipment Unsafely 5 ☐ Unsafe Loading, Placing, Mixing 6 ☐ Taking Unsafe Position 7 ☐ Working on Moving or Dangerous Equipment 8 ☐ Distraction, Teasing, Horse Play 9 ☐ Failure to use Personal Protective Devices 10 ☐ Lack of effective instruction or supervision Why did the unsafe condition exist? _____	
Section G: Guide to Corrective Action (Base on the cause checked above, I am taking the following corrective action)		
UNSAFE ACT ☐ Stop the Behaviour ☐ Study the job ☐ Instruct (tell-show-try-check) ☐ Follow Up ☐ Enforce	UNSAFE CONDITION ☐ Remove ☐ Guard ☐ Warn ☐ Supervisory Training	If Supervisor can't handle, then recommend to ☐ Site Engineer, or ☐ Site Manager, or ☐ Project Manager, or ☐ Safety Committee
Detail below any immediate remedial actions that have been taken:		
Detail below any corrective and preventative actions that could be taken to prevent future re-occurrence:	Responsible	Completion Date

Section H: Witness Statement			
Witness Name		Interviewer Name	
Section I: Reviewed & Recommend by			
Recommendation: 			
Reviewed By:	Position:	Signature:	Date:
Remarks : If Accident or Incident happened with lost time injury and affected to the publicity must further report to Safety Department; : First Aid Cases will not applicable to this form; : The accident report shall submit to Safety Department within 3 days : Attached the photograph or sketch the location of accident/incident;			

Appendix A.7 Archaeological 'Chance Find' procedure

Background

The purpose of this document is to address the possibility of archaeological deposits becoming exposed during ground altering activities within the project area and to provide protocols to follow in the case of a chance archaeological find to ensure that archaeological sites are documented and protected as required.

Archaeological sites are an important resource that is protected for their historical, cultural, scientific and educational value to the general public and local communities. Impacts to archaeological sites must be avoided or managed by development proponents. The objectives of this 'Archaeological Chance Find Procedure' are to promote preservation of archaeological data while minimizing disruption of construction scheduling/ It is recommended that due to the moderate to high archaeological potential of some areas within the project area, all on site personnel and contractors be informed of the Archaeological Chance Find Procedure and have access to a copy while on site.

Potential Impacts to Archaeological Sites

Developments that involve excavation, movement, or disturbance of soils have the potential to impact archaeological materials, if present. Activities such as road construction, land clearing, and excavation are all examples of activities that may adversely affect archaeological deposits.

Archaeological 'Chance Find' Procedure

If you believe that you may have encountered any archaeological materials, stop work in the area and follow the procedure below:

The following 'chance-find' principles will be implemented by the contractor throughout the construction works to account for any undiscovered items identified during construction works:

- (i) Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance.
- (ii) Should any potential items be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that area.
- (iii) If the site supervisor determines that the item is of potential significance, an officer from the department of Archaeology (DoA) will be invited to inspect the site and work will be stopped until DoA has responded to this invitation.
- (iv) Work will not re-commence in this location until agreement has been reached between DoA and proponent as to any required mitigation measures, which may include excavation and recovery of the item.
- (v) A precautionary approach will be adopted in the application of these procedures.

Detailed Procedural Steps

If the Director, department of Archaeology receives any information or otherwise has the knowledge of the discovery or existence of an antiquity of which there is no owner, he shall, after satisfying himself as to the correctness of the information or knowledge, take such steps with the approval of the Government, as he may consider necessary for the custody, preservation and protection of the antiquity.

Whoever discovers, or finds accidentally, any movable antiquity shall inform forth with the Directorate within seven days of its being discovered or found.

If, within seven days of his being informed, the Director decides to take over the antiquity for purposes of custody, preservation and protection, the person discovering or finding it shall hand it over to the Director or a person authorized by him in writing.

Where the Director decides to take over an antiquity, he may pay to the person by whom it is handed over to him such cash reward as may be decided in consultation with the Advisory Committee.

The Director or any officer authorized by him with police assistance may, after giving reasonable notice, enter into, inspect and examine any premises, place or area which or the sub-soil of which he may have reason to believe to be, or to contain an antiquity and may cause any site, building, object or any antiquity or the remains of any antiquity in such premises, place or area to be photographed, copied or reproduced by any process suitable for the purpose.

The owner or occupier of the premises, place or area shall afford all reasonable opportunity and assistance to the Director.

No photograph, copy of reproduction taken or made shall be sold or offered for sale except by or with the consent of the owner of the object of which the photograph, copy or the reproduction has been taken or made.

Where substantial damage is caused to any property as a result of the inspection, the Director shall pay to the owner thereof reasonable compensation for the damage in consultation with the Advisory Committee.

If the Director after conducting an inquiry, has reasonable grounds to believe that any land contains any antiquity, he may approach the Government to direct the Revenue Department to acquire such land or any part thereof and the Revenue Department shall thereupon acquire such land or part as for a public purpose.

Appendix A.8 Dust Management Plan

General

The purpose of this plan is to describe the measures that the project shall take to ensure that the risk of emissions from dust generated by site operations during construction are minimized and that best practice measures are implemented.

Dust emissions from construction can cause ill health effects to Contractor staff along with nuisance and annoyance to members of the local community. Dust will be controlled through:

Elimination

Reduction/Minimisation

Control

This dust management plan shall be implemented based on the measures already provided in the Environmental Management Plan (EMP) relating to controlling dust emissions.

Methodology

The following methodology will be undertaken for each project section:

Step 1 – Identify the dust generating activities

Construction activities that are likely to produce dust will be identified. The activities that will be taken into account are:

Haulage Routes, Vehicles and Asphalt/Concrete Batching Plant

Roads, surfaces and public highways

Static and mobile combustion plant emissions

Tarmac laying, bitumen surfacing and coating

Materials Handling, Storage, Spillage and Disposal

Storage of material

Stockpiles

Spillages

Storage of Waste

Site Preparation and Restoration after Completion

Earthworks, excavation and digging

Storage of spoil and topsoil

Demolition

Construction and Fabrication Processes

Step 2 – Identify Sensitive Receptors

Sensitive receptors have already been identified. The nature and location of the sensitive receptors will be taken into account when implementing control measures.

Step 3 – Implement Best Practice Measures to Control

Based on the nature of the activity producing the dust, the likelihood of dust being produced and the possible consequence of dust based on the sensitive receptors, the most effective control measure will be identified and implemented.

Step 4 – Monitor effectiveness of control

Construction Supervision Staff (CSC) will have the responsibility to ensure that dust control measures are being implemented and are effective.

Step 5 – Record and report result of monitoring

All inspections, audits and results of monitoring will be recorded and kept as part of the site filing system.

Method Statements and Risk Assessments

The Contractor's Risk Assessments and Method Statements will be required to be approved by the CSC prior to commencing work and will be required to contain environmental aspects of the task, including dust control measures where required.

Where dust has been identified within the risk assessment as a significant issue, the method statement will be required to cover the following:

Methods and materials that will be used to ensure that dust generation is minimized.

The use of pre-fabricated materials where possible.

Optimum site layout:

Dust generating activities to be conducted away from sensitive receptors

Supply of water for damping down.

Good housekeeping and management

All employees will be briefed on the Risk Assessment and Method Statement before starting work.

Training

All Contractor staff will be required to attend training seminars as already mentioned in the EMP document. A site-specific induction will also be required before being allowed to work on site. These will include site-specific sensitive receptors and details regarding dust control measures to be taken.

Toolbox talks on air pollution and minimizing dust emissions will be provided on a regular basis to Contractor staff.

Identification of Dust Generating Sources and Control Methods

Haulage Routes, Vehicles and Asphalt/Concrete Batching Plant

Dust Source	Dust Control Methods
Major haul roads and traffic routes	Haul roads will be dampened down via a mobile bowser, as required.
Public Roads	Road sweeper will be used to clean public roads as required.
Site traffic management	Site traffic will be restricted to constructed access roads as far as possible. Site speed limit will be set at 10 mph as this will minimize the production of dust.

Dust Source	Dust Control Methods
Road Cleaning	A mechanical road sweeper will be readily available and used.
Handling, Storage, Stockpiling and Spillage of Dusty materials	
Material handling operations	The number of times a material will have to be handled will be kept to a minimum to prevent double handling and ensure dusty materials are not handled unnecessarily.
Transport of fine dusty materials and aggregates.	Closed tankers will be used or sheeted vehicles.
Vehicle loading/unloading materials on to vehicles and conveyors.	Dusty materials will be dampened down Drop heights will be kept to a minimum and enclosed where possible.
Storage of Materials	
Bulk cement, bentonite etc.	Bentonite will be delivered in tankers and stored in dedicated enclosed areas. Bulk cement will be transported through tractor trollies or trailers.
Fine dry materials	These will be protected from the weather and by storing in appropriate containers and indoors, where necessary.
Storage location	Material will be stored in dedicated lay-down areas.
Storage of Stockpiles	
Stockpile location	Stockpiles will be placed so as to minimize double handling and facilitate the site restoration.
Building stockpiles	Stockpiles, tips and mounds will not be stored at an angle greater than an angle of repose of the material.
Small and temporary stockpiles	Where possible, stockpiles will be placed under sheeting. Dusty material will be damped down. Wind barriers (protective fences) of a similar height to the stockpile will be erected, if required.
Large and long term stockpiles	Long-term stockpiles will be vegetated and stabilized as soon as possible. Stock piles will be dampened down until stabilized, where necessary. Wind barriers (protective fences) of a similar height to the stockpile will be erected, if required.
Waste Material from Construction	

Dust Source	Dust Control Methods
Disposal method	A dedicated lay-down area will be available for waste. Waste will not be allowed to build up and will be disposed off at the designated locations as per EMP.
Site Preparation and Restoration	
Earthworks, excavation and digging	These activity areas will be kept damp where required and if possible, will be avoided during dry and windy periods.
Completed earthworks	Surfaces will be stabilized by re-vegetation as soon as possible, where applicable.
Construction and Fabrication Process	
Crushing of material for reuse, transportation and disposal	Authorization will be obtained from PMU and ADB before using any mobile plant on site for activities such as crushing and screening. Any crushing or screening activities will be located away from sensitive receptors.
Cutting, grinding, drilling, sawing, trimming, planning, sanding	These activities will be avoided wherever possible. Equipment and techniques that minimize dust will be implemented. Water will be used to minimize dust.
Cutting roadways, pavements, blocks	Water sprinkling to be used.
Angle grinders and disk cutters	Best practice measures will be used such as dust extraction

Monitoring Arrangements

Monitoring will be conducted at sensitive receptor locations in the project area as provided in the EMP. Furthermore, at locations where PM levels are exceeding applicable guidelines, additional stringent measures will be implemented at the respective location(s) in the project area to ensure dust levels are controlled as far as possible.

Appendix A.9 Site Specific EMP (SSEMP) Guide & Template for Guidance to Contractor

Guide for Development of SSEMP

Step 1: Define Boundaries

Step 2: Identify Sensitive Receptors

Step 3: Specify construction activities

Step 4: Conduct Risk Assessment

Step 5: Assign Environment Management measures

Step 6: Prepare Site Plans

Step 7: Prepare Environment Work Plans (if required)

Step 8: Monitoring

Step 1: The project area needs to be clearly defined.

Step 2: The mapping of sensitive receptors has already been conducted and needs to be presented clearly in a map.

Step 3: The tentative construction activities to be conducted are as follows:

Site Surveying and Vegetation (Trees and plants) Clearance

Establishment of Work Camp, Batching and Asphalt plant and access roads

Dismantling of Asphalt and existing structures including Utilities

Preparation of ground for Asphalting

Asphalting

Landscaping

Step 4: The Risk Assessment matrix template is provided in the table below.

Risk is assessed as the likelihood that the activity will have an effect on the environment as well as the consequence of the effect occurring. It is often described like this:

Risk = Likelihood × Consequence

Likelihood Scale

Likelihood	Definition	Scale
Certain	Will certainly occur during the activity at a frequency greater than every week if preventative measures are not applied	5
Likely	Will occur more than once or twice during the activity but less than weekly if preventative measures are not applied	3
Unlikely	May occur once or twice during the activity if preventative measures are not applied	2
Rare	Unlikely to occur during the project	1

Consequence Scale

Consequence	Definition	Score
Catastrophic	The action will cause unprecedented damage or impacts on the environment or surrounding community e.g. extreme loss of soil and water resources and quality from stormwater runoff extreme pollution of soil and water resources including major contamination from hazardous materials widespread effects on ecosystems with deaths of fauna/flora widespread community impacts resulting in illness, injury or inconvenience loss or destruction of archaeological or historical sites Occurrence will almost certainly result in the work being halted and a significant fine.	5
Major	The action will cause major adverse damage on the environment or surrounding communities' e.g. major loss of soil and water resources and quality from stormwater runoff major pollution of soil and water resources including contamination from hazardous materials significant effects on ecosystems with isolated deaths of non-vulnerable flora and fauna significant annoyance or nuisance to communities major damage to or movement required to archaeological or historical sites Occurrence may result in work being halted and a fine	3
Moderate	No or minimal adverse environmental or social impacts e.g. no measurable or noticeable changes in stormwater quality. Water quality remains within tolerable limits little noticeable effect on ecosystems no or isolated community complaints no or unlikely damage to archaeological or historical sites no likelihood of being fined	2
Minor	No or minimal adverse environmental or social impacts e.g. no measurable or noticeable changes in stormwater quality. Water quality remains within tolerable limits little noticeable effect on ecosystems no or isolated community complaints no or unlikely damage to archaeological or historical sites	1

	no likelihood of being fined	
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Risk Score Table

Likelihood	Consequence				
		Catastrophic	Major	Moderate	Minor
	Certain	25	15	10	5
	Likely	15	9	6	3
	Unlikely	10	6	4	2
	Rare	5	3	2	1

Risk: Significant: 15-25

Medium: 6-10

Low 1-5

Any Medium to Significant risk requires an environmental management measure to manage the potential environmental risk. Judgement will be required concerning the application of an environmental management measure to mitigate low risk situations.

The higher the risk the more intensive the required mitigation measure will need to be; e.g. where site sedimentation is deemed to be low risk, then silt fences may be needed but as the risk increases, then sediment traps may be required. The selection of the appropriate mitigation measure will require judgement based on the level of risk and the specific site parameters.

Step 5: The Environmental Management measures are to be extracted from the EIA study for the project and should be added in the last column of the table below.

No.	Construction Activity	Hazards to Consider	Likelihood that the site or sensitive receptors will be affected?	Consequence of the site or sensitive receptors being affected?	Risk Score (consequence x likelihood)	Environmental Management Measures
i	Site Surveying & vegetation clearance	Damage to vegetation beyond project footprint				These can be taken from the EMP provided in the EIA report (If Risk Score is 6 or more)
		Erosion of exposed areas and sediment				
		Loss of topsoil				
		Dust generation				
		Noise				
ii	Establishment of Work Camp, Batching plant etc.	Soil deposited onto roads from tires				
		Stochastic erosion				
		Noise & Vibration				
		Traffic congestion				
		Fuel spills				

iii	Dismantling of Asphalt and existing structures including Utilities	Noise and vibration				
		Dust generation				
		Community safety				
		Worker safety				
		Traffic Congestion				
iv	Preparation of Sub-Base	Noise and vibration				
		Dust generation				
		Traffic Congestion				
v	Asphalting	Noise and vibration				
		Dust generation				
		Traffic Congestion				
		Community safety				
		Labor safety (PPEs)				
vi	Landscaping	Dust generation				

		Sediment runoff				
		Failure of vegetation to take root				

Step 6: The Site plans are a critical part of the SSEMP and will need to be prepared, otherwise the ADB will consider the document as incomplete.

The site plan will need to provide the following:

Indication of North and scale

Existing and planned supporting infrastructure (e.g. access roads, water supplies and electricity supplies)

Location of planned work

Contours

Drainage systems

Locations of sensitive receptors

Step 7 (if required)³⁴: The completed SSEMP provides details of all the environmental management requirements for all stages of the construction process. For individual work teams who are responsible for only a small part of the overall construction works it can be confusing as to what is required for their particular work component. For example, the work team responsible for stripping soil for the construction areas are not going to be interested in the requirements for pouring concrete for footings and foundations. However, it is essential that the soil stripping team knows exactly what to clear and what to leave and where to put stockpiles of soil for later use.

