7.1 RISK ASSESSMENT

7.1.1 Introduction

Risk Assessment policies are essential tools to prevent and mitigate undue harm to people during the development process. When identifying and designing a project, Risk Assessment helps assess the potential physical, environmental and social risks and impacts (Positive and Negative) associated with a development intervention.

A hazard is something that can cause harm, viz., chemicals, electricity, working on height, noise due to machines/ running of plant, work stress etc. However, risk is the chance or the scale say high or low that any hazard will actually cause somebody harm.

7.1.2 Evaluation Hazard

The need for the sophisticated techniques for evaluating hazards depends on the result of Preliminary Hazard Analysis. Various techniques for evaluation hazards are: Hazard and Operability Study (HAZOP) Physical Hazards

- Accident Consequence Analysis
- Event Tree Analysis
- Fault Tree Analysis
- Failure Modes, Effects and Criticality Analysis

TABLE 7.1 HAZARD IDENTIFICATION

S. No.	Toxicity	Oral Toxicity LD50 (mg/kg)	Dermal Toxicity LD50 (mg/kg)	Inhalation Toxicity LD50(mg/kg)
1	Highly Toxic	1-50	1-200	0.1-0.5
2	Extremely Toxic	51-500	201-2000	0.5-2.0

In order to be in a state of readiness to face the adverse effects of accidents, an Emergency Preparedness Plan (EPP) has to be prepared. Such a plan must. Inter-alia, cover the possible hazardous situations in the locality and the causes, areas most likely to be affected, on-site and off-site plans, establishment of Emergency Control Centers(ECC), location of emergency services and duties of officers/staff during emergency. The EPP document for accidents is to be designed to provide for measures to contain the incident and for minimization of effects due to fire, explosives, release or escape of toxic gas, spillage of hazardous substances in storage, processing or during transportation. The necessary preventive and protective steps required to be taken before, during and after anaccident need to be worked out in operational terms and detailed in the document.

7.1.3 Identification of Toxic, Flammable, Explosive Chemicals

Toxic Chemicals: Chemicals having the following values of acute toxicity and which owing to their physical and chemical properties are capable of producing major accidents:

Flammable Chemicals: Flammable gases: Gases which at 200°C and at standard pressure of101.3 KPa are:-

Ignitable when in a mixture of 13 percent or less by volume with air, or have a flammable range with air of at least 12 percentage points regardless of the lower flammable limits.

Note: -*The flammability shall be determined by tests or by calculation in accordance with methods adopted by InternationalStandards Organization ISO Number10156 of 1990 or by Bureau of Indian Standards ISI Number 1446 of 1985.*

Extremely flammable liquids: chemicals which have flash point lower than or equal to 230C and boiling point less than 35°C

Very highly flammable liquids: chemicals which have a flash point lower than or equal to 230C and initial boiling point higher than 35°C.

Highly flammable liquids: chemicals which have a flash point lower than or equal to 600C but higher than 23°C.

Flammable liquids: chemicals which have a flash point higher than 60°C but lower than 90°C.

Explosives: Explosives means a solid or liquid or pyrotechnic substance (or a mixture of substances) or an article.

This is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings;

7.2 ON-SITE EMERGENCY PLAN

An onsite emergency is caused by an accident or hazard that takes place within the plant area and the effects are confined to the plant area.The onsite emergency plan consists of following key elements:

- Planning as per hazard analysis
- Preventive measures
- Emergency response procedure
- Recovery procedure

7.2.1 PLANNING

1. Mapping of hazard vulnerable area.
2. There shall be Disaster Management Cell in place.
3. The disaster management cell have following members to share the responsibility:

- Site Controller (Administrator of complex)
- Incident Controller (Asstt. Administrator)
- Personal Manager

- Communication Officer
- Fire Officer
- Security Officer
- Engineering In-charge
- Fire pump attendant
- First Aid Team

7.2.2 EARTHQUAKE

The project is situated at Seismic zone-IV area. Special attention shall be given to the structural design of foundation, elements of masonry, timber, plain concrete, reinforced concrete, prestressed concrete, and structural steel. All applicable guidelines will also be followed in this regard to ensure safety of the building.

7.2.3 FLOODING

To avoid flooding or water logging in the area due to the existing nearby low lying area.All the rain water will be diverted to rain water / storm water drain and extra water will be diverted in storm line of area

7.2.4 FIRE AND LIFE SAFETY

Safety Precautions

1. Smoking must be prohibited.
2. Vehicle access should be strictly controlled.
3. Fuel tanks, packaged materials shall be kept in separate rooms.
4. Ventilation must be sufficient to cope with the maximum expected vapor levels in building.
5. Storage tank vents to atmosphere should be sized for fire-heated emergency vapor release.
6. Electrical equipment must be explosion-proof to meet national electrical code requirements.
7. Dry chemical extinguishers should be accessible for small fires. An adequate supply of hand-held and wheeled types should be available.
8. Hydrants should be strategically placed with adequate hoses.
9. Small spills should be remediated with sand, earth, or other non-combustible absorbent material, and the area then flushed with water. Larger spills should be diluted with water and dyked for later disposal.

Precaution in case of Fire

- For proposed Common Bio-medical waste treatment, all practicable measures shall be taken to prevent outbreak of fire and its spreads, both internally and externally, to provide and maintain

a) Safe means of escape for all person in the event of a fire, and

b) The necessary equipment and facilities for extinguishing fire.

- Effective measures shall be taken to ensure that all the workers are familiar with the means of escape in case of fire and have been adequately trained in the routine to be followed in such cases.
- Fire Fighting Personal Protective Equipment.
- Due consideration must be given to hazards from chemical and heat exposure. Therefore, fire-fighters should wear full-face, positive pressure, self-contained breathing apparatus or an air-line. Chemical protection may be provided with impervious clothing, gloves and footwear. Suitable materials include polyvinyl plastic, neoprene or rubber.

7.2.5 CHEMICAL & HAZARDOUS MATERIAL

The only chemical used in the treatment is Sodium Hypo Chlorite (NaOCl) shall be used as disinfectant in Autoclaving. NaOCl is a highly reactive oxidizer. It is greenish-yellow in color with an odour similar to that of chlorine. Strength hypochlorite is often diluted prior to being injected into a water stream, in order to provide proper mixing and disinfection. When an insufficient amount of dilution water is used the hypochlorite can cause the pH to rise. If the dilution water is hard water, the rise in pH will result in calcium carbonate precipitation which will coat the inside of piping, valves and pumps. This scale deposit will tend to be greatest in areas of high turbulence. In order to prevent scaling use soft water.Besides it fuel HSD shall be used in Incinerator & D.G. Sets

Measures to be adopted while Chemical & Fuel Handling:

- Workers shall wash their hands thoroughly after handling.
- Fuels/chemicals shall be used only in a well-ventilated area.
- Workers shall use spark-proof tools and explosion proof equipment.
- Workers shall avoid contact with eyes, skin, and clothing.
- Container shall be kept tightly closed.
- Workers shall avoid contact with heat, sparks and flame.
- Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.
- Operator training as well as written operating instructions, safety rules and check lists shall be provided.

Protective protection:

Sources of Exposure -Human exposure to fuels can occur via absorption, contact with the eyes, inhalation or ingestion.

First Aid Measures

1. In case of fuel come in contact with the skin, remove contaminated clothing. Wash with soap and water for 15 minutes. Seek medical attention if irritation occurs.
2. In case of chemicals contact with the eyes, flush immediately with gently running water for a minimum of 15 minutes, ensuring all surfaces and crevices are flushed by lifting lower and upper lids. Obtain medical attention.
3. In case of inhalation of chemical's vapour, remove the individual to fresh air, but only if it is safe to do so. Asphyxiation from vapour may require artificial respiration. Due to the possibility of delayed onset of more serious illness, it is important to obtain medical attention.
4. Ingestion of chemicals is life threatening. Onset of symptoms may be delayed for 18 to 24 hours after ingestion. Do not induce vomiting. Transport to medical attention. The individual should remain under close medical care and observation for several days.

Chemical & Fuel Storage:

- Chemical/Fuel shall be kept away from heat, sparks, and flame. Keep away from sources of ignition. Store in a tightly closed container.
- Chemical/Fuel shall be stored in a cool, dry, well-ventilated area away from incompatible substances.
- Storage & handling area shall be readily accessible with safety showers, fire extinguishers and other fire-fighting equipment, water hydrants with spray nozzle and other emergency equipment such as chemical proof suits and respiratory apparatus.
- The flammable materials shall be stored in a separate safety storage room. Keep away from heat. Keep away from sources of ignition. Keep container tightly closed. Keep in a cool, well ventilated place.

Spills / Leaks: Spills will be absorbed with inert material (e.g. vermiculite, sand or earth), they will be placed in suitable container. All sources of ignition shall be removed and a spark-proof tool shall be used. Ventilation shall be provided and a vapour suppressing foam shall be used to reduce vapour.

TABLE 7.2: LIST OF HAZARDOUS MATERIALS

S. No.	Name of the Hazardous substance	Place of storage	State and operating pressure & Temp	Type of hazards possible	Control measures Provided
1.	Yellow Category waste (Human	Red storage room	Ambient Condition	Fire, Infection	1] Fire Extinguisher (CO_2,DCP) 2] PPE

	anatomical waste, animal waste, soiled waste etc.)	(plant area)			3] sand Bucket 4] Emergency provision for FireBrigade from outside source. 5] PPE shall be provided
2.	Red category Waste (microbiology & Biotechnology waste, tubing, catheters, intravenous sets etc.)	Yellow storage room (plant Area)	Ambient Condition	Fire, Infection	1] Fire Extinguisher (CO2,DCP) 2] PPE 3] sand Bucket 4] Emergency provision for Fire Brigade from outside source 5] PPE shall be provided
3.	Diesel	DG Room & Process Room	Ambient Condition	Fire	1]Fire Extinguisher (Foam) 2] Sand Buckets

Major accidental Release measures & measures for storage & handling

- The chemical/fuel shall be stored in a separate safety storage room, shall be kept away from sources of ignition.
- Proper ventilation should be maintained.
- Proper medical facility arrangement shall be provided in case of any accidental release.
- In case of leak or spill, ventilate area of leak or spill. Keep unnecessary and unprotected people away from area of spill. Wear appropriate personal protective equipment. Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. Do not contact with acids. Do not handle with bare hands.

Collection, development and dissemination of information

- Prior to working with these chemicals, workers should be trained on its proper handling & storage.
- Label Precautions and First Aid.
- Emergency plan shall be prepared and mock drill of the on-site emergency should be conducted
- Inspection of the CBWTF shall be done at least once in year and annually status report on the compliance with the Rules shall be submitted.
- **Mechanical:**

Mechanical hazards are created by powered operation of equipments or tools.Mechanical hazards can occur at:

1. Process machinery
2. DG set room
3. Vehicular Movement

Following preventive measures shall be taken:

1. Periodic replacement of critical components of machine.
2. Proper training to operators of machines.
3. There will be safe distance demarcation on heavy machines like cranes (during construction)
4. Sign of danger at the hazard places.

TABLE 7.3: PROCESS & VESSEL HAZARDS AND CONTROLS

S. No.	Name of Plant	Hazardous Process and Operation	Materials in the process/ operation with their quanity	Name of the vessel and its location	Operating Parameters	Type of Hazard Possible	Control Measures Provided
1.	Incineration Plant	Incineration	Yellow category waste	Primary Chamber and secondary chamber, Incineration area	Temp 850°C – primary chamber and 1200°C – secondary chamber		1] Fully Automatic 2]Emergency Local Stop 3] Fire Extinguisher (CO2) 4] PPE 5]Emergency Provision for Fire Brigade from outside source.
2.	Auto-clave	Sterilization	Red category waste	Autoclave	Temp. around 135°C & 2.2Kg/sq.cm pressure	Fire, Health Hazard	1] Fully automatic Computer based automation 2]Emergency Local Stop 3] PPE

- **Electrical:**

The electrical current can pass to the floor & metals due to inadequate insulation or accidently.

Electric spark can generate due to short circuiting in the electrical room

- **Thermal:**

Thermal hazards are objects or substances that transfer energy as heat. Incinerator is a thermal hazard for Bio Medical Waste processing.

The thermal hazard can cause burn of skin; following preventive measures can be taken:

1) Operators in the thermal hazard area shall be provided with protective gears like gloves, goggles etc.
2) For emergency first aid room will be maintained.

7.2.6 EMERGENCY RESPONSE PROCEDURE

Even after all the preventive measures for any emergency, following infrastructure shall be provided:

1. There will be an Emergency Control Room.
2. Assembly area shall be demarked for Industry.
3. Communication system shall be installed which includes intercom and public address system.
4. Fire alarm shall be installed at vulnerable place.
5. The safe zones (at the time of emergency) shall be displayed at different locations.
6. First Aid facility shall be made available at Control room.

In case of emergency following action shall be taken:

1. The emergency shall be declared in case of following:

I. Fire alarm buzzing (Fire hazard)
II. Vibration/Earthquake feeling (Earthquake)
III. Water logging above 30 cm from ground level (Flood)
IV. Any unusual smell of gas or suffocating feeling (Chemical leakage)
V. Security alarm from main gate. (Security risk/Terrorism)

2. On declaration of emergency, communication shall be made to residents
3. All the workers of the affected area shall be moved to safe zone
4. Control measures shall be taken as per the emergency action plan for each type of hazard.
5. All the members of disaster management cell shall take charge of their respective duties.
6. Outside help like fire tender, police, ambulance etc. shall be called by site controller or Incident controller.

Recovery Procedure

The recovery procedure will depend on the type of emergency. Recovery procedure shall be followed by engineering section to restore the essential services. The PLI (Public Liability Insurance) shall be done as a part of off/on site emergency plan.

7.3.1 OFF-SITE MANAGEMENT PLAN

If an accident takes place in unit & its impacts are felt outside its premises, the situation is called an "Off-site Emergency". To meet such Emergencies, an Off-site Emergency Plan is required to be prepared.

Cause of off-site emergency

In a Common Biomedical Waste Treatment Facility, the chemical & raw material storage room & handling area & transportation of the raw material may cause off- site emergency to occur.

Preventive Measures during Transportation

Transportation system with proposal of safety measures and appropriate waste handling system.There will be use of approx. 09 vehicles daily for transportation of bio-medical waste. These vehicles are for collection of bio medical waste from various medical establishments for 24 Hrs. The Vehicles shall be designed as per following CPCB norms:

- Separate cabins for driver/staff and the bio medical waste. There shall be provision of bulkhead between the driver's cabin and the vehicle body, which shall be designed to retain the load if the vehicle is involved in a collision.
- The base of the waste cabin shall be leak proof and is easy to wash and disinfect.
- The inner surface of the waste cabin shall be made of smooth surface to minimize water retention.
- The vehicles shall be properly labeled with the symbol of Biohazard as per schedule III of the Rules and display the name, address and telephone number of the Company.
- The waste cabin shall have provision for sufficient opening from rear side so that Biomedical Waste can be easily loaded and unloaded.
- The vehicles shall be provided with the first aid kit to handle emergency situations.
- Empty plastic bags, suitable protective clothing, cleaning equipment, tools, and disinfectant, together with special kits for dealing with liquid spills, shall be carried in a separate compartment in the vehicle.
- Vehicles or containers used for the transportation of biomedical waste shall not be used for the transportation of any other material. They shall be kept locked at all times, except when loading and unloading.
- Details of GPS system which shall be installed at all the transport vehicles

All the vehicles engaged in the collection and transportation of Bio Medical Waste from Health Care Establishments (HCE) shall be provided with Global Positioning System (GPS) to keep a track on the services rendered to the HCE. Reports will be generated on the routes covered by these

vehicles for proper planning and management of collection and transportation of Bio Medical Waste. Flagging system shall be provided with the GPS system to view the online coverage of all the routes of the vehicles.

During Storage & Handling

- A written procedure to handle and report needle stick injuries and other waste-handling incidents. Injuries caused by needle sticks and sharp instruments will be documented, reviewed, and changes implemented to prevent similar incidents in the future;
- The threshold limit for the storage of the chemical at any point of time shall not exceed.
- To prevent and control risk and damage, all the raw material shall be stored in leak proof polybags at a secured and contained location with proper safety measures.
- Handling is shall be done as per NIOSH guidelines
- There shall be no drainage lines or water bodies near the raw material storage & chemical or fuel storage room to avoid contamination of water up to long distances.

Emergency Response Procedure

Under the 'Manufacture, Storage and Import of Hazardous Chemicals Rules 'preparation of 'Off-site Emergency Plan' is covered in Rule No.14. The duty of preparing and keeping up to date the 'Off-site Emergency Plan' as per this rule is placed on the District Emergency Authority. Already so, occupiers are charged with the responsibility of providing the above authority with such information, relating to the industrial activity under their control, as they may require for preparing the off-site emergency plan.

As per the rules, the main component of the Off-Site Emergency Plan is coordination with the District Authority. The District Authority (i.e. District Collector, Factory Inspector etc.) in conjunction with the company & nearby industries under mutual aid scheme and relevant emergency services should have an off-site emergency plan considering the following:

- Incidents at the site including fires and/or explosions would likely cause concern among local population. Although, the unit does not fall in residential area & does not have any residential premises in the vicinity, the people will be advised to stay away from the area, and relevant actions shall be followed.
- In addition to company's own Emergency control center, the "local" external agencies will also be involved in the formulation of procedures for off-site incidents and in response to any incident;

Other external agencies that will also be involved in response to any incident are:

- Traffic Police;
- Fire services available with nearby industries;
- Civil Authority;
- Factory Inspector;
- State Pollution Control Board; etc.

The following aspects shall be addressed in any detailed response to an off-site incident:

- Organization: details of command structure, coordination arrangement, implementation procedures, emergency control centers. The organizational chart to deal with the emergencies (onsite & off site) is given ahead.
- Communication: identification of personnel involved, communication center, lists of telephone numbers (as given above) etc.
- Specialist Emergency Equipment; details of availability & location of heavy lifting gear bulldozers, specialized fire-fighting equipments;
- Specialist Technical Knowledge; details of organization or individuals whom it may be necessary to call e.g. for specialized chemical knowledge, impact knowledge etc.;
- Mutual Aid Scheme: details of companies in this scheme and available facilities with them & their phone nos.;
- Meteorological Information Sources; arrangements for obtaining details of weather conditions prevailing and weather forecast on regular basis;
- Humanitarian Arrangements; details of provisions for transport, evacuation routes and centers, food, treatment of injured etc.;
- Public Information; arrangements for dealing with the media, informing relatives of employees and local population;
- Incident Assessment; arrangements for collecting information on incident causes and reviewing the efficiency and effectiveness of all aspects of the emergency plan;

Efficient off-site incident planning also involves interaction on regular basis among various organizations. To ensure that every procedure put in place will run efficiently and effectively, exercise (mock drills) involving all the relevant organizations will be carried out. These will be monitored and assessed with procedures updated to reflect knowledge gained;

Roles & Responsibilities of External Agencies

The roles of the various parties that may be involved in the implementation of an off-site plan are described below:

A) Role of the Police

- Protecting life and property and controlling traffic movements.
- Controlling bystanders, evacuating the public, identifying the dead and dealing with casualties and informing relatives of dead or injured.

B) Role of the Fire Authorities

- The control of a fire is normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site.
- Fire authorities having major hazard works in their area should have familiarized themselves with the location on site of all stores of flammable materials, water and foam supply points and firefighting equipment.

C) Role of the Health Authorities

- Health authorities, including doctors, surgeons, hospitals, ambulances and so on, have a vital part to play following a major accident and they should form an integral part of any emergency plan.

D) Roles of the Government Safety Authority

- In the event of an accident, local arrangements regarding the role of the factory inspector will apply.
- In the aftermath, factory inspectors may wish to ensure that the affected areas are rehabilitated safety.

Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 prescribes for the constitution of the State Crisis Group as apex body at the State Level to deal with major chemical accidents and to provide expert guidance for handling major chemical accidents and for the constitution of District and Local Crisis Groups.

A. Functions of the State Crisis Group

i. Review all district off-site emergency plans in the State with a view to examine its adequacy in accordance with the Manufacture, Storage and Import of Hazardous Chemical, Rules and forward a report to the Central Crisis Group once in three months;
ii. Assist the State Government in the planning, preparedness and mitigation of major chemical accidents at a site in the State;
iii. Continuously monitor the post-accident situation arising out of a major chemical accident in the State and forward a report to the Central Crisis Group;
iv. Review the progress report submitted by the District Crisis Groups;

B. Functions of the District Crisis Group

i. Assist the preparation of the district off-site emergency plan;

ii. Review all the on-site emergency plans prepared by the occupier of Major Accident Hazard's installation for the preparation of the district off-site emergency plan;

iii. Assist the district administration in the management of chemical accidents at a site lying within the district.

iv. Ensure continuous information flow from the district to the Centre and State Crisis Group regarding accident situation and mitigation efforts;

v. Forward a report of the chemical accident to the State Crisis Group; and Conduct mockdrill of a chemical accident at a site each year.

C. Functions of the Local Crisis Group

i. Prepare local emergency plan for the industrial pocket;

ii. Ensure dovetailing of the local emergency plan with the district off-site emergency plan;

iii. Train personnel involved in chemical accident management;

iv. Conduct at least one full scale mock-drill of a chemical accident at a site every six months and forward a report to the District Crisis Group; and

v. Respond to all public inquiries on the subject

Recovery Procedure

The recovery procedure will depend on the type of emergency. Recovery procedure shall be followed by engineering section to restore the essential services. The PLI (Public Liability Insurance) shall be done as a part of off/on site emergency plan.

Emergency Control Team

KEY PERSONNEL

The key Personnel involved in Emergency (Onsite & Offsite) are given below:

1. Emergency Controller – Plant Head
2. Incident Controller
3. Security Supervisor
4. HOD – Utility & EHS
5. Safety Officer
6. Fire fighter
7. Evacuation members [Emergency Response Team (ERT) Members]
8. First Aid provider
9. Rescue members

7.3.2 OCCUPATIONAL HEALTH & SAFETY

Workers handling and disposing biomedical waste are at potential risk of exposure to infection from sharps related accidents or when containers of waste burst, open and leak, or spills of certain waste materials occur. Exposure to a needle or other sharp object contaminated with the blood of an infectious person presents the greatest potential risk for transmission of HBV, HIV, and other blood borne pathogens to the health-care worker and waste handler.

Action plan for the implementation of OHS standards as per OSHAS shall be followed as given below:

- Occupational health surveillance programme shall be done six monthly & and their records are being maintained.
- Company will take reasonable steps to reduce the risk of exposure to infection by establishing written policies and procedures based upon the most currently accepted clinical and occupational health and safety information in consultation with workers, handling and disposing of biomedical waste. These policies and procedures will be reviewed and updated regularly, with compliance to their requirements verified as necessary.
- Regular assessment of waste management procedures shall be done to assure compliance with applicable standards
- A written procedure to handle and report needle stick injuries and other waste-handling incidents shall be there. Injuries caused by needle sticks and sharp instruments will be documented, reviewed, and changes implemented to prevent similar incidents in the future;
- Emphasize the need for point of generation segregation so that waste shall be placed within an appropriate waste container.
- Type and quality of waste containers will be review regularly, if necessary it will be upgraded to more suitable container;
- Handling practices will be reviewed regularly to determine problems of inappropriate handling. If so, modify the handling techniques. At project site in case of emergency First Aid facility shall be provided.
- Health check-up camps shall be organized on regular basis at company dispensary / nearby locations.
- Prior to working with bio-medical, workers shall be trained on its proper handling & storage.
- To educated/ train the workers for MSDS & handling of these chemicals.
- Proper medical facility arrangements shall be provided in case of any accidental release.
- ESI facility shall be made available.

- Proper fire-fighting measures like buckets & portable fire extinguishers shall be provided at strategic locations.
- Emergency plan shall be prepared and mock drill of the on-site emergency shall be conducted.
- Employers and employees shall be made aware of the hazardous properties of materials in their workplaces, and the degree of hazard each poses. Inspection of the treatment facility shall be done at least once in year and annually status report on the compliance with the Rules is being submitted.
- It shall be made sure that waste haulers and handlers will always be proper clothed and wear personal protective equipment so that harmful agents, whether physical, chemical, or infectious, are prevented from gaining access to open wounds, cuts, or by absorption through the skin. Personal protective equipment may include cut proof gloves, gowns, safety glasses, protective footwear, etc.
- A course of Hepatitis B (HBV) vaccine will be offered to all employees dealing with handling and disposing of biomedical waste who are at risk of exposure to human blood, blood products, or body secretions.
- A safety officer / environmental officer shall be recruited and lead all the safety issues related to man, machine & materials.
- Exterior refuge or safe areas shall be located away from the site of the emergency and which provides sufficient space to accommodate the employees.
- Public Liability Insurance Act, 1991 shall be followed.

7.3.3 PERSONAL PROTECTIVE EQUIPMENT

The level of risk of exposure to particular chemical will dictate the appropriate level of personalprotective equipment (PPE) required, provide wearing side shielded safety spectacles and appropriate gloves, footwear, and face shields, respiratory protection, fire-resistant clothing, or chemical suits.

- Respirators: A complete respiratory protection program has been instituted. It includes evaluations of workers' abilities to perform tasks while wearing CPC, Regular training of personnel, fit testing, Periodic environmental monitoring, Regular maintenance, inspection, and cleaning.
- Clothing: Workers wear appropriate protective clothing to prevent skin exposure.
- Skin Protection: Workers wear solvent resistant gloves and clothing.

- Eye Protection: Workers wear splash proof chemical goggles and face shield when working with liquid, unless full face piece respiratory protection is worn.
- Eyewash facility and a safety shower: Common work places are equipped with Eyewash facility and a safety shower.

7.3.4 WORKER HEALTH CHECKUP PLAN

Company shall conduct pre-employment and post-employment medical tests for its employees besides various educative and awareness programs on health and safety. A full time medical assistance center will be made available to its employees to carry out any first aids.

7.3.5 SAFETY, HEALTH AND ENVIRONMENT (SHE) MANAGEMENT PLAN AND TEAM

The company has a written policy for the safety, Health and Environment Management. Through this policy, the company management commits itself to the following objectives.

- Meet all the relevant laws, regulations and international agreements
- Conduct its activities safely, protecting the health of all employees and the products users
- Reduce the adverse environmental impacts to a practicable minimum at an acceptable cost to the company and society
- Encourage continuous improvement in safety, health and environment performance

7.3.6 SOCIAL IMPACT ASSESSMENT, R&R ACTION PLAN

No rehabilitation and resettlement is applicable for this project.

7.4 GEOLOGY & TOPOGRAPHY STUDIES

7.4.1 Geology

7.4.1.1 Topography

The topography of project site is flat and elevation is 177 meter. The buffer of 10km radius area minimum elevation is 168 meter in E direction and maximum elevation is 183 meter in W direction. The topography of district exhibits a flat topography with a few gentle undulations. Physiographical district occupies a part of Ganga Yamuna Doab, in which Ganga river traverses through the geophysical control of the district in the direction from north to south. The tributaries of Ganges viz., river Kali and river Bhuri Ganga provide most of the fertile patch to the district with the transference of the younger alluvium.

Geography/ Geomorphology

The area is part of the western fringe of Ganga alluvial plain and slopes gently towards east and along the drainage lines. The following geomorphological units have been delineated. Two main geomorphic units identified in the district are:

1. Younger Alluvium Plain

2. Older Alluvium Plain

1 Younger Alluvium Plain: Younger alluvium plain is mainly restricted to present river course and mainly represented by sand and loam. It is further divided into (a) Present flood plain and (b) Old flood Plain. The present flood plain has two main land forms i.e. present river course and sand plain sand bar. Similar the old flood plain is characterized by flowing land forms which are represented by loamy sand. The land forms are:

i. Abandoned Channel

ii. Meandering Scar

iii. Black- swamp

2 Older Alluvium Plain: This unit is mainly characterized by yellow clay, kankar and Reh. It is represented by following land forms.

i. Alluvium plain

ii. Salt affected plain

iii. Water logged plain

The maximum area of the district falls under these land forms.

Regional & Local Geology

The entire tract along the Ganga is a fertile land which has brought agricultural prosperity in Kasganj tehsil. The geology of the district belongs to Recent. The main sub-order associations of soils are Psamments – Fluvents-Aquents, Orhrepts–Psamments, Ochrepts- Orthents-Rock outcrops–and Ochrepts- Aquepts- Ustalfs. There are no forests in the district. On the basis of factors like geology, soils, topography, climate and natural vegetation, the district has been divided into following five sub-micro regions.

Ganga Khadar: The region extends parallel to the Ganga River in elongated shape in east- west side. It is a Khadar tract demarcated by high bluff from south. The Burhi Ganga is an offspring of the Ganga River, which originates from the Ganga and after flowing parallel in the region again joins the main stream just beyond the region. Actually it is not a separate stream but the old course of Ganga River which has shifted. This left course channel has been renamed as Burhi Ganga. There are numerous pockets of bhur and small water bodies. The Ganga is the main constraint for the development of roads and canals. The geology of the district belongs to Recent. The main sub-order soil associations are Psamments- Fluvents-Aquents, Ochrepts- Psamments, Ochrepts- Orthents Rock out crops and Ochrepts-Aquepts-Ustalfo, There are few local roads,

which connect the places within the region. The highways and rail pass through the area and cross the Ganga at Kachhhia. The settlements in general are scattered. Ganj Dundwara, Soron and Sahawar are the important places in this area.

Middle Kali Plain: The region covers the catchments area of Kali Nadi which drains in the middle of the region. It is more wide in Kasganj and Patiyali tahsils and narrow towards Aliganj. The slope is towards eastern side. The upper course is known as Nim, Karon, is the other tributary of Kali. Besides there are number of small rivulets which join the Kali on both sides but they are dry in most part of the year. Small patches of bhur are spread over in the region. The geology of the region belongs to Alluvium, Dun Gravels (Recent). The main soil sub-order association is Ochrepts-Orthents-Rock outcrops. Since it is flat plain, transport and irrigation system are very developed. There are number of major roads which connect the important places of region. Cart tracts and foot-paths join the rural areas. Agriculture is the main occupation which is supported by the Lower Ganga canal system. The important places situated in this region are Kasganj, Bilram, Amanpur, Mohanpur, Sidhpura.

Stratigraphic sequence:-

Stratigraphically the quaternary alluvium is built up of alternate layers of sand and clay with occasional interbeds of kankar which were deposited on the eroded and upturned surface of bhander limestone of the upper Vindhyan group of upper proterozoic age.

Quarternary- alluvium-alternate layers of sand and clay with occasional interbeds of kankar.

---------- UNCONFORMITY ----------

Upper Vindhyan- Greenish grey dolomitic limestone, reddish brown quartz arenite, grayish brown shale, reddish broen argellacious limestone, quartz wacke & quartz arenite,

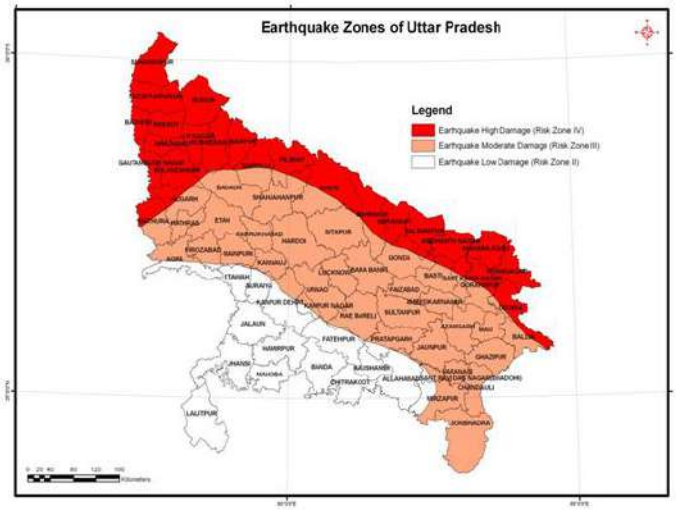
---------- UNCONFORMITY ----------

7.4.1.2 Sesimology

Kasganj falls in seismic zone IV which makes it high at risk in regards to earthquakes. However No major earthquake has occurred in Kasganj in recent years, also the site does not include any buildup area or bridges, so it makes the project site area less risky towards the earthquake, according to the Indian Standard Seismic Zoning Map. Suitable seismic coefficients in horizontal and vertical directions respectively will be adopted.

FIGURE NO. 7.1 SEISMIC ZONES OF INDIA

FIGURE NO. 7.2 SEISMIC ZONES OF UTTAR PRADESH



Earthquake History

Most of the state of Uttar Pradesh lies in the Gangetic Plain. This is a fore-deep, a downwarp of the Himalayan foreland, of variable depth, converted into flat plains by long-vigorous sedimentation. This is known as a geosyncline and the Gangetic Plain is the Indo-Gangetic Geosyncline. This has shown considerable amounts of flexure and dislocation at the northern end and is bounded on the north by the Himalayan Frontal Thrust. The floor of the Gangetic trough (if see without all the sediments) is not an even plain, but shows corrugated inequalities and buried ridges (shelf faults). Beneath Uttar Pradesh, run the Delhi-Haridwar Ridge (DHR), trending NNE-SSW along New Delhi to the Gharwal region. The Delhi-Muzaffarnagar Ridge (DMR), which trends east to west, running from New Delhi to Kathgodam, in Nepal. The last ridge is the Faizabad ridge (FR), which runs in a curved manner, first east to west from Allahabad to Kanpur and then starts to bend towards the north-east towards Lucknow and carries on in this direction towards the Himalayas in Nepal. The depression that forms between the DMR and the FR, forms the West Uttar Pradesh shelf in the west and the Sharda Depression in the east. The region to the south of the FR, forms the East Uttar Pradesh shelf. There are several faults in the region, among them the Moradabad Fault which trends NE-SW and the Bhairwan Fault in the vicinity of Allahabad. Apart from these there are east-west running tear faults in the region that control the courses of the main rivers. Earthquakes have occurred in mostly all parts of Uttar Pradesh. Major earthquakes in the neighbouring states of New Delhi, Uttaranchal, Bihar and from across the Indo-Nepal border have also shaken many parts of Uttar Pradesh. However, it must be stated that proximity to faults does not necessarily translate into a higher hazard as compared to areas located further away, as

damage from earthquakes depends on numerous factors such as subsurface geology as well as adherence to the building codes.

IMPACT OF GEOLOGY

The new construction is always expected to have impacts on surround environment land use directly or indirectly based on quantum of area under construction. The possible impacts identified on topography and geology of the area will occur due to land grading, cutting, excavation of the earth work for making road, work shed related civil construction activities etc.

MITIGATION MEASURES

There is no heavy construction work envisaged. Hence, the following is the measures to minimize the impact on land environment.

- The installation activities include excavation of soil from the proposed site.
- The excavated loose soil will be utilized for leveling of low lying areas inside the plant. Thus, the impact on topography during construction phase is insignificant.
- There are no geological structures identified in the project area.
- The strata is competent to bear the construction proposed.

Hence there will be no significant impact from changing the land topography on account of geology.

7.5 Hydrogeology

Block Name	Soron (As per CGWA Classification)
Category of Block	Safe (Non-Notified)
Water Demand	5KLD

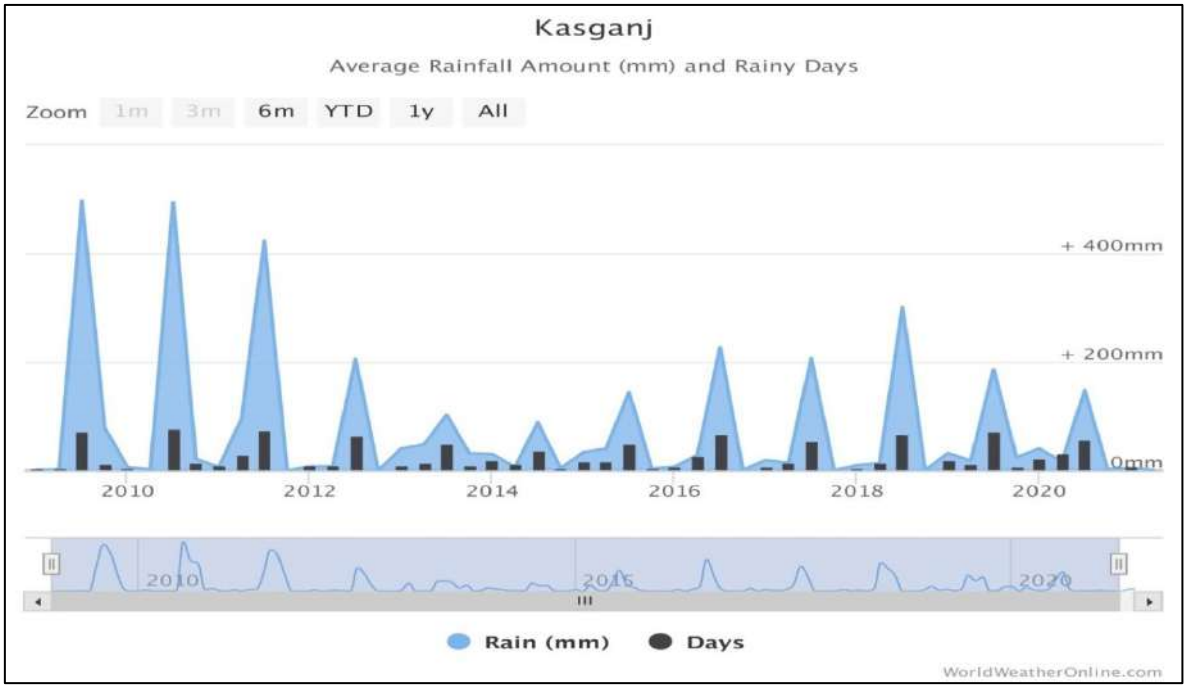
Rainfall

The average annual rainfall is 722.40 mm. The climate is sub-tropical humid and it is characterized by a hot dry summer and a pleasant to extreme cold season. About 88% of rainfall takes place from June to September. During the monsoon surplus water is available for deep percolation to ground water. The pre monsoon depth of water level is 3.11 to 10.24 mbgl and in post monsoon it reaches to 2.58 to 9.79 mbgl. **(Source-District Survey Report)**

TABLE NO. 7.4 AVERAGE RAINFALL DATA OF 10 YEAR (2011-2020)

Sr. No.	Year	Total Rainfall (MM)	Average Rainfall (MM)
1	2011	1578.37	131.53
2	2012	662.35	55.20
3	2013	669.16	55.76
4	2014	391.09	32.59
5	2015	670.13	55.84
6	2016	791.32	95.94

7	2017	724.00	60.33
8	2018	977.02	81.41
9	2019	786.20	65.52
10	2020	626.00	52.16
Total Average Rainfall (MM)			**686.28/10 = 68.628 say 69**
Source: www.worldweatheronline.com			



Surface water:

The chief rivers of the district are the Ganga the Burhi Ganga, the Kali Nadi, the Isan, the Rind, the Sengar and the Bagarh.

Ganga: The Ganga forms for about 74 km. the northern boundary of the district flowing in south – easterly direction. The river flows at a distance varying from 5-15 km from its old high bank

Burhi Ganga: The former bed of the Ganga is marked by Burhi Ganga which enters the district in the northwest corner and flows south-east wards at a considerable distance from the old high bank which is locally known as the pahar

Kali Nadi: The Kalinadi or Kalinadi as it is often called locally flows to the south of the Burhi Ganga at a distance of 11 to 27 km. entering the Kasganj district from the Aligarh in the northwest its general trend is to the south-east. The valley through which the river flows is deep and about 5 km in width

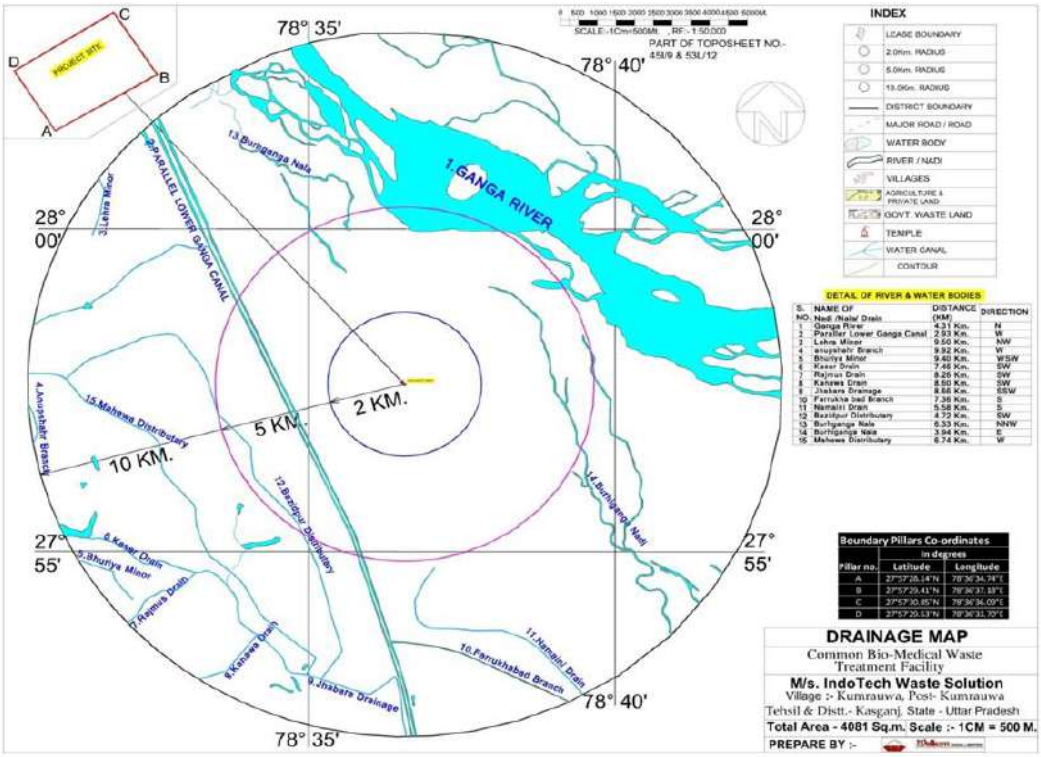
Surface water in the study area :-

TABLE NO. 7.5 SURFACE WATER IN 10 KM. RADIUS

Sr. No.	River/ water body	Distance Km	Direction
1	Ganga River	4.31	N
2	Paraller Lower Ganga Canal	2.93	W

3	Lehra Minor	9.50	NW
4	Anupshar Branch	9.92	W
5	Bhuriya Minor	9.40	WSW
6	Kasar Drain	7.46	SW
7	Rajmus Drain	8.26	SW
8	Kanawa Drain	8.60	SW
9	Jhabara Drainage	8.66	SSW
10	Farrukha bad Branch	7.36	S
11	Namaini drain	5.58	S
12	Bazidpur Distributary	4.72	SW
13	Burhganga Nala	6.33	NNW
14	Burhiganga Nala	3.94	E
15	Mahewa Distributary	6.74	W

FIGURE NO. 7.3 DRAINAGE MAP OF 10 KM. RADIUS



Ground water:

Occurrence of Ground Water: The ground water occurs in the pore spaces of unconsolidated alluvial sediments in the zone of sedimentation. The top silty/ sandy clay beds mixed with kankar support the dug-wells where ground water occurs under water table conditions. The ground water in the deeper aquifers occur in semi confined to confined conditions.

Ground Water Resources:

Precipitation is the main source of ground water recharge in the district. The quantity of recharge depends upon the intensity and duration of rainfall, nature and texture of soil, vegetation cover and land use pattern of the area.

The other sources which replenish the ground water are as under

1. Seepage from canal system
2. Return flow from applied irrigation
3. Sub surface in flow from adjoining area
4. Influent recharge from the river system

Status of Ground Water Development

Ground water development should take place in those blocks only where the stage of ground water development falls under safe category

TABLE NO. 7.6 BLOCKS FALLING UNDER SAFE CATEGORY, KASGANJ DISTRICT, UP

S. No.	Name of Block	Category of Block
1	Amanpur	Safe
2	Ganjdundwara	Safe
3	Patiyali	Safe
4	Sahawar	Safe
5	Sidhapura	Safe
6	**Soron**	**Safe**
7	Kasganj	Over Exploited

However, further development of ground water should be done judiciously in Kasganj block as to sustain the safe category and the ground water development should be completely restricted/ regulated in the Kasganj.

Water Conservation and Artificial Recharge

Artificial recharge structures (Rainwater Harvesting) may be developed in study area to recharge the aquifer for improving the ground water scenario in the block and also for improving the category of the block.

Surface Water Quality:

Surface water quality had been assessed by3 sample of surface water Ganga River Upstream, Ganga River Downstream and Parallel Lower Ganga Canal. The other samples were collected as grab sampling from different ponds/Nalla/water body within the impact zone. The details of sampling locations and analysis reports are given below:

TABLE NO. 7.7 DETAILS OF GROUND WATER SAMPLING LOCATION AND ANALYSIS REPORTS

Sr. No.	Parameter	Unit	Ganga River Upstream (SW)	Ganga River Downstream (SW)	Parallel Lower Ganga Canal (SW)
1.	pH	-	7.11	7.18	7.29
2.	EC	**µs/cm**	213.3	223.1	239.7
3.	Color	**Hazen**	<5	<5	<5
4.	Odour		Agreeable	Agreeable	Agreeable
5.	Turbidity	**NTU**	0.5	0.5	0.7
6.	TDS	**mg/l**	122	128	156
7.	Hardness	**mg/l**	80	86	98
8.	Calcium	**mg/l**	17.6	18.4	24.8
9.	Magnesium	**mg/l**	9.6	9.6	8.6
10.	Alkalinity	**mg/l**	74	78	82
11.	Chloride	**mg/l**	11	12	14
12.	Fluoride	**mg/l**	0.2	0.2	0.2
13.	Sulphate	**mg/l**	7.8	9.3	14.8
14.	Nitrate	**mg/l**	1.2	1.4	2.1
15.	Sodium	**mg/l**	11.8	12.8	19.2
16.	Potassium	**mg/l**	2.4	2.7	2.6
17.	Phosphate as PO4	**mg/l**	(<0.1) BDL	(<0.1) BDL	0.10
18.	Zinc	**mg/l**	(<0.01) BDL	(<0.01) BDL	(<0.01) BDL
19.	Lead	**mg/l**	(<0.01) BDL	(<0.01) BDL	(<0.01) BDL
20.	Iron	**mg/l**	(<0.1) BDL	(<0.1) BDL	(<0.1) BDL
21.	Cadmium	**mg/l**	(<0.01) BDL	(<0.01) BDL	(<0.01) BDL
22.	Mercury	**mg/l**	(<0.001) BDL	(<0.001) BDL	(<0.001) BDL
23.	Boron	**mg/l**	(<0.1) BDL	(<0.1) BDL	(<0.1) BDL
24.	Copper	**mg/l**	(<0.1) BDL	(<0.1) BDL	(<0.1) BDL
25.	Arsenic	**mg/l**	(<0.01) BDL	(<0.01) BDL	(<0.01) BDL
26.	Chromium	**mg/l**	(<0.02) BDL	(<0.02) BDL	(<0.02) BDL
27.	Cyanide	**mg/l**	(<0.01) BDL	(<0.01) BDL	(<0.01) BDL
28.	DO	**mg/l**	7.8	7.3	7.0
29.	BOD	**mg/l**	1.9	2.2	2.5
30.	COD	**mg/l**	(<5) BDL	8.3	8.3

FIGURE NO. 7.4 GANGA RIVER SURFACE WATER SAMPLE

Ground water Quality:

The quality of ground water is good in shallow aquifers except in Soron block where EC, Th., are more than permissible limits. The quality of deeper aquifer is not suitable for drinking purposes at places. It is observed that the ground water is suitable for drinking and domestic uses.

Ground water quality had been assessed by selecting 8 sampling stations in impact zone. The details of sampling locations and analysis reports are given below:

TABLE NO. 7.8 DETAILS OF SURFACE WATER SAMPLING LOCATION AND ANALYSIS REPORTS

Sr. No.	Parameter	Unit	Project site(GW)	Nagla Jaisiya (GW)	Takharu (GW)	Gohati (GW)	Kaindi (GW)	Pachlana (GW)	Kamraua (GW)	Sirawali (GW)
1.	pH	-	7.15	7.10	7.28	7.08	7.22	7.03	7.17	6.96
2.	EC	**µs/cm**	803.2	739.4	343.2	1079	337.9	414.6	486.4	560.4
3.	Color	**Hazen**	-	-	-	-	-	-	-	-
4.	Odour		Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5.	Turbidity	**NTU**	0.4	0.3	0.5	0.4	0.4	0.5	0.6	0.4
6.	TDS	**mg/l**	510	456	216	706	208	272	322	370
7.	Hardness	**mg/l**	316	290	160	388	144	196	232	284
8.	Calcium	**mg/l**	78.4	88.8	48	110.4	45.6	56	59.2	70.4
9.	Magnesium	**mg/l**	28.8	16.3	9.6	26.9	7.2	13.4	20.2	25.9
10.	Alkalinity	**mg/l**	280	360	218	300	198	192	202	276
11.	Chloride	**mg/l**	38	34	16	74	18	16	38	20
12.	Fluoride	**mg/l**	0.4	0.5	0.3	0.5	0.3	0.3	0.4	0.4
13.	Sulphate	**mg/l**	27.4	54.7	11.2	73.2	11.9	14.1	11.2	13.8
14.	Nitrate	**mg/l**	3.3	5.5	2.4	3.8	3.8	1.7	2.9	1.7
15.	Sodium	**mg/l**	74.2	83.4	17.9	108.4	24.8	41.6	36.1	40.6
16.	Potassium	**mg/l**	5.1	7.6	4.2	6.4	4.4	4.8	5.1	4.9
17.	Phosphate as PO4	**mg/l**	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)
18.	Zinc	**mg/l**	0.11	(<0.01)	(<0.01)	0.10	(<0.01)	(<0.01)	(<0.01)	0.11
19.	Lead	**mg/l**	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
20.	Iron	**mg/l**	0.10	0.18	(<0. 1)	0.12	0.14	(<0. 1)	0.11	(<0.1)
21.	Cadmium	**mg/l**	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
22.	Mercury	**mg/l**	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)
23.	Boron	**mg/l**	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)
24.	Copper	**mg/l**	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)	(<0.1)
25.	Arsenic	**mg/l**	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)
26.	Chromium	**mg/l**	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)	(<0.02)
27.	Cyanide	**mg/l**	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)	(<0.01)

FIGURE NO. 7.5 GROUND WATER SAMPLE

	
Village- Kumraua (GW)	**Village- Pachlana (GW)**

Water Requirement for Project:

During Construction phase water requirement will be approx. 2 KLD

(Source- Water Tankers)

During Operational Phase water requirement will be approx. 5KLD.

(Source- Bore Well & External Water Tankers)

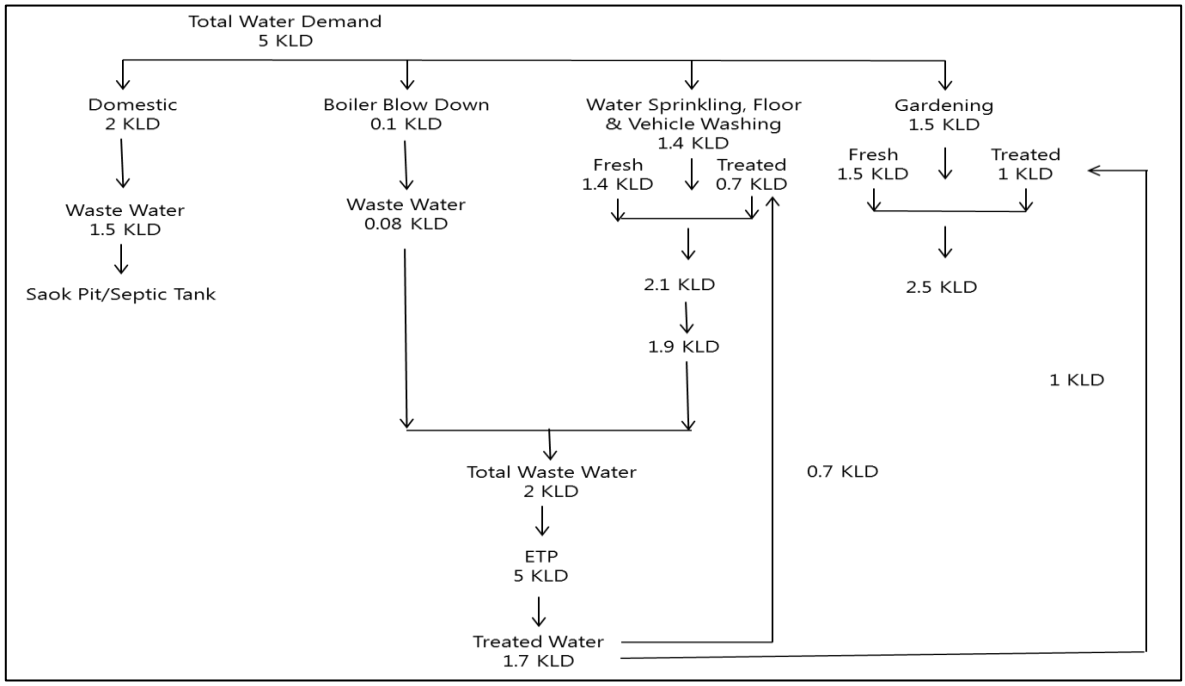
The amount of total waste water generated out of proposed CBWTF is 2 KLD which shall be treated in 5 KLD ETP. It will be a Zero Liquid Discharge Unit.

Details of water consumption for the proposed activity are given in Table below:

TABLE NO. 7.9 WATER BALANCE FOR OPERATION PHASE

S. No.	Activity	Total Water	Treated Water (Requirement)	Discharge to ETP
1.	Floor & Vehicle Washing, Water Sprinkling	1.4KLD	0.7 KLD	1.9 KLD
3.	Boiler Blow down	0.1 KLD	-	0.08 KLD
4.	Domestic use	2 KLD	-	Sent to Soak Pit/Septic Tank
5.	Gardening	1.5 KLD	1 KLD	-
Total		**5 KLD**	**1.7 KLD**	**2 KLD**

FIGURE NO. 7.6 WATER BALANCE DIAGRAM



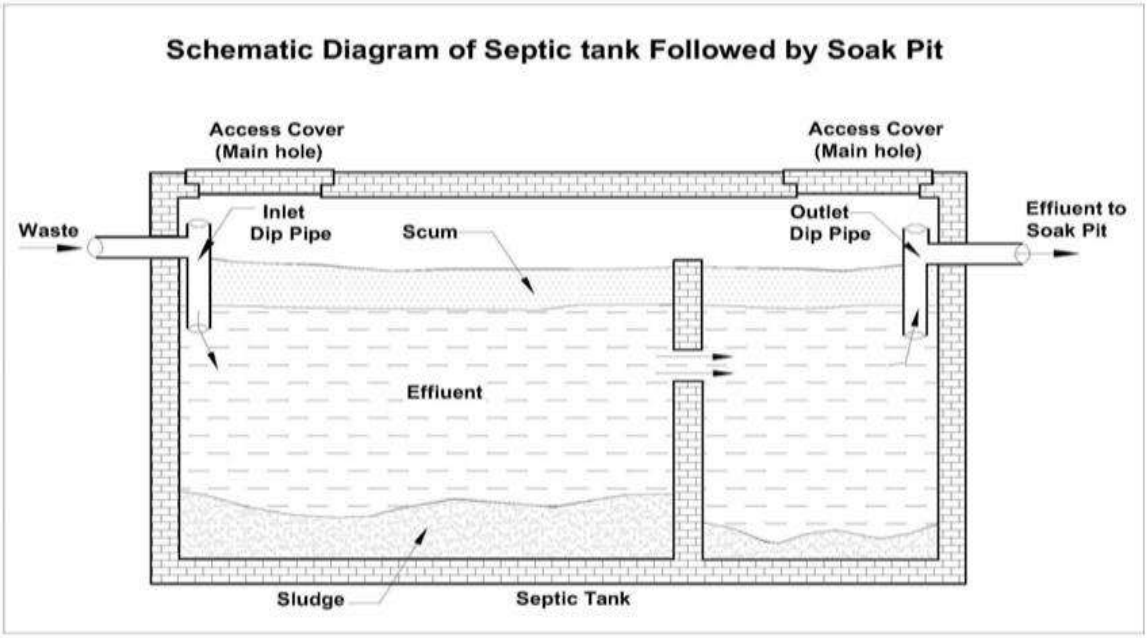
Tank Capacity:

The size of the tank must be suitable for the number of people that intend to use it, so

C = 42P + 2000
C = (42 X 30) + 2000
= 3260 liters (for 1 year)
C = Capacity of the tank in liters
P = The Population served

a) Construction of Tanks, Soak Pits etc. with diagram.

FIGURE NO. 7.7 SOAK PIT



Impact & Mitigation measures of Hydro-geology

Impact: Following are the impacts identified on HG due to proposed project as Kashganj district is flat and elevation is 177 meter, as below:

- Proposed project is for Bio-medical waste plant and belongs to polluting industry (Red Category) and as per CGWA Public Notice, only rooftop rainwater harvesting is envisaged.
- Hence, in order to prevent pollution of ground water due to recharge, it has been decided that such industries which are likely to contaminate groundwater, shall conserve roof top rain water only by constructing storage tank on the surface and shall not recharge within the premises.
- Sort term negative impacts due to water consumption & sewage disposal are envisaged due to the proposed project.
- The wastewater generation will be from the domestic and industrial activities. It will be properly treated.

Mitigation Measures: Following mitigation measures are suggested to be adopted in construction and operational phase, given as below:

- Water requirement for construction phase will be very limited and for short period only. Thus, there will not be any significant impact on water environment.
- Domestic effluent will be disposed of through septic tank into soak pit.
- Greenbelt development will have positive impact on ground water table and treated water will be preferably used for greenbelt development.
- Measures will be implemented to prevent seepage of liquid materials into ground where it could contaminate groundwater and soil.
- Ensure prompt cleaning up of accidental spillages measures will be followed to prevent the contamination of hydrological features by diesel, grease, oil, etc. derived from the working area.
- Provisions will be made to ensure the construction vehicles stick to the access track to prevent mud & dirt being deposited on roads.
- Fence will be constructed around the site to trap sediments from runoff water.
- Separate drainage will be proposed for storm water and for sewage to avoid run off contamination as well as any contamination of surface water sources.

- Rainwater harvesting will be proposed and recharge the ground water as well as rain water will be reuse in project premises so overall water demand will be reduced as per CGWA.
- Drip irrigation system will be provided for landscaping to reduce fresh water demand.

Rooftop Rainwater Harvesting Structures

The storm water disposal system for the premises shall be self-sufficient to avoid any collection/stagnation and flooding of water. The amount of storm water run-off depends upon many factors such as intensity and duration of precipitation, characteristics of the tributary area and the time required for such flow to reach the drains. The drains shall be located near the carriage way along either side of the roads. Taking the advantage of road camber, the rainfall run off from roads shall flow towards the drains. Storm water from various areas/shall be connected to adjacent drain by a pipe through catch basins. Therefore, it has been calculated to provide 3 rainwater storage tanks for rooftop water collection only at selected locations:

1) Since the existing topography is congenial to surface disposal, a network of storm water pipe drains is planned adjacent to roads. The building roof water will be brought down through these pipes.
2) Proposed storm water system consists of pipe drain, catch basins and seepage pits at regular intervals for rain water recharging and ground water recharging.
3) Peak Hourly rainfall of 90 mm/hr has been considered for designing the storm water drainage system. Rain water recharging has been catered to and designed as per the guidelines of CGWA.

The bottom of the recharge structure will be kept 5 m above the ground water level. At the bottom of the recharge well, a filter media is provided to avoid choking of the recharge bore. Design specifications of the rain water recharging plan are as follows:

- Catchments/roofs would be accessible for regular cleaning.
- The roof will have smooth, hard and dense surface which is less likely to be damaged allowing release of material into the water. Roof painting shall be avoided since most paints contain toxic substances and may peel off.
- All gutter ends will be fitted with a wire mesh screen and a first flush device would be installed. Most of the debris carried by the water from the rooftop like leaves, plastic

bags and paper pieces will get arrested by the mesh at the terrace outlet and to prevent contamination by ensuring that the runoff from the first 10-20 minutes of rainfall is flushed off.

- No sewage or wastewater would be admitted into the system.
- No wastewater from areas likely to have oil, grease, or other pollutants has been connected to the system.

Based on the site plan of the project area, the computation of annual runoff of entire project premises has been worked out and the details are tabulated below in Table (7.7) & (7.8).

TABLE NO. 7.10 ANNUAL RUNOFF FROM ENTIRE PROJECT

S. No.	Particulars	Area (Sqm)	Rain fall (m)	Runoff Coefficient*	Quantum of Run off available (Cum/Year)
	1	2	3	4	5 (2*3*4)
1	***Roof Top of building/Shed/**	**1165**	**0.069**	**0.85**	**68.32725**
2	Road/Paved area	1080	0.069	0.65	
3	Open Land	1347	0.069	0.20	
4	Green Belt	489	0.069	0.15	
5	**Total (sqm)**	**4081**		**Total Quantum of available runoff (cum/y)**	**68.32725**
*** Ref: Manual of Artificial Recharge of Ground Water, (CGWB,2007)**					
***Note: As per CGWA guidelines, in the bio-medical waste projects, only roof top rainwater harvesting is considered for calculation.**					

From the above computation, it is evident that a total quantum nearly of 68.3272 m^3 of rainwater can be generated annually. In order to design the recharge structure, hourly runoff of 90 mm/hr has been taken into account and the details are given below in Table (7.8)

TABLE NO. 7.11 RAIN WATER QUANTITY CALCULATIONS

S. No.	Particulars	Area (Sqm)	Rain fall (m)	Runoff Coefficient*	Quantum of Run off available (Cum/Year)
	1	2	3	4	5 (2*3*4)
1	***Roof Top of building/Shed/**	**1165**	**0.069**	**0.85**	**68.32725**
2	Road/Paved area	1080	0.069	0.65	
3	Open Land	1347	0.069	0.20	
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5	**Total (sqm)**	**4081**		**Total Quantum of available runoff (cum/y)**	**68.32725**
*** Ref: Manual of Artificial Recharge of Ground Water, (CGWB,2007)**					

***Note: As per CGWA guidelines, in the bio-medical waste projects, only roof top rainwater harvesting is considered for calculation.**

It has been worked out that total runoff generated within project premises per hour with 90 mm/hr intensity of rainfall shall be **68.3272 m^3/hr.**

The calculations are as under:

Taking 20 minutes retention time, total volume of storm water = 68.3272/3= 22.7757 m^3

Taking effective width & depth of a storage tank as 3.0 m & 3.5 m respectively;

Volume of Storage tank = 3.0× 3.0 × 2.5 = 22.5 m^3

Total volume of single Storage tank = 22.5 m^3

No. of Storage tank required = 68.3272/22.7757 = 3

As 1 tank per acre is to be proposed approximate; thus, total 3 no. of Rain Water storage tank have been proposed within the project premises.

Layout showing rain water recharging pits

The rain water collected on the entire whole building roof will be recharge ground water by rooftop Rainwater harvesting structure.

Rainwater harvesting can serve as a solution to the water problem in the water crises area by capturing the runoff. Rainwater harvesting helps in utilizing the primary source of water to prevent the runoff from going into sewer or storm drains, thereby serving dual purpose making water available for future use and reducing the load on treatment plants as well as other service lines.

Rainwater harvesting comprises of two components:

- Storing rainwater in groundwater reservoirs for beneficial use in future.
- Rain water harvesting for artificial recharge of ground water.
- Amount of water that can be effectively harvested is called the harvesting potential of the site. Efficiency of rainwater harvesting and recharging groundwater can be increased by following methods:

1. Use vegetated swales and depressions to reduce runoff.
2. Reduce and filter surface runoff.
3. Catchment drainage all along the periphery of plot to prevent surface runoff.

Rain water harvesting structures will be provided to recharge the groundwater resources in the region. The run-off water from the roof structure and paved areas will

be collected through storm water drainage system and led to rain water harvesting structure.

Storm Water Management:

Rainwater runoff comprises of storm water, which flows into both surface water and groundwater. Proper management of this resource ensures that storm water discharge is free of contamination. A detailed "Storm Water Management Plan" will be developed. The plan consists of best management practices, which include consideration of the following:

- Good housekeeping in the above areas.
- Conducting routine inspections to ensure cleanliness
- Secondary containment and dykes in fuel/oil storage facilities
- Preparation of spill response plans, particularly for fuel and oil storage areas.
- Provision of silt traps in storm water drains.
- Regular inspection and cleaning of storm drains.

Design of Rain Water Harvesting Structure:

The dimensional parameters of De-silting/Settlement chamber would be 3 m (length) x 3 m (width) x 2.5 (depth). Each structure will be capable of handling rainwater volume @ 22.5 m^3/day

FIGURE NO. 7.8 ROOFTOP RAINWATER HARVESTING STRUCTURE (MODEL)

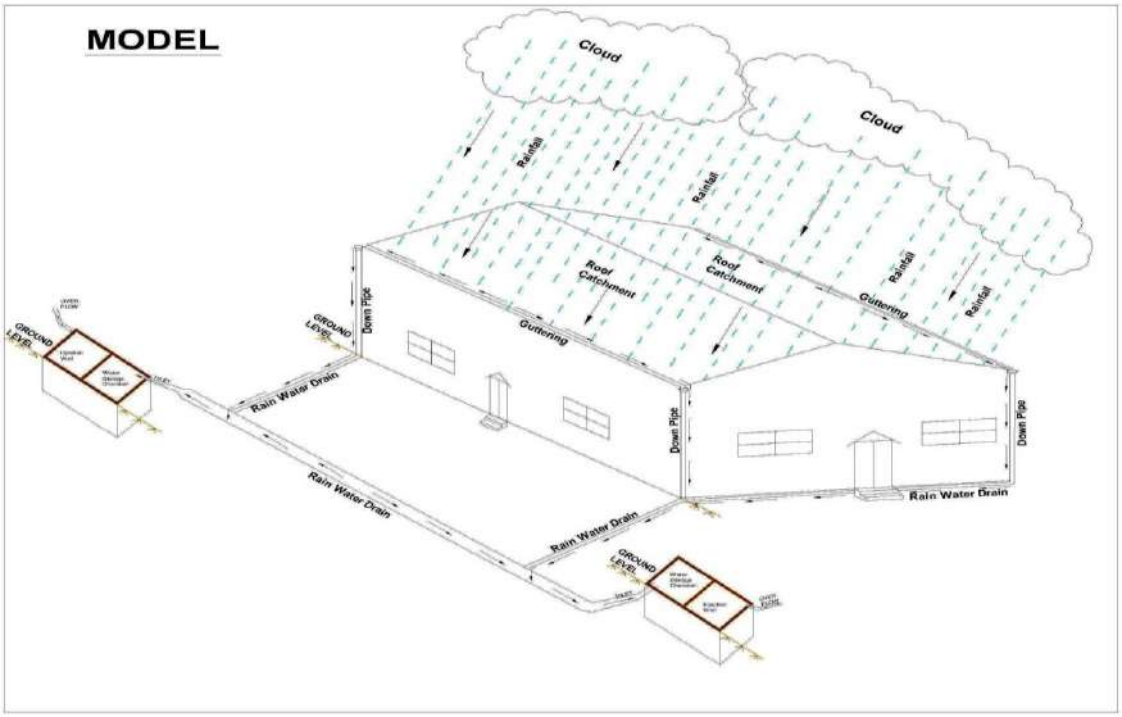
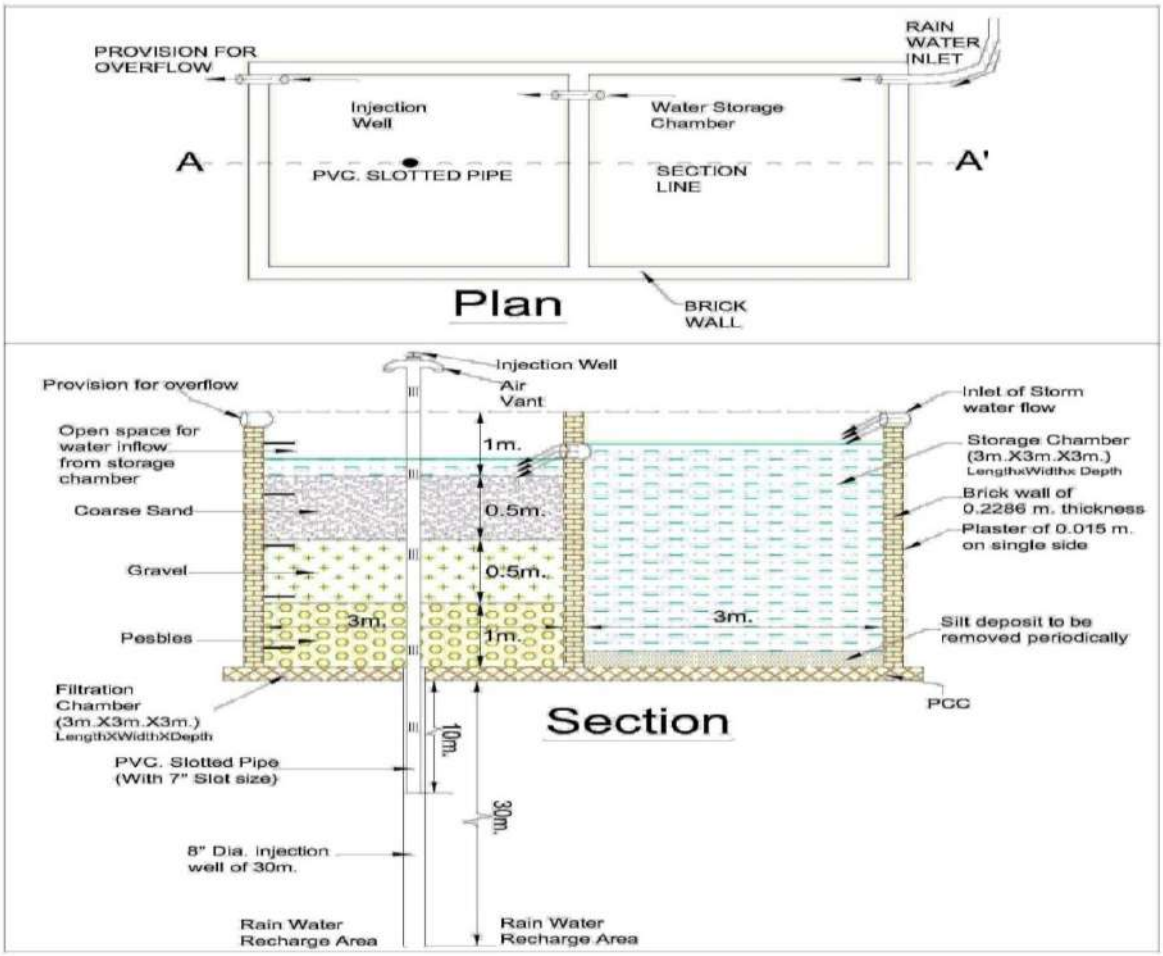


FIGURE NO. 7.9 ROOFTOP RAINWATER HARVESTING STRUCTURE (PLAN & SECTION)



Precautions: While carrying out roof top rainwater harvesting & surface runoff utilization works following precautions must be taken so that maximum benefits are derived. The roof tops of the buildings to be used for collecting rainwater must be cleaned before the onset of first rainfall so that any dust, leaves, pollutants do not enter the filtration tank. Grating must be used to trap debris or tree leaves before rainwater enters the drainpipes. A steel wire mesh maybe enveloped around the slotted pipe of injection well to minimize the clogging of slots. The filter material must be washed with water before putting in the filtration tank as these may be covered with silt or clay. Every year, before the onset of first monsoon, the filter material must be taken out and washed and then put back in the filtration tank & other recharge structures so that silt/clay deposited during the filtration process of preceding year is removed and original filtration rate is achieved.