Quality Assurance Authority

Government of Haryana

Standard Operating Methods and Procedures
&
Checklists
For
Sewerage, Water Supply Scheme & Irrigation Projects

2nd May 2025

Rajeev Arora

FOREWORD

On behalf of the Quality Assurance Authority (QAA), I extend my heartfelt gratitude to the Honourable Chief Minister Sh. Nayab Singh for inspiring and guiding us with his vision and invaluable insights. Under his leadership, Haryana continues to advance toward greater transparency, accountability, and excellence in infrastructure development.

It is with immense pride that I present this comprehensive compilation of Standard Operating Methods and Procedures (SOMPs) to elevate the standards of infrastructure projects across Haryana. These SOMPs represent our unwavering commitment to achieving excellence in infrastructure development, encompassing Roads, Buildings, Water Supply Systems, Sewerage and STP, Irrigation and Canal Systems, Power Transmission, and Power Distribution.

The establishment of the QAA signifies a transformative step in Haryana's journey toward infrastructure excellence. The QAA gratefully acknowledges the vision and leadership of Hon'ble Sh. Manohar Lal, Union Minister, Housing, Urban Affairs, and Power, and the then Chief Minister, Haryana, whose foresight led to the conceptualization of this Authority for institutionalizing process-driven improvements in quality of Engineering Works in the State.

These SOMPs serve as a cornerstone for implementing a robust quality assurance framework, fostering a culture of accountability and continuous improvement in engineering projects. Our focus extends beyond compliance; we are dedicated to driving innovation, sustainability, and long-term reliability across the entire lifecycle of the projects.

These SOMPs are a testament to the collaborative efforts and credible inputs by various State Government departments implementing engineering works and organizations owned and controlled by the State Government. Together, we are committed to building a future where every infrastructure project reflects the values of quality, safety, and sustainability, contributing to Haryana's growth and serving as a model for others.

Rajeev Arora, IAS (Retd.)
Chairperson
Quality Assurance Authority
Government of Haryana

Office: Bay 35-38, Second Floor, Sector 4, Panchkula, Haryana – 134112
Telephone: 0172 3501244 Email: qaapklhry@gmail.com

TABLE OF CONTENTS

Office: Bay 35-38, Second Floor, Sector 4, Panchkula, Haryana – 134112
Telephone: 0172 3501244 Email: qaapklhry@gmail.com

Quality Assurance Authority

Government of Haryana

Standard Operating Methods and Procedures

For

Technical Quality Assurance

In

Sewerage Project

PREFACE

The QAA has already framed Technical Quality Assurance Parameters outlining indicators and sub-indicators required for Quality Assurance of the projects throughout their lifecycle.

Now the QAA has further developed the Standard Operating Methods and Procedures (SOMPs) for Quality Assurance/Quality Control in the planning & design, construction, operation and maintenance of Sewerage Schemes for the purpose of having a ready reckoner to ensure that all quality parameters are adhered to during and after the construction of any project.

The Quality Control process focuses on detecting and correcting defects in a product or service. It involves identifying quality issues and taking corrective actions to resolve them. This is carried out by quality control monitors who would conduct inspections, perform tests, and implement necessary corrective measures. Through this systematic approach, the department would be able to identify shortcomings and defects on a real-time basis and shall ensure the delivery of a high-quality product or service.

Whereas the quality Assurance process ensures the delivery of a high-quality product or service throughout its entire life cycle by preventing quality problems from the outset. This comprehensive approach involves the entire organization, from top management to front-line employees, working in tandem to meet quality standards within the timeline and financial outlay. Key aspects of this process include planning, design, execution, delivery, training, documentation, and audits. By focusing on defect prevention, Quality Assurance ensures that the product or service meets the desired standards throughout the deliverable period.

Standard Operating Methods and Procedures (SOMP) for Sewerage Schemes offer numerous advantages such as:

1. Ensures Consistency: SOMPs help standardize procedures across different teams and locations, ensuring that the sewerage system is managed consistently.

2. Improves Efficiency: With a clear set of instructions, operational tasks can be performed efficiently, minimizing downtime and errors.

3. Ensures Safety and Quality: SOMPs ensure that safety standards are met, protecting both workers and consumers. It also helps in maintaining the quality of effluent by adhering to predefined guidelines for treatment and disposal.

4. Compliance with Regulations: Many sewerage systems are governed by national and state laws. SOMPs help ensure that operations comply with legal and environmental regulations.

5. Training and Skill Transfer: SOMPs provide a training guide for new employees and help retain institutional knowledge, ensuring that the system can operate smoothly even if experienced staff is not available.

6. Emergency Management: SOMPs provide clear steps to handle emergencies, like leaks or contamination, to minimize damage and ensure a swift response

7. Accountability: With documented processes, it's easier to identify who is responsible for different tasks, improving accountability within the organization.

In this respect, the Quality framework relating to all Quality Assurance parameters, indicators, and sub-indicators required in the various stages of sewerage projects has been prepared in detailed consultation with the user department responsible for the quality assurance and quality control for the sewerage projects. QAA is further hopeful that State Government departments implementing engineering works and organizations owned and controlled by the State Government would evolve suitable mechanisms to implement the required Quality Assurance plans with the objective of achieving economic and social development of the State and improving the quality of life of the people.

CONTENTS

CHAPTER 1

PART A: Executive Summary

This document provides a detailed overview of the sewerage system project's development and management. It includes the design phase, covering planning and system specifications; the execution phase, focusing on construction and coordination; and the commissioning phase, involving testing and validation. It also addresses safety protocols, project management strategies, environmental considerations, user engagement practices, and ongoing operations and maintenance. Each phase is described to ensure the project meets all technical, regulatory, and community requirements efficiently.

Planning and Design:

The sewerage scheme and sewage treatment plant (STP) are designed with a focus on meeting both current and future wastewater treatment needs. The planning phase includes detailed assessments of population growth, institutional activity, and environmental considerations to ensure that the infrastructure can handle increased loads over time. The design emphasizes optimal flow management, ensuring that sewage is efficiently transported through the network without blockages or overflows. Advanced treatment technologies are incorporated to achieve high levels of pollutant removal, ensuring that the treated effluent meets stringent regulatory standards before being discharged into the environment. The design also allows for future expansion, enabling the system to scale up in response to growing demands. Sustainability is a key consideration, with provisions for energy efficiency, water recycling, and the use of renewable energy sources to minimize the environmental footprint of the plant. Major tasks for Planning and Design are listed below:

- Conduct site surveys and topographic studies to assess the terrain and existing infrastructure.
- Evaluate population growth, institutional development, and seasonal variations to determine sewage generation.
- Assess existing sewer infrastructure to identify areas for upgrades or integration.
- Design the pipe network layout, including alignment, diameter, and slope, using advanced software.
- Plan for the optimal location and capacity of the Sewage Treatment Plant (STP), considering future expansion.
- Obtain necessary environmental clearances and NOCs from relevant authorities.

Execution, Inspection, and Testing:

The execution phase follows a carefully structured approach to ensure that the project is completed on time and within budget. Detailed project timelines are developed, outlining each phase of construction, from the installation of pipelines to the construction of treatment units and control systems. Resource allocation is meticulously planned, with skilled labour, machinery, and materials coordinated to ensure smooth progress. Throughout construction, regular inspections are carried out to verify that the work meets the required quality standards. Rigorous testing is conducted on key components, such as pipelines, pumps, and treatment units, under various operational conditions to ensure that they function reliably and effectively.

Any issues identified during testing are promptly addressed to prevent future operational problems. Major tasks for Execution, Inspection, and Testing are listed below:

- Construct treatment units such as sedimentation tanks, aeration tanks, clarifiers, and sludge digesters. Ensure proper alignment, dimensions, and foundation strength.
- Install and test pumps, blowers, mixers, and other mechanical equipment essential for the treatment process. Install and test electrical systems, control panels, and automation systems to monitor and operate the plant.
- Lay and connect internal pipelines for raw sewage inflow, treated water outflow, sludge removal, and air distribution for aeration systems.
- Check that pumps, blowers, mixers, and other mechanical equipment are correctly installed according to design specifications and manufacturer's instructions.
- Inspect all electrical wiring, control systems, and automation panels for compliance with electrical safety codes and ensure they are functional.

Commissioning and Handing Over:

As the project moves into the commissioning phase, the focus shifts to final testing and fine-tuning of the system. This phase is critical to ensuring that all components work together seamlessly and that the plant operates at peak efficiency. The system undergoes a thorough inspection, with performance validated against the design criteria. Any necessary adjustments are made to optimize the system's performance. Once commissioning is successfully completed, the project is formally handed over to the operations team. This handover process includes the transfer of all relevant documentation, such as design drawings, operation manuals, and maintenance schedules, as well as the provision of training for the operational staff. This ensures that the team is fully equipped to manage the plant and maintain its performance over time. Major tasks in Commissioning and Handover are listed below:

- Commission and test all installed equipment, including pumps, pipelines, and treatment units, automation system to ensure they meet operational standards.
- Conduct a thorough system flush and cleaning to remove any debris or contaminants before operational use.
- Verify all safety systems, including alarms and emergency shutdown mechanisms, are functional and properly configured.
- Provide training to the operating personnel on the use, maintenance, and troubleshooting of the installed systems.
- Obtain all necessary certifications and approvals from regulatory authorities before the handover.

Safety Measures:

Safety is a top priority throughout the entire project. Comprehensive safety protocols are integrated into every phase, from design and construction to operation. During the design phase, potential hazards are identified, and measures are put in place to mitigate risks. During construction, workers are provided with personal protective equipment (PPE), and safety training sessions are held regularly to reinforce safe working practices. Emergency response plans are developed to ensure that all personnel are prepared to respond quickly and effectively in the event of an incident. Regular safety audits are conducted to identify any potential issues, and corrective actions are taken as needed to maintain a safe working environment. Major tasks for Safety Measures are listed below:

- Conduct regular inspections and maintenance of all sewerage infrastructure to identify and address potential hazards, including leaks, blockages, and structural weaknesses.
- Implement proper ventilation systems in confined spaces to prevent the accumulation of toxic gases, such as hydrogen sulphide and methane, which pose significant health risks to workers.
- Provide comprehensive training and personal protective equipment (PPE) to all personnel working on sewerage systems, ensuring they are aware of and protected from chemical, biological, and physical hazards.
- Establish emergency response protocols, including procedures for spill containment, evacuation, and first aid, to ensure a rapid and effective response in case of accidents or exposure to hazardous substances.
- Install and regularly test safety alarms and monitoring systems, such as gas detectors, to promptly detect and mitigate dangerous conditions within the sewerage network.

Project Management:

Effective project management is essential to the success of the sewerage scheme and STP. The project management team employs industry best practices to ensure that the project is completed on time, within budget, and to the required quality standards. Project management software is used to track progress, manage resources, and coordinate communication between various stakeholders. Regular progress meetings are held to review the status of the project, identify any potential risks, and develop contingency plans as needed. This proactive approach to project management helps to ensure that any challenges are addressed promptly, minimizing the impact on the project's timeline and budget. Major tasks for Project Management are listed below:

- Prepare detailed cost estimates and establish a budget for the project, including contingencies for unexpected expenses, aligning it with project timelines to avoid delays.
- Supervise construction activities to ensure adherence to design specifications, quality standards, and safety regulations, while managing timelines and coordinating with contractors.
- Implement quality control measures to verify that materials and construction work meet the required standards and specifications.
- Track project progress, address any issues or delays, and provide regular updates and reports to stakeholders on the project's status and performance.

Environmental Measures:

Environmental sustainability is a core focus of the sewerage scheme and STP. The design and operation of the plant incorporate a range of measures to minimize its environmental impact. Energy-efficient technologies are used to reduce the plant's energy consumption, and renewable energy sources, such as solar power, are integrated where possible. The treatment process is designed to minimize greenhouse gas emissions, and the treated effluent is monitored to ensure that it meets or exceeds environmental discharge standards. Additionally, the project includes provisions for the recycling and reuse of treated water, reducing the demand for fresh water and contributing to sustainable water resource management. Major tasks for environmental measures are listed below:

- Conduct environmental impact assessments and ensure compliance with regulations, if applicable.
- Implement measures to minimize environmental disruption, such as controlling emissions and managing waste.
- Monitor and manage soil and water quality throughout the project.
- Ensure proper disposal and treatment of hazardous materials.
- Regularly review and update environmental management practices based on project progress and feedback.

User Feedback:

User feedback is an important aspect of the project, ensuring that the needs and concerns of the communities and stakeholders affected by the sewerage scheme are addressed. Feedback mechanisms are established early in the project to gather input from users, including regular surveys and public consultations. This feedback is carefully analysed and used to refine operational procedures, improve service delivery, and enhance overall user satisfaction. The project team remains engaged with the community throughout the project, providing updates and addressing any concerns that arise. Major tasks for User Feedback are listed below:

- Set up various channels for users to provide feedback, such as surveys and community meetings.
- Gather and analyse user input to identify common issues and suggestions.
- Respond to feedback promptly and address concerns.

Operations and Maintenance:

Operations and maintenance (O&M) are critical to the long-term success and sustainability of the sewerage scheme and STP. A detailed O&M plan is developed, outlining the procedures for maintaining the plant's infrastructure and equipment. This includes scheduled maintenance activities, such as cleaning and servicing equipment, as well as real-time monitoring of the system's performance to identify and address issues before they lead to downtime. The O&M plan also includes training for operational staff, ensuring that they have the skills and knowledge needed to manage the plant effectively. This proactive approach to operations and maintenance helps to extend the life of the infrastructure, reduce operational costs, and ensure that the plant continues to operate at peak efficiency for years to come. Major tasks for Operations and Maintenance are listed below:

- Develop and implement an operations and maintenance plan, outlining procedures and responsibilities.
- Train staff on operating procedures, safety protocols, and maintenance tasks.
- Establish a schedule for routine maintenance and inspections to ensure system efficiency.
- Monitor system performance and address any operational issues or failures.
- Manage inventory and procurement of necessary spare parts and equipment.
- Review and update maintenance procedures based on performance data and feedback.

Part B: Responsibilities of stakeholders

In the context of ensuring quality assurance for a Sewerage Scheme, the roles and responsibilities of the key stakeholders—such as the Client Department, Executing Agency, and other associated parties—are critical in maintaining the project's success and longevity. Here's a detailed breakdown of each stakeholder's responsibilities:

1. Client Department (Owner/Employer):

The Client Department, typically a government agency that commissions the project, holds overarching responsibility for ensuring that the sewerage scheme meets all regulatory, environmental, and quality standards.

Responsibilities:

Project Conceptualization and Planning:

- Oversee the project's initial design, ensuring it aligns with community needs, environmental sustainability, and national/state effluent standards.
- The client must hire qualified designers and consultants to prepare technical documents such as feasibility studies, environmental impact assessments, and detailed project reports.

Setting Quality Standards:

- Define specific quality parameters and benchmarks based on regulatory standards, effluent standards (e.g., State Pollution Control Board and Central Pollution Control Board), and safety requirements.
- Ensure that the technical specifications of materials, such as pipes, and pumps, adhere to industry norms and quality expectations.

Tendering and Selection of Contractor:

- Draft comprehensive tender documents with clear quality standards, performance indicators, and timelines.
- Evaluate and select contractors based on their expertise, technical competency, past performance, and ability to meet the required quality standards.
- Approve subcontractors and suppliers involved in the sewerage scheme.

Supervision and Monitoring:

- Organize regular site inspections to ensure compliance with the approved designs, materials, and construction practices.
- Set up independent quality control teams or third-party agencies to monitor on-site activities.
- Ensure that the contractor follows proper procedures for sewage treatment, disposal system, and overall construction quality.

Material Approval:

- Approve materials after conducting appropriate testing or reviewing third-party certifications (e.g., ISI marks or other international certifications).
- Review quality certificates provided by suppliers for key components like pipes, fittings, pumps, and filters.

Change Management:

- In the event of design changes or unforeseen circumstances (e.g., changes in groundwater level, material shortages, etc.), assess the impact on quality and authorize necessary modifications in consultation with the contractor.

Testing and Quality Audits:

- Oversee effluent quality tests during commissioning and operation.
- Ensure that treated effluent meets quality standards, conducting bacteriological and chemical tests as required.

Final Inspection and Approval:

- Conduct a thorough final inspection before commissioning the project to verify compliance with all quality standards.
- Ensure operational tests (such as pump efficiency, pressure, and blower air quantity, etc.) are carried out and that any defects identified are rectified before the project is handed over for use.

Ensuring Regulatory Compliance:

- Ensure that all aspects of the project, from planning to implementation, comply with state and national regulations, including environmental, effluent quality.
- Maintain close coordination with other regulatory bodies such as the Environmental Protection Agency, State and Central Pollution Control Boards.

2. Executing Agency:

The Executing Agency is responsible for executing the work as per the designs, specifications, and quality standards set by the Client Department. Their role is critical in ensuring that the project is built to last and functions effectively.

Responsibilities:

Work Execution as per Specifications:

- Implement the construction of the sewerage scheme exactly as per the approved design, materials, and methods.
- Ensure that all procedures are followed in accordance with the quality benchmarks set forth by the client.

Material Procurement and Handling:

- Procure materials that meet the approved quality standards (e.g., corrosion-resistant pipes, durable pumps).
- Verify that the materials supplied by vendors have undergone proper quality testing and have the required certifications.

Implementation of Quality Control (QC) Plan:

- Establish and maintain an internal quality control system with qualified staff responsible for conducting quality checks on materials, processes, and completed work.
- Set up an on-site testing laboratory to conduct regular material tests (e.g., tensile strength of pipes, water leakage tests, pressure tests, etc.).

Coordination with Client and Third Parties:

- Maintain close communication with the Client Department regarding progress updates, challenges, and any deviations from the design or quality requirements.
- Coordinate with third-party quality auditors or inspectors for regular assessments.

Documentation and Reporting:

- Preparation of Design and Drawing of the project.
- Maintaining the record of Design and Drawing of the project at site.
- Maintain proper records of all quality-related processes, including material tests, inspection reports, daily work logs, and certificates from suppliers.
- Prepare and submit regular reports on the progress and quality of work to the Client Department.
- Maintenance of the Day Book for daily progress of the work containing all details of the material, manpower, and work done at site.

Rectification of Defects:

- Address any defects, quality issues, or non-compliance highlighted during inspections or testing.
- Ensure proper measures are taken to correct the defects and report the corrections back to the client for re-inspection.

Health, Safety, Environmental, and Labour Law Compliances:

- Ensure that workers follow health and safety regulations to prevent accidents and ensure smooth project execution.
- Implement proper waste management practices to avoid environmental damage, including the disposal of construction debris and treatment of wastewater and sludge.

Testing and Commissioning:

- Conduct all necessary tests (e.g., pressure testing of pipelines, testing effluent quality, and pump performance tests) prior to final commissioning.
- Handover the system after ensuring that it is in full compliance with the approved quality parameters and is ready for operation.

3. Third-Party Quality Auditors/Consultants:

In many sewerage projects, independent third-party consultants or quality assurance teams are engaged to monitor effluent quality.

Responsibilities:

Quality Audits:

- Perform scheduled and surprise audits on the construction site to verify compliance with the quality standards set by the client department.
- Check that the materials used and construction methods align with the approved specifications.

Testing and Certification:

- Conduct third-party tests on materials and completed work, including effluent quality testing, structural integrity checks, and system performance testing.
- Issue certifications of quality where appropriate, ensuring all testing is documented and reported to both the client and executing agency.

Reporting and Recommendations:

- Provide independent reports on the findings during inspections and audits, identifying any discrepancies and recommending corrective measures.
- Suggest improvements in processes, if necessary, to enhance the overall quality of the project.

4. Suppliers (Material and Equipment Providers):

Suppliers are responsible for providing high-quality materials and equipment that meet the specifications required for the sewerage scheme.

Responsibilities:

Material Supply:

- Supply materials such as pipes, pumps, blowers and other equipment that meet the specifications provided by the client and contractor.

Quality Certifications:

- Provide proper quality certifications and test reports for all materials supplied, ensuring they comply with the industry standards (e.g., ISI or international standards).

Material Testing:

- Ensure that all materials are tested prior to delivery, with evidence of passing all relevant quality checks.

Replacement of Defective Materials:

- Replace any defective or substandard materials immediately when identified during on-site inspections or testing.

5. End Users (Communities/Local Bodies):

- The ultimate users of the sewerage scheme, often represented by community members, such as farmers also have a role to play.

Responsibilities:

Feedback on Quality:

- Provide feedback on the functioning of the sewerage system, particularly regarding effluent quality, and system reliability once the system is operational.

Activities to be performed by the Departmental Officers/Officials and Executing Agency

S No.	Activity	CE	SE	EE	AE	JE	Executing Agency
Planning and Design							
1.	Topographic Survey.			✓	✓	✓	
2.	Land Acquisition, Forest clearance etc.			✓	✓	✓	
3.	NOC from Railways, Electricity Board, water Resources, Roads, Panchayat			✓	✓	✓	
4.	Assessment of influent quantity			✓	✓	✓	
5.	Assessment of existing sewerage system infrastructures and their uses.			✓	✓	✓	
6.	Selection of latest software in design	✓	✓	✓	✓	✓	
7.	Selection of modern mechanized/digital equipment	✓	✓	✓	✓	✓	
8.	Framing specifications for materials	✓	✓	✓			
9.	Preparation of Detailed Project Report along with design, drawings, and cost estimate and its timeline.			✓	✓		
10.	Approval of Detailed Project Report	✓	✓				
11.	Identification of funding agency with annual budget allocation	✓	✓				
12.	Call of tenders and award of work after completing all formalities	✓	✓	✓			
Execution, Inspection and Testing							
13.	Preparation of Design and Drawing of the project.						✓
14.	Approval of Design and Drawings received during execution of project		✓	✓	✓	✓	
15.	Maintaining the record of Design and Drawing of the project at site.						✓
16.	Selection of approved source for materials such as aggregates, sand etc.			✓	✓	✓	✓
17.	Submission of design mix and its approval			✓	✓	✓	✓
18.	Procurement of pipes and machinery of approved make by the department	✓	✓	✓	✓	✓	✓
19.	Pre inspection for pipes and machinery at manufacture's premises before dispatch	✓	✓	✓	✓		
20.	Procurement of cement, steel, etc.			✓	✓	✓	✓

21.	Ensuring the execution as per design and specifications, and as per the bid document			✓	✓	✓	✓
22.	Qualified manpower deployment as per requirement			✓	✓	✓	✓
23.	GIS mapping of sources, network and all other infrastructures			✓	✓	✓	
24.	Maintenance of the Day Book for daily progress of the work containing all details of the material, manpower, and work done at site.						✓
25.	Ensuring the restoration of dismantled road and streets and disposal of dismantled material			✓	✓	✓	✓
26.	Ensuring relevant mandatory tests with required frequency during execution at every stage of construction.			✓	✓	✓	✓
27.	Effluent and Sludge sample testing after treatment			✓	✓	✓	✓
28.	Setting up effluent testing laboratories having all testing equipment relevant to the project requirements and STP			✓	✓	✓	✓
29.	Preparation of site inspection and quality control registers			✓	✓	✓	✓
30.	Checking of test results by Engineer in Charge			✓	✓	✓	✓
31.	Submission of reports and rectification of defects			✓	✓	✓	✓
32.	Flow testing in pipes after laying at site				✓	✓	✓
33.	Availability of electric/ Solar energy as per requirements			✓	✓	✓	
Commissioning and Handover							
34.	Ensuring 100% sewer connections			✓	✓	✓	✓
35.	Ensuring system flushing			✓	✓	✓	✓
36.	Ensuring specified quality and quantity of effluent				✓	✓	✓
37.	Proper operation of SCADA, automation and online analyzer			✓	✓	✓	✓
38.	Submission of Assets completion Plan and report						✓
39.	Approval of Assets completion Plan and report and certificate			✓	✓	✓	
40.	Preparation of Manual for running of STP						✓
41.	Ensuring emergency response mechanism			✓	✓	✓	✓

Safety Measures							
42.	Providing of safety measures such as first aid & firefighting equipment, safety uniforms etc.						✓
43.	Monitoring and Surveillance			✓	✓	✓	✓
44.	Controlling the access of unauthorized person in the premises of STP					✓	✓
45.	Detection, alert and remedial measures in case of chlorine gas leakage if applicable			✓	✓	✓	✓
46.	Incident response and reporting				✓	✓	✓
Operation and Maintenance							
47.	Deployment of skilled staff for operation and maintenance			✓	✓	✓	✓
48.	Deployment of adequate manpower			✓	✓	✓	✓
49.	Grievance redressal and record keeping			✓	✓	✓	✓
50.	Maintenance schedule development and its compliance			✓	✓	✓	✓
51.	Availability of spare parts/stand by machinery			✓	✓	✓	✓
52.	Regular chlorination					✓	✓

Note 1: Responsibilities for carrying out above activities by the departmental officers shall be governed by the Technical Sanction Powers vested in them by the Government of Haryana

Note 2: Responsibilities for carrying out pre-inspection for supply of pipes and machinery at the manufacturer's premises by the departmental officers shall be governed by the Departmental Procedure.

CHAPTER 2

SOMPs for Sewerage Schemes

1. PLANNING AND DESIGN

Part A: General Parameters

1.1) Survey & Investigation

1.1.1) Topographic Survey: The Details

I. Site Preparation:

- Identify the alignment of the proposed sewer line.
- Clear the survey path of any obstructions such as vegetation, debris, or temporary structures and mark control points and reference benchmarks using durable markers.

II. Survey Execution:

- Use Total Station, GPS, and other precise instruments for data collection.
- Calibrate equipment before starting the survey.
- Record elevations at regular intervals.
- Capture natural and man-made features, including roads, utilities, water bodies, and structures along the alignment.
- Take cross-sectional measurements at critical points like road crossings, rivers, and valleys.

Documentation: Prepare detailed survey reports, including maps, L-Sections, and data logs. Submit the final survey documents for approval by the project engineer or relevant authority.

1.1.2) Soil Investigations: Bearing Capacity (SBC) and Ground Water Table / Spring Water Level

I. Soil Investigation and Testing:

- Identify appropriate locations for soil testing through a site visit, focusing on areas where structures such as pumping stations, and the STP are planned.
- Ensure the survey covers areas with different soil types to get a comprehensive understanding of the site's soil characteristics.
- Engage a qualified geotechnical firm to perform Standard Penetration Tests (SPT) at identified borehole locations. Ensure sufficient boreholes are drilled (minimum 3-5 per site) to capture soil variability.
- Collect undisturbed soil samples from various depths for laboratory testing. Analyse the SBC based on these tests to ensure foundation designs can support the load of the structures.
- Provide recommendations for foundation design, such as the type and depth of foundation, based on SBC results and soil characteristics like cohesion, angle of internal friction, and settlement potential.
- The groundwater table/spring water level can also be ascertained from the data available with CGWB or hydrological data available with the states.

II. Compliance with Standards:

- Ensure soil investigation and analysis are carried out in compliance with IS 1893 (Criteria for Earthquake Resistant Design of Structures) and IS 6403 (Code of Practice for Determination of SBC of Soils).
- Prepare a comprehensive report including borehole logs, SPT results, SBC analysis, and groundwater level data.
- Ensure that the report contains foundation design recommendations and mitigation measures if problematic soil or groundwater conditions are found.
- Submit the report to the design consultant and project authority for review and incorporation into design plans.

1.1.3) Land Acquisition, Forest Clearance, etc.

I. Land Acquisition:

- Identify the required land based on the project's alignment and infrastructure needs.
- Coordinate with local land records offices to verify ownership and land use.
- Engage with landowners, local authorities, and community representatives to discuss the acquisition.
- Conduct public hearings or consultations if required by law.

II. Legal Process:

- Initiate the land acquisition process under relevant laws (e.g., Land Acquisition Act).
- Prepare necessary documentation, including notices, compensation agreements, and legal titles.
- Obtain the necessary approvals from the relevant authorities.
- Disburse compensation to landowners as per the agreed terms. Ensure the legal transfer of land ownership to the project authority.
- Take possession of the land and clear it for construction.

III. Forest Clearance:

- Determine if any part of the project affects forested areas or eco-sensitive zones.
- Prepare and submit a proposal for forest clearance to the Ministry of Environment, Forest and Climate Change (MoEFCC) or relevant state authorities.
- Include detailed project reports, environmental impact assessments, and mitigation plans.
- Engage with forest officials, local communities, and environmental groups. Organize public hearings as required.
- Follow up with the authorities for the review and approval of the clearance.
- Address any objections or queries raised during the review.
- Implement the conditions set by the clearance, such as afforestation or wildlife conservation measures.

1.1.4) NOC from Railways, Electricity Board, Water Resources, Roads, Panchayat

- Identify crossings or alignments near railway tracks or property.
- Determine if the project interferes with overhead lines, underground cables, or substations.
- Assess the impact on existing water bodies, drainage systems, and irrigation channels.
- Identify any road crossings or works that might affect existing roads and highways.

- Engage with local panchayats for works within their jurisdiction, including access roads and community land.

I. Preparation of Application:

- Compile detailed project reports, including design drawings, alignment plans, and impact assessments.
- Prepare and submit applications for NOCs to the respective authorities. Include necessary fees, supporting documents, and certifications.
- Address any objections, queries, or additional requirements raised by the authorities. Conduct site inspections with the authorities if required.

II. Obtaining NOC:

- Secure the NOC from each authority. Ensure all conditions and stipulations mentioned in the NOC are understood and implemented.
- Document the NOC and keep it available for review by the project team and other stakeholders.

III. Final Review and Documentation:

- Review all obtained NOCs to ensure consistency and alignment with the project's design and execution plans.
- Compile a comprehensive report of all NOCs, including copies of certificates and correspondence.

1.2) Demand and Resource assessment

1.2.1) Population Growth, Floating Population, Institutional Development & Seasonal Variation for STP Capacity

I. Population Growth:

- Begin by analysing historical population growth data in the area served by the STP.
- Use demographic studies and census data to project future population increases over the design life of the STP.
- Consider factors such as urbanization trends and migration patterns.

II. Floating Population:

- Assess the impact of transient or floating populations, such as tourists or temporary workers, on the sewage load.
- Collect data from local tourism departments, large construction projects, or seasonal employment trends to estimate the additional sewage generation during peak periods.

III. Institutional and Commercial Development:

- Evaluate the potential for institutional and commercial growth in the area, including the establishment of new factories, educational hub business parks, or other commercial developments.
- Adjust the STP design to accommodate both current and projected population loads.

IV. Seasonal Variation:

- Study the impact of seasonal changes on sewage generation, considering factors like weather patterns, agricultural cycles, and festivals.
- Analyse past sewage flow data to identify trends during different seasons. Ensure the STP design includes provisions to handle peak loads during high-demand periods and to efficiently operate during low-flow periods.

V. Capacity Estimation:

- Integrate the findings from population growth, floating population, institutional development, and seasonal variation studies to determine the required capacity of the STP.
- Ensure that the capacity estimate includes a safety margin to account for unforeseen increases in sewage generation.

1.3) Cost Analysis, Budget planning, timeline estimates

1.3.1) Financial Implication with Cost Index up to Implementation Period

I. Cost Estimation:

- Prepare a detailed cost estimate for the sewerage scheme, covering all aspects including contingencies to cover unforeseen expenses.
- Utilize current market rates for materials, labour, and equipment to ensure accuracy where Haryana Schedule of Rates are not available for some item.
- Select and use an appropriate cost index to account for inflation and other economic factors that may affect costs over the implementation period.
- Prepare a cash flow analysis to project the timing of expenditures throughout the project's lifecycle to aligns with the project's implementation schedule and funding availability.
- Consider factors such as payment schedules, advance payments to contractors, and retention amounts.
- Consider the cost of horticulture development to improve overall aesthetic and functional value of the facility
- Identify potential financial risks that could impact the project, such as fluctuations in material prices, changes in labour rates, or delays in implementation.
- Develop mitigation strategies to manage or transfer risks, such as fixed-price contracts or price escalation clauses.

1.3.2) Identification of Funding Agency with Annual Budget Allocation

I. Funding Source Identification & Engagement:

- Identify potential funding sources for the sewerage schemes such as government grants, loans from financial institutions, international development agencies, and public-private partnerships.
- Engage the selected funding agencies to discuss the sewerage scheme.
- After identifying a funding agency, prepare a formal request for an annual budget allocation including a breakdown of the total project cost, the proposed funding amount, and the expected disbursement schedule.

II. Funding Agreement Negotiation:

- Negotiate the terms of the funding agreement with the selected agency.
- Ensure that the agreement specifies the funding amount, disbursement schedule, reporting requirements, and any conditions or covenants that must be met.
- Seek legal advice to review the agreement and ensure that it protects the interests of the project.

Documentation:

- Once the funding agreement is finalized, prepare a detailed funding plan that outlines the sources of funds, the disbursement schedule, and the budget allocation for each project component.
- Ensure that the funding plan is integrated into the overall project financial plan and that all stakeholders are informed of the funding arrangements.

1.4) Framing specification

1.4.1) Identification of Suitable Materials Proposed to be Used

I. Material Requirement Analysis:

- Identify the materials required for the construction and operation of the sewerage scheme including pipes, manhole covers, pumps, valves, treatment units, electrical components, and any other materials necessary for the project.
- Assess the specific requirements for each material, such as strength, corrosion resistance, ease of installation, and compatibility with existing infrastructure.
- Conduct market research to identify available materials that meet the project's specifications considering factors such as local availability, delivery lead times, and the reputation of suppliers in the industry.

II. Compliance with Standards:

- Ensure that all selected materials comply with relevant national /international standards, such as ASTM, ISO, or BIS.
- Review the technical specifications provided by manufacturers and verify that the materials meet the required quality and performance criteria. If necessary, request sample materials for testing and evaluation.

III. Cost-Benefit Analysis:

- Perform a cost-benefit analysis to compare the long-term performance and maintenance costs of different materials. Consider factors such as the expected lifespan of the materials, maintenance requirements, and the potential impact on the overall project cost.
- Select materials that offer the best value for money while meeting the project's technical and environmental requirements.

1.4.2) Framing Specifications

I. Specification Development:

- Based on the selected materials, develop detailed technical specifications that outline the required properties, dimensions, tolerances, and quality standards for each material.
- Ensure that the specifications are clear, precise, and unambiguous to avoid misunderstandings during procurement and construction.
- Reference relevant national and international standards in the specifications to ensure that all materials meet the required quality and performance criteria. Include specific testing methods, certification requirements, and quality assurance procedures to be followed by suppliers and contractors.
- Incorporate the framed specifications into the project's cost estimate. Ensure that the estimate accurately reflects the cost of the materials based on the specified quality and

standards. Include contingencies to cover potential variations in material costs or availability during the project's implementation.

II. Bid Document Preparation and Approval:

- Include the material specifications in the bid documents to be provided to prospective contractors and suppliers. Ensure that the bid documents clearly outline the required materials, quantities, and delivery schedules.
- Specify the testing and certification requirements that must be met before materials are accepted for use in the project.
- Submit the framed specifications and bid documents to the relevant authorities for review and approval.
- Ensure that any feedback or revisions are incorporated before the documents are finalized and issued to bidders.

Part B: Parameters relating to Sewerage System

1.5) Preliminary spade work for laying of sewer

1.5.1) Assessment of Existing Sewer Infrastructure and Its Uses

- Conduct site visits to visually inspect the condition of key components such as sewer lines, manholes, pumping stations, and treatment facilities.
- Analyse the current flow data and compare it with the design capacity of the existing infrastructure.
- Consider the impact of future population growth and institutional development on the infrastructure's capacity.
- Evaluate the physical condition of the existing sewer lines, manholes, and associated structures.
- Use methods such as CCTV inspections, smoke testing, and dye testing to detect leaks, blockages, cracks, and other defects.
- Assess the structural integrity of the system and identify areas that may require repair, rehabilitation, or replacement.
- Determine the current usage patterns of the existing infrastructure, including the proportion of domestic, commercial, and institutional sewage being handled.
- Evaluate the effectiveness of the infrastructure in transporting sewage to the treatment facility and identify any bottlenecks or inefficiencies.
- Prepare a detailed assessment report summarizing the findings, including maps, inspection data, capacity analysis, and recommendations for repairs, upgrades, or replacements.
- Submit the report to the project manager or relevant authority for review and inclusion in the project planning process.

1.6) Selection of technology for network design

1.6.1) Use of Latest Software for Pipe Network and Drawings

I. Software Selection:

- Identify and select the latest and most appropriate software tools for designing the sewer pipe network and creating detailed drawings.

- Consider software that offers features such as 3D modelling, hydraulic analysis, and compatibility with Geographic Information Systems (GIS) such as AutoCAD Civil 3D, and Bentley Sewer GEMS, BIM etc.

II. Training and Implementation:

- Ensure that all project team members, including engineers and CAD operators, are adequately trained in the selected software by organising workshops or training sessions
- Implement the software across all design stages, from preliminary planning to detailed design and documentation.

III. Pipe Network Design & Drawing Preparation:

- Use the software to create a comprehensive model of the sewer pipe network, including all pipes, manholes, pumping stations, and treatment facilities.
- Input accurate data on pipe sizes, materials, gradients, and flow rates.
- Perform hydraulic analysis within the software to ensure the network can handle the projected sewage loads without surcharging or excessive velocities.
- Generate detailed drawings of the sewer pipe network, including plan views, profiles, and cross-sections.

1.6.2) Preparation of L-Sections of Sewer Lines

I. Data Collection:

- Carry out a detailed topographical survey along the proposed route of the sewer lines using Total Station or GPS equipment as detailed above in Clause 1.1.1.
- Record ground elevations, contours, and key features such as roads, natural drainage channels, utility crossings, and existing sewerage infrastructure.
- Identify critical points where elevations change rapidly, as these areas will require special design considerations, such as slope adjustments and manhole placement.

II. Preparation of L-Section:

- Prepare longitudinal sections (L-sections) based on the survey data, showing the natural ground level, proposed invert levels, manhole locations, and pipe slopes.
- Ensure that the gradient of the sewer line maintains a minimum slope to prevent blockages and allows self-cleansing flow depending on the pipe diameter and design standards.
- Incorporate manholes at regular intervals and at changes in direction or elevation, ensuring access for maintenance.
- Ensure proper hydraulic design to handle peak sewage flow, considering future population growth and potential industrial wastewater discharge.

III. Review and Approval:

- Conduct an internal review of the L-section design to verify accuracy and compliance with design parameters. Cross-check survey data and pipe sizing calculations to ensure they meet flow and slope requirements.
- Submit the prepared L-sections and associated drawings to the competent authority (local municipal body or engineering department) for review and approval.
- Incorporate any feedback, ensuring alignment with city-wide sewerage plans and standards before proceeding to construction.

Part C: Parameters Relating to Sewage Treatment Plant (STP)

1.7) Selection of modern Technologies & equipment and processes

1.7.1) Optimum Design of STP with Advanced Treatment Technologies

I. Technology Selection:

- Consider & Evaluate technologies such as Membrane Bioreactors (MBR), Moving Bed Biofilm Reactors (MBBR), Sequential Batch Reactors (SBR), and Advanced Oxidation Processes (AOP) etc. based on the required effluent quality, energy consumption, and operational complexity.
- Select technologies that offer the best balance between performance, cost, and ease of maintenance.

II. Process Design:

- Determine the design capacity of the STP based on the projected sewage load, including considerations for population growth and other factors
- Ensure that the selected technologies can handle peak loads while maintaining consistent treatment performance.
- Incorporate redundancy in critical components to ensure reliability and continuity of operations during maintenance or unexpected surges in sewage volume.
- Develop a detailed process flow diagram that outlines each stage of the treatment process, from preliminary treatment (screening, grit removal) to primary, secondary, and tertiary treatment.
- Specify the advanced treatment technologies to be used at each stage.
- Ensure that the process design meets all relevant environmental regulations and effluent discharge standards.

III. Energy Efficiency:

- Incorporate energy-efficient design features to minimize the STP's operational costs and environmental footprint.
- Consider options such as energy recovery from automation, solar power integration, and variable frequency drives (VFDs) for pumps and blowers.

IV. Automation and Control:

- Design the STP with a high level of automation to enhance operational efficiency and reduce the need for manual intervention.
- Specify the use of advanced control systems, such as Supervisory Control and Data Acquisition (SCADA), to monitor and control key process parameters in real time.
- Ensure that the automation system is integrated with the selected treatment technologies and can be remotely accessed for monitoring and troubleshooting.

Documentation:

- Prepare detailed design documentation, including process flow diagrams, layout drawings, equipment specifications, and control system architecture.

- Include a comprehensive operation and maintenance (O&M) manual that outlines the procedures for operating and maintaining the advanced treatment technologies.
- Submit the final design documents for approval by the project team or relevant authorities.

1.7.2) Use of Modern Mechanised/Digital Equipment

i) Remote Monitoring:

- Implement remote monitoring systems to enable real-time tracking of key STP parameters such as flow rates, effluent quality, and equipment performance.
- Choose monitoring equipment that provides high accuracy and reliability.
- Ensure that the remote monitoring system is connected to a central control room and accessible via web or mobile interfaces for off-site monitoring.

ii) SCADA (Supervisory Control and Data Acquisition):

- Integrate a SCADA system to provide centralized control and automation of the STP processes.
- The SCADA system should be configured to monitor and control various aspects of the STP, including pumps, blowers, chemical dosing, and sludge handling.
- Ensure that the system is capable of generating alarms, logging data, and producing reports for analysis and decision-making.

iii) GIS (Geographic Information System):

- Utilize GIS technology to manage and analyse spatial data related to the STP and the sewer network.
- Use GIS to map the location of all STP components, pipelines, and manholes, and to plan maintenance activities.
- Integrate GIS with the SCADA system to enable real-time visualization of system performance and to support decision-making during emergencies.

iv) Smart Pumping Systems:

- Install smart pumping systems equipped with variable frequency drives (VFDs) and sensors to optimize energy consumption and ensure reliable operation.
- The smart pumping system should be capable of adjusting pump speeds based on real-time flow conditions and should be integrated with the SCADA system for automated control.

v) Online Effluent Quality Analysers:

- Deploy online effluent quality analysers to continuously monitor parameters such as Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and pH in the treated effluent.
- The analysers should be calibrated regularly to ensure accuracy and should be connected to the SCADA system for real-time data logging and analysis.
- Alerts should be configured to notify operators of any deviations from the permitted effluent quality standards.

vi) Mobile Applications:

- Develop or adopt mobile applications that allow STP operators and maintenance personnel to access real-time data, receive alerts, and perform remote diagnostics.

- The mobile application should be user-friendly and provide secure access to the SCADA system, remote monitoring tools, and maintenance logs.

vii) Customer Portals:

- Create a customer portal that allows stakeholders, including regulatory authorities such as Central Pollution Control Board and Haryana Pollution Control Board and the public, to access information about the STP's performance. The portal should include features such as effluent quality reports, operational statistics, and environmental compliance data.
- Ensure that the portal is regularly updated and accessible via web and mobile devices.

viii) Drone Photography:

- Utilize drone photography for aerial surveys and inspections of the STP and associated infrastructure.
- Drones can be used to monitor construction progress, inspect hard-to-reach areas, and assess the condition of pipelines and manholes.
- Ensure that drone operations comply with local regulations and that captured data is integrated with the GIS and SCADA systems for comprehensive analysis.

1.7.3) Obtaining Consent to Establish from State Pollution Control Board

I. Application Preparation:

- Compile all necessary documents, including the project's Detailed Project Report (DPR), Environmental Impact Assessment (EIA), No Objection Certificates (NOCs) from relevant local authorities, and technical design details of the sewage and STP system.
- Include specific details on the sewage treatment process, the anticipated volume of sewage to be treated, and the final quality of treated effluent to be discharged into the environment.

II. Submission of Application:

- Ensure the Consent to Establish (CTE) application adheres to the requirements of the Water (Prevention & Control of Pollution) Act and the Air (Prevention & Control of Pollution) Act.
- Submit the application along with all required supporting documents, and include details of effluent standards to be met, discharge points, and pollution control measures proposed.

III. Follow-up and Approval:

- Regularly follow up with the SPCB for updates on the application status. Respond promptly to any additional information or clarifications requested by the board.
- Once the CTE is granted, ensure that the construction and operation of the STP strictly comply with the conditions outlined in the consent. Keep the CTE certificate on record for future reference and inspections.

1.7.4) Preparation of Design and Drawings by Consultant and Approval by Competent Authority

I. Design Development:

- Appoint a qualified consultant with expertise in sewage and wastewater treatment design to prepare the detailed design complying with effluent standards and construction of drawings for STP.

- Ensure that the consultant incorporates site-specific data, including topographical surveys, soil investigation results, and projected sewage loads, into the design.

II. Design Review:

- Conduct internal reviews at key stages of the design process. Verify that the designs meet project specifications, environmental regulations, and safety standards.
- Check for design optimization opportunities, such as cost-saving measures, energy-efficient technologies, and reuse of treated effluent.

III. Approval by Competent Authority:

- Submit the detailed design and drawings to the relevant project authority, such as the municipal corporation or engineering department, for review and approval.
- Address any feedback from the approval authority and revise the design as necessary. Once approved, ensure that the final drawings are issued to contractors for execution.

1.8) Long term Planning

1.8.1) Future Requirement Projections such as Vacant Space for Expansion and Modular Design of STP

I. Demand Forecasting:

- Begin by conducting a detailed analysis of future sewage generation, taking into account factors such as population growth, institutional development, and changes in water usage patterns.
- Use this data to forecast the future capacity requirements of the STP over its extended lifespan.
- Ensure that the design allows for phased expansion in response to these projections.

II. Space Allocation:

- Design the STP layout to include vacant space that can be utilized for future expansion.
- Identify potential areas where additional treatment units, storage facilities, or auxiliary structures can be installed without disrupting existing operations.
- Ensure that the space allocated for expansion is accessible and does not interfere with the current STP operations or nearby infrastructure.

III. Modular Design Approach:

- Incorporate a modular design approach in the STP's layout, allowing for incremental capacity increases.
- Specify treatment units that can be easily scaled up by adding more modules in the future.
- Ensure that the modular components are compatible with the existing system and that the expansion process can be carried out with minimal disruption to the ongoing operations.

IV. Infrastructure Considerations:

- Plan the supporting infrastructure, such as access roads, utilities, and pipelines, to accommodate future expansion.
- Ensure that the existing infrastructure can support the increased capacity or can be easily upgraded as needed.
- Incorporate flexibility in the design of key components such as pumping stations and control systems to handle future loads.

1.8.2) Provision for Reuse and Disposal of Treated Effluent with the Consent of Concerned Department

I. Effluent Reuse Planning:

- Explore viable applications for the reuse of treated effluent, such as irrigation for agricultural land, industrial cooling processes, or landscaping in urban parks as per reuse of wastewater policy of the Department of Public Health Engineering, Haryana
- Ensure that the quality of treated effluent meets the standards required for the intended reuse/disposal, particularly with respect to parameters like Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and Total Suspended Solids (TSS).

II. Disposal Plan Development:

- If reuse is not feasible, develop a safe and environmentally compliant effluent disposal plan. This could involve discharge into nearby water bodies, after ensuring compliance with surface water discharge norms.
- Obtain approval from the relevant departments (e.g., irrigation, municipal body) for both reuse and disposal strategies.

III. Approval and Implementation:

- Submit the reuse and disposal plans to the concerned departments for review and consent. Ensure that all required NOCs are obtained before proceeding.
- Implement the approved reuse or disposal mechanisms during the operational phase of the STP.
- Additionally, the "Reuse of Treater Waste Water Policy – 2019" issued by the State of Haryana vide notification No. 5/18/2018-3PH dated 30th October 2019 has been attached at Annexure IV

1.8.3) Provision for Sludge Management

I. Sludge Management Strategy:

- Develop a comprehensive plan for sludge treatment, including dewatering, drying, and stabilization.
- Identify potential disposal sites or reuse applications for treated sludge, such as agricultural land application (if it meets safety standards) or landfill disposal at approved sites.

II. Compliance with Environmental Standards:

- Ensure sludge treatment and disposal comply with SPCB guidelines and other relevant environmental regulations.

- Obtain necessary permits and clearances for transporting and disposing of sludge at designated facilities.

1.8.4) Horticulture Planning for Sewage Projects (Pump Houses & STP Sites)

Horticulture planning in pump houses and sewage treatment plant (STP) sites is essential with the following benefits:

- Maintaining environmental sustainability
- Reducing dust
- Improving the overall aesthetic and functional value of the facility
- Erosion control
- Noise reduction
- Temperature regulation

I. Site Assessment & Planning

- Assess availability of space, including open areas, buffer zones, and peripheries
- Evaluate soil and water conditions, including drainage patterns and water availability
- Avoid deep-rooted trees near underground pipelines and structures
- Select plants that absorb pollutants and control unpleasant odors

II. Selection of Suitable Plants

- Recommended plants: Bermuda Grass, Carpet Grass, Creeping Fig, Bougainvillea, Hibiscus, Lantana, Lavender, Rosemary, Ficus, Duranta, Clerodendrum, Bamboo (clumping type), Neem, Ashoka, Areca Palm, Aloe Vera, Snake Plant, Spider Plant, Gulmohar, Cassia, Amaltas
- Plants to avoid: Banyan, Peepal, and fruit-bearing trees due to root damage risk and hygiene concerns

III. Establishment of Own District-Wise Centralized Nursery (if required)

- Establish a dedicated nursery to ensure availability of plants and reduce costs
- Locate near STP or pump house for easy maintenance
- Use propagation methods like seed sowing, cuttings, and transplanting
- Develop infrastructure such as shade nets, drip irrigation, and compost pits
- Maintain regular weeding, pruning, and pest control

IV. Protection & Maintenance

- Use tree guards to protect young saplings
- Conduct regular pruning to prevent overgrowth near equipment
- Implement organic pest and weed control measures

V. Environmental & Safety Considerations

- Maintain safe distance from pipelines and tanks

- Use fire-resistant plants near electrical panels
- Prioritize native, low-maintenance plants
- Restrict plantations near treatment units to avoid interference

VI. Points of Consideration for Horticulture Planning in Sewerage Projects

- Risk of root damage to infrastructure: Use shallow-rooted plants
- Increased maintenance & water consumption: Opt for drought-resistant plants, drip irrigation, and rainwater harvesting
- Risk of pest infestation & animal attraction: Avoid fruit-bearing plants and ensure proper drainage
- Safety hazards: Regular pruning, clearing of dry leaves, and maintaining accessibility
- Space constraints: Use vertical gardens, potted plants, and designated small green zones

1.9) Reducing O&M cost

1.9.1) Provision of Solar Energy

- Based on the energy requirements of the STP and the calculate the size of the solar energy system needed to meet a significant portion of the plant's electricity demand.
- Consider the peak power requirements, average daily energy consumption, and potential for future energy demand increases.
- Size the solar system to optimize both cost and energy output, taking into account local solar irradiance data and the norms of the Nigam.
- Check the size of solar energy system as per the norms of DHBVN/UHBVN.
- Design the solar energy system to integrate seamlessly with the STP's existing electrical infrastructure.
- Ensure that the system includes inverters, controllers, and necessary wiring to convert and manage the solar power generated.
- Consider incorporating energy storage solutions, such as batteries, to provide backup power during periods of low sunlight or power outages and net metering system in ordinary running timings.
- Ensure that the solar energy system design complies with local regulations, building codes, and safety standards.
- Oversee the installation process to ensure that it meets the design specifications and quality standards.
- After installation, conduct a thorough commissioning process to verify the system's performance and ensure it operates as intended.

1.9.2) Provision of Automation

I. System Design & Integration:

- Begin by designing a comprehensive automation system that covers all key processes within the STP.
- Identify areas where automation can optimize operations, such as in the control of pumps, blowers, chemical dosing, and sludge management.

- Ensure that the automation system includes sensors, controllers, and actuators for real-time monitoring and control of the plant's operations.
- Implement a Supervisory Control and Data Acquisition (SCADA) system to provide centralized control and monitoring of the STP's automated processes.
- Ensure that the SCADA system is capable of collecting data from various sensors, displaying real-time information on user-friendly interfaces, and generating alerts for any deviations from normal operating conditions.
- The system should also support remote access for off-site monitoring and troubleshooting.

II. Programmable Logic Controllers (PLCs):

- Install Programmable Logic Controllers (PLCs) to manage the automated operations of individual components and processes.
- Ensure that the PLCs are programmed to execute control logic based on predefined parameters and that they can communicate with the SCADA system for coordinated operation.
- Use robust and reliable PLCs that can withstand the environmental conditions of the STP.

III. Automation of Critical Processes:

- Prioritize the automation of critical processes that require precise control, such as chemical dosing, aeration, and sludge dewatering.
- Equip these processes with advanced sensors that can detect real-time conditions such as flow rates, pH levels, and dissolved oxygen.
- Use automation to adjust process parameters dynamically, optimizing performance and reducing energy consumption.

IV. Training and Documentation:

- Provide comprehensive training for STP operators and maintenance staff on the use and troubleshooting of the automation systems.
- Ensure that they are familiar with the SCADA interfaces, PLC programming, and automated process controls.
- Prepare detailed documentation, including system diagrams, operation manuals, and maintenance schedules, and make them readily accessible to all relevant personnel.

2. EXECUTION, INSPECTION, AND TESTING

Part A: General Parameters

2.1) Use of all construction materials

2.1.1) Procurement of Materials Such as Cement, Steel, Coarse and Fine Aggregates, Etc., from Approved Source

I. Source Approval:

- Identify and evaluate potential suppliers to ensure they meet quality standards and project requirements. Review their certifications, past performance, and compliance with industry standards.
- Obtain approval from relevant authorities for the selected suppliers. Ensure that the suppliers are listed in the project documentation as approved sources.

II. Material Specifications:

- Verify that materials from approved sources meet the required specifications, including size, grade, and composition. Conduct tests and inspections as needed.
- Maintain records of material specifications, test results, and supplier approvals.

III. Delivery and Handling:

- Inspect materials upon delivery to confirm they match approved specifications. Check for any damage or discrepancies.
- Store materials in appropriate conditions to prevent contamination or deterioration. Ensure that storage areas are secure and organized.

Documentation:

- Keep detailed records of material sources, approvals, and inspection results.
- Ensure records are organized and accessible for review and audits.

2.1.2) Use of Design Mix

I. Design Mix:

- Develop concrete mix designs based on project requirements, including strength, durability, and workability. Use standard mix design methods and adjust as needed for specific site conditions.
- Verify that the mix design is approved by relevant authorities before use.
- For on-site mixing, use accurate weighing equipment to measure ingredients according to the approved mix design.
- Ensure proper mixing procedures are followed.
- For off-site mixing, order ready mix concrete from approved suppliers.
- Ensure that the concrete is delivered and used within the specified time to maintain quality in case of use of RMC.

II. Quality Control:

- Conduct tests on concrete samples to verify compliance with strength and quality requirements.
- This may include slump tests, compressive strength tests, and other relevant tests.
- Maintain records of mix designs, test results, and delivery details for ready mix concrete.

2.1.3) Procurement of Pipes and Machinery of Approved Make and Manufacturer

- Evaluate potential pipe, Machinery manufacturers based on their track record, compliance with standards, and quality certifications.
- Obtain approval from relevant authorities for the selected manufacturers.
- Ensure that manufacturers are listed in project documentation.
- Place orders with approved manufacturers for pipes, machinery specifying the required specifications, quantities, and delivery schedules.

2.1.4) Carrying Out Tests at Manufacturers' Premises Before Dispatch

I. Test Planning:

- Determine the scope of tests required for pipes, machinery including dimensions, material properties, and pressure tests etc. in case of pipes and discharge, head and NPHSR etc in case of machinery.
- Coordinate with the manufacturer to schedule and conduct tests before dispatch.

II. Testing Procedures:

- Perform tests at the manufacturer's premises, including visual inspections and technical tests to verify compliance with specifications.
- Document test results and verify that they meet project requirements and standards.

2.2) Supervision by skilled manpower/TPIA

2.2.1) Deployment of Appropriately Qualified Personnel

- Identify the qualifications and experience required for each role involved in the sewerage project. This includes engineers, technicians, and other specialists.
- Verify that all personnel have the necessary certifications, skills, and experience required for their assigned tasks.
- Assign roles and responsibilities based on the qualifications and expertise of the personnel.
- Ensure that the right personnel are deployed to appropriate tasks and areas.
- Monitor the performance of deployed personnel to ensure that tasks are performed according to project specifications and standards.

2.3) Documentation and Reporting

2.3.1) Preparation of Site Inspection and Quality Control Registers

I. Site Inspection Register:

- Record details of all site inspections, including date, time, inspector's name, and scope of inspection.
- Document observations, findings, and any issues identified during the inspection.
- Note any corrective actions taken or required to address issues identified during inspections.
- Include follow-up inspections to verify that corrective actions have been implemented.

II. Quality Control Register:

- Maintain a register of quality control checks performed on construction materials, equipment, and STP operations.

- Record details of tests conducted, including test parameters, results, and any deviations from standards.
- Document compliance with quality standards and specifications.
- Include records of any non-compliance issues and actions taken to resolve them.

2.3.2) Checking of Test Results by Engineer in Charge

I. Test Result Review:

- The Engineer in Charge must review test results to verify accuracy and consistency with project specifications and regulatory standards.
- Cross-check results with laboratory records and testing procedures.
- Identify and investigate any discrepancies or issues in the test results.
- Determine the cause of any deviations and take corrective actions as needed.

II. Approval and Documentation:

- Provide formal approval of test results once verified. Ensure that approved results are documented and communicated to relevant stakeholders.
- Maintain records of test result reviews, including documentation of any issues identified and actions taken.
- Ensure that records are organized and accessible for review and audits.

2.3.3) Rectification of Defects

- Review inspection and test reports to identify defects or non-compliance issues.
- Document details of each defect, including location, description, and severity.
- Develop a plan for rectifying identified defects. Include specific actions to be taken, responsible personnel, and a timeline for completion.
- Execute the rectification plan, including repairs, modifications, or replacements as needed.
- Ensure that all actions are carried out in accordance with project specifications and quality standards.
- Conduct follow-up inspections to verify that defects have been properly rectified and that the system meets all required standards.
- Maintain records of rectification actions, including details of defects, corrective measures taken, and verification results.

2.3.4) Submission of Reports and Keeping the Record

- Prepare reports on various aspects of the sewerage project, including progress, inspections, test results, and compliance with standards.
- Ensure reports are accurate, complete, and clearly presented.
- Submit reports to relevant stakeholders, including project managers, regulatory authorities, and other parties as required by the project agreement or regulations.
- Maintain comprehensive records of all submitted reports, including copies of reports, correspondence, and supporting documentation.
- Ensure records are organized and stored securely.
- Ensure that records are accessible for review, audits, and future reference.

Part B: Parameters Relating to Laying of Sewerage

2.4) Conformity to relevant standards

2.4.1) Physical Inspection of Pipes at Site Before Laying

I. Inspection Preparation:

- Prepare an inspection checklist that includes criteria for evaluating the quality and condition of pipes.
- This may include dimensions, material integrity, and absence of defects.
- Ensure that inspection tools and equipment are available and calibrated.
-

II. Inspection Process:

- Conduct physical inspections of pipes at the site, verifying that they conform to specifications and standards.
- Check for any visible defects, damage, or deviations from the required specifications.

III. Documentation and Action:

- Document inspection results, including any issues identified and corrective actions taken.
- Address any defects or non-compliance issues before proceeding with the laying of pipes.

2.4.2) Work Executed as per Originally Approved Bid Document

I. Review of Bid Document:

- Review the originally approved bid document to understand the scope of work, specifications, and requirements.
- Ensure that all project activities are aligned with the specifications and terms outlined in the bid document.

II. Execution Monitoring:

- Monitor work execution to ensure that it adheres to the approved bid document. This includes checking compliance with technical specifications, quality standards, and contractual terms.
- Address any deviations or non-compliance issues promptly to bring the work back in line with the approved bid document.

III. Execution of Horticulture Development:

- Follow proper guidelines for horticulture planning as outlined in the bid document/estimate, keeping in mind the aesthetic appeal, safety, plantation techniques, and maintenance and upkeep.

2.4.3) Maintaining Slopes for Laying of Pipes (as per design) for Ensuring Gravitational Flow of Sewage

I. Slope Design:

- Design slopes for pipe installation based on the requirements for gravitational flow. This includes calculating the correct gradient to ensure efficient flow and prevent blockages.
- Reference relevant standards and guidelines for slope design in sewerage systems.

II. Installation:

- Ensure that pipes are laid according to the design/specified slopes during installation.
- Use levelling instruments and measurements to verify that slopes are maintained.
- Correct any deviations from the specified slopes during installation to ensure proper flow.

III. Inspection and Verification:

- Conduct inspections to verify that slopes are maintained throughout the length of the pipes.
- Address any issues or deviations identified during inspections.
- Document inspection results and corrective actions taken.

IV. Maximum Depth of Sewers:

- The depth of sewer system is determined by the various factors, including topography, width of street, traffic conditions, soil conditions, hydraulic requirements, and water table, etc.
- Generally, the maximum depth of sewer is designed to ensure functionality by balancing in construction, and Operation and Maintenance cost, and safety.

2.5) Making good the dismantled surfaces

2.5.1) Dismantled Roads and Streets are Repaired Properly and Dismantled Material Disposal

- Develop a plan for repairing roads and streets that have been dismantled or disrupted during the project.
- Coordinate repair activities with relevant authorities and ensure that repairs are as per the original surface specifications.
- Establish procedures for the disposal of dismantled materials, including guidelines for handling, sorting, and transporting materials.
- Ensure that disposal practices comply with environmental regulations and guidelines. Recycle or reuse materials where possible.

Part C: Parameters relating to Construction of STP

2.6) Pumping system efficiency enhancement

2.6.1) Use High Efficiency Pumps & Motors Specifically Designed for Site Requirements

- Assess site-specific requirements, including flow rates, pressure, and operational conditions.
- Select high-efficiency pumps and motors that meet these requirements and are designed for the site conditions.
- Follow manufacturer guidelines and best practices for the installation of pumps and motors.
- Ensure proper alignment, connections, and calibration.
- Test the equipment to ensure it operates correctly and efficiently under site conditions.

2.6.2) Installation of Various Modern Equipment as per Bid Document

I. Equipment Selection and Approval:

- Thoroughly review the bid document to identify the list of modern equipment required for the project, including specifications such as capacity, brand, technical features, and performance standards.
- Ensure all selected equipment adheres to the specifications outlined in the bid document and complies with relevant national and international standards (e.g., BIS, ISO, ASTM).
- Verify that the selected equipment is approved by the competent authority before proceeding with the procurement process.
- Obtain approval for any deviations from the bid specifications, if necessary, ensuring that changes are justified and documented properly.

II. **Pre-Installation Planning**:

- Conduct a detailed site assessment to determine the layout, space requirements, and supporting infrastructure needed for the installation of the equipment (e.g., electrical supply, foundation requirements, access points).
- Ensure that the site is prepared with proper civil works and foundations in accordance with the technical specifications of the equipment and manufacturer's guidelines.
- Coordinate the delivery schedule of the equipment with the supplier, ensuring timely arrival on site to align with the overall project timeline.
- Arrange for safe handling, transportation, and storage of the equipment on-site, minimizing the risk of damage or deterioration before installation.

III. **Installation Process**:

- Engage qualified and experienced technicians or contractors who are certified by the equipment manufacturer to carry out the installation.
- Ensure that the installation team has access to the manufacturer's technical manuals, installation guidelines, and any special tools or equipment required for the process.
- Verify that the installation process strictly adheres to the procedures, quality standards, and timelines mentioned in the bid document.
- Inspect the installation at critical stages to ensure that the equipment is being installed correctly, following safety standards and operational requirements.

IV. **Testing and Commissioning**:

- Before commissioning, perform pre-installation tests such as alignment, vibration testing, insulation resistance tests, and functional checks as per the manufacturer's recommendations.
- Record all test results and compare them with the bid document's requirements to ensure compliance.
- Conduct full system tests after installation, ensuring that the equipment operates efficiently and meets the performance standards outlined in the bid document.
- Verify that all auxiliary systems (e.g., control panels, monitoring devices) are functioning as intended and integrated into the overall system.

V. **Documentation and Handover**:

- Prepare detailed as-built documentation that includes equipment specifications, installation procedures, testing results, and maintenance requirements for each piece of installed equipment.

- Submit the documentation for approval by the project's competent authority and ensure that it is included in the project's final completion report.
- Provide training sessions for the operational staff to ensure they are familiar with the correct operation, safety protocols, and maintenance procedures for the installed equipment.
- Hand over all warranties, manuals, and certifications associated with the equipment to the project management team or relevant department.

2.7) Setting up of testing laboratory and obtaining consent from Pollution Control Board

2.7.1) Setting Up Effluent Testing Laboratories at Site of STP

I. Laboratory Setup:

- Choose a suitable location within the STP site for the laboratory, considering factors such as accessibility, safety, and proximity to effluent discharge points.
- Procure and install necessary laboratory equipment, including BOD incubator, DO meter, COD digestor, Spectrophotometers, pH meters, turbidity meters, and other analytical instruments.
- Ensure that the laboratory is equipped with proper ventilation, lighting, and safety equipment.
- Hire qualified personnel with expertise in water and wastewater analysis.
- Ensure that staff are trained in the use of laboratory equipment and testing procedures.

II. Testing Procedures:

- Develop and standardize testing methods for key parameters such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), and pH.
- Establish procedures for the collection, preservation, and handling of effluent samples to ensure accuracy and reliability of test results.

2.7.2) Provision for Reuse and Discharge of Treated Effluent Made and Consent Obtained from Concerned Department

I. Reuse Provisions:

- Design and install infrastructure at the STP to facilitate the reuse of treated effluent, such as pipelines, storage tanks, and pumping stations to convey treated water to reuse sites.
- Ensure continuous monitoring of effluent quality, especially parameters like nitrogen, phosphorus, and microbiological contaminants, to ensure suitability for reuse.

II. Consent from Authorities:

- Secure consent from relevant authorities (e.g., agriculture, industry departments, etc.) for the reuse of treated effluent. Submit required reports and evidence showing that the effluent meets reuse standards.
- Ensure that all documentation and approvals are in place before effluent reuse begins, and that it is regularly reviewed for continued compliance.

2.7.3) Obtaining Consent to Operate from State Pollution Control Board

- Prepare and submit an application to the SPCB, including all required documentation.

- Include a comprehensive description of the STP, including its design, capacity, and operational procedures.
- Provide information on effluent quality, emission controls, and waste management practices. Coordinate with the SPCB for site inspections and assessments.
- Address any concerns or recommendations provided by the SPCB during the inspection.
- Obtain the formal consent from the SPCB, which authorizes the operation of the STP valid for the required period.

3. COMMISSIONING AND HANDOVER

Part A: General Parameters

3.1 Guarantee of works

3.1.1) Post-Commissioning Monitoring and Support

I. Monitoring:

Implement a system for continuous monitoring of the sewerage system's performance. This should include:

- Define key performance indicators (KPIs) for system operation, such as flow rates, treatment efficiency, and energy consumption.
- Use monitoring tools and software to collect and analyse data on system performance.
- Schedule regular inspections to assess the condition of equipment and infrastructure.

II. Support Services:

Provide technical support and maintenance services as needed. This includes:

- Offer technical support for troubleshooting and resolving issues.
- Develop and follow a maintenance schedule to address routine and preventive maintenance tasks.
- Provide assistance to system operators and users in managing and operating the system effectively.

III. Reporting:

- Generate and submit regular performance reports to stakeholders, including details on system performance, maintenance activities, and any issues encountered.
- Include recommendations for improvements or corrective actions.

Documentation:

- Keep detailed records of monitoring activities, support services provided, and performance reports.
- Ensure that documentation is organized and accessible for future reference and audits.

3.1.2) Withholding of Security Amount

I. Security Amount Terms:

- Review the terms of the project agreement related to the security amount.
- This includes understanding the conditions under which the security amount can be withheld or released.

II. Withholding Procedure:

- Identify specific conditions or milestones that must be met before the security amount can be withheld.
- Prepare and submit necessary documentation to support the decision to withhold the security amount.

III. Release Procedure:

- Verify that all contractual obligations have been fulfilled before releasing the security amount.
- Prepare and submit documentation to confirm the release of the security amount.

3.1.3) Submission of Assets Completion Plan and Completion Report by Agency and Certificate by Department

I. Asset Completion Plan:

The agency responsible for the sewerage project must prepare a detailed Asset Completion Plan. This plan should outline the status of all assets, including sewer pipelines, treatment facilities, and associated infrastructure. It should include:

- A comprehensive list of completed assets.
- Verification of completion against project specifications.
- Documentation of any deviations or modifications made during the project.
- An estimated timeline for any remaining work or final adjustments.

II. Completion Report:

The agency must submit a Completion Report upon finishing the project. The report should include:

- A summary of work completed, including detailed descriptions and specifications of each asset.
- Photographs and diagrams of completed installations.
- Records of inspections and quality checks performed throughout the project.
- Any issues encountered during the project and the solutions implemented.

III. Certificate by Department:

The relevant department must review the Asset Completion Plan and Completion Report and issue a certificate of completion if all requirements are met. The certificate should confirm that:

- The assets meet the technical and quality standards specified in the agreement.
- All necessary documentation and inspections have been completed.
- Any minor issues or defects have been addressed or are noted for future resolution.

Documentation:
Maintain comprehensive records of all submitted plans, reports, and certificates. Ensure these documents are organized, accessible, and stored securely for future reference and potential audits.

Part B: Parameters Relating to Sewerage

3.2) Testing and Functionality of STP

3.2.1) Flushing of Pipeline

I. Pipeline Flushing:

- Inspect pipelines to identify any obstructions or debris that may affect free flow of sewage. Ensure all valves and connections are in good working condition.
- Use appropriate equipment, such as high-pressure water jets, to flush out debris and sediments from the pipelines. Ensure that the flushing is done in stages to cover all sections of the pipeline.
- Inspect the pipelines after flushing to ensure that all debris has been removed and that the pipelines are clean and clear.

3.2.2) All Proposed Connection made to the Sewer System

I. Survey and Identification:

- Conduct a thorough survey to identify all households within the project area. Use GIS mapping tools to accurately document the locations and ensure no household is overlooked.
- Assess the existing connections to the sewer system, identifying any gaps or areas where households are not yet connected.

II. Connection Planning:

- Develop a detailed plan for extending the sewer network to unconnected households. Ensure that the design meets technical standards and integrates seamlessly with the existing sewer infrastructure.
- Engage with local communities to inform them about the benefits of connecting to the sewer system. Address any concerns and provide assistance in the connection process.

II. Implementation:

- Carry out the physical work of connecting each household to the sewer system. Ensure that the work is performed according to the approved design and quality standards.
- After completing the connections, conduct inspections to ensure that all households are properly linked to the system. Perform tests to verify that the connections are functional and free from leaks or blockages.

III. Documentation and Reporting:

- Maintain detailed records of all households connected to the sewer system, including the date of connection, the contractor responsible, and any issues encountered during the process.
- Regularly update project stakeholders, including local authorities and funding agencies, on the progress of household connections. Ensure that reports reflect the percentage of households connected and any challenges faced.

IV. Post-Connection Support:

- Provide ongoing support to households after connection, including troubleshooting any issues that arise and ensuring proper use of the sewer system.
- Conduct awareness campaigns to educate households about the importance of maintaining their connections and avoiding practices that could lead to blockages or system failures.

V. Review and Compliance:

- Regularly monitor the sewer connections to ensure that all households remain connected and that the system operates efficiently.
- Schedule follow-up inspections to check for any new households or developments that need to be connected to the system.

Part C: Parameters Relating to STP

3.3) Testing of system and Functionality of STP

3.3.1) Cleaning of STP

I. STP Cleaning:

- Use suitable cleaning agents and equipment to clean the STP components, including screens, and tanks. Ensure that all parts are thoroughly cleaned and disinfected.
- Inspect the STP to ensure that cleaning has been effectively carried out and that all components are in proper working condition.

3.3.2) Ensuring proper operation of all modern equipment installed at STP as per bid document including SCADA, online analyzers, and VFD etc.

I. SCADA System Operation:

- Configure the SCADA system to monitor key parameters and control processes in the sewerage system. Ensure that all sensors, controllers, and communication links are properly set up.
- Use SCADA to continuously monitor system performance, including flow rates, chemical dosing, and equipment status. Respond to any alerts or deviations from normal operation.
- Perform regular maintenance and updates on the SCADA system to ensure its continued functionality and accuracy.

II. Online Analysers Operation:

- Install and calibrate online analysers to measure parameters such as BOD, COD, TDS, and dissolved oxygen in real-time. Ensure that analysers are properly maintained and calibrated.
- Collect and review data from online analysers to monitor the performance of the treatment processes. Use this data to make informed operational decisions.

3.3.3) Automation of STP Operations

I. Automation System Design:

- Identify the requirements for automation, including the processes and equipment to be automated. Develop a system design that includes control strategies and integration with existing infrastructure.
- Install and configure automation equipment, such as programmable logic controllers (PLCs), sensors, and actuators, to automate key STP processes, including chemical dosing, sludge handling, and flow control.

II. Operation and Monitoring:

- Monitor the performance of automated systems to ensure they are functioning as intended. Adjust control parameters as needed to optimize performance.
- Perform regular maintenance on automation equipment to prevent failures and ensure reliable operation.

3.3.4) Specified Quality of Treated Effluent

I. Quality Standards:

- Review the regulatory requirements and quality standards for treated effluent, including parameters such as BOD, COD, TSS, P, Total Nitrogen, and pH etc.
- Establish operational targets based on these standards to guide treatment processes and ensure compliance.

II. Testing Procedures:

- Collect samples of treated effluent at various stages of the treatment process using standardized methods.
- Conduct laboratory tests to analyse the quality of the treated effluent. Compare results with the specified quality standards.
- If results do not meet the quality standards, implement corrective actions to address any deficiencies in the treatment process.

3.3.5) Preparation of Manual on Standard Operating Methods and Procedures for STP

I. Manual Preparation:

The manual should include detailed SOMPs for all aspects of STP operation and maintenance. It should cover:

- Step-by-step instructions for daily operations, including start-up, monitoring, and shut-down procedures.
- Guidelines for routine and preventive maintenance tasks, including equipment checks, cleaning schedules, and replacement of parts.
- Safety procedures for handling chemicals, operating machinery, and responding to emergencies.
- Common issues and troubleshooting steps to address operational problems.
- Procedures for maintaining operational logs, maintenance records, and incident reports.

II. Review and Approval:

- Review the draft manual with relevant stakeholders, including engineering teams and operational staff.
- Incorporate feedback and ensure the manual aligns with regulatory requirements and best practices.
- Obtain formal approval from the relevant authority.

III. Training:

- Provide training to STP operators and maintenance personnel on the use of the manual.
- Ensure that all staff are familiar with the procedures and understand their roles and responsibilities.

3.3.6) Emergency Response Mechanism Such as Standby Arrangement of Machinery, etc.

I. Emergency Response Plan:

Develop an Emergency Response Plan outlining procedures for various emergency scenarios, such as equipment failure, natural disasters, or safety incidents. The plan should include:

- List of key contacts, including emergency services, suppliers, and internal response teams.
- Step-by-step instructions for responding to different types of emergencies, including immediate actions, containment measures, and communication protocols.
- Define the roles and responsibilities of personnel involved in the emergency response.

II. Standby Arrangements:

Ensure that standby arrangements are in place for critical machinery and equipment. This includes:

- Procurement and maintenance of backup machinery that can be quickly deployed in case of failure.
- Maintain an inventory of essential spare parts to facilitate rapid repairs.
- Establish service contracts with suppliers or contractors for emergency repair and support.

III. Training and Drills:

- Conduct regular training sessions and emergency drills to ensure that personnel are familiar with the emergency response procedures and standby arrangements.
- Evaluate the effectiveness of drills and make improvements as needed.

Documentation:

- Maintain detailed records of the Emergency Response Plan, standby arrangements, training sessions, and emergency drills.
- Ensure that documentation is up-to-date and accessible for review and audits.

4. SAFETY AND SECURITY

4.1) Adherence to safety standards

4.1.1) Providing of Safety Measures at the time of Deep Excavations (Shoring, Caution Boards, Barricading, Night Signals, etc.)

I. Site Safety Planning:

- Conduct a thorough risk assessment of the site prior to deep excavation activities, identifying potential hazards such as soil instability, water ingress, and nearby utilities.
- Develop a safety plan that includes mitigation strategies, contingency measures, and emergency response protocols.
- Ensure that all required excavation permits are obtained from relevant authorities before starting the work. This includes submitting plans and securing approvals for deep excavation and trench work.

II. Implementation of Safety Measures:

- Install visible caution boards at all excavation sites, indicating the nature of the work, safety precautions, and restricted access zones.
- Use clear, multilingual signs to communicate safety messages to workers and the public, especially if the site is in a residential or high-traffic area.
- Erect sturdy barricades or fences around the excavation area to prevent unauthorized entry and accidental falls. Ensure the barricades are well-marked with reflective tape and maintained throughout the duration of the excavation.
- Set up adequate lighting and reflective night signals around the excavation site, especially in urban areas where the public may pass nearby. Use flashing warning lights to alert vehicles and pedestrians during night hours.

III. Compliance and Monitoring:

- Conduct regular inspections of the site to ensure that all safety measures remain intact and are being adhered to by the workforce.
- Designate a safety officer responsible for ensuring compliance with excavation safety protocols and addressing any violations immediately.

4.1.2) Providing Safety Measures

I. First Aid & Firefighting Equipment:

- Ensure that first aid kits and firefighting equipment are readily available and strategically placed throughout the site.
- Equip first aid kits with essential medical supplies
- Firefighting equipment includes ABC type fire extinguishers, and alarms.

II. Safety Uniforms:

- Provide safety uniforms and personal protective equipment (PPE) such as helmets, gloves, safety glasses, and boots to all personnel.

- Ensure that uniforms meet safety standards and are appropriate for the specific work environment.

III. Gas Release Vents:

- Install gas release vents in areas where hazardous gases are used or generated.
- Ensure that vents are properly maintained and functional to prevent gas accumulation and potential exposure.

IV. Inspection:

- Regularly inspect safety equipment and uniforms to ensure they are in good condition and operational.
- Replace or repair any damaged items promptly.

4.2) Safety measures for workers and users

4.2.1) Access Control

- Install access control systems such as card readers, biometric scanners, or keypad entry systems at entry points to secure areas.
- Ensure systems are functioning correctly and are regularly updated.
- Define access levels based on personnel roles and responsibilities.
- Issue access credentials only to authorized individuals and maintain a record of access permissions.
- Regularly review and update access permissions to reflect personnel changes or role adjustments.
- Monitor access logs to detect any unauthorized access attempts.

4.2.2) Detection, Alert, and Remedial Measures in Case of Chlorine Gas Leakage, If Applicable

I. System Installation:

- Install a reliable chlorine gas leak detection alarm system in areas where chlorine is stored or used.
- Ensure the system is designed to detect low concentrations of chlorine and trigger alerts.
- Integrate the alarm system with existing safety and emergency response systems to ensure a coordinated response in case of a leak.

II. Detection & Alerts:

- Install chlorine gas detectors in areas where chlorine is used or stored.
- Ensure detectors are calibrated and functioning correctly to provide accurate readings.
- Set up alert systems to notify personnel in case of chlorine gas detection.
- This may include alarms, visual indicators, or automatic notifications to emergency response teams.

III. Remedial Measures:

- Develop and implement procedures for responding to chlorine gas leaks.
- This includes evacuation plans, containment measures, and corrective actions to address the source of the leak.
- Provide training to personnel on how to respond to chlorine gas leaks, including the use of detection equipment, evacuation procedures, and emergency protocols.

4.2.3) Compliance of Safety Measures as per Provisions of Labour Laws

I. Labour Law Compliance:

- Ensure that all safety measures comply with the provisions outlined in relevant labour laws, such as the Building and Other Construction Workers' Act, and the Occupational Safety, Health, and Working Conditions Code.
- Ensure compliance with specific clauses relating to working conditions, safe machinery, personal protective equipment (PPE), and the right to a safe workplace.

II. Implementation of Safety Standards:

- Ensure all workers are provided with adequate safety gear such as helmets, gloves, boots, and safety vests as per the legal requirements.
- Train workers on the proper use of PPE and ensure they understand the importance of using safety equipment during operations.
- Monitor work conditions regularly to ensure compliance with health and safety standards, especially in hazardous operations like trenching, welding, and lifting heavy machinery.
- Set up safety measures for proper ventilation, fall protection, and equipment handling in line with labour law provisions.

III. Compliance Monitoring and Reporting:

- Conduct regular labour inspections at the site to ensure compliance with safety measures as mandated by labour laws. Keep records of all safety audits, violations, and corrective actions taken.
- Submit reports to local labour authorities as required, documenting the safety measures implemented and their alignment with legal standards.

4.2.4) Compliance to Prohibition of Employment as Manual Scavengers and their Rehabilitation Act

I. Legal Compliance:

- Ensure strict compliance with the provisions of the Prohibition of Employment as Manual Scavengers and their Rehabilitation Act, 2013.
- Prohibit any form of manual scavenging in all project operations, including sewer cleaning and other sanitation-related activities.
- Implement alternative mechanized systems for cleaning sewer lines, septic tanks, and manholes.

II. Employment Practices:

- Ensure no worker is employed in manual scavenging activities. Utilize modern technologies and machines for such operations.
- Facilitate the rehabilitation of any worker previously engaged in manual scavenging, providing alternative job opportunities, skill development, and access to welfare schemes.

III. Health and Safety Provisions:

- Ensure that all workers involved in mechanized cleaning or other sanitation tasks are provided with protective equipment, training, and safe working conditions.

- Monitor the use of safety gear and ensure proper hygiene practices are followed by workers in line with health regulations.

4.3) Security measures

4.3.1) Physical Security Measures

I. Perimeter Security & Protocols:

- Install fencing, gates, and barriers around the site to prevent unauthorized entry.
- Ensure that access points are secured and monitored.
- Conduct regular security patrols of the site to deter and detect any security breaches.
- Assign security personnel to monitor access points and secure areas.

II. Lighting:

- Install adequate lighting around the site, especially in areas prone to security breaches.
- Ensure that lighting is functional and covers all critical areas.

4.3.2) Incident Response and Reporting

- Develop an incident response plan outlining steps to take in various types of incidents, including security breaches, safety hazards, and operational disruptions.
- Ensure that incidents are reported promptly to the relevant authorities and stakeholders.
- Use standardized reporting forms or systems to document details of the incident, including the nature, impact, and resolution.
- Conduct investigations to determine the root cause of incidents and implement corrective actions to prevent recurrence.

5. PROJECT MANAGEMENT

Part A: General Parameters

5.1) CPM/PERT Charts

5.1.1) Preparation of CPM/PERT Charts

I. Project Planning:

- Break down the entire sewage and STP project into key phases, such as design, procurement, construction, and commissioning.
- Identify all individual tasks within each phase, such as laying sewer lines, building STP units, and connecting households to the sewer system.

II. Chart Development:

- Use the Critical Path Method (CPM) to identify the longest sequence of dependent activities that determine the project's completion time.
- Identify critical tasks that must be completed on time to avoid project delays.
- Input start and end dates for each task, dependencies between activities, and allocate resources for efficient project execution.
- Use PERT to estimate the time required for each activity, focusing on probabilistic time estimates (optimistic, most likely, and pessimistic).
- Incorporate buffer times for tasks where there may be uncertainties or potential delays, such as weather-dependent activities like excavation or concrete work.

III. Review and Approval:

- Share the prepared CPM charts with the project management team for review. Ensure that the timelines and task dependencies align with the overall project plan.
- Adjust the charts based on feedback to ensure feasibility and resource availability.
- Submit the finalized charts to the project's competent authority or funding agency for approval. Use the charts as a basis for scheduling, resource allocation, and progress monitoring throughout the project.

Part B: Parameters Relating to Sewerage

5.2) Adherence to Time Schedule and Cost Estimates as per Agreement

5.2.1) Adhering to Timelines of the Project for Sewerage Pipelines as per Agreement

I. Project Scheduling:

- Develop a comprehensive project schedule that includes all key milestones, such as site preparation, trenching, pipe installation, and backfilling as detailed in Clause 5.1.1 above.
- Use project management tools or software to create a detailed timeline.
- Coordinate with all relevant stakeholders, including contractors, suppliers, and project managers, to align on the schedule and ensure that everyone is aware of their deadlines and responsibilities.

II. Progress Monitoring:

- Implement a system for tracking the progress of pipeline installation activities.
- Regularly compare actual progress against the scheduled timeline to identify any deviations.

- Schedule regular site inspections and progress meetings to review the status of the project.
- Document any delays or issues encountered and the reasons for them.

III. Issue Resolution:

- Identify and address potential delays promptly.
- This may include reallocating resources, adjusting work plans, or expediting material deliveries to mitigate impacts on the timeline.
- Develop contingency plans for common issues that may affect the schedule, such as weather-related delays or supply chain disruptions.

IV. Reporting:

- Provide regular progress reports to stakeholders, including project sponsors, management, and regulatory authorities.
- Include updates on milestones achieved, delays encountered, and corrective actions taken.
- Use clear and concise reporting formats to ensure that information is easily understood and actionable.

5.2.2) Adhering to Cost Estimates of the Project for Sewerage Pipelines as per Agreement

I. Cost Estimation:

- Develop a detailed cost estimate for the sewerage pipeline project, including labour, materials, equipment, and overhead costs.
- Review and approve the budget before project initiation.
- Ensure that the cost estimate accounts for all project requirements and potential contingencies.

II. Cost Tracking:

- Implement a financial tracking system to monitor actual expenditures against the cost estimates.
- Regularly review and compare costs related to pipeline construction, materials, and labour.
- Conduct periodic financial reviews and audits to ensure that expenditures align with the budget and identify any discrepancies.

III. Cost Control:

- Address any cost overruns or deviations from the budget promptly.
- Implement cost control measures such as optimizing resource allocation, negotiating with suppliers, or revising work plans to reduce costs.
- Adjust cost forecasts as necessary and communicate any changes to stakeholders.

IV. Reporting:

- Provide regular financial reports to stakeholders, including project sponsors and management.
- Include comparisons between budgeted and actual costs, highlighting any variances and actions taken to address them.
- Use clear and concise financial reporting formats to facilitate understanding and decision-making.

Part C: Parameters Relating To STP

5.3) Adherence to Timelines and Cost Estimates as per Agreement

5.3.1) Adhering to Timelines of the Project for Sewage Treatment Plant as per Agreement

I. Project Planning:

- Create a comprehensive timeline for the STP project, including all phases such as site preparation, equipment installation, system testing, and commissioning as detailed in Clause 5.1.1 above.
- Ensure that the schedule is realistic and accounts for all project requirements.
- Coordinate with contractors, equipment suppliers, and engineering teams to finalize the schedule and ensure all parties are aligned on deadlines and deliverables.

II. Progress Tracking:

- Implement a system to monitor the progress of STP construction and commissioning activities.
- Regularly review progress against the established timeline and address any deviations promptly.
- Conduct periodic site visits and progress reviews to assess the status of construction activities and identify any potential delays.

III. Corrective Actions:

- Address any issues that may impact the timeline, such as delays in equipment delivery, construction delays, or regulatory approvals.
- Implement corrective measures to minimize the impact on the overall project schedule.
- Adjust the project timeline as needed while ensuring that any changes are communicated to all stakeholders and documented appropriately.

IV. Reporting:

- Provide regular updates on STP progress to stakeholders, including project managers, regulatory authorities, and project sponsors.
- Include details on completed milestones, any delays, and actions taken to address issues.
- Use reporting tools and formats that clearly convey progress, challenges, and corrective actions.

5.3.2) Adhering to Cost Estimates of the Project for Sewage Treatment Plant as per Agreement

I. **Cost Planning and Budget Allocation**:

- Prepare a comprehensive cost estimate for the project, covering all phases including design, procurement, construction, labour, and materials. Ensure the cost estimate includes contingencies for unforeseen expenses.
- Break down the budget into subcategories such as civil works, mechanical works, electrical works, and operational expenses to ensure detailed monitoring.
- Ensure that the approved budget aligns with the project's agreement and that any additional costs or overruns are authorized in advance by the relevant authorities.
- Document and secure approval for any scope changes that may affect the overall project cost.

II. **Cost Control and Monitoring**:

- Implement a cost tracking system to monitor expenses in real time, ensuring that actual costs are compared to the budgeted amounts.
- Monitor all procurement, labor, and subcontracting costs to ensure they stay within the estimated budget.
- Implement strict cost control measures to prevent overruns. Ensure that any additional costs due to scope changes, material price fluctuations, or unforeseen events are promptly addressed and mitigated.
- Use procurement strategies like competitive bidding and negotiations with suppliers to control costs.

III. **Periodic Financial Reviews and Adjustments**:

- Conduct monthly financial reviews to assess the project's financial health, comparing actual costs incurred to the budget. Identify and flag any areas where overspending may occur and implement corrective actions.
- Prepare and submit periodic financial reports as required under the agreement, providing a clear summary of expenses and projections.
- Manage the project's contingency fund effectively, ensuring that it is used only for authorized changes or unforeseen events.
- Ensure that contingency spending is documented and approved by the project's competent authority.

IV. **Final Cost Reconciliation**:

- Upon project completion, perform a final cost reconciliation, comparing the actual cost with the budget and identifying any variances.
- Prepare a final financial report, including explanations for any deviations, cost-saving measures, and recommendations for future projects.

6. OPERATION AND MAINTENANCE

Part A: General Parameters

6.1) Timely rectification of defects

6.1.1) Grievance Redressal and Record Keeping

I. Grievance Management:

- Implement a structured process for receiving grievances through multiple channels, such as online forms, email, telephone, or in-person submissions. Ensure that all complaints are acknowledged promptly.
- Enter details of each grievance into a centralized record-keeping system. Record essential information including the nature of the grievance, the date received, the complainant's details, and any supporting documents.
- Assign grievances to appropriate personnel for investigation and resolution. Develop a standard process for addressing different types of grievances, including timelines for resolution and escalation procedures.
- After resolving a grievance, follow up with the complainant to ensure satisfaction and confirm that the issue has been resolved to their satisfaction.

II. Record Keeping:

- Maintain detailed records of all grievances, including the initial complaint, investigation reports, resolution actions, and correspondence with the complainant. Ensure that records are complete and accurate.
- Periodically review grievance records to identify trends or recurring issues. Use this information to improve processes and address systemic problems.
- Ensure that all grievance records are stored securely and that sensitive information is handled confidentially to protect the privacy of individuals involved.

III. Reporting:

- Prepare and submit regular reports on grievance management to senior management. Include metrics such as the number of grievances received, resolution times, and satisfaction levels.
- Use insights from grievance reports to implement improvements in operations and address recurring issues proactively.

6.1.2) Maintenance Schedule Development and Its Compliance

I. Schedule Development:

- Create a maintenance schedule that outlines routine, preventive, and corrective maintenance activities.
- Include specific tasks, frequencies, responsible personnel, and resources needed.
- Assess the criticality of each piece of equipment and adjust the maintenance schedule based on its impact on operations and potential risks associated with equipment failure.
- Ensure that the maintenance schedule is integrated with overall operational plans and does not disrupt normal STP operations.
- Ensure regular trimming, pruning, and pest control of vegetation around the area to not compromise with operational efficiency.

II. Compliance Monitoring:

- Implement systems to track the completion of scheduled maintenance tasks.
- Conduct regular inspections and audits of maintenance activities to verify compliance with the schedule.
- Address any deviations or non-compliance promptly.
- Establish a feedback mechanism for maintenance staff to report any issues encountered during maintenance tasks or suggest improvements to the schedule.

III. Review and Adjustment:

- Regularly review the performance of the maintenance schedule based on equipment performance, downtime, and maintenance costs.
- Make adjustments as needed to optimize maintenance practices.
- Incorporate lessons learned from maintenance activities into future planning.
- Adjust the schedule based on changes in equipment conditions, operational demands, and technological advancements.

6.1.3) Availability of Spare Parts/Standby Machinery

I. Inventory Management:

- Develop and maintain an inventory of critical spare parts required for routine and emergency repairs.
- Categorize parts based on priority and usage frequency.
- Procure and maintain standby machinery that can be quickly deployed in case of equipment failure.
- Ensure that standby machinery is tested regularly to confirm its readiness.

II. Monitoring:

- Conduct regular inventory checks to ensure that spare parts and standby machinery levels are adequate.
- Reorder items as needed to prevent shortages.
- Track the usage of spare parts and machinery to identify trends and adjust inventory levels accordingly.

6.1.4) Training and Capacity Building

I. Training Programs:

- Conduct a training needs assessment to identify skill gaps and areas for improvement.
- Consider technological advancements, regulatory changes, and staff feedback.
- Develop training programs tailored to the identified needs. Include both theoretical and practical components, covering technical skills, operational procedures, safety practices, and regulatory compliance.
- Use a variety of training methods, including workshops, seminars, online courses, and hands-on sessions.
- Ensure that training materials are up-to-date and relevant.

II. Capacity Building:

- Organize regular workshops and seminars to provide staff with advanced knowledge and skills.

- Include expert guest speakers, case studies, and interactive exercises.
- Encourage staff to pursue additional certifications, attend industry conferences, and engage in professional development activities.
- Support their growth through educational incentives and resources.

III. Evaluation:

- Evaluate the effectiveness of training programs through assessments, quizzes, and feedback from participants.
- Measure improvements in staff performance and operational outcomes.
- Collect feedback from staff on training programs to identify areas for improvement.
- Use this feedback to refine and enhance future training initiatives.

Part B: Parameters Relating to Sewerage

6.2) Proper running of Sewers

6.2.1) Timely jetting/cleaning of sewers and manholes

I. Scheduling and Planning of Cleaning Operations:

- Develop a preventive maintenance schedule for the jetting and cleaning of sewers and manholes, based on the sewer size, usage intensity, and potential blockages.
- Set cleaning frequencies (e.g., monthly, quarterly, or biannually) based on the condition and flow rates of different sections of the sewer network. Ensure critical areas are prioritized.

II. Deployment of Jetting and Cleaning Equipment:

- Ensure that all jetting and sewer cleaning equipment (such as jetting machines, vacuum trucks, and rodding machines) is available and in operational condition. Maintain a fleet of modern, high-pressure jetting equipment suitable for the sewer diameters in question.
- Assign trained personnel to operate the equipment, ensuring they follow safety and operational protocols.
- Allocate cleaning crews and equipment to different zones of the sewer network, ensuring efficient use of resources. Larger and more critical sections of the sewer system should be assigned higher capacity jetting machines.
- Identify any damage or wear to the sewers during the cleaning process and report it for repair or further maintenance.
- Maintain detailed records of cleaning activities, including the sections cleaned, equipment used, duration, and any obstructions or damage encountered.

IV. Emergency Cleaning Protocols:

- Establish an emergency response mechanism for immediate cleaning and jetting in case of sewer blockages or manhole overflows.
- Keep emergency cleaning teams on standby, particularly during high-risk periods (e.g., rainy seasons).

6.2.2) Timely operation of pumping sets installed at Intermediate Pumping Stations

I. Operational Schedule and Planning:

- Create a detailed operational schedule for the pumping sets installed at Intermediate Pumping Stations (IPS). The schedule should align with the inflow and outflow requirements of the sewage system and should take into account peak and off-peak flow times.
- Ensure that pumping sets operate on a rotational basis, allowing for even wear and tear across all units. Maintain a standby pump in case of unexpected failures or high demand periods.

II. Remote and On-Site Monitoring Systems:

- Install Supervisory Control and Data Acquisition (SCADA) systems or similar remote monitoring tools to oversee the real-time operation of the pumping sets. The system should track key parameters such as pump runtime, flow rates, suction and discharge pressure, and energy consumption.
- Set up automated alarms and notifications for abnormalities such as pump stoppages, low flow rates, or energy overconsumption, ensuring immediate attention.
- In addition to remote monitoring, conduct periodic manual inspections of the IPS to ensure that the pumping sets are operating as intended. Technicians should check for any unusual noises, vibrations, or excessive heat generation.
- Monitor the suction and discharge pressure gauges regularly to ensure the pumps are performing at the designated levels as per the operational plan.

III. Maintenance for Optimal Performance:

- During operation, perform regular checks on pump performance metrics such as flow rate, pressure, and energy use to ensure they align with design specifications. Ensure that the pumps operate within their optimal performance range without being overburdened.
- Lubricate all moving parts, tighten loose connections, and check for leaks in seals and pipes to ensure uninterrupted operation.
- Maintain a daily logbook to record the start and stop times, runtime duration, flow rates, and any abnormalities detected during operation. This will help track performance trends over time and identify the need for preventive or corrective maintenance.
- Record energy consumption data daily to monitor efficiency and adjust operations for optimal energy use.

IV. Timely Response to Operational Issues:

- In the event of pump malfunction or failure, initiate a rapid response protocol to switch over to standby pumping sets. Ensure that maintenance personnel are available 24/7 to address any issues.
- For major issues, escalate to technical experts or manufacturers for quick repairs or replacement of parts. Ensure minimal downtime to avoid system overload.
- Periodically review the operational performance of the pumping sets based on the data collected from monitoring systems and logs. Identify areas for improvement, such as operational inefficiencies or frequent downtimes.
- Adjust the operation schedule as needed to accommodate any changes in inflow patterns, equipment wear, or seasonal changes that could impact system performance.

V. Documentation and Reporting:

- Submit regular reports on the operational status of the pumping sets to the competent authority, including details on pump runtimes, efficiency, energy use, and any operational challenges encountered.
- Maintain a detailed record of all operational issues, resolutions, and performance adjustments for future audits and system optimization efforts.

Part C: Parameters Relating To STP

6.3) Effective operation of STP

6.3.1) Random Sampling of Treated Effluent

I. Sampling Plan:

- Establish a random sampling schedule for treated effluent at the STP to ensure consistent quality monitoring.
- Samples should be taken at different times of the day, and different stages of the treatment process to ensure that quality is maintained.
- Use grab samples and composite samples to capture variations in effluent quality over time.

II. Compliance with Standards:

- Test samples for key parameters such as pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), and other relevant pollutants in compliance with SPCB/CPCB standards and local regulations.

III. Record Keeping and Reporting:

- Keep detailed records of all sampling results, noting the date, time, and location of each sample.
- Submit regular reports to the concerned environmental authorities demonstrating compliance with effluent quality standards. In the event of non-compliance, take corrective action immediately and document all steps taken.

6.3.2) Ensuring Specified Quality of Effluent

- Conduct regular tests on the treated effluent to ensure it meets the specified quality parameters, such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), Total Phosphorous, Total Nitrogen and pH.
- Compare test results with regulatory standards and project specifications.
- Implement adjustments to the treatment process if effluent quality deviates from specified standards. This may include modifying chemical dosages, adjusting operational parameters, or enhancing treatment processes.
- Establish preventive measures to avoid recurring quality issues, such as regular maintenance of equipment and adherence to operational protocols.

6.3.3) Ensuring Specified Quantity & Quality of Sludge

I. Sludge Monitoring:

- Regularly measure the quantity of sludge generated, including the volume and weight, to ensure it aligns with specified requirements.

- Test the quality of sludge for parameters such as moisture content, organic content, and other relevant characteristics.

II. Management Practices:

- Implement proper disposal or utilization practices for sludge, such as dewatering, stabilization, and disposal in accordance with regulatory guidelines.
- Ensure that sludge management practices adhere to quality standards and prevent any environmental or health impacts.

6.3.4) Alarm System for Chlorine Gas Leak Detection

I. Testing and Calibration:

- Conduct regular tests of the alarm system to verify its functionality and accuracy.
- Ensure that the system responds correctly to simulated leak conditions.
- Calibrate the alarm system as per manufacturer recommendations and regulatory standards to maintain its effectiveness.

II. Response Procedures:

- Develop and implement emergency response procedures for chlorine gas leaks, including evacuation plans, containment measures, and communication protocols.
- Train staff on the use of the alarm system and emergency response procedures to ensure prompt and effective action.

Documentation:

- Maintain records of alarm system installation, testing, calibration, and emergency response procedures. Ensure records are organized and accessible for review and audits.

6.3.5) Deployment of Skilled Staff for Operation and Maintenance

I. Staff Qualification & Training:

- Identify the skills and qualifications required for operation and maintenance roles.
- This includes technical knowledge, certifications, and experience in wastewater treatment.
- Deploy staff with the required qualifications and experience to handle operational and maintenance tasks effectively.
- Provide ongoing training and development opportunities for staff to keep their skills up-to-date with the latest technologies and best practices in wastewater treatment.

6.3.6) Deployment of Required Number of Staff for O&M

I. Staffing Requirements:

- Assess the staffing requirements based on the size and complexity of the STP, including the number of operators, maintenance personnel, and support staff needed.
- Develop a staffing plan that outlines the required number of staff for various operational and maintenance tasks.

II. Scheduling:

- Implement shift planning to ensure continuous coverage for all critical operations and maintenance activities. Consider peak times, emergencies, and routine tasks in the scheduling process.

- Adjust staffing levels as needed based on changes in operational demands, staffing availability, and any unforeseen circumstances.

6.3.7) Running as per Operation Manuals/Design

I. Operation Manuals and SOMPs:

- Review operation manuals to understand the procedures, guidelines, and design specifications for operating and maintaining the STP.
- Ensure that all operational activities are conducted in accordance with the instructions and standards outlined in the manuals.

II. Adherence to Design:

- Follow design specifications during operation and maintenance to ensure that the STP functions as intended and meets performance criteria.
- Make any necessary adjustments to operations based on design requirements, operational feedback, and performance evaluations.

III. Monitoring and Evaluation:

- Conduct regular audits to ensure compliance with operation manuals. Address any deviations or issues identified during audits.
- Implement continuous improvement practices based on audit findings and feedback to enhance operational efficiency and effectiveness.

6.3.8) Ensuring Reuse of Treated Effluent

I. Effluent Reuse Planning and Infrastructure:

- Identify suitable reuse applications for treated effluent, such as irrigation, industrial cooling, or landscaping. Ensure the treated effluent meets the required quality standards for the intended use.
- Install infrastructure for transporting and storing treated effluent, such as pipelines, storage tanks, and pumps.

II. Implementation and Monitoring:

- Monitor the reuse of treated effluent regularly to ensure it is being applied as planned and in compliance with environmental regulations.
- Keep records of the volume of treated effluent reused and the specific applications to which it is applied.

6.3.9) Ensuring Appropriate Disposal of Sludge

I. Sludge Disposal Plan:

- Identify disposal methods for sludge produced during sewage treatment, such as land application, composting, or disposal in a designated landfill.
- Ensure that the sludge is treated (e.g., by dewatering or drying) to reduce volume and improve handling before disposal.

II. Compliance with Environmental Standards:

- Ensure that the sludge disposal methods comply with relevant environmental standards, including CPCB and local authority guidelines for sludge management.
- Test the sludge for harmful contaminants like heavy metals and pathogens to confirm that it is safe for disposal or reuse.

III. Record Keeping and Reporting:

- Keep detailed records of all sludge disposal activities, including the quantity, treatment method, and final disposal site.
- Submit reports to environmental authorities as required, ensuring full transparency and accountability in sludge disposal practices.

6.3.10) Regular Chlorination of Effluent

- Calculate the required dosage of chlorine based on effluent volume, contamination levels, and regulatory disinfection standards.
- Adjust dosage as needed for varying conditions.
- Implement chlorination using automated dosing systems or manual methods, ensuring even distribution and proper contact time with the effluent.
- Chlorine dosage generally vary between 5 to 20 mg/l, depending upon the quality of the wastewater.

6.3.11) No Penalty of Electric Bill for Non-Installation of Capacitor, Overload, Delayed Payments, Etc.

- Install capacitors as required by the electric utility to improve power factor and avoid penalties and decrease consumption of power and hence electricity bill.
- Ensure compliance with utility specifications for installation and operation.
- Conduct periodic inspections of capacitor installations to verify their effectiveness and address any issues promptly.
- Monitor electrical loads to prevent overload conditions that can result in penalties.
- Implement load management strategies to balance electrical demands and avoid exceeding capacity limits.
- Install protective devices such as circuit breakers and overload relays to safeguard equipment and prevent damage due to excessive loads.
- Establish a system for managing and scheduling electricity bill payments to avoid late fees and penalties.
- Monitor due dates and ensure payments are made on time.
- Regularly review electricity invoices for accuracy and address any discrepancies with the utility provider.
- Maintain records of payments and any correspondence related to billing issues.

Documentation:

- Maintain records of capacitor installations, load management activities, and payment schedules.
- Ensure that documentation is accurate, organized, and accessible for review and audits.
- Track any penalties or fees incurred due to non-compliance or delayed payments, and document actions taken to address and resolve these issues.

CHAPTER 3

I.S Codes for Sewerage Systems

Category	IS Code	Description
Pipes - Concrete	IS 458	Specification for Precast Concrete Pipes (with and without reinforcement) for sewers.
Pipes - PVC	IS 4985	Specification for Unplasticized PVC Pipes for Potable Water Supplies.
Pipes - HDPE	IS 4984	Specification for High-Density Polyethylene Pipes for Potable Water Supplies.
Pipes - Cast Iron	IS 1536	Specification for Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas, and Sewage.
Pipes - Ductile Iron	IS 8329	Specification for Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Water, Gas, and Sewage.
Pipes - Steel	IS 1239 (Part 1)	Specification for Mild Steel Tubes, Tubulars, and Other Wrought Steel Fittings.
Valves	IS 14846	Specification for Sluice Valves for Waterworks Purposes.
Pumps - Centrifugal	IS 5120	Technical Requirements for Rotodynamic Special Purpose Pumps.
Pumps - Submersible	IS 8034	Specification for Submersible Pump Sets for Clear, Cold Water.
Pumps - Reciprocating	IS 5120	Code of Practice for Testing of Reciprocating Pumps.
Motors - Induction	IS 325	Specification for Three-Phase Induction Motors.
Motors - Submersible	IS 9283	Specification for Motor Driven Submersible Pumpsets.
Motors - Monoblock	IS 9079	Specification for Electric Monoblock Pumps for Clear, Cold Water.
Motors - Efficiency	IS 12615	Energy Efficient Induction Motors - Three Phase Squirrel Cage.
Accessories - Fittings	IS 1879	Specification for Malleable Cast Iron Pipe Fittings.
Control Panels	IS 8623	Specification for Low-Voltage Switchgear and Control Gear Assemblies.
Control Panels	IS 13947	Specification for Low-Voltage Switchgear and Control Gear, including Circuit-Breakers.

Automation Systems	IS 14443	Guidelines for Programmable Logic Controllers (PLCs) in Automation Systems.
Automation - SCADA	IS 15970	Guidelines for Supervisory Control and Data Acquisition (SCADA) Systems in Water and Sewage Management.
VFD - General	IS 13364	Specification for AC Motor Drives Powered by Voltage Source Converters.
VFD - Performance	IS 16102	Specification for Energy Efficient Motors and VFDs for Specific Applications.
Electrical Safety	IS 732	Code of Practice for Electrical Wiring Installations for Low Voltage, High Voltage, and Extra-High Voltage Systems.
Electrical Safety	IS 5578	Guide for Marking of Insulated Conductors.
Control Gear - MCC	IS 60947	Specification for Low-Voltage Switchgear and Control Gear, specifically Motor Control Centers (MCC).
Instrumentation	IS 9670	Code of Practice for Instrumentation in Institutional Control Systems.
Sensors	IS 12960	Specification for Sensors and Transducers in Institutional Automation.
Electrical Equipment	IS 12063	Classification of Degrees of Protection Provided by Enclosures of Electrical Equipment (IP Code).
Sampling and Testing	IS 3025	Methods of Sampling and Test (Physical and Chemical) for Water and Wastewater.
Sewerage System Layout	IS 5225	Recommendations for Layout of Sewerage Systems.
Aeration Equipment	IS 5330	Test Code for Surface Aerators used in sewage treatment.
Sedimentation Tanks	IS 8419 (Part 1)	Requirements for the Design and Construction of Sedimentation Tanks.
Secondary Settling Tanks	IS 8419 (Part 2)	Requirements for the Design and Construction of Secondary Settling Tanks.
Design Criteria	IS 10400	Criteria for the Design of Secondary Settling Tanks.
Basic Requirements	IS 1172	Code of Basic Requirements for Water Supply, Drainage, and Sanitation.
STP Installation	IS 15386	Guidelines for the Installation of Sewage Treatment Plants (STPs).
Treatment and Disposal	IS 10553	Guide for Treatment and Disposal of Sewage.

Noise Measurement	IS 8788	Methods for Measurement of Airborne Sound Emitted by Sewage Treatment Plants.
Anaerobic Digesters	IS 11401	Requirements for Anaerobic Digesters in Sewage Treatment Plants.
Sludge Management	IS 13428	Code for Sludge Digestion in Sewage Treatment Plants.
Energy Audit	IS 16130	Guidelines for Energy Audit of Sewage Treatment Plants.
Biogas Plants	IS 13160	Requirements for Biogas Plants in Sewage Treatment.
Reuse of Treated Sewage	IS 16323	Guidelines for the Reuse of Treated Sewage.
Design and Construction	IS 3370 (Part 1)	Code of Practice for Concrete Structures for Storage of Liquids – Part 1: General Requirements
Design and Construction	IS 3370 (Part 2)	Code of Practice for Concrete Structures for Storage of Liquids – Part 2: Design and Construction
Design and Construction	IS 3370 (Part 3)	Code of Practice for Concrete Structures for Storage of Liquids – Part 3: Maintenance of Concrete Structures
Design and Construction	IS 3370 (Part 4)	Code of Practice for Concrete Structures for Storage of Liquids – Part 4: Testing of Concrete Structures
Materials and Testing	IS 456	Code of Practice for Plain and Reinforced Concrete
Materials and Testing	IS 383	Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
Mix Design	IS 10262	Code of Practice for Mix Design
Reinforcement	IS 1786	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
Reinforcement	IS 2502	Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
Durability	IS 1498	Classification and Coding of Soils – Based on Plasticity Index and Shrinkage Limit
Construction and Testing	IS 516	Method of Test for Strength of Concrete
Construction and Testing	IS 1199	Methods of Sampling and Analysis of Concrete
Waterproofing	IS 2645	Code of Practice for the Application of Water Proofing Treatment to Concrete Structures

Concrete Formwork	IS 456	Code of Practice for Plain and Reinforced Concrete
Structural Safety	IS 13920	Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces
Seismic Design	IS 1893	Criteria for Earthquake Resistant Design of Structures
Load Specifications	IS 875 (Part 1)	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Part 1: Dead Loads
Load Specifications	IS 875 (Part 2)	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Part 2: Live Loads
Concrete Quality	IS 9103	Specification for Admixtures for Concrete

Manuals for Sewerage Systems

1. Manual on Sewerage and Sewage Treatment (CPHEEO)

Published by the Central Public Health and Environmental Engineering Organization (CPHEEO) under the Ministry of Housing and Urban Affairs.

2. National Building Code (NBC)

Issued by the Bureau of Indian Standards (BIS).

3. Environmental Guidelines for Sewage Treatment Plants (STPs)

Issued by the Central Pollution Control Board (CPCB).

4. Manual on Water Supply and Sewerage (BIS)

Published by the Bureau of Indian Standards (BIS).

CHAPTER 4

Description of Components Required in a Sewerage System

A sewerage system is a complex infrastructure designed to collect, transport, and treat wastewater from residential, commercial, and institutional sources. The main components of a sewerage system can be categorized into several key elements:

1. Sewer Pipes and Network

I. Collection Pipes: These pipes gather wastewater from individual buildings or properties and transport it to the main sewer lines. They can be constructed from various materials, including PVC, concrete, or ductile iron, and are typically designed to handle the expected flow rates and loads.

II. Main Sewer Lines: These are larger pipes that collect wastewater from multiple collection pipes and transport it to the treatment plant or main sewerage system. They are designed to handle larger volumes and higher flow rates.

III. Trunk Sewers: These are major sewer lines that carry wastewater from several main sewer lines to the treatment facility or discharge point. They are designed for high capacity and are usually larger in diameter.

IV. Force Mains: These are pressurized pipes used to transport wastewater from lower elevation areas to higher elevation areas where gravity cannot be used. They are typically used in conjunction with lift stations.

V. Manholes: These are access points to the sewer system that allow for inspection, maintenance, and cleaning of the sewer pipes. They are placed at regular intervals along the sewer lines and at points where the direction or size of the sewer changes.

VI. Inspection Chambers: Similar to manholes, these are smaller access points used for inspection and maintenance, often found in residential or smaller sewer networks.

A. Types of Pipes

I. Unplasticized Polyvinyl Chloride (uPVC) Pipes

- Similar to PVC but with enhanced durability and strength, uPVC pipes are commonly used in sewerage networks for carrying wastewater, including industrial effluents.
- Stronger and more rigid than regular PVC, with good chemical resistance. They are also non-toxic and have a long service life.
- More expensive than standard PVC pipes and may require special fittings.

II. High-Density Polyethylene (HDPE) Pipes

- Preferred for large-diameter sewer lines and where flexibility is required, such as in areas with shifting soil or seismic activity.
- Highly durable, flexible, and resistant to corrosion, chemicals, and impact. HDPE pipes have a long lifespan and can be used for trenchless installations.
- Higher initial cost compared to PVC, and installation may require specialized equipment and skills.

III. Concrete Pipes (Reinforced Cement Concrete, RCC)

- Commonly used in trunk sewers and large sewerage systems, especially for gravity sewer lines.

- High strength, durability, and resistance to heavy loads and external pressures. Suitable for large diameter pipes and deep installations.
- Heavy, difficult to handle, and install. Prone to chemical attack in acidic environments unless lined or coated.

IV. Ductile Iron (DI) Pipes

- Used in areas requiring high strength and durability, such as force mains in sewerage systems.
- Very strong and capable of withstanding high pressures. Resistant to corrosion with proper coating and lining, and have a long service life.
- Heavy and expensive, requiring more effort and cost for transportation and installation.

V. Cast Iron Pipes

- Traditionally used in sewerage systems, though now less common, still found in older installations.
- Strong and durable, with good resistance to mechanical damage. They provide excellent soundproofing qualities.
- Prone to corrosion if not properly lined or coated, and heavy, making them difficult to handle and install.

VI. HDPE lined Concrete Pipes

- HDPE (High-Density Polyethylene) lined concrete pipes are a combination of concrete for strength and HDPE lining for chemical resistance, often used in sewerage and drainage systems where the pipe is exposed to aggressive chemicals and corrosive environments.
- Concrete provides structural strength, while the HDPE liner offers excellent resistance to abrasion, chemicals, and corrosion, ensuring a long service life in harsh conditions.
- The HDPE liner is smooth, reducing friction and enhancing the flow capacity of the pipe. It also helps to prevent the buildup of deposits, which can cause blockages over time.
- Typically, more expensive than standard concrete pipes due to the added cost of the HDPE liner and the manufacturing process, but they offer better longevity and reduced maintenance costs.
- HDPE lined concrete pipes may require specialized equipment for installation due to their weight and size, and special care is needed to ensure proper alignment and sealing of the joints to maintain the integrity of the liner.

VII. Stoneware Pipes

- Stoneware pipes, or vitrified clay pipes, are durable and chemically resistant, making them ideal for sewerage systems.
- Made from natural clay that undergoes vitrification, these pipes are non-porous and resistant to abrasion, suitable for both gravity sewer systems and wastewater treatment plants.
- However, their brittleness, weight, and rigidity pose challenges in handling, installation, and alignment. While stoneware pipes offer environmental benefits and longevity, they require careful installation and maintenance.
- Despite the rise of modern alternatives like PVC and HDPE, stoneware pipes remain valuable in specific applications requiring their unique properties.

B. Pumping Stations

I. Lift Stations: These facilities are used to lift wastewater from lower elevations to higher elevations, where gravity flow can be utilized. They include pumps, control systems, and emergency backup systems.

II. Pumps: Various types of pumps (e.g., centrifugal, submersible) are used within lift stations to move wastewater through the force mains. The choice of pump depends on the flow characteristics and system requirements.

Types of Pumps

I. Centrifugal Pumps

- Centrifugal pumps are the most commonly used type of pump in sewerage systems. They work by converting rotational energy, typically from a motor, into kinetic energy to move fluids through a system.
- Ideal for transferring large volumes of wastewater over short to medium distances.
- Reliable, simple design, easy to maintain, and cost-effective.

II. Submersible Pumps

- Submersible pumps are designed to operate while fully submerged in the wastewater. They are commonly used in wet wells and pump stations.
- Suitable for pumping raw sewage, sludge, and wastewater in lift stations.
- Compact, efficient, and reduce the risk of pump cavitation since they are submerged in the fluid.

III. Positive Displacement Pumps

- Positive displacement pumps move fluid by trapping a fixed amount and displacing it through the pump. They are typically used in applications where the flow rate needs to be constant regardless of the pressure.
- Used for pumping viscous fluids like sludge or when a precise flow rate is required.
- Effective for handling high-viscosity fluids, providing a steady flow, and can operate at high pressures.

IV. Diaphragm Pumps

- Diaphragm pumps use a reciprocating diaphragm to move fluid. They are known for their ability to handle a variety of fluids, including those containing solids.
- Often used for chemical dosing, dewatering, or pumping sludge and wastewater.
- Can handle corrosive and abrasive fluids, self-priming, and can run dry without damage.

V. Screw Pumps

- Screw pumps use one or more screws to move fluid along the screw's axis. They are efficient at handling large volumes of fluid, especially those containing solids.
- Commonly used in wastewater treatment plants for transferring sludge and raw sewage.
- High efficiency, low shear on the fluid, and can handle solids and viscous fluids.

VI. Vacuum Pumps

- Vacuum pumps create a vacuum to draw fluid into the pump and are often used in systems where gravity flow is insufficient.

- Employed in sewerage systems for priming other pumps or for specialized applications like removing air or gas from the system.
- Effective at creating suction, useful in challenging applications, and can handle a wide range of fluids.

VII. Lift Station Pumps

- These are a type of submersible pump specifically designed for sewage lift stations. They are used to pump sewage from lower to higher elevations, especially where gravity flow is not possible.
- Integral to municipal and industrial sewerage systems for moving wastewater from low-lying areas.
- Durable, designed for continuous operation, and can handle raw sewage with solids.

C. Control Systems: These systems manage the operation of the pumps, monitor flow rates, and handle alarms for any issues such as pump failures or high water levels.

2. Treatment Facilities

A. Preliminary Treatment:

I. Screens: Used to remove large debris and solids from the incoming wastewater to protect downstream equipment.

Types of Screens:

I. Bar Screens

- Bar screens consist of a series of vertical bars spaced at regular intervals. Sewage flows through the bars, which capture larger solids and debris.
- Effective at removing large particles, simple design, and low maintenance.
- Can become clogged with large objects, requiring periodic cleaning.

II. Mesh Screens

- Mesh screens use a fine mesh or perforated plate to filter out smaller particles and debris from the sewage. They are typically made of metal or synthetic materials.
- Capable of removing finer particles compared to bar screens, can be self-cleaning in some designs.
- May become clogged with small debris, requiring regular maintenance.

III. Rotary Screens

- Rotary screens consist of a cylindrical screen drum that rotates as sewage flows through it. The rotation helps in the continuous removal of solids.
- Efficient in handling large volumes of sewage, self-cleaning due to the rotating action.
- Higher initial cost and more complex maintenance compared to static screens.

IV. Drum Screens

- Drum screens are cylindrical screens that rotate continuously. The sewage flows through the screen as it rotates, and solids are captured on the exterior of the drum.
- Provides continuous operation, effective at handling large volumes and coarse solids.
- Requires regular cleaning and maintenance of the drum surface.V. Fine Screens
- Fine screens use very small mesh openings to remove fine particles and debris. They are typically used in conjunction with other types of screens for enhanced filtration.

- Highly effective at removing fine particles, improves overall treatment efficiency.
- Higher maintenance requirements due to clogging, more expensive to operate.

VI. Coarse Screens

- Coarse screens are designed to capture larger debris such as sticks, plastic, and other sizable objects. They are usually the first stage of screening in primary treatment.
- Removes large objects that could damage subsequent equipment, simple and durable.
- Not effective for smaller particles, may require frequent cleaning.

VII. Static Screens

- Static screens are fixed and do not move. Sewage flows over the screen, and solids are retained by gravity.
- Low energy consumption, simple design with minimal moving parts.
- Can become clogged more easily, may require manual or mechanical cleaning.

VIII. Automated Screens

- Automated screens use mechanical systems to periodically clean the screen surface and remove captured debris. These systems can be integrated with sensors and controls.
- Reduces manual labour and provides continuous operation with minimal downtime.
- Higher initial cost and complexity, require regular maintenance of mechanical components.

II. Grit Chambers: Designed to remove sand, gravel, and other heavy particles from the wastewater.

Types of Grit Chambers

I. Horizontal Grit Chambers:

- Horizontal grit chambers are long, rectangular tanks where wastewater flows horizontally at a relatively low velocity, allowing heavier particles to settle to the bottom.
- Simple design, effective for removing larger grit particles.
- Requires a large footprint and may need regular cleaning to remove settled grit.

II. Vertical Grit Chambers:

- Vertical grit chambers are cylindrical tanks where wastewater flows vertically, and grit settles at the bottom. The design may include mechanisms for the periodic removal of accumulated grit.
- Compact design, effective for space-constrained areas.
- Can be more complex to maintain and may require additional equipment for grit removal.

III. Vortex Grit Chambers:

- Vortex grit chambers use a swirling or vortex motion to create a centrifugal force that causes grit to settle out of the flow. Wastewater enters the chamber tangentially, creating a spiral motion that helps separate the grit.
- Efficient at removing fine grit and sand, compact design.
- Requires careful design to ensure effective vortex formation, may have higher initial costs.

IV. Aerated Grit Chambers:

- Aerated grit chambers use air or mechanical agitation to help separate grit from the wastewater. The added turbulence assists in the settling process and keeps organic matter in suspension.
- Improved grit removal efficiency can handle varying flow rates.
- Higher energy requirements for aeration, more complex design.

Advantages of Grit Chambers:

- By removing coarse particles, grit chambers protect downstream equipment such as pumps, valves, and other mechanical components from damage and abrasion.
- Reduces the load on secondary treatment processes by removing larger particles that can interfere with biological and chemical treatment stages.
- Prevents clogging and fouling in subsequent treatment stages, improving overall plant performance.

Disadvantages of Grit Chambers:

- Requires regular cleaning and maintenance to remove accumulated grit and ensure proper operation.
- Some designs, particularly horizontal grit chambers, may require significant space, which can be a constraint in compact plant layouts.
- Can involve significant initial investment and operational costs, particularly for aerated and vortex designs.

B. Primary Treatment:

Primary settling tanks, also known as primary clarifiers or sedimentation tanks, are crucial components in sewage treatment plants. They are designed to remove large solids and particulate matter from raw sewage through the process of sedimentation, which is the settling out of suspended solids under gravity.

Function:

- Primary settling tanks serve to reduce the load of suspended solids and organic matter in the incoming sewage. This step helps to protect and enhance the efficiency of subsequent treatment stages, such as biological treatment.
- Sewage flows into the primary settling tank where the flow velocity is reduced, allowing heavier solids to settle to the bottom of the tank. Lighter materials, such as grease and oil, float to the surface and are skimmed off.
- Typically, primary settling tanks are circular or rectangular and are designed with a gentle flow to promote sedimentation. They usually include an inlet structure, a sedimentation zone, and an outlet structure.
- Solids that settle at the bottom are collected as sludge and periodically removed for further processing or disposal. Scum and floatable materials are collected and removed from the surface.
- The tank must be sized to provide adequate retention time for effective settling. This is usually in the range of 1 to 2 hours, depending on the flow rate and the design of the tank.

Advantages:

- Significantly lowers the concentration of suspended solids and organic matter in the sewage, which can improve the performance of secondary treatment processes.

- Helps to prevent clogging and damage to equipment in subsequent treatment stages by removing large particles and debris.

Disadvantages:

- While effective at removing solids, primary settling tanks do not significantly reduce dissolved organic matter or nutrients. Additional treatment stages are required to address these pollutants.
- Regular maintenance is required to manage sludge accumulation and prevent operational issues.

Equalizer Tanks

Equalizer tanks, also known as equalization tanks or equalization basins, are used in sewage treatment plants (STPs) to balance the flow and load of wastewater entering the treatment system. They help manage variations in influent flow rates and concentrations, ensuring that the treatment process operates efficiently and consistently.

Function:

- Equalizer tanks smooth out fluctuations in the flow rate of wastewater, which can result from variations in daily or seasonal usage patterns. By holding excess wastewater during peak flows and releasing it during lower flow periods, equalizer tanks help maintain a steady flow rate through the treatment system.
- These tanks also help balance the load of contaminants, such as organic matter and suspended solids, by diluting or concentrating the wastewater as needed. This ensures that the treatment processes downstream can handle the load more effectively.

Types of Equalizer Tanks:

I. Manual Equalization Tanks:

- These are simple tanks without automated controls. They rely on manual operation to manage the flow and load of wastewater.
- Lower initial cost and simpler design.
- Requires manual intervention for operation and maintenance, less efficient at managing fluctuating flows.

II. Automatic Equalization Tanks:

Equipped with automated controls, these tanks can adjust the flow rate and volume of wastewater entering the treatment system based on real-time data. They often include sensors, flow meters, and control valves.

Efficiently handles varying flow rates and loads, reduces manual labour, and improves overall system performance.

Higher initial cost and complexity, requires regular maintenance of automated systems.

Advantages of Equalizer Tanks:

- By providing a consistent flow and load to the treatment processes, equalizer tanks help optimize the performance and efficiency of downstream treatment stages.
- They minimize the impact of flow and load fluctuations on treatment equipment, reducing the risk of operational issues and equipment damage.
- Equalizer tanks allow for better control of the treatment process by maintaining a stable input for biological and chemical treatments.

Disadvantages of Equalizer Tanks:

- Equalizer tanks can require significant space, particularly in systems designed to handle large volumes or high variability in flow.
- The initial investment and maintenance costs can be substantial, especially for automated systems.
- Regular cleaning and inspection are required to ensure proper operation and to prevent issues such as sediment build-up or clogging.

C. Secondary Treatment:

Secondary treatment is the stage of sewage treatment that follows primary treatment. Its primary goal is to significantly reduce the organic matter and suspended solids remaining after the primary treatment phase, typically through biological processes. This stage focuses on degrading the remaining contaminants using microorganisms.

Types of Secondary Treatment:

Activated Sludge Process:

- The activated sludge process is widely used where microorganisms are added to the wastewater in aeration tanks.
- These microorganisms consume organic pollutants, breaking them down into simpler compounds.
- In the aeration tank, wastewater is mixed with activated sludge (a mixture of microorganisms) and aerated to provide oxygen.
- The microorganisms digest the organic matter.
- The mixture then flows to a secondary clarifier where the sludge settles out, and the treated effluent is separated.
- This process is highly efficient, with high removal of organic matter and nutrients, and is flexible and scalable.
- However, it requires significant energy for aeration and generates large volumes of sludge that need further treatment.

Trickling Filters:

- Trickling filters involve wastewater passing over a bed of microbial-covered media.
- The microorganisms on the media degrade the organic matter as the wastewater flows over and through the media.
- The media can be plastic, concrete, or other materials that provide a surface for microbial growth.
- Wastewater is distributed over the media and trickles down, allowing microorganisms to treat the wastewater.
- This method is simple to operate, with lower energy requirements compared to activated sludge.
- However, it is less effective in handling high loads or varying flow rates and requires regular maintenance to avoid clogging.

Rotating Biological Contactors (RBCs):

- Rotating biological contactors consist of rotating disks covered with a microbial film.
- Wastewater is spread over these disks, and the microorganisms degrade the organic pollutants as the disks rotate.

- The disks partially immerse in the wastewater and rotate through the air, allowing the microbial film to treat the wastewater.
- The treated effluent is collected after passing over the disks.
- RBCs are effective for smaller to medium-sized treatment plants and have lower energy consumption compared to activated sludge.
- However, they require higher maintenance for the rotating mechanism and have a limited capacity for high-strength wastewater.

Moving Bed Biofilm Reactors (MBBR):

- MBBRs use suspended plastic media that provide surface area for microbial growth.
- Wastewater flows through a tank containing these media, and microorganisms on the media degrade the organic matter.
- The media is designed to remain suspended in the tank and provide a large surface area for microorganisms.
- The tank is typically aerated to supply oxygen and enhance microbial activity.
- MBBRs are compact, with high treatment efficiency, and are suitable for retrofitting existing plants.
- However, they require regular monitoring and control of media and can be more expensive to install.

Sequencing Batch Reactors (SBRs):

- SBRs operate in batch mode, treating wastewater in a single tank through a series of phases, including filling, reaction, settling, and decanting.
- Wastewater is filled into the tank, aerated for biological treatment, allowed to settle, and then the treated effluent is decanted.
- This process is flexible, effective for variable flows and loads, and compact.
- However, batch operation can lead to fluctuations in treatment performance and requires careful management.

Advantages of Secondary Treatment:

- Significantly reduces organic matter and suspended solids, improving water quality.
- Some processes can also remove nutrients such as nitrogen and phosphorus, depending on the configuration.
- Environmentally friendly by reducing the environmental impact of wastewater discharge through the removal of contaminants.

Disadvantages of Secondary Treatment:

- Secondary treatment processes often require significant energy consumption, especially in methods like activated sludge.
- They generate large volumes of sludge that require further treatment and disposal.
- Secondary treatment systems require careful monitoring and control to ensure efficient performance and compliance with discharge standards.

D. Tertiary Treatment:

Types of Tertiary Treatment

1. Filtration

Filtration processes are used to remove remaining suspended solids and particulate matter from the effluent after primary and secondary treatment.

Types:

i. Sand Filters: Employ layers of sand and gravel to trap particles and provide additional clarification.

ii. Membrane Filters: Utilize semi-permeable membranes to remove very fine particles, including bacteria and viruses. This includes microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, each with varying pore sizes.

iii. Cartridge Filters: Use replaceable cartridges to capture solids and particulates.

2. Disinfection

Disinfection processes aim to kill or inactivate pathogens in the treated effluent to ensure it is safe for discharge or reuse.

Methods:

i. Chlorination: Adds chlorine or chlorine compounds to the effluent to eliminate microorganisms. It often requires dechlorination before discharge to avoid harming aquatic life.

ii. Ultraviolet (UV) Radiation: Uses UV light to disrupt the DNA of microorganisms, rendering them incapable of reproduction. Effective against bacteria, viruses, and protozoa.

iii. Ozonation: Introduces ozone gas into the water to oxidize and disinfect contaminants. Ozone decomposes into oxygen, leaving no residual chemicals.

3. Nutrient Removal

Targets the reduction of nitrogen and phosphorus to prevent eutrophication in receiving water bodies.

Processes:

i. Chemical Precipitation: Uses chemicals such as alum or ferric chloride to precipitate and remove phosphorus from the effluent.

ii. Biological Nutrient Removal: Includes processes like Enhanced Biological