In situations where different work activities are required at different times or at different locations, environmental work plans can be prepared. These are similar to the work method statements that are often produced for major construction projects.

Step 8: A detailed monitoring plan will be provided along with frequency and responsibilities to ensure all key environmental parameters are monitored to ensure compliance with both national and ADB requirements.

Template for SSEMP

Introduction

Project Overview

Scope of SSEMP

Objectives of SSEMP

Map of Sensitive Receptors

Construction Activities

Risk Assessment

Risk Assessment Matrix & Mitigation Measures

Site Plan(s)

Environmental Monitoring Plan

Instrumental Monitoring of Environmental Parameters by Contractor as per EMP

In-house monitoring

³⁴ ADB, Safeguards Unit for Central & West Asia Department, *Environmental Management for Construction Handbook*.

Third Party environmental monitoring

Visual monitoring of Environmental Parameters by Contractor as per EMP

Responsibilities

Organizational Responsibilities and Communication

Responsibility of EA

Responsibility of Construction Supervision Consultant (CSC)

Responsibility of Contractor

Responsibility of EPA

Appendix A.10 ToRs of Third Party Monitor

- Develop specific monitoring indicators for undertaking monitoring and evaluation of EMP implementation including the Community Participation, consultation and disclosure;
- Review results of internal monitoring and verify claims through random checking at the field level to assess whether EMP and resettlement objectives have been met. Involve the affected people and community groups in assessing the impacts of EMP implementation and resettlement measures for monitoring and evaluation purposes.
- Review monitoring reports and conduct field inspections and verify the progress in EMP and RAP implementation of the project and prepare reports for the PMU and the ADB.
- Evaluate and assess the adequacy of compensation given to the PAPs and the livelihood opportunities and incomes as well as the quality of life of PAPs of project-induced changes.
- Evaluate and assess the adequacy and effectiveness of the consultative process with PAPs, including the adequacy and effectiveness of grievance procedures and legal redress available to the affected parties, and dissemination of information about these.
- Socioeconomic conditions of the PAPs in the post-resettlement / rehabilitation period;
- Communications and reactions from PAPs on entitlements, compensation;
- Grievance procedures; its recording, reporting and processing time and its redressal;
- Institutional arrangements and effectiveness and efficiency of PMU, and Supervision Consultants in EMP and RAP Implementation;
- Evaluation and assessment of the adequacy of compensation given to the PAPs and the livelihood opportunities and incomes as well as the quality of life of PAPs of project-induced changes.
- Level of satisfaction of PAPs in the post resettlement period.
- Assessment of the resettlement efficiency, effectiveness, impact and sustainability for drawing lessons for future resettlement policy formulation and planning.

Appendix A.11 Traffic Management Plan

Need for Plan

The construction of the Landfill will take over 24 months and in this period, huge vehicular movement carrying large amount of material and machinery is expected. This will definitely interrupt the local traffic and is therefore important to manage the traffic to avoid the nuisance to local residents in terms of noise, dust, congestion and inconvenience.

The plan

The Objective of Traffic Management Plan (TMP) is to define the requirements that should be implemented to mitigate any potential negative risks to the environment, workers or the community resulting from construction traffic.

The TMP will advise and inform site Contractors and external suppliers of equipment and materials of access and entry points along with other key information such tipping areas and wash-out areas. It is intended to compliment and work alongside relevant ESMMP. The TMP will be classed as “live” and therefore be subjected to updates as required.

Contractor, at the time of the execution of the project will prepare a comprehensive TMP in coordination with local traffic police department, PMU, emergency services and local administrative department. The PMU and CSC will review and approve contractors TMP. The contractor's TMP shall include following mitigation measures during its preparation:

Undertake a road conditions assessment prior to and following the peak construction period, to assess any damage to road infrastructure that can be attributed to Project construction.

Repair damage as appropriate or enter into a voluntary agreement with the relevant roads authority to reimburse the cost of any repairs required to the public road network as a result of the Project.

Spoil dumpsites located close to Project site to minimise journey distance and limit movements to site access roads.

Concrete mixing plant located at Project site limiting traffic movements associated with concrete delivery to site access roads

Construction of worker accommodation on site to reduce light vehicle movements relating to travel to/ from the site

Provision of bus/minibus services for personnel living in nearby settlements

Movements of construction workers will be planned to avoid the busiest roads and times of day when traffic is at its greatest.

Schedule deliveries and road movements to avoid peak periods

Road maintenance fund to leave a useful asset for communities after the construction phase.

Driver training for HGV drivers and refresher course every six months for Project drivers

Speed restrictions for project traffic travelling through communities (to be agreed with Traffic Manangement Authority)

Run a safety campaign to improve the people's knowledge of the traffic hazard on their roads, public information and other activities to address the issues.

Run a pedestrian awareness programme

Temporary signage

The traffic management plan is provided below.

Other Recommendations

It is important to manage public access routes during construction because it can cause delay to local traffic and create a safety hazard both on and offsite. People working and living near the project site would be annoyed by the emissions, noise and visual intrusion of queuing vehicles. Some important factors involved in access routes and site traffic are as follows:

Public Access Routes

The use of public road for site access may be restricted in terms of:

Vehicle size, width and type of load

Time limits

Parking

Pedestrian conflicts

Contractor should have consultation with the local police or local authority to address these issues and to effectively manage them before the beginning of the construction.

Site Workers Traffic

Site personnel should not be permitted to park vehicles near the site boundary; this will lead to disruption in material deliveries. Designated parking area with appropriate parking space will be needed for this purpose; any plain area near construction site can be used for this purpose.

Site Rules

Access to and from the site must be only via the specified entrance.

On leaving the site, vehicles must be directed to follow the directions given.

Drivers must adhere to the site speed limits.

All material deliveries to site must keep allocated time limits.

No material or rubbish should be left in the loading-unloading area.

Develop a map for alternate routes showing material delivery services.

Assign designated personnel on site to receive deliveries and to direct the vehicles.

Monitor vehicle movement to reduce the likelihood of queuing or causing congestion in and around the area.

Project vehicles should have a unanimous badge or logo on windscreen displaying that they belong to the project.

Contractor's Obligation

The traffic management plan of the Contractor should be safe enough and widening of access roads and construction of the detours must be completed before start of project construction activities so that heavy vehicular transportation for construction activities do not hinder the normal course of traffic lanes. While widening the access roads, the safe movement of the vehicles, people, animals and wildlife must be ensured. It will be sole responsibility of Contractor. The roads widening should be designed on the basis of the traffic survey, summarized and estimated site traffic. Contractor must ensure that road closures are carried out by a competent person. The Contractor obligation must include the display of traffic signs according to the need to divert the traffic volume and to guide the road users in advance. The traffic sign, traffic light should be placed from any diverting route or road marking.

The Contractor should consider the environmental and social impacts of the traffic during construction. It will be sole responsibility of the Contractor to implement a plan which produces minimum nuisance to the local people and to the environment. Safety of the people should be given due importance. It will be under Contractor obligation to notify the traffic management

plan and its later changes to CSC, PMU, emergency services and Traffic Police, and also publish weekly programme in local newspapers.

Appendix A.12 PEQS Guidelines

Parameter	Unit	Standards (maximum allowable limit)
Temperature increase	°C	<3
pH value (acidity / basicity)	pH	6-9
5-day biochemical oxygen demand (BOD) AT 20 °C	mg/l	80
Chemical oxygen demand (COD)	mg/l	150
Total dissolved solids	mg/l	200
Total dissolved solids	mg/l	3,500
Grease and oil	mg/l	10
Phenolic compounds (as phenol)	mg/l	0.1
Chloride (as Cl)	mg/l	1.0
Fluoride (as F)	mg/l	10
Sulfate (SO ₄)	mg/l	600
Ammonia (NH ₃)	mg/l	40
Cadmium	mg/l	0.1
Chromium (trivalent and hexavalent)	mg/l	1.0
Copper	mg/l	1.0
Lead	mg/l	0.5
Mercury	mg/l	0.01
Selenium	mg/l	0.5
Nickel	mg/l	1.0
Silver	mg/l	1.0
Total toxic metals	mg/l	2.0
Zinc	mg/l	5
Arsenic	mg/l	1.0
Barium	mg/l	1.5
Iron	mg/l	8.0
Manganese	mg/l	1.5
Boron	mg/l	6.0
Chlorine	mg/l	1.0

Notes:

1. The standard assumes that dilution of 1:10 on discharge is available. That is, for each cubic meter of treated effluent, the recipient water body should have 10 m³ of water for dilution of this effluent.
2. Toxic metals include cadmium, chromium, copper, lead, mercury, selenium, nickel and silver. The effluent should meet the individual standards for these metals as well as the standard for total toxic metal concentration.

Source: Government of Pakistan (2000) (SRO 549(I)/2000).

Pollutants	Time-Weighted Average	Concentration in Ambient Air		Method of Measurement
		Effective from 1st July 2010	Effective from 1st January 2013	
Sulfur Dioxide (SO ₂)	Annual Average *	80 µg/m ³	80 µg/m ³	Ultraviolet Fluorescence
	24 hours**	120 µg/m ³	120 µg/m ³	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m ³	40 µg/m ³	Gas Phase Chemiluminescence
	24 hours**	80 µg/m ³	80 µg/m ³	
Ozone (O ₃)	1 hour	180 µg/m ³	130 µg/m ³	Non dispersive UV absorption
Suspended Particulate Matter (SPM)	Annual Average*	400 µg/m ³	360 µg/m ³	High Volume Sampling, (Average flow rate not less than 1.1 m ³ /minute).
	1 hour	180 µg/m ³	130 µg/m ³	
Respirable Particulate Matter. PM ₁₀	Annual Average*	200 µg/m ³	120 µg/m ³	β Ray absorption
	24 hours**	250 µg/m ³	150 µg/m ³	
Respirable Particulate Matter. PM _{2.5}	Annual Average*	25 µg/m ³	15 µg/m ³	β Ray absorption
	24 hours**	40 µg/m ³	35 µg/m ³	
	1 hour	25 µg/m ³	15 µg/m ³	
Lead (Pb)	Annual Average*	1.5 µg/m ³	1.0 µg/m ³	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	2.0 µg/m ³	1.5 µg/m ³	
Carbon Monoxide (CO)	8 hours**	5 µg/m ³	5 µg/m ³	Non dispersive Infra-Red (NDIR)
	1 hour	10 µg/m ³	10 µg/m ³	

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

24 hourly / 8 hourly values should be met 98% of the in a year. 20% of the time, it may exceed but not on two consecutive days.

Source: Government of Pakistan (2010) (SRO 1062 (I)/ 2010).

Punjab Environmental Quality Standards for Noise¹

S/No.	Category of Area/Zone	Limit in dB(A) Leq	
		Day Time	Night Time
1	Residential area (A)	55	45
2	Commercial area (B)	65	55
3	Industrial area (C)	75	65
4	Silence zone (D)	50	45

1: Effective from 1st July, 2012.

Note: 1. Day time hours: 6 am to 10 pm

2. Night time hours: 10 pm to 6 am

3. Silence zone: Zones that are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.

4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

Punjab Environmental Quality Standards for Motor Vehicle Exhaust and Noise

(A) For In-use Vehicles

Sr. No.	Parameter	Standard (Maximum permissible Limit)	Measuring Method	Applicability
1	Smoke	40% or 2 on the Ringlemann Scale during engine acceleration mode	To be compared with Ringlemann Chart at a distance 6 or more.	Immediate effect
2	Carbon Monoxide	6%	Under idling conditions: Non-dispersive infrared detection through gas analyzer.	
3	Noise	85 db (A).	Sound meter at 7.5 meters from the source.	

Punjab Standards for Drinking Water Quality

Parameter	Unit	
E-Coli	numbers/ml	Must not be detectable in any 100 ml sample
Total Coliform	numbers/ml	Must not be detectable in any 100 ml sample
Color	TCU	≤ 15 TCU
Taste	No objectionable/Acceptable	-
Odor	No objectionable/Acceptable	-
Turbidity	NTU	< 5 NTU
Total Hardness	mg/l	< 500 mg/l
TDS	mg/l	< 1000
pH		6.5-8.5
Aluminum	mg/l	≤0.2
Antimony	mg/l	≤0.005 (P)
Arsenic	mg/l	≤0.005 (P)
Barium	mg/l	0.7
Boron	mg/l	0.3
Cadmium	mg/l	0.01
Chloride	mg/l	<250
Chromium	mg/l	≤0.05
Copper	mg/l	2
Cyanide	mg/l	≤0.05
Fluoride	mg/l	<1.5
Lead	mg/l	≤0.05
Manganese	mg/l	≤0.5
Mercury	mg/l	≤0.0001
Nickel	mg/l	≤0.02
Nitrate	mg/l	≤50
Nitrite	mg/l	≤3
Selenium	mg/l	0.01
Residual Chlorine	mg/l	0.2-0.5 at consumer end
Zinc	mg/l	5

Appendix A.13 Solid Waste Management Framework

INTRODUCTION

Framework Solid Waste Management Plan for the development of Bahawalpur Landfill is provided. Construction contractors may use this framework as guiding document for preparation of site specific solid waste management plan. The purpose of this Framework Solid Waste Management Plan is to ensure that wastes arising from the proposed construction works at Bahawalpur Landfill are managed, reused, recovered or disposed of by a method that ensures the provisions of the Punjab Environmental Protection, 1997 (Amended 2017) and ADB SPS, 2009. It also ensures that the optimum levels of waste reduction, re-use and recycling are achieved.

Waste management priorities for project are based following waste management hierarchy.

- Prevent material wastage
- Minimise the quantity of waste
- Reuse of site materials
- Recycling of waste
- Energy recovery
- Disposal

WASTE MANAGEMENT AT BAHAWALPUR LANDFILL

National Level

Waste management of the project will be carried as per national rules including:

- Solid Waste Management Policy, 2000
- Requirements of Punjab Environmental Protection Act, 1997 (Amended 2017)
- Draft Guidelines on Solid Waste Management, 2005.
- Section 11 of PEPA, 1997 prohibits discharge of waste in amount that violates the NEQS.
- Draft Hazardous Substances rule of 1999
- Section 132 of Cantonment Act, 1942
- Provision Contains in the Local Government Ordinance, 2001

Regional Level

- Asian Development Bank (ADB) SPS, 2009
- IFC guidelines for Solid Waste Management
- Best practices of waste management on construction sites

DESCRIPTION OF THE PROJECT

The proposed LANDFILL will be developed at Mari Sheikh Shijra, located approximately 11 km away from Bahawalpur city in Punjab province of Pakistan at an elevation of 392 ft (119 m) above mean sea level (AMSL). The proposed landfill will be developed on 110 acres of vacant land with the proposed site being accessible through a metalled road.

The development of the proposed LANDFILL is designed to support the BWMC and other involved agencies, so as to completely transform the SWM system in Bahawalpur. Complete with institutional strengthening, recycling and other support initiatives, the project includes the installation of primary and secondary Municipal Solid Waste (MSW) collection systems and the development of an international standard MSW management facility that will accommodate Bahawalpur's residual MSW for at least 20 years.

Details of the wastes to be produced

During construction/civil works potential sources of waste will include spoils generated during excavation, concrete and construction waste, domestic wastes (solid & wastewater), fuel or oil leakages or spills, onsite effluents from vehicle wash & cleaning, and cement spills. It is the responsibility of all personnel on site including Contractors, Sub-Contractors and their Employees to ensure compliance with this Waste Management Plan.

Main Waste Categories

Contractors are required to develop inventory of main waste categories that will be generated during construction phase of the project. Anticipated main waste categories include construction debris, concrete waste, scrap wood, bricks, concrete, asphalt, plumbing fixtures, piping, insulation (asbestos and non-asbestos), metal scraps, oil, electrical wiring and components, chemicals, paints, solvents.

Anticipated Hazardous Waste Arising

Fuels stored on site that will be used during the construction phase are classed as hazardous. There will be fuel stored on site for machinery and construction vehicles. All fuel tanks and draw off points will be banded. If the fuel is correctly contained and banded, it is not expected that there will be any fuel wastage at the site. Other sources of hazardous waste include used paints, used oil/lubricants, electrical waste and chemicals. Project contractors are required to develop SOPs for handling, storage and disposal of hazardous waste arising from the project.

ESTIMATED WASTE GENERATION

Construction Waste Generation

Project contractors are required to develop and maintain waste inventory clearly showing the type, amount and location of waste generated from different activities at the site. Waste record keeping is key to successful implementation of waste management plan.

Proposed Waste Management Options

Waste will be segregated on site. Contractor will ensure that sufficient number of waste drums are placed at site with appropriate color coding. All recyclable waste will be handed over to recycling contractor. The appointed waste contractor will collect and transfer the recyclable wastes as receptacles are filled. The non-recyclable waste will be transferred by an authorized waste collector to an appropriate facility. Project contractors will identify both recycling and non-recycling contractor working in the project area. Contractors through bidding documents will be bound to hire such waste contractors for efficient waste management at project sites. A successful Waste Management Plan is largely dependent on how readily it can be changed in to normal site operations by the person responsible. It is recognized that the plan should not be obstructive to site operations and the construction program by placing the responsibility of construction waste management with the Manager, all reuse, recycling, wastage and necessary disposal can be monitored as close to the source as possible. An Environmental Representative from each Works Sub-Contractor will also be nominated responsible for all waste management in their own operations. In this way, it is possible to identify where the greatest material wastage occurs, with a view to implementing better management.

The site Construction Manager will be designated as the Responsible Person and have overall responsibility for the implementation of the on-site Waste Management Plan. The Responsible Person will be assigned the authority to instruct all site personnel to comply with the specific provisions of the plan. At the operational level, a nominated Environmental Representative from each sub-contractor company on the site shall be assigned the direct responsibility to

ensure that the discrete operations stated in this framework for solid waste management are performed on an on-going basis.

Tracking and documentation procedures for off-site waste

The site construction Manager will maintain a copy of all waste collection permits. If waste (soil & stone) is being accepted on-site, a waste docket must be issued to the collector. If the waste is being transported to another site, a copy of the waste permit for that site must be provided to the manager. Record of waste collection docket, a receipt from the final destination of the material will be kept as part of the on-site waste management records. All information will be entered in a waste management system to be maintained on-site.

Disposal Waste

Contractors are required to develop SOP for disposal of recyclable, non-recyclable and hazardous waste generated at site. Food waste will be disposed at food waste pit which will be fenced. Recycling waste will be handed over to recycling waste contractor. Hazardous waste will be disposed through incineration facility available in close proximity of the project area. Workers on the site will be encouraged to recycle as much municipal waste as possible i.e. cardboard, plastic, metals and glass. Prior to removal, the municipal waste will be examined to determine if recyclable materials have been placed in other containers. If this is the case, effort will be made to determine the cause of the waste not being segregated correctly.

ESTIMATED COST OF WASTE MANAGEMENT

Contractors are required to estimate and budget cost for waste management through BOQ items. Such waste management cost should include cost of waste drums, cost of waste handling crew, cost of waste transportation, cost of EPA approved waste contractor services and associated incineration costs if any. By reusing materials on site, there will be reduction in transport and disposal costs for a waste contractor taking the material away.

TRAINING PROVISIONS FOR WASTE MANAGER AND SITE CREW

A waste manager will be appointed or designated by construction contractors to ensure commitment, operational efficiency and accountability during the project execution.

Site Manager Training and Responsibility

The waste manager will be given responsibility and authority to select a waste team if required i.e. members of the site crew that will aid him in the organization, operation and recording the waste management system implemented on-site. The waste manager will have overall responsibility to oversee record and provide feedback to the CSC on everyday waste management at the site. Authority will be given to the waste manager to delegate responsibility to sub-contractors where necessary and to co-ordinate with suppliers, service providers and sub-contractors to prioritize waste prevention and salvage. The waste manager will be trained in how to set up and maintain a record keeping system, how to perform an audit and how to establish targets for waste management on-site. He will also be trained in the best method for segregation and storage of recyclable materials, have information on the materials that can be reused on-site and know how to implement this Framework for Solid Waste Management.

Site Crew Waste Management Training

Training of the site crew is the responsibility of the waste manager and as such, a waste training program should be organized. A basic awareness course will be held for all crew to outline the construction waste management plan and to detail the segregation of waste at source. This may be incorporated with other training needs (e.g. general site induction, safety

training etc.). This basic course will describe the materials to be segregated, the storage methods and the location of the waste storage areas. A subsection on hazardous wastes will be incorporated and the particular dangers of each hazardous waste will be explained.

RECORD KEEPING

Records will be kept for each waste material which leaves the site, either for reuse on another site, recovery, recycling or disposal. A system will be put in place to record the construction waste arising on-site. The waste manager or delegate will record the following:

- Waste taken off-site for reuse
- Waste taken off-site for recovery
- Waste taken off-site for recycling
- Waste taken off-site for disposal
- Waste (soil & stone) accepted on-site for recovery

For each movement of waste off-site, a signed waste collection docket will be obtained by the waste manager (or delegate) from the contractor. This will be carried out for each material type. This system will also be linked with the delivery records. A signed waste acceptance docket will be issued for each movement of waste on-site.

OUTLINE WASTE AUDIT PROCEDURE

Contractors are required to develop SOP for waste auditing at the construction sites. Such SOP should reflect frequency and types of waste audits, audit criteria and way forward to close non-compliances.

Responsibility for Waste Audit

The appointed waste manager will be responsible for conducting a waste audit at the site during project execution.

Review of Records and Identification of Corrective Actions

A review of all the records for the waste generated and transported off-site, as well as waste accepted, should be undertaken. If waste movements are not accounted for, the reasons for this should be established in order to see if and why the record keeping system has not been maintained. Each material type will be examined in order to see where the largest percentage waste generation is occurring. The waste management methods for each material type will be reviewed in order to highlight how the targets can be achieved. Waste management costs will also be reviewed. Upon completion of the construction phase a final report will be prepared summarizing the outcomes of waste management processes adopted and the total recycling/reuse/recovery figures for the development.

CONSULTATION WITH RELEVANT BODIES

Local Authority

Project contractors are required to maintain close coordination with PMU, BWMC and PUNJAB EPA to ensure that all available waste reduction, re-use and recycling opportunities are identified and utilized.

EPA Approved Waste Contractors

Companies that specialize waste management will be contacted to determine their suitability for engagement. If used, each company will be audited in order to ensure that relevant and up-to-date waste collection permits and/or license are held. In addition, information regarding individual materials will be obtained including the feasibility of recycling each material, the

costs of recycling/reclamation and the means by which the wastes will be collected and transported off-site, and the recycling/reclamation process each material will undergo off-site.

Appendix A.14 NOC from Punjab EPA for Site in 2018

 **ENVIRONMENT PROTECTION DEPARTMENT**
Government of the Punjab
National Hockey Stadium, Lahore.

NO. DD (EIA)/EPA/1161/2017/1808/554
Dated: 7/9/2018

To,
Managing Director,
Bahawalpur Waste Management Company,
2-B Ghaznavi Road, Model Town A,
Near Al-Farooq School,
District Bahawalpur,

Subject: **DECISION OF EPA PUNJAB REGARDING THE PROJECT "CONSTRUCTION OF A LANDFILL SITE BY BAHAWALPUR WASTE MANAGEMENT COMPANY AT MOUZA NOABAD, DISTRICT BAHAWALPUR."**

1. **Description of Project:** Construction of a landfill site

2. **Location of Project:** Mouza Noabad, Tehsil Bahawalpur, District Bahawalpur

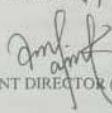
3. **Date of filing:** 22.11.2017

4. EPA Punjab has reviewed the Environmental Impact Assessment (EIA) Report and considered Site Inspection Reports received from Deputy Director (Environment), Bahawalpur vide letter No. F-BWMC/2018/EPA/BWP/158 dated 14.02.2018. EPA Punjab has also considered the recommendations of Committee of Experts (Meeting dated 18.08.2018) & other relevant record to take a lawful decision.

5. **EPA, Punjab accords Environmental Approval under Section 12 of Punjab Environmental Protection Act 1997 for construction of aforesaid project subject to the following conditions**

- i. The Proponent shall ensure compliance of Punjab Environmental Quality Standards (PEQS) during construction and operational phase w.r.t noise, waste water and gaseous emissions.
- ii. Mitigation Measures suggested in the Environmental Impact Assessment report and Environmental Management Plan (EMP) shall be strictly adhered to minimize any negative impacts on soil, ground water, air and biological resources of the project area. The proponent will depute staff to monitor the compliance of EMP.
- iii. The Proponent shall maintain the record of auditable measures taken for implementation of Environmental Management Plan for verification by EPA, Punjab.
- iv. Monitoring shall be carried out during the entire period of the project activities. Monitoring reports shall be submitted to EPA Field office on quarterly basis.
- v. Proponent must not pollute or over use any surface water body in the vicinity of the project.
- vi. The Proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system.
- vii. The Proponent shall redress the objections / concerns of neighbours / stakeholder on priority basis (if any at any stage).
- viii. The Proponent shall obtain NOCs/ clearance of all other concerned departments before commencement of work.
- ix. The Proponent shall plant 5,000 trees of 6-7 feet height of indigenous species in consultation with EPA Field office within six months. The Proponent shall also take measures for protection and maintenance of these trees and maintain their proper record for verification by EPA.
- x. The Proponent shall follow building by laws and the construction plan approved by the competent authority including seismic, structural and geotechnical analysis.
- xi. The Proponent shall avoid the disturbance of the traffic flow due to heavy traffic during construction and operation phase
- xii. The Proponent shall make proper parking arrangements as per approved plan and shall not convert the parking area to other use.
- xiii. Camping sites by the contractor shall be located at suitable distance away from any settlement to avoid disturbance to the local people and he will ensure restoration of camping site to its original condition as well.
- xiv. The Proponent shall not place the construction material openly.
- xv. The construction material shall be piled / stored in such a way that it shall not destroy the flora / environment of the locality.

- xxi. The Proponent shall do landscaping and restore the environment after completion of the construction work.
 - xxii. The Proponent will install standby power generator (if required) adopting sound proofing techniques and it shall be equipped with chimney with proper height to discharge the hot gases / smoke and the proponent will not install the generator on residential area side.
 - xxiii. Proponent shall submit undertaking that no interim injunction has been issued by any court of law against said project as of date of issuance and receiving of this approval and in case any such injunction this approval shall stand cancelled.
 - xxiv. Arrangements shall be made for safe disposal of sanitary and solid waste. The solid waste shall be retained within the unit boundary/premises and will be disposed off in an environment friendly way at a suitable disposal facility. Toilet/washrooms will be maintained in an orderly and hygienic manner for public use.
 - xxv. Compensation shall be provided to the inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. should be settled amicably before the start of the project activities.
 - xxvi. The proponent shall take all necessary measure to safeguard the social and economic conditions affecting the community life.
 - xxvii. The Proponent shall provide latest, according to international best practices the PPEs to the workers.
 - xxviii. There must be a proper leachate collection system.
 - xxix. The proponent must install effective odour control system/measures/ odour control system to be properly adopted.
 - xxx. The Proponent shall follow the SOPs regarding dengue larvae eradication and shall ensure removal of stagnant water on daily basis.
6. The Proponent shall, before commencing construction of the project, acknowledge acceptance of the stipulated conditions by executing an Undertaking in the form prescribed in Schedule VII of Review of IEE/EIA Regulations 2000.
7. The Proponent shall be liable for correctness and validity of information supplied to this department directly or through the environmental consultant.
8. This approval is accorded only for the construction phase of the project. The Proponent shall apply for confirmation of compliance under Regulation 14 of IEE / EIA Regulation, 2000 by submitting Environmental Management Plan for operational phase along with compliance status report of the Environmental Approval of the construction phase of the project.
9. The Proponent shall be liable for compliance of Regulations 13, 14, 18 and 19 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.
10. EPA reserves the right to impose any other condition based on its monitoring.
11. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.
12. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with and in case of any interim injunction by any court of law against said project.
13. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Regulation 17 of IEE / EIA Regulations, 2000.
14. This approval can be withdrawn at anytime without any prior notice if deemed necessary in the public / national interest.
15. This decision is issued with approval of Director General, EPA Punjab


ASSISTANT DIRECTOR (EIA)

NO. & DATE EVEN.

A copy is forwarded to the Assistant Director (Environment) Bahawalpur w.r.t letter No. F-BWMC/2018/EPA/BWP/158 dated 14.02.2018. He is requested to:

- i. Obtain undertaking from the project proponent mentioned at para 6 for the record of EPA Headquarter and Field Office.
- ii. Ensure compliance of the conditions mentioned in the Environmental Approval and maintain the file / record of correspondence with the project proponent properly.


ASSISTANT DIRECTOR (EIA)

Appendix A.15 IBAT Proximity Report of Bahawalpur LFS



Integrated Biodiversity Assessment Tool

PROXIMITY REPORT

LFS BAWAWALPUR

Country: Pakistan

Location: [29.3, 71.6]

Date of analysis: 16 January 2023 (GMT)

Size of site: 0 km²

Buffers applied: 1 km | 3 km | 5 km

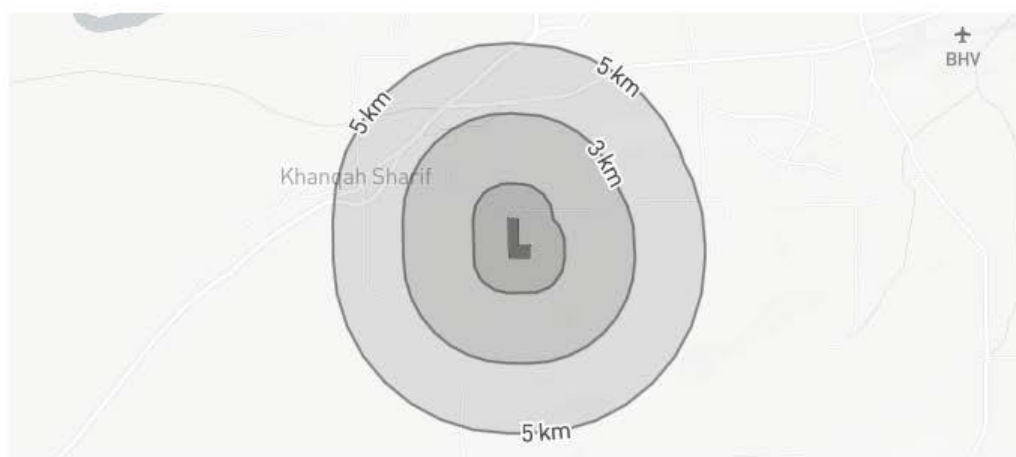
IUCN Red List Biomes: Freshwater, Terrestrial

Generated by: Aziz Karim

Organisation: ADB

Overlaps with:

Protected Areas	0
Key Biodiversity Areas	0
IUCN Red List	36



Displaying project location and buffers: 1 km, 3 km, 5 km





About this report

This report presents the results of [29905-38691] proximity analysis to identify the biodiversity features and species which are located within the following buffers: 1 km, 3 km, 5 km.

This report is one part of a package generated by IBAT on 16 January 2023 (GMT) that includes full list of all species, protected areas, Key Biodiversity Areas in CSV format, maps showing the area of interest in relation to these features, and a 'How to read IBAT reports' document.

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

Please note, sensitive species data are currently not included in IBAT reports in line with the [Sensitive Data Access Restrictions Policy for the IUCN Red List](#). This relates to sensitive Threatened species and KBAs triggered by sensitive species.

Data used to generate this report

- UNEP-WCMC and IUCN, 2023. Protected Planet: The World Database on Protected Areas (WDPA)[On-line], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net - January 2023.
- BirdLife International (on behalf of the KBA Partnership), 2022. Key Biodiversity Areas - November 2022.
- IUCN, 2022. IUCN Red List of Threatened Species - December 2022.
- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). <https://www.iucnredlist.org>
- IUCN. Threats Classification Scheme (Version 3.2). (2019)
- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729 (2020). <https://doi.org/10.1038/s41586-020-2784-9>



Protected Areas

The following protected areas are found within 1 km, 3 km, 5 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No protected areas within buffer distance

Key Biodiversity Areas

The following key biodiversity areas are found within 1 km, 3 km, 5 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

No KBAs within buffer distance

IUCN Red List of Threatened Species

The following threatened species are potentially found within 50km of the area of interest.

For the full IUCN Red List please refer to the associated csv in the report folder.

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Vanellus gregarius	Sociable Lapwing	AVES	CR	Decreasing	Terrestrial
Gyps bengalensis	White-rumped Vulture	AVES	CR	Decreasing	Terrestrial
Geoclemys hamiltonii	Spotted Pond Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Hardella thurjii	Crowned River Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Nilssononia gangetica	Indian Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater
Nilssononia hurum	Indian Peacock Softshell Turtle	REPTILIA	EN	Decreasing	Terrestrial, Freshwater

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Platanista minor	Indus River Dolphin	MAMMALIA	EN	Increasing	Freshwater
Axis porcinus	Hog Deer	MAMMALIA	EN	Decreasing	Terrestrial, Freshwater
Oxyura leucocephala	White-headed Duck	AVES	EN	Decreasing	Terrestrial, Freshwater
Rynchops albicollis	Indian Skimmer	AVES	EN	Decreasing	Terrestrial, Freshwater
Haliaeetus leucoryphus	Pallas's Fish-eagle	AVES	EN	Decreasing	Terrestrial, Freshwater
Neophron percnopterus	Egyptian Vulture	AVES	EN	Decreasing	Terrestrial, Freshwater
Falco cherrug	Saker Falcon	AVES	EN	Decreasing	Terrestrial, Marine, Freshwater
Leptoptilos dubius	Greater Adjutant	AVES	EN	Decreasing	Terrestrial, Freshwater
Glyptothorax punjabensis		ACTINOPTERYGII	EN	Decreasing	Freshwater
Panthera tigris	Tiger	MAMMALIA	EN	Decreasing	Terrestrial
Varanus flavescens	Yellow Monitor	REPTILIA	EN	Decreasing	Terrestrial
Aquila nipalensis	Steppe Eagle	AVES	EN	Decreasing	Terrestrial
Crocodylus palustris	Mugger	REPTILIA	VU	Stable	Terrestrial, Freshwater

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
Pangshura tecta	Indian Roofed Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Wallago attu		ACTINOPTERYGII	VU	Decreasing	Freshwater
Aythya ferina	Common Pochard	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Columba eversmanni	Yellow-eyed Pigeon	AVES	VU	Decreasing	Terrestrial, Freshwater
Sterna aurantia	River Tern	AVES	VU	Decreasing	Terrestrial, Marine, Freshwater
Clanga clanga	Greater Spotted Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila rapax	Tawny Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Aquila heliaca	Eastern Imperial Eagle	AVES	VU	Decreasing	Terrestrial, Freshwater
Chrysomma altirostre	Jerdon's Babbler	AVES	VU	Decreasing	Terrestrial, Freshwater
Lissemys punctata	Indian Flapshell Turtle	REPTILIA	VU	Decreasing	Terrestrial, Freshwater
Schizothorax plagiostomus	Snow Trout	ACTINOPTERYGII	VU	Decreasing	Freshwater
Bagarius bagarius		ACTINOPTERYGII	VU	Decreasing	Freshwater
Acinonyx jubatus	Cheetah	MAMMALIA	VU	Decreasing	Terrestrial

Species Name	Common Name	Taxonomic Group	IUCN Category	Population Trend	Biome
<i>Panthera pardus</i>	Leopard	MAMMALIA	VU	Decreasing	Terrestrial
<i>Saara hardwickii</i>	Indian Spiny-tailed Lizard	REPTILIA	VU	Decreasing	Terrestrial
<i>Saxicola macrorhynchus</i>	White-browed Bushchat	AVES	VU	Decreasing	Terrestrial
<i>Chlamydotis macqueenii</i>	Asian Houbara	AVES	VU	Decreasing	Terrestrial



Recommended citation

IBAT Proximity Report. Generated under licence 29905-38691 from the Integrated Biodiversity Assessment Tool on 16 January 2023 (GMT). www.ibat-alliance.org

How to use this report

This report provides an indication of the potential biodiversity-related features - protected areas, key biodiversity areas and species - close to the specified location. It provides an early indication of potential biodiversity concerns, and can provide valuable guidance in making decisions. For example, this information can be helpful when assessing the potential environmental risk and impact of a site, categorising investments/projects, preparing the terms of reference for an impact assessment, focusing attention on key species of conservation concern and sites of known conservation value, and reviewing the results of an impact assessment.

The report does not provide details of potential indirect, downstream or cumulative impacts. Furthermore, the report should be regarded as a "first-step", providing a set of conservation values sourced from global data sets, and is not a substitute for further investigation and due diligence, especially concerning national and/or local conservation priorities.



Appendix A.16 Urdu summary of the project



مختصر خلاصہ برائے ماحولیاتی اثرات کی تشخیص

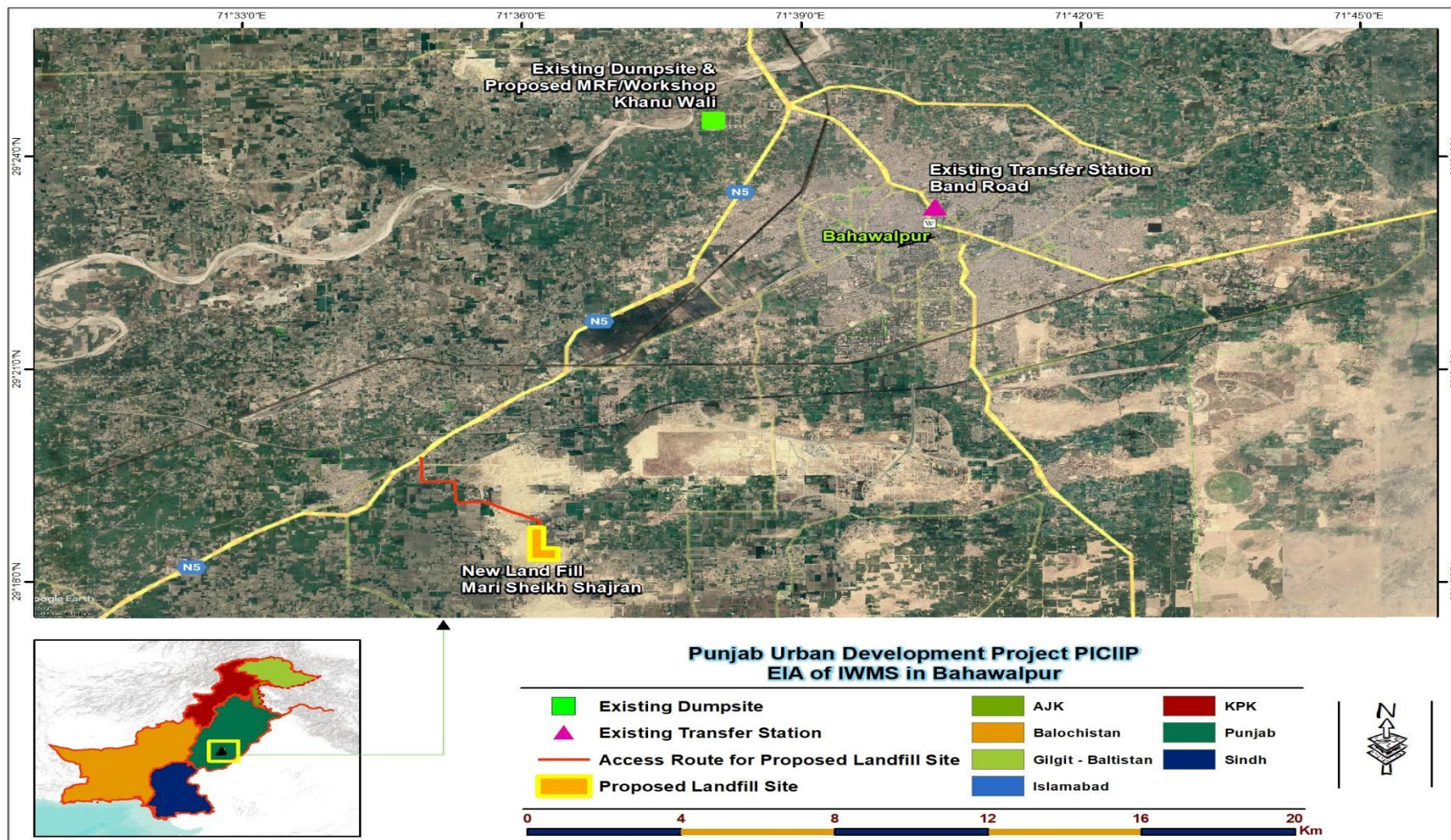
پنجاب کے وسطی شہروں کی بہتر سرمایہ کاری کا منصوبہ

پاکستان : بہاولپور میں کچرا کنڈی کے قیام کا منصوبہ

ماحولیاتی اثرات کے اقدامات کا خلاصہ

منصوبے کا جائزہ

1. حکومت پنجاب ایشیائی ترقیاتی بینک (اے ڈی بی) کے مالی تعاون سے وسطی اضلاع میں پنجاب انٹر میڈیٹ سٹیز امپروومنٹ انویسٹمنٹ پراجیکٹ (پی آئی سی آئی پی) پر عملدرآمد کر رہی ہے۔ پی آئی سی آئی پی پنجاب کے مختلف شہروں میں شہری انتظام کے بنیادی ڈھانچے اور خدمات میں سرمایہ کاری کا ہدف رکھتا ہے۔
2. شہروں میں کھلے عام کچرا پھینکنے کی وجہ سے کچرے کی گندگی اور بدبو لوگوں کو پریشان کر رہی ہے اور ماحول کو آلودہ کر رہی ہے۔ بہاولپور ویسٹ مینجمنٹ کمپنی (بی ڈبلیو ایم سی) کا مقصد ان طریقوں کا مقابلہ کرنا ہے لیکن موجودہ سالڈ ویسٹ مینجمنٹ سسٹم اور (بی ڈبلیو ایم سی) جدید طرز، ضروری آلات، لینڈ فل اور افرادی قوت سے مکمل طور پر لیس نہیں ہے۔
3. بہاولپور لینڈ فل کو ایک مربوط سہولت کے طور پر ڈیزائن کیا گیا ہے یہ 150 میٹر x 200 میٹر کے 4 خلیات پر مشتمل ہے جسے ترتیب وار تیار کیا جائے گا۔ سال 2024 میں سیل ون تیار کیا جائے گا اور جنوری 2025 تک کچرا وصول کرنے کے لئے تیار ہو جائے گا۔ بائیو ری ایکٹر کو لینڈ فل گیس ریکوری سسٹم، لینڈ فل گیس فلرنگ اور میتھین اجزاء کو سی این جی میں تبدیل کرنے کے ساتھ مربوط کیا گیا ہے۔ جگہ کے تصوراتی خاکہ کی بندش اور بندش کے بعد کا استعمال شامل ہے جس میں ترمیم کرنا پڑ سکتی ہے کیونکہ خلیوں کی بندش سالوں میں آگے بڑھتی ہے۔ مزید برآں علاج شدہ طبی کچرا کو ٹھکانے لگانے کے لئے سیل کا ایک حصہ لینڈ فل سائٹ پر زیر غور ہے۔
منصوبے کی جگہ کا مقام
4. مجوزہ لینڈ فل سکی جگہ ماڑی شیخ شجرہ کے مقام پر تیار کی جائے گی، جو بہاولپور شہر کے مرکز سے تقریباً 11 کلومیٹر دور سطح سمندر (اے ایم ایس ایل) سے 392 فٹ (119 میٹر) کی بلندی پر واقع ہے۔ یہ جگہ بستی یار محمد روڈ کے ذریعے قابل رسائی ہے، تاہم ایل ایف ایس (تقریباً 2.5 کلومیٹر لمبائی) کی طرف جانے والی رسائی سڑک ابھی تک تعمیر نہیں کی گئی ہے اور اس کی تعمیر منصوبے کے فزیبلٹی ڈیزائن میں شامل ہے۔ تقریباً 10 کلومیٹر مرکزی سڑک کی بہتری بھی منصوبے کا حصہ ہے۔
5. خانوالا میں واقع موجودہ ڈمپنگ سائٹ پر ایک چھوٹے پیمانے پر کمپوسٹ پلانٹ قائم کیا جائے گا جس میں تجارتی کچرا سے الگ نامیاتی کچرا استعمال کیا جائے گا۔ لکڑی کا کچرا، سبزیوں اور فروٹ مارکیٹ کے کچرے، ریسٹورانوں اور ہوٹلوں سے پکا ہوا کھانا اور دکانوں سے زائد المیعاد کھانا ملایا جائے گا۔ موجودہ ڈمپ سائٹ بنیادی کچرا جمع کرنے والے علاقوں سے اوسطاً تقریباً 10 کلومیٹر پر واقع ہے۔ (قریب ترین آبادی کے مرکز سے 5.8 کلومیٹر اور دور ترین علاقے سے 15 کلومیٹر)۔ یہ کسی بھی ماحولیاتی کنٹرول کے بغیر ایک کھلی ڈمپ سائٹ ہے جو نیچے یا سائیڈ وال لائنر سسٹم ہے، کوئی لیچیٹ کلیکشن اور ٹریٹمنٹ سسٹم یا لینڈ فل گیس ریکوری سسٹم نہیں ہے۔ جمع شدہ کچرا روزانہ ڈھانپنے والی مٹی سے ڈھکا ہوا نہیں ہے۔
6. مجوزہ ایم آر ایف مقام ایک پرانی ڈمپ سائٹ اور گندے پانی کے کھلے تالابوں سے متصل ہے۔ ایم آر ایف قومی شاہراہ سے حاصل پور روڈ تک بائی پاس پر واقع ہے۔ 10 ایکڑ اراضی پر اس سائٹ پر ایم آر ایف کے قیام سے اخراج میں کمی کر کے سائٹ کے مجموعی کاربن فٹ پرنٹ کو کم کیا جاسکے گا۔ بی ڈبلیو ایم سی ایم آر ایف چلائے گی۔ شہر کی مغربی طرف سے آنے والی سڑک کو بہتری کی ضرورت ہوگی جو سڑک کو دو طرفہ سڑک میں تبدیل کر رہی ہے۔ سڑک کی بہتری کی لمبائی کا تخمینہ تقریباً 5 کلومیٹر ہے۔ اس میں سے 2.5 کلومیٹر سنگل روڈ کو ڈبل لین تک توسیع دی جائے گی اور 2.5 کلومیٹر نئی دو طرفہ سڑک ہوگی۔ منصوبے میں مخصوص سی اینڈ ڈی ویسٹ کنٹریکٹر کے ذریعے تعمیراتی اور انہدام (سی اینڈ ڈی) کچرے کی ری سائیکلنگ کی بھی تجویز دی گئی ہے۔



منصوبے کی ضرورت ہے۔

7. ٹھوس کچرے کو ٹھکانے لگانا ماحولیاتی صحت کے بنیادی اشارے میں سے ایک ہے۔ ٹھوس کچرے کو غلط طریقے سے ٹھکانے لگانے اور ویکٹر سے پیدا ہونے والی بیماریوں کے واقعات کے درمیان گہرا تعلق ہے۔ لہذا، ٹھوس فضلے کو ٹھکانے لگانے کا موثر نظام علاقے کی ایک اہم ضرورت ہے تاکہ اس طرح کے کچرے کی وجہ سے صحت کے خطرات کو کم سے کم کیا جاسکے۔ بہاولپور شہر میں ٹھوس کچرے کو ٹھکانے لگانے کی موجودہ صورتحال ماحولیاتی صحت کے خطرے کے دیگر اشاریوں کے مقابلے میں زیادہ تشویشناک ہے۔
8. پورے شہر میں میونسپل فضلہ جمع کرنا اور ٹھکانے لگانا بھی مناسب حد تک مناسب نہیں ہے۔ جمع شدہ کچرا اکثر سڑک کے کنارے کھلی جگہوں میں پھینک دیا جاتا ہے اور مسافروں اور آس پاس کے علاقوں کے رہائشیوں کے لئے انتہائی تکلیف دہ ہوجاتا ہے۔ یہ عمل ان کی کمی اور قابو کے بجائے ماحولیاتی صحت کے خطرات کی ایک اور سنگین وجہ ہے۔ فی الحال بہاولپور میں کوئی سائنسی اور انجینئرڈ لینڈ فل سائٹ دستیاب نہیں ہے۔ کھلی ڈمپنگ کے ساتھ صرف محدود گھریلو فضلہ جمع کرنے کی جگہ ہے۔
9. مجوزہ بہاولپور آئی ایس ڈبلیو ایم ایس بہاولپور ویسٹ مینجمنٹ کمپنی (بی ڈبلیو ایم سی) اور پنجاب ایل جی اینڈ سی ڈی ڈی کو شہر میں ایس ڈبلیو ایم سسٹم کو مکمل طور پر تبدیل کرنے میں مدد فراہم کرے گا۔ اس منصوبے میں پرائمری اور سیکنڈری میونسپل سالڈ ویسٹ (ایم ایس ڈبلیو) جمع کرنے کے نظام کی تنصیب اور بین الاقوامی معیار کے بائیو ریاکٹر لینڈ فل بشمول ایم آر ایف اور کمپوسٹنگ پلانٹ کی ترقی بھی شامل ہے تاکہ بہاولپور سے میونسپل ٹھوس کچرے کو کم از کم 20 سال تک ذخیرہ کیا جاسکے۔
عوامی مشاورت کا عمل
10. مجموعی طور پر 160 سے زائد مختلف افراد سے جامع مشاورت کے دو دور منعقد کیے گئے۔ عوامی مشاورت کا پہلا دور نومبر 2022 کے پہلے ہفتے میں منعقد ہوا تھا جبکہ عوامی مشاورت کا دوسرا دور دسمبر 2022 کے مہینے میں مکمل ہوا تھا۔ ان مشاورتوں میں تعمیراتی اور آپریشنل مرحلے سے وابستہ مثبت اور منفی اثرات اور منفی اثرات کو مناسب طور پر کم کرنے کے بارے میں معلومات کا تبادلہ کیا گیا۔
متبادل کا تجزیہ
11. کچرے کو ٹھکانے لگانے کا موجودہ نظام غیر کنٹرول ڈمپ سائٹس کے ذریعے کیا گیا ہے۔ ان ڈمپ سائٹس کو اکثر ایک ایسے علاقے کی خصوصیت دی جاتی ہے جہاں کچرا آسانی سے لے جایا جاتا ہے، اتارا جاتا ہے، اور بعض اوقات بلڈوزر کے ذریعہ برابر کیا جاتا ہے۔ تقریباً یہ تمام مقامات مٹی اور زیر زمین پانی کی آلودگی کے خلاف کوئی تحفظ کے بغیر کام کرتے ہیں۔
12. زمین بھرنے کی ترقی کے لئے تین مختلف مقامات درج ذیل تھے:
یزمان - مالوٹ مشینری اسٹور کے بغل میں ماروٹ یزمان روڈ بہاولپور میں واقع ہے۔
خانو ولی - یہ مقام دریائے ستلج سے 0.5 کلومیٹر کے فاصلے پر واقع ہے اور قریب ترین انسانی بستی منصوبے کی جگہ سے 350-400 میٹر کے دائرے میں واقع ہے۔ مجوزہ جگہ کا علاقہ 25 سال کی قابل استعمال زندگی کے لئے کافی ہے۔
ماڑی شیخ شجرہ - بستی یار محمد، بہاولپور کے قریب واقع ہے۔ جگہ کا کل رقبہ 110 ایکڑ ہے۔ مجوزہ جگہ زیادہ تر زرعی کھیتوں سے گھری ہوئی ہے اور قریبی انسانی بستیوں سے محفوظ فاصلے پر واقع ہے۔
13. ماڑی شیخ شجرہ کی جگہ کچرا کنڈی کے انتخاب کے لئے درکار زیادہ تر معیار کو پورا کرتی ہے۔ یہ شہر سے کافی دور ہے۔ آبادی بہت کم ہے اور اگرچہ کچھ حساس ریسپیٹرز موجود ہیں، لیکن مناسب ماحولیاتی جائزے کیے جارہے ہیں اور ماحولیاتی اور سماجی اقتصادی اثرات دونوں کو کم سے کم کرنے کے لئے بازآبادکاری کے منصوبے تیار کیے جارہے ہیں۔ آس پاس کا زیادہ تر علاقہ بنجر اور زرعی ہے۔ دیگر متبادل مقامات کو دیکھتے ہوئے، تمام یا تو زرعی یا نیم شہری علاقے تھے، جو کم از کم اس جگہ کو باقی میں سب سے زیادہ مثالی رکھتے ہیں۔
14. کسی اضافی اراضی کے حصول کی ضرورت نہیں ہے کیونکہ 110 ایکڑ اراضی کا رقبہ پہلے ہی بی ڈبلیو ایم سی کی ملکیت ہے اور سیل کے مقامات بفر زون کی ضروریات کو پورا کرتے ہیں جو اس بات کو یقینی بناتا ہے کہ لینڈ فلنگ آپریشن کے ممکنہ اثرات کے باہر کسی ناقابل قبول اثر کا سبب نہ بنیں۔ قریبی آبادی کو بائیو ری ایکٹر لینڈ فل کی خوبیوں کے بارے میں تعلیم دے کر اس منصوبے کی سماجی قبولیت میں اضافہ کیا گیا ہے۔ اس منصوبے میں کوئی نجی اراضی کا حصول شامل نہیں ہے۔

15. دیگر قسم کے متبادل جن پر غور کیا گیا ان میں اینزوبک نظام ہضم کے لئے تکنیکی متبادل، مواد کی بازیابی کی سہولت کے لئے تکنیکی متبادل، کچرے کو ٹھکانے لگانے کے متبادل کے ساتھ ساتھ ممکنہ علاج کے اختیارات کا موازنہ کرنے کے ساتھ ساتھ مختلف قسم کی لینڈ فلنگ طریقہ کار کا اقتصادی پہلو تجزیہ شامل تھا۔ ممکنہ بڑے اثرات

تعمیر سے پہلے / ڈیزائن کا مرحلہ: اہم ممکنہ اثرات جن کا جائزہ لیا گیا ہے اور جن کے لئے ضروری تخفیف کے اقدامات بھی تجویز کیے گئے ہیں، حسب ذیل ہیں:

- کچرا کنڈی کی نامناسب ڈیزائننگ مختلف اثرات کا باعث بنتا ہے۔
 - آئی ایف سی گائیڈ لائنز پر عمل نہ کرنے کی وجہ سے لینڈ فل سائٹ کا نامناسب انتخاب۔
 - زمین کے استعمال میں تبدیلی،
- تعمیر کا مرحلہ: اہم ممکنہ اثرات جن کا جائزہ لیا گیا ہے اور جن کے لئے ضروری تخفیف کے اقدامات بھی تجویز کیے گئے ہیں، حسب ذیل ہیں:

- لینڈ فل کی نامناسب تعمیر حتمی ڈیزائن کے مطابق نہیں۔
 - مقامی افراد کی صحت اور حفاظت کے مسائل۔
 - پیشہ ورانہ صحت اور حفاظت کے مسائل۔
 - خطرناک اور غیر خطرناک کچرے کی نامناسب طریقے ٹھکانے لگانا۔
 - ایم آر ایف اور لینڈ فل سائٹ تک رسائی کے لئے سڑکوں کی تعمیر سے وابستہ اثرات۔
- آپریشن کا مرحلہ: اہم ممکنہ اثرات جن کا جائزہ لیا گیا ہے اور جن کے لئے ضروری تخفیف کے اقدامات بھی تجویز کیے گئے ہیں، حسب ذیل ہیں:

- لیچیٹ کی نسل
- مٹی اور زیر زمین پانی کی ممکنہ آلودگی
- لینڈ فل گیس کی پیداوار
- قابل اعتراض بدبو کی پیداوار اور ہوا کے معیار پر اثرات
- ورم اور بیماری ویکٹر کی پیداوار کی کشش
- پیشہ ورانہ صحت اور حفاظت
- کچرا جمع کرنے اور اٹھانے کے اثرات
- ہوا سے بھرا ہوا کچرا
- بندش اور بندش کے بعد کے اثرات

تخفیف کے اقدامات

16. ای آئی اے رپورٹ میں تعمیر سے قبل، ڈیزائن، آپریشن، بندش اور بندش کے بعد کے مراحل سے متعلق تخفیف کے اقدامات کی تفصیل دی گئی ہے۔ لیچیٹ جمع کرنے اور علاج، لینڈ فل گیس مینجمنٹ، بدبو اور ویکٹر کنٹرول کے لئے ضروری ڈیزائن پر غور شامل کیا گیا ہے۔ ای آئی اے رپورٹ میں مٹی اور زمین / سطحی پانی کی آلودگی، او ایچ ایس کے مسائل، معاشرتی تنازعات، پودوں کے نقصان اور متعدی بیماریوں سے بچنے کے لئے تعمیراتی مرحلے سے وابستہ تخفیف کی تفصیل دی گئی ہے۔

17. آپریشن کے مرحلے کے لئے تخفیف فراہم کی جاتی ہے تاکہ اس بات کو یقینی بنایا جاسکے کہ لیچیٹ اور لینڈ فل گیس کا مناسب انتظام کیا جائے، کچرا اٹھانے کے اثرات، ٹریفک کے مسائل، ہوا سے اڑنے والا کچرا، ویکٹر اسپریڈ اور ہوا کے معیار کے مسائل نہ ہوں۔ بدبو اور کوڑے کے مسائل سے بچنے کے لئے روزانہ کور کا استعمال کیا جائے گا۔ علاقے کی جمالیاتی کشش کو بہتر بنانے کے لئے ضروری شجرکاری کے ذریعے بفر زون تیار کیا جائے گا اس منصوبے کے نتیجے میں کچرے کے انتظام کی بہتر خدمات، صحت عامہ میں بہتری اور علاقے کی جمالیاتی حسن میں بہتری آئے گی۔
مجموعی اثرات:

18. لینڈ فل منصوبے کے علاقے میں کوئی دوسرا بنیادی ڈھانچہ کام کرنے کا منصوبہ نہیں ہے جبکہ یہ منصوبے کے کام ۲۰۲۵ تک انجام دیئے جائیں گے۔ اس طرح، کسی مجموعی اثرات کی توقع نہیں ہے۔
بالواسطہ اور متاثرکن اثرات:

19. مجوزہ بہاولپور ایس ڈبلیو ایم سہولت کے ہر مرحلے کے ممکنہ اثرات کی نشاندہی کی گئی ہے اور فیلڈ ڈیٹا، ثانوی اعداد و شمار، ماہرین کی رائے اور تحقیق کا استعمال کرتے ہوئے پاکستان میں پہلے کے تقابلی منصوبوں کا جائزہ لیا گیا ہے۔ ان میں جسمانی، حیاتیاتی اور سماجی و اقتصادی ماحول پر اثرات شامل ہیں۔ ہوا کے اخراج، ٹریفک اور شور سے ماحول پر پڑنے والے اثرات کا بھی جائزہ لیا گیا ہے اور یہ قابل قبول اور ماحول کی گنجائش کے اندر پایا گیا ہے۔

20. اس طرح، مجوزہ لینڈ فل کاموں سے منفی بالواسطہ اور متاثر کن اثرات کی توقع نہیں ہے۔
نتیجہ اور سفارشات

21. رپورٹ میں ذمہ داران کے واضح کردار اور ذمہ داریوں کے ساتھ ایک ایکشن پلان فراہم کیا گیا ہے۔ پی ایم یو، کنٹریکٹرز اور کنسٹرکشن سپرویزر کنسلٹنٹ اس ایکشن پلان کے بڑے اسٹیک ہولڈرز ہیں۔ تعمیراتی کام شروع ہونے سے پہلے ایکشن پلان پر عمل درآمد ہونا ضروری ہے۔

22. تخفیف کے اقدامات کو تعمیر اور آپریشن کے دوران ماحولیاتی نگرانی کے ایک پروگرام کے ذریعہ یقینی بنایا جائے گا تاکہ اس بات کو یقینی بنایا جاسکے کہ ای ایم پی میں تمام اقدامات پر عمل درآمد کیا جاتا ہے اور اس بات کا تعین کیا جاتا ہے کہ آیا ماحول کو ارادے کے مطابق محفوظ کیا گیا ہے یا نہیں۔ اس میں سائٹ پر اور باہر مشاہدات، دستاویزات کی جانچ پڑتال، اور کارکنوں اور فائدہ اٹھانے والوں کے ساتھ انٹرویو شامل ہوں گے، اور اصلاحی کارروائی کے لئے کسی بھی ضروریات کی اطلاع دی جائے گی۔

23. ڈیزائن، تعمیر اور آپریشن سے وابستہ ممکنہ منفی اثرات کو مناسب انجینئرنگ ڈیزائن اور تجویز کردہ تخفیف اقدامات اور طریقہ کار کی شمولیت یا اطلاق کے ذریعہ بغیر کسی مشکل کے معیاری سطح تک کم کیا جاسکتا ہے۔ یہ نتیجہ اخذ کیا گیا ہے کہ مجوزہ منصوبے کو ای آئی اے مطالعہ میں نشاندہی کردہ مناسب تخفیف اقدامات اور نگرانی کے پروگراموں کے ساتھ آگے بڑھنا چاہئے۔

Appendix A.17 NOC from Wildlife Department for Site


PUNJAB WILDLIFE & PARKS
DEPARTMENT

OFFICE OF THE DEPUTY DIRECTOR WILDLIFE
BAHAWALPUR REGION, BAHAWALPUR
Ph No.062-9253189 Email:ddwbwp1@gmail.com

No. 545/DDW-BWP/2023 Dated Bahawalpur, the 21/02/2023

To,

The Infrastructure Engineer
PMU, PICIIP LG&CD Department
Bahawalpur

**SUBJECT:- REQUEST FOR NO OBJECTION CERTIFICATE (NOC) CONFORMING NO
ENDANGERED SPECIES IN THE PROJECT AREA**

Reference: Letter No. LG&CD/PICIIP/PRF-PUDP/CIU-PWP/22-55 Dated: 20.02.2023

It is apprised that Assistant Director Wildlife Protection Force, Bahawalpur has reported vide letter No. 11/AD-WPF-BWO/2023 Dated: 21.02.2023 that there is no disturbance for wildlife is observed in the area of the project and most of species red listed by IUCN are not native to the said area. Furthermore, in case the project is extended beyond the boundary limits a comprehensive study of such area would be required.

2. Hence, this department has no objection to the execution of the said projection at proposed site.


(SYED ALI USMAN BUKHARI)
**DEPUTY DIRECTOR WILDLIFE
BAHAWALPUR REGION
BAHAWALPUR**

Appendix A.18 Hydrogeological Assessment Report

Estimation of Leachate Leaking Effect on Ground Water Quality

(Bahawalpur Landfill site)

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Part 1: Problem statement

Sanitary landfills generally are constructed by placing wastes in excavations and covering the material daily with soil--thus the term "sanitary" to indicate that garbage and other materials are not left exposed to produce odours or smoke or attract vermin and insects. Even though a landfill is covered, leachate may be generated by the infiltration of precipitation and surface runoff. Fortunately, many substances are removed from the leachate as it filters through the unsaturated zone, but leachate may contaminate groundwater and even streams if it discharges at the surface as springs and seeps.

In Bahawalpur Landfill site (LFS), as per geotechnical investigation, the ground comprises of Silty Sand (SM / SP) dominates up to 4-6m depth afterward 2-3m Silty Clay/Lean Clay and Sandy Strata (SP-SM)/Silty Sand (SM) is observed till borehole termination depth. A Silty Clay (CL-ML)/Lean Clay (CL) layer of 1-2m is observed at varying depth of 12-14m in all boreholes except BH-03. However in all four excavated test pits, Silty Sand (SM) is dominant up to termination depth. The groundwater table was encountered in boreholes at depths 14 to 16.5m.

The ground condition reveals mostly Sandy silty with occasional bands of Lean Clay and Silty Clay. Overall the soil can be considered as Silty Sand (SM), as a conservative estimate of Geology. Soil profile for different boreholes carried out during the geotechnical investigation is provided in Geotechnical Investigation Report.

A leachate leak from any of the storage cells may result in the contamination of the water table below the LFS. The geology of the site is Sandy Silt (Moderately High Permeability) with occasional bands of Lean Clay of low permeability. The water table, based on actual data from site as well as the surroundings of LFS, shows that the water table is sloping towards nearby mosque and a few households. **Figure 2** below shows the community location and the ground water flow from North-East towards South West in the surrounding of the LFS.

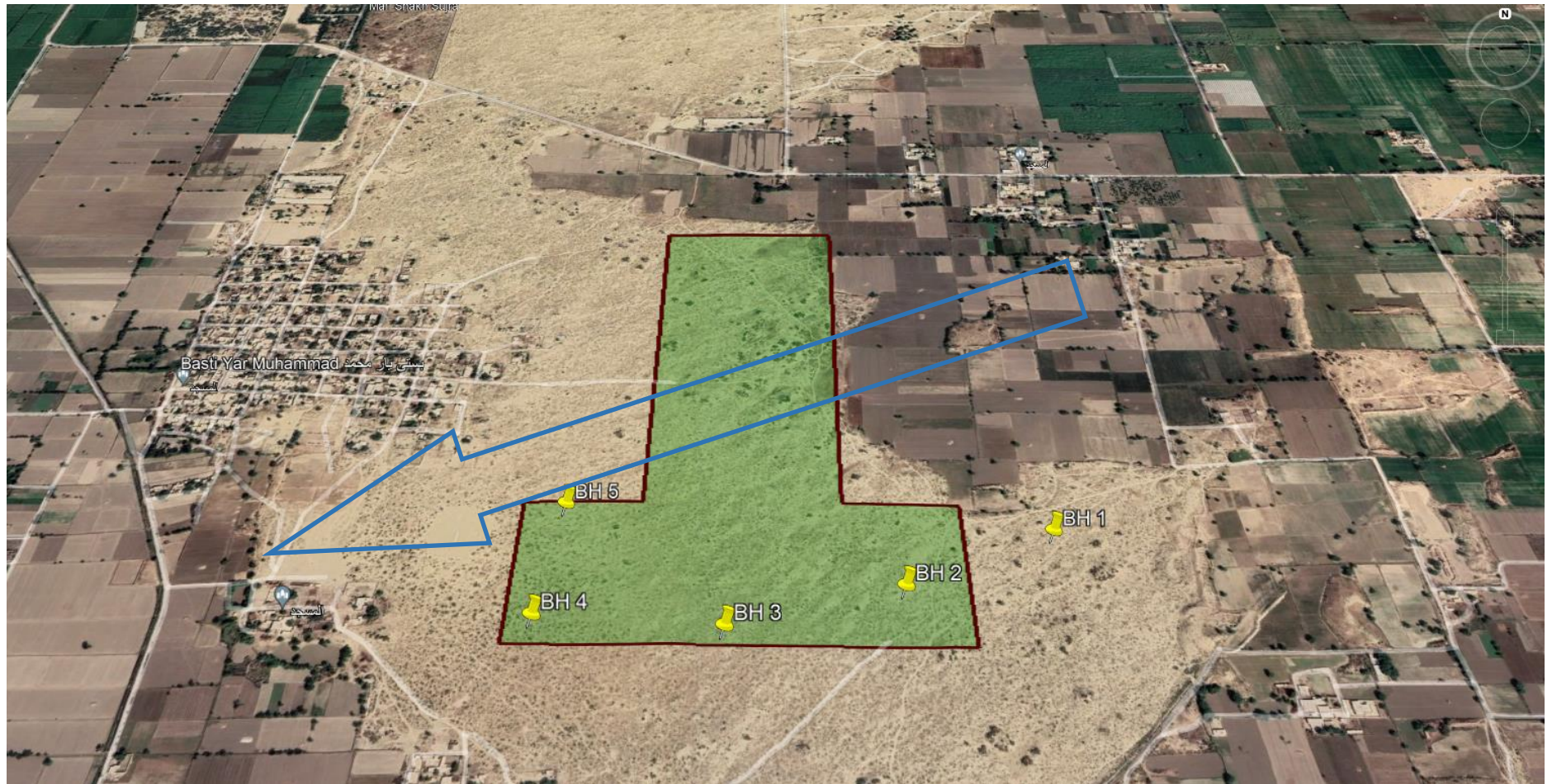


Figure 1: Location of tube wells and groundwater levels showing underground flow direction

Sr.No.	Bore No.	Coordinates		Drilling Depth (m)	GWT (m)
		N	E		
1	BH-01	3243377	752238	15 m	14 m
2	BH-02	3243267	751984	18 m	16 m
3	BH-03	3243229	751750	20 m	N/A
4	BH-04	3243218	751460	16 m	14.80 m
5	BH-05	3243357	751471	18 m	16.5 m

Table 1: Depth of water table from boreholes

As per **Figure 2** above, the nearest communities with respect to the proposed LFS is at risk in the direction of the flow are Residential houses (Distance 340m), and a Mosque (Distance 320m). The conceptual model as well as the pathway of the groundwater flow is shown below in **Figure 3**.

This report focuses on checking the source, identify transport mechanisms and potential targets affected by the contamination using a qualitative and quantitative risk assessment of the problem. The involve computation of contaminant concentration at the targets identified in a conceptual model, estimating the concentration at various target points. In the end, the remedial measures will be advised based on the analyses and any further data required will be identified.

Part 2: Conceptual model

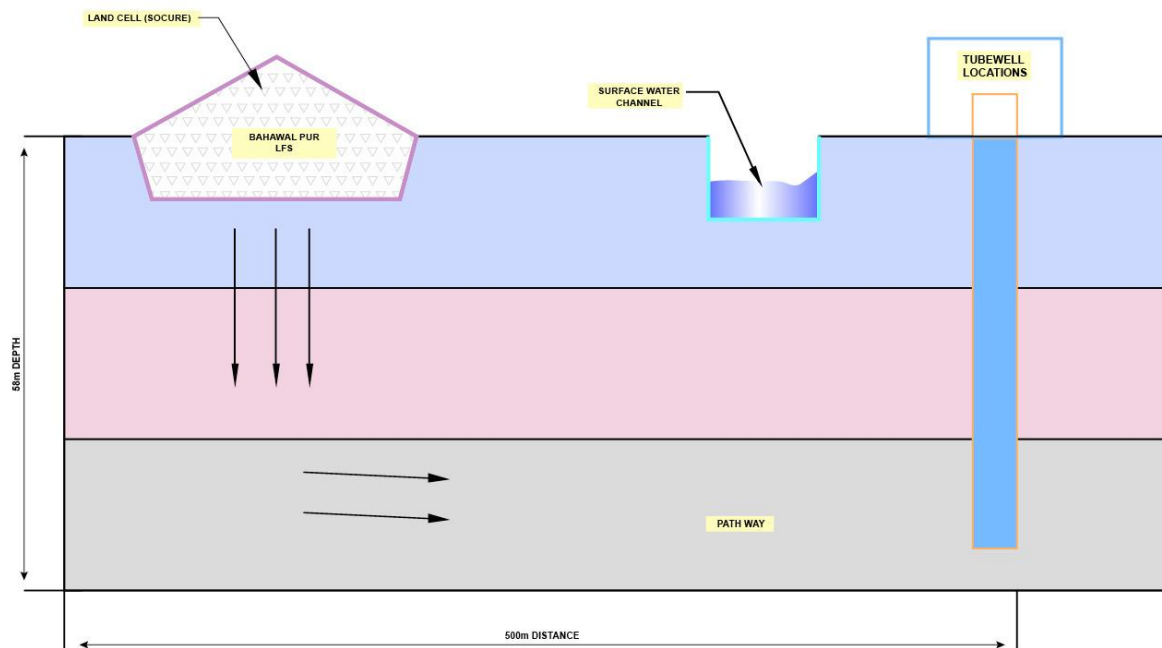


Figure 2: Conceptual model showing source, pathway, and targets

Part 3: Sources pathways and targets

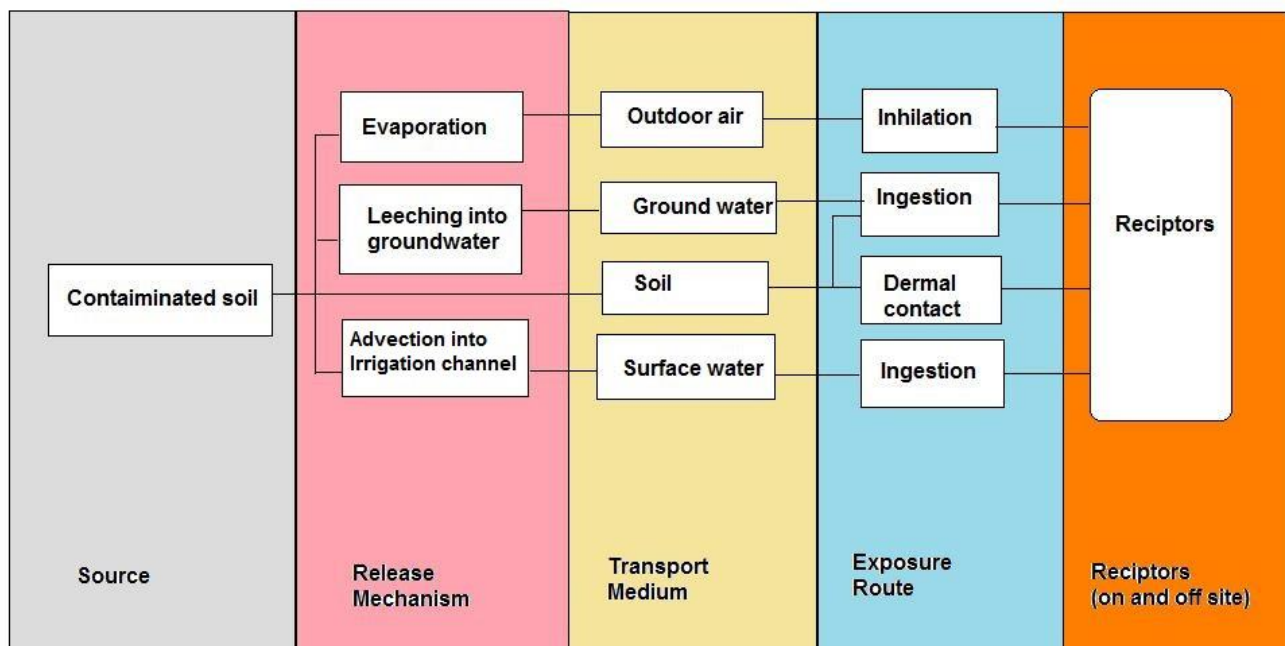


Figure 3: Transport and fate mechanisms for contaminant movement

Part 4: Qualitative risk assessment

The qualitative risk assessment for the study is described in the following steps:

- Step 1: Identification of Key Risks based on the data collection
- Step 2: Establishment of PI matrix to categorize different risks
- Step 3: Assigning PI to the agreed risks to calculate risk score from PI matrix

- Step 4: Ranking the risk scores to create a severity table and finalize ranks for different key risks

Step 1 Identification of Key Risks

Risk No	Description
1	Contamination of groundwater from leachate leaking cell
2	Contamination of surface water in the irrigation channel
3	Contamination uptake in drinking water by the local community
4	Evaporation of contaminant in the air to reduce air quality
5	Dermal contact while using water for washing and cleaning
6	Danger to the aquatic life in the area
7	Contamination uptake in vegetation and subsequent ingestion (eating)

Step 2 PI Matrix

Impact ↓					
Very High	Med. Risk	Med. Risk	High risk	High risk	High risk
Serious	Med. Risk	Med. Risk	Med. Risk	High risk	High risk
Moderate	Low risk	Med. Risk	Med. Risk	Med. Risk	High risk
Minor	Low risk	Low risk	Low risk	Med. Risk	Med. Risk
Insignificant	Low risk	Low risk	Low risk	Med. Risk	Med. Risk
Probability →	Very Low	Low	Medium	High	Very High

Step 3 Assigning PI to the agreed risks to calculate risk score from PI matrix

Risk No	Description	Impact	Probability	Risk score
1	Contamination of groundwater from leachate leaking cell	Serious	High	High
2	Contamination of surface water in the irrigation channel	Serious	Low	Low
3	Contamination uptake in drinking water by the local community	Very High	High	High
4	Evaporation of contaminant in the air to reduce air quality	Minor	Low	Low

5	Dermal contact while using water for washing and cleaning	Moderate	Medium	Medium
6	Danger to the aquatic life in the area	Minor	Low	Low
7	Contamination uptake in vegetation and subsequent ingestion (eating)	Insignificant	Low	Low

Step 4 Ranking the risk scores to create a severity table

Risk No	Description	Impact	Probability	Risk score	Rank
1	Contamination of groundwater from the leaking tank	Serious	High	High	1
3	Contamination uptake in drinking water by the local community	Very High	Very High	High	1
5	Dermal contact while using water for washing and cleaning	Serious	Medium	Medium	2
2	Contamination of surface water in the irrigation channel	Moderate	Medium	Low	3
4	Evaporation of contaminant in the air to reduce air quality	Minor	Low	Low	3
6	Danger to the aquatic life in the area	Minor	Medium	Low	3
7	Contamination uptake in vegetation and subsequent ingestion (eating)	Insignificant	Low	Low	3

The above risk analysis indicates that the contamination of groundwater from possible leakage of a storage cell may result in the uptake of contamination by the nearby community. Therefore, the possibility of contamination reaching the community, time taken to reach the community and the concentration at the target needs further investigation.

Part 5: Estimates of likely range of contamination at targets

The calculations for the estimates of likely range of contamination at targets and time travel are provided below:

i. Available data:

Soil conditions:

Sandy Silt (SM): 0 to 18m

Permeability $K = 5 \times 10^{-6}$ m/sec or 4.3×10^{-1} m/day,

Porosity $n = 0.33$ (Terzaghi, K., Peck, R., and Mesri, G., Soil Mechanics in Engineering Practice. Wiley, New York, 1996.)

Thickness = 18m from three boreholes

Aquifer:

Material Type = Sandy Gravel

Permeability $K =$ between 30 m/day, (Estimated)

Porosity $n = 0.23$

Thickness = Not determined (assumed to be greater than mixing depth on the conservative side)

Groundwater:

Water table elevations:

Name of TW	Depth of Water Table (m)
BH 1	14
BH 2	16
BH 4	14.8
BH 5	16.5

Landfill Cell:

Cell Area = 103600 m²

The base of contaminant tank = 10m below ground level

Water supplies:

By Tube well at local community

Population = 2000 people (Estimated) Community of about 200 Homes.

Flow rate = 0.5 m³/sec (Estimated)

Distance from landfill site = 340m

Water consumption = 200 litres/person/day (includes, washing, drinking, cooking, toilets etc)

Water drinking = UNKNOWN

Calculating containment concentration at source Co:

Rate of leakage = 2211 Kg/year

Permeability = 0.43 m/day

Slope of water table

$dh/dx = 2/280$ m/m

Ground water flow rate $V_d = -K * dh/dx = 30 * 0.03 = 0.21$ m/day

Mixing depth $Z = (0.0112 * L^2)^{0.5} + b (1 - \exp[(-L * \text{inf}) / (K * dh/dx * b)])$ (equation 1)

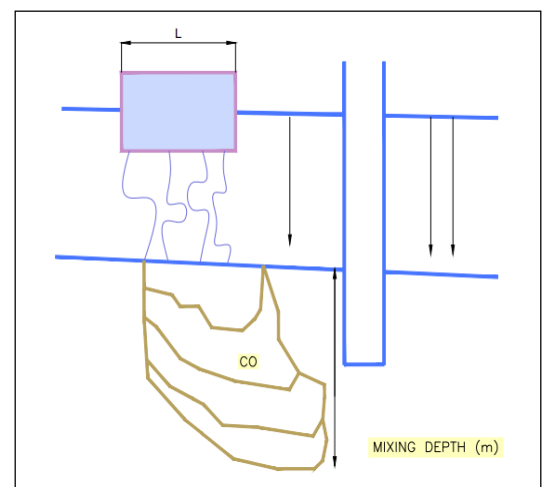
Where

L = source length parallel to ground water flow = 200m

b = Aquifer thickness = 100m

inf = infiltration rate of rain = 0.0038 m/day

K = Hydraulic conductivity (taking minimum) = 30 m/day



dh/dx = hydraulic gradient of water table = 2/280 m/m

Putting the values in equation 1 we get

$Z = 27.5$ m, Near 20m which is maximum usual thickness

Flow rate below the Cell $Q = V_d * Z * Y$ m³/day

Where Y is width of the tank

$$Q = 0.9 * 22.02 * 10$$

$$Q = 59.081 \text{ m}^3/\text{day}$$

$$Q = 21564 \text{ m}^3/\text{year}$$

Contamination at source C_o = amount lost per year / flow rate

$C_o = 0.12 \text{ Kg/m}^3$ Contamination per m³ in water table just below source

ii. **Using Ogata and banks equation to calculate contaminant concentration at various targets identified;**

$C/C_o = \frac{1}{2} \times \text{ERFC} \left[\frac{(x - (v/R_i)t)/(4(D/R_i)t)^{1/2}} \right] \rightarrow$ Ogata and banks equation with no biodecay

Note: error check was made for $[(x - vt)/(4Dt)^{1/2}] < 0$, and for negative values

ERFC (fx) = 1 + ERF (-fx) is used

Targets point identified for Ogata and banks equation is Tube wells at nearest community 340m away from Landfill

First calculating dispersion coefficient for the contaminant

$$D = \alpha_L \times v + D^*$$

Where D^* = diffusivity of Leachate

$D^* = 0 \text{ m}^2/\text{day}$ (Assuming no diffusion is taking place – conservative estimate)

Flow path length $L = \text{True velocity} \times \text{time}$

$$\text{Time} = 365 \times 1 = 365 \text{ days}$$

$$\text{True velocity } v = K \times (dh/dx)/n$$

$$V = 0.64 \text{ m/day}$$

$$L = 0.64 \times 365 = 219 \text{ m}$$

Therefore using equation

$$\alpha_L = 0.83 (\log L)^{2.414}$$

$$\alpha_L = 23.7 \text{ m}$$

As

$$D = \alpha_L \times v + D^*$$

Putting the values we get

$$D = 15.3 \text{ m}^2/\text{day}$$

Using Excel to solve Ogata and banks equation

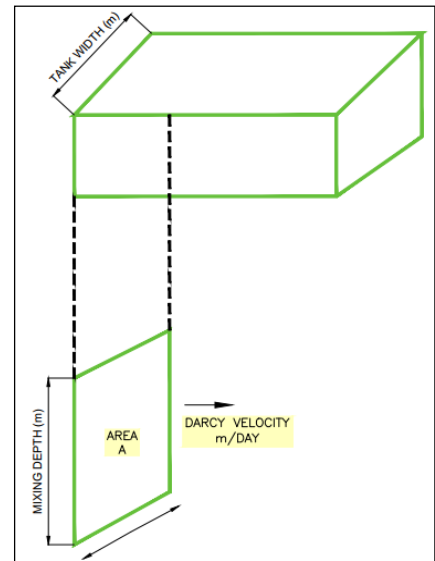


Table 2: Input data for Otaga and Banks equation

Using excel to calculate the expected concentration of a contaminant 340m from a source Vs time after the source started emitting contamination based on the following data			
Inputs	Co	0.12	kg/m ³
	K	30	m/day
	dh	2	m
	dx	280	m
	porosity	0.33	
	D, Dispersion Coefficient	15.3	
	x, Distance from Source	340	m
Calculations			
	Darcy Velocity	0.214285714	m/day
	v, True Velocity	0.649350649	m/day

Table 3: Contaminant concentration at the tube well location at 340m from the landfill site

Time t (days)	Contaminant concentration C, (kg/m ³)
25	0.00
50	0.00
75	0.00
100	0.00
125	0.00
150	0.00
175	0.00
200	0.00
225	0.00
250	0.00
275	0.00
300	0.01
325	0.01
350	0.02
375	0.02
400	0.03
425	0.03

450	0.04
475	0.05
500	0.05
525	0.06
550	0.07
575	0.07
600	0.08
625	0.08
650	0.09
675	0.09
700	0.09
725	0.10
750	0.10
775	0.10
800	0.10
825	0.11
850	0.11
875	0.11
900	0.11
925	0.11
950	0.11
975	0.11
1000	0.12
1025	0.12
1050	0.12
1075	0.12
1100	0.12
1125	0.12
1150	0.12
1175	0.12
1200	0.12
1225	0.12
1250	0.12
1275	0.12
1300	0.12

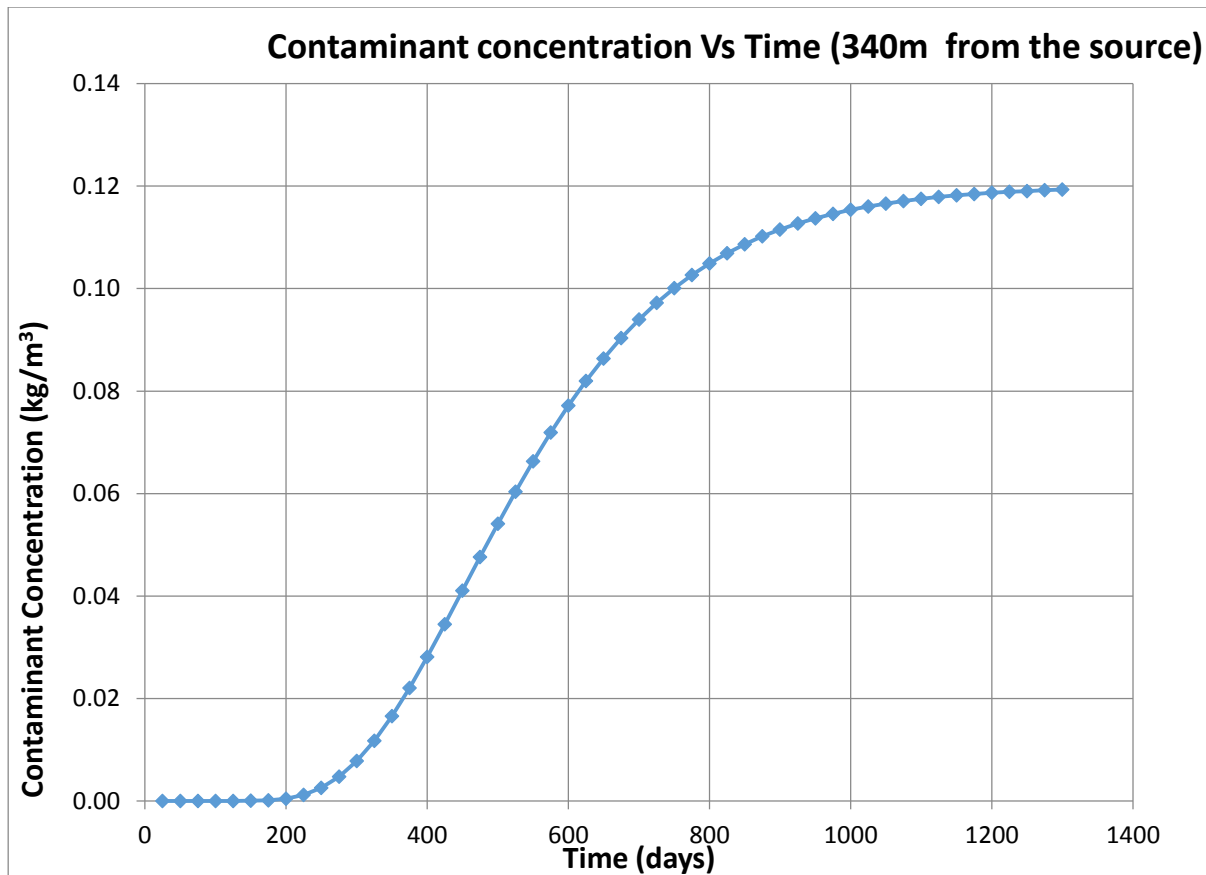


Figure 4: Breakthrough curve Contaminant concentration at local community location Vs time in days

Time taken by the contamination to appearing in the local community water supply after cell breach at the LFS = $4/0.432 + 300 = 310$ Days

Time required to reach the full concentration of 0.12 kg/m³ will be 1010 days

Part 6: Conclusions.

- The hydrogeological analysis was based on a very conservative estimate of contaminant movement through strata considering no bio decay, diffusion or retardation is occurring to model worst-case scenario.
- Based on analysis, it will take a total of **310 Days** for contamination to start appearing at the nearest tube well located in the direction of flow at the local community 340m away from the landfill site.
- Once the contamination start appearing in the water supply from the tube well it will take about 700 more days to reach full concentration.
- Under part 2a of section 57 (Environmental Protection Act 1990, UK Guidance) as the amount of contamination is below the guidelines values for contamination the part of the land cannot be described as contaminated land here.
- However, there is a significant chance of harm if the amount of groundwater flow reduces or the contamination level increases above the current levels. Therefore it is recommended to use observation boreholes to monitor groundwater quality and also

additional checks should be made on monthly basis by collecting water samples from the nearest tube well for detection of any contamination. If any contamination is detected then the necessary action to plug the breach should be completed within 310 days.

- The leachate discharge should be measured on regular basis to indicate barrier breach from loss of leachate.

Appendix A.19 Air Dispersion Modelling Report

AIR DISPERSION MODELLING FOR CRITERIA POLLUTANTS

(PM, NO_x, CO, SO₂)

BAHAWALPUR LANDFILL SITE

For
IEC

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1. General:

This document deals with the quantitative and qualitative estimates of criterial pollutants i.e., Particulate Matter (PM₁₀), Carbon Monoxide (CO) and Oxides of Nitrogen (NO_x) to be emitted through the flare stack of proposed landfill site located at mouza Nouabad, District Bahawalpur, Punjab.

2. Location:

The proposed landfill site will be developed at Mari Sheikh Shijra, located approximately 11km away from Bahawalpur city center at an elevation of 392 ft (119 m) above mean sea level (AMSL).

The google coordinates of the proposed site are given **Table -1** below.

Table -4: Bahawalpur Solid Waste Management Facility Locations

Site Name	Latitude	Longitude
Proposed Landfill Site (LFS)	29°17'46.46"N	71°35'26.70"E

3. Methodology:

Lakes Environmental Software³⁵, “AERMOD view” was adapted to predict the downwind transportation or dispersion of criteria pollutants emission from the operation of the flare stack of landfill site.

AERMOD View is our most commonly used air dispersion model and is applicable to a wide range of buoyant or neutrally buoyant emissions up to a range of 50km.

3.1 AERMOD View:

The AERMOD view air pollution dispersion modelling system is an integrated system that includes three modules:

- A steady-state dispersion model designed for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary sources.
- A meteorological data pre-processor (AERMET) that accepts surface meteorological data, upper air soundings, and the inbuilt data from the model backups. It then calculates atmospheric parameters needed by the dispersion model, such as atmospheric turbulence characteristics, mixing heights, friction velocity, Monin-Obukov length and surface heat flux.

³⁵ <https://www.weblakes.com/software/air-dispersion/aermod-view/>

- A terrain preprocessor (AIRMAP) whose main purpose is to provide a physical relationship between terrain features and the behavior of air pollution plumes. It generates location and height data for each receptor location.

Specific electronic file formats on the meteorological conditions and terrain were used to form input in the model sub-processors to successfully run the program.

- **Mixing Height:** The mixing height (or depth) can be described as “the height above the surface through which relatively vigorous vertical mixing occurs”. The mixing height is therefore well defined under neutral or unstable conditions and is undefined in stable conditions. A mixing height of 50 and 150 meters was assumed for neutral and unstable conditions respectively.
- **Stability:** The atmospheric stability category associated with maximum concentrations varies depending on the dispersion coefficient and the source height. The maximum concentration of pollutant generally increases with decreasing wind speeds. Wind stability D (neutral) was used.

3.2 Main Assumptions:

The following assumptions were made for the air dispersion model:

- The plume spread has a Gaussian distribution in both the horizontal and vertical planes;
- The mean wind speed; (a) is high enough to ignore the diffusion effect in the lee-ward direction; (b) is constant throughout the layer where the plume is being transported; and (c) the wind speed remains constant during travel and for that particular time;
- The Pasquill Stability Categories considered are B & D, (B: representing semi-turbulent conditions in summer within the transporting wind field, which is more appropriate for the meteorological conditions and D: representing neutral conditions which prevail during winter months in the area.
- Turbulence is assumed same everywhere during the period under consideration;

3.3 Key Inputs:

The key inputs required by the model were (**Table-2**); Number, height, inner diameter, velocity, emission rate of pollutants and temperature of stack. The pollutant concentrations and other related data obtained from the Designer of landfill Project.

Table-5: Inputs data

Sr. No.	Stack Parameter	Values
Technical Inputs / Specification of Stacks		
1	Stack height	42.50 m

Sr. No.	Stack Parameter	Values
2	Stack diameter	0.85 m
3	Δh (Gas Enthalpy)	1.94 j
4	Stack Gas exit Velocity or Gas Flow Rate	1.15 m
5	Down wind speed (u)	1.27m/s
6	Stability class	D (Neutral)
7	Ambient Temperature	24.5°C
8	Stack Temperature	24.5°C
9	Urban /Rural Class Option	Rural
10	Total number of stacks	01
11	Gas Emission rate	0.0561g/s
Pollutants Specifications		
The concentration of pollutants as percentage ratio of the total pollutant concentration was estimated at “15% oxygen normalization” as below:		
<u>Exhaust Analysis % Vol.</u>		
• Nitrogen 74.51% • Oxygen 13.15 % • Carbon Dioxide 3.47% • Water 6.99% • Particulates 1.88 %		

3.4 Modeling Outputs

Downwind model summaries of overall 24-hourly levels at receptors distanced at 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1500, 2000, 2500, 3000, 4000 and 5000 meters from the stack along 16 radial directions 22.5° apart from each. The stack was treated as point source for modeling the plume dispersion.

Modeling levels have been compared to verify compliance with the allowable ambient levels. Comparison of levels has been made with WHO allowable atmospheric (ambient) concentration for CO, NO_x, & PM₁₀ for 24-hours µg/m³.

The dispersion and ground level concentrations of emissions were determined by the interaction of the following variables:

- Flare Stack characteristics
- Physical and chemical characteristics of the emissions

- c) Meteorological conditions near the site during the time the emissions traveled from the stack to the ground level receptor
- d) Topographical conditions of the site and surrounding areas

The special dispersion of the pollution levels around the project site was modeled for ground level concentration. Dispersion of maximum pollutants is found in the north east direction driven by the south-westerly wind. Models for dispersion of NO_x, and PM based 24-Hour Averages for proposed facilities have been recorded in Air Quality Modeling Tables 3, 4 and 5.

Table-6: 24hs Average NO_x Concentration (µg/m³)

Direction (Degrees)	Distance (Meters)															
	100	200	300	400	500	600	700	800	900	1000	1500	2000	2500	3000	4000	5000
22.5	0.00	0.09	0.05	0.22	0.14	0.19	0.28	0.29	0.36	0.41	0.33	0.33	0.36	0.34	0.15	0.08
45	0.00	0.13	0.07	0.17	0.15	0.14	0.15	0.11	0.14	0.13	0.12	0.13	0.11	0.10	0.08	0.06
67.5	0.00	0.08	0.16	0.19	0.16	0.17	0.16	0.14	0.12	0.11	0.10	0.12	0.14	0.40	0.16	0.15
90	0.00	0.03	0.17	0.16	0.15	0.13	0.14	0.12	0.11	0.10	0.11	0.08	0.06	0.04	0.00	0.00
112.5	0.00	0.09	0.18	0.19	0.17	0.16	0.14	0.12	0.10	0.11	0.10	0.12	0.14	0.40	0.16	0.15
135	0.00	0.07	0.07	0.17	0.15	0.14	0.13	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04
157.5	0.00	0.06	0.09	0.16	0.14	0.13	0.12	0.10	0.11	0.10	0.09	0.08	0.06	0.04	0.03	0.00
180	0.00	0.05	0.08	0.15	0.13	0.14	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.02
202.5	0.00	0.07	0.10	0.17	0.15	0.14	0.13	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04
225	0.00	0.04	0.17	0.16	0.15	0.13	0.14	0.12	0.11	0.10	0.11	0.08	0.06	0.04	0.00	0.00
247.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01
270	0.00	0.00	0.00	0.00	0.01	0.05	0.14	0.15	0.13	0.14	0.12	0.11	0.10	0.05	0.03	0.04
292.5	0.00	0.00	0.00	0.02	0.14	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04	0.03	0.01
315	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.11	0.18	0.20	0.18	0.17	0.15	0.13	0.20	0.00
337.5	0.00	0.00	0.00	0.06	0.40	0.39	0.18	0.20	0.18	0.17	0.15	0.13	0.2	0.01	0.00	0.00
360	0.00	0.06	0.09	0.16	0.14	0.13	0.12	0.10	0.11	0.10	0.09	0.08	0.06	0.04	0.03	0.00

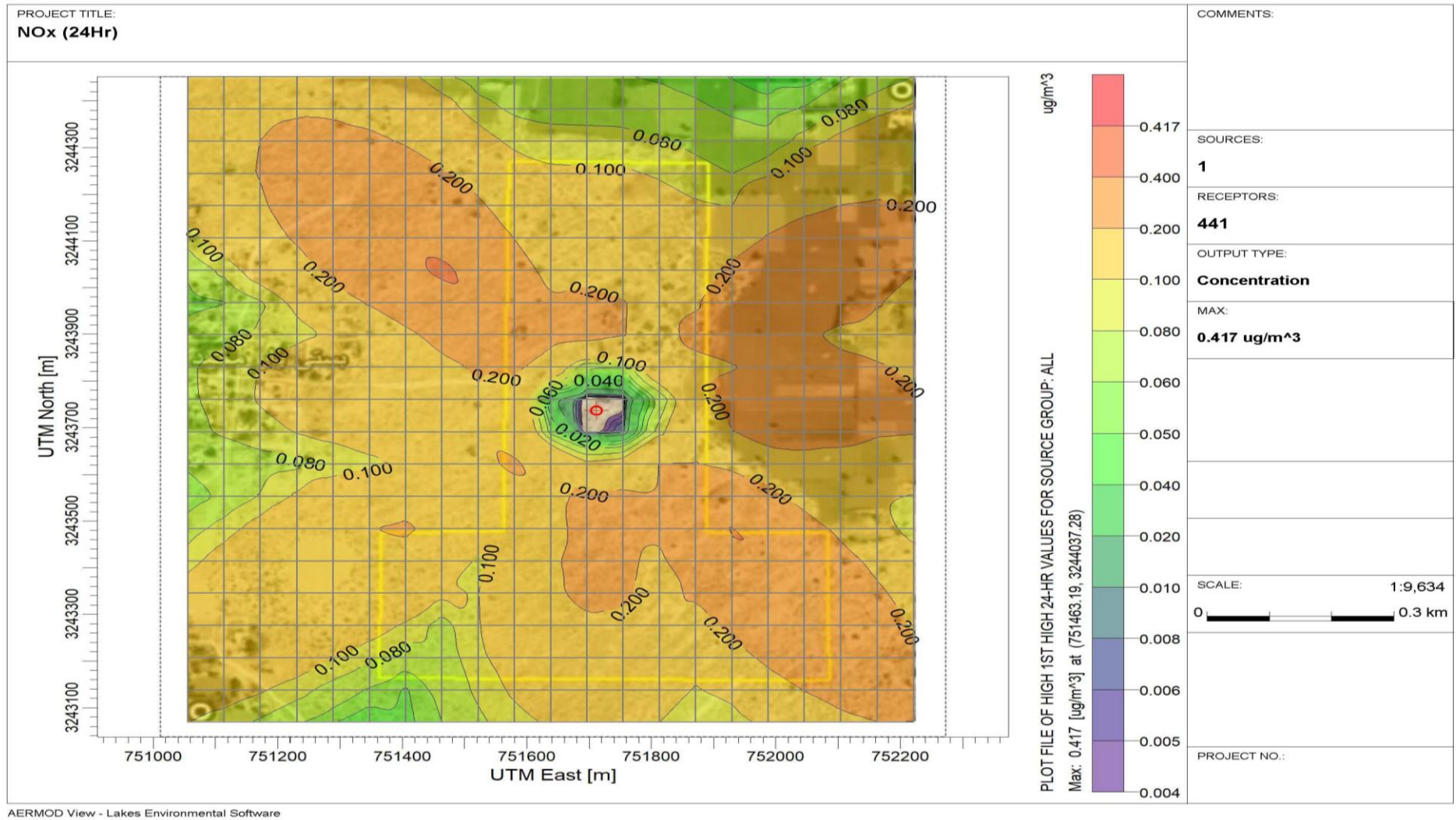


Figure-5: Contour Map Showing 24hs Average NOx Concentration ($\mu\text{g}/\text{m}^3$)

Table-7: 24-HR Average CO Concentration ($\mu\text{g}/\text{m}^3$)

Direction (Degrees)	Distance (Meters)															
	100	200	300	400	500	600	700	800	900	1000	1500	2000	2500	3000	4000	5000
22.5	0.00	0.09	0.05	0.22	0.14	0.19	0.28	0.29	0.32	0.34	0.31	0.31	0.30	0.24	0.15	0.08
45	0.00	0.08	0.16	0.19	0.16	0.17	0.16	0.14	0.12	0.11	0.10	0.12	0.14	0.40	0.16	0.15
67.5	0.00	0.03	0.17	0.16	0.15	0.13	0.14	0.12	0.11	0.10	0.11	0.08	0.06	0.04	0.00	0.00
90	0.00	0.02	0.11	0.10	0.08	0.07	0.06	0.05	0.11	0.10	0.11	0.08	0.06	0.04	0.00	0.00
112.5	0.00	0.07	0.07	0.17	0.15	0.14	0.13	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04
135	0.00	0.06	0.09	0.16	0.14	0.13	0.12	0.10	0.11	0.10	0.09	0.08	0.06	0.04	0.03	0.00
157.5	0.00	0.05	0.08	0.15	0.13	0.14	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.02
180	0.00	0.07	0.10	0.17	0.15	0.14	0.13	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04
202.5	0.00	0.04	0.17	0.16	0.15	0.13	0.14	0.12	0.11	0.10	0.11	0.08	0.06	0.04	0.00	0.00
225	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01
247.5	0.00	0.00	0.00	0.00	0.01	0.05	0.14	0.15	0.13	0.14	0.12	0.11	0.10	0.05	0.03	0.04
270	0.00	0.00	0.00	0.02	0.14	0.11	0.14	0.13	0.12	0.10	0.11	0.10	0.07	0.04	0.03	0.01
292.5	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.11	0.18	0.20	0.18	0.17	0.15	0.13	0.20	0.00
315	0.00	0.00	0.00	0.06	0.40	0.39	0.18	0.20	0.18	0.17	0.15	0.13	0.2	0.01	0.00	0.00
337.5	0.00	0.06	0.09	0.16	0.14	0.13	0.12	0.10	0.11	0.10	0.09	0.08	0.06	0.04	0.03	0.00
360	0.00	0.03	0.06	0.18	0.16	0.14	0.13	0.12	0.11	0.10	0.09	0.08	0.06	0.04	0.03	0.00

Figure-6: Contour Map Showing 24hs Average CO Concentration ($\mu\text{g}/\text{m}^3$)

Table -8: 24-HR Average PM₁₀ Concentration (µg/m³)

Direction (Degrees)	Distance (Meters)															
	100	200	300	400	500	600	700	800	900	1000	1500	2000	2500	3000	4000	5000
22.5	0.000	0.002	0.002	0.002	0.0014	0.0019	0.0028	0.0029	0.0026	0.0046	0.003	0.003	0.003	0.002	0.001	0.0009
45	0.000	0.0008	0.002	0.002	0.002	0.0014	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.0011	0.001
67.5	0.000	0.000	0.000	0.000	0.000	0.0014	0.0013	0.0012	0.0011	0.10	0.0011	0.0008	0.0006	0.0004	0.000	0.000
90	0.000	0.000	0.000	0.000	0.000	0.002	0.002	0.003	0.001	0.001	0.001	0.0008	0.0006	0.0004	0.000	0.000
112.5	0.000	0.0007	0.0007	0.0017	0.0015	0.0014	0.0013	0.0011	0.0014	0.0013	0.0012	0.0010	0.0011	0.0010	0.0007	0.0004
135	0.000	0.0006	0.0009	0.0016	0.0014	0.0013	0.0012	0.0010	0.0011	0.0010	0.0009	0.0007	0.0006	0.0004	0.0003	0.0000
157.5	0.000	0.0005	0.0008	0.0015	0.0013	0.0014	0.0015	0.0012	0.0011	0.0010	0.0009	0.0008	0.0007	0.0006	0.0003	0.0001
180	0.000	0.0007	0.0010	0.0017	0.0015	0.0014	0.0013	0.0011	0.0014	0.0013	0.0012	0.0010	0.0011	0.0010	0.0008	0.0005
202.5	0.000	0.0004	0.0017	0.0016	0.0014	0.0013	0.0014	0.0012	0.0011	0.0010	0.0011	0.0008	0.0006	0.0004	0.0000	0.0000
225	0.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
247.5	0.000	0.0000	0.0000	0.0000	0.0001	0.0005	0.0014	0.0015	0.0013	0.0014	0.0012	0.0011	0.0010	0.0005	0.0003	0.0002
270	0.000	0.0000	0.0000	0.0002	0.0014	0.0011	0.0014	0.0013	0.0012	0.0010	0.0011	0.0010	0.0007	0.0004	0.0003	0.0001
292.5	0.000	0.0000	0.000	0.0010	0.0006	0.002	0.0007	0.0011	0.0018	0.0021	0.0018	0.0017	0.0016	0.0014	0.0020	0.0002
315	0.000	0.0000	0.000	0.006	0.0040	0.0036	0.0018	0.0020	0.0018	0.0017	0.0015	0.0013	0.002	0.0001	0.0000	0.0000
337.5	0.000	0.0006	0.009	0.006	0.0014	0.0013	0.0012	0.0010	0.0011	0.0010	0.0009	0.0008	0.0006	0.0004	0.0003	0.0000
360	0.000	0.003	0.06	0.0018	0.0017	0.0015	0.0014	0.0012	0.0011	0.0010	0.0009	0.0008	0.0006	0.0004	0.003	0.0000

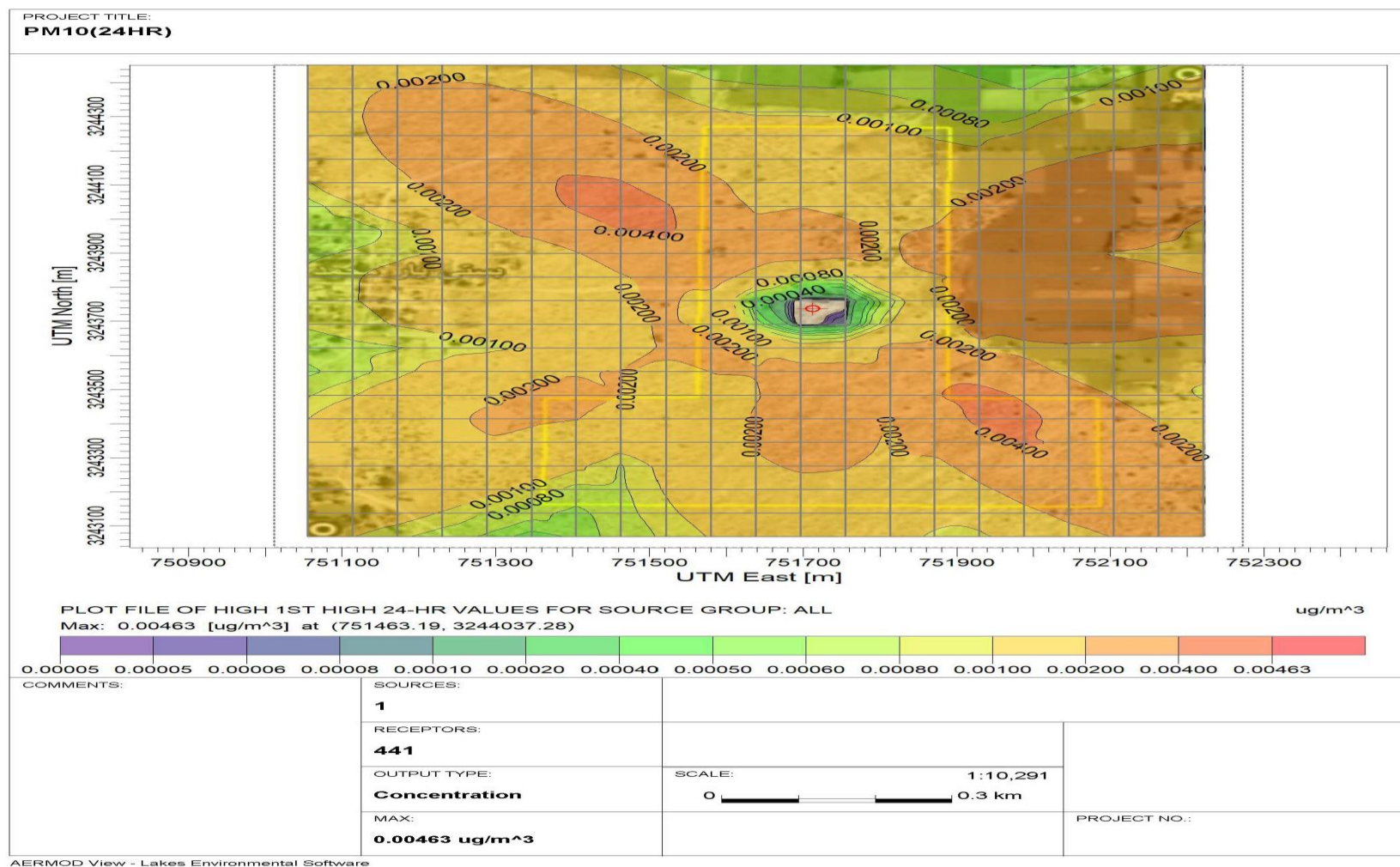


Figure-7: Contour Map Showing 24hs Average PM₁₀ Concentration (μg/m³)

Table -9: Airshed Classification with Model Outputs

Pollutants	WHO		Pak. NEQS		Modelling Out Put (ug/m ³)
	Avg. Time	Standard	Avg. Time	Standard	
CO	24hr	04 mg/m ³	8 hrs	5 mg/m ³	0.347 (75°14'63.19N /3244037.28E)
NO ₂	24hr	25 ug/m ³	24 hrs	80 ug/m ³	0.417 (75°14'63.19N /3244037.28E)
PM ₁₀	24hr	45 ug/m ³	24 hrs	150 ug/m ³	0.00463 (75°14'63.19N /3244037.28E)

The results of modeling in Table 3, 4 and 5 shows that the 24-hour average highest ground level concentration of CO from the flare remains 0.347µg/m³ at 1000 meters (75°14'63.19N, 3244037.28E) NOx from the flare remains 0.417µg/m³ at 1000 meters (75°14'63.19N, 3244037.28E) and PM₁₀ from the plant remains 0.00463µg/m³ at 1000 meters (75°14'63.19N, 3244037.28E) when flare operating at its normal conditions.

Pertinent to mention that all the emissions are well in compliance with the WHO and national ambient air quality standards.

The color contours maps plotted by the model for the proposed emissions effect of the proposed flare display the extent of dispersion of the pollutants. The dispersion plumes shown in above figures show that the plant is located at 1000 meters from the origin set at top left corner of the map. Contours maps expand to 5000 meters from the flare site. The contours show that the emissions disperse in north-east-north direction.

3.5. Conclusion

This modeling analysis demonstrates that operation of the facility described in this report neither causes nor contributes to any exceedance of applicable air quality standards outside proposed flare. The limits set by NEQS/WHO also suggest that the quality of airshed would not be altered to hazardous state by the

emissions from the flare. Establishment of proposed flare would therefore be an environmentally safe proposition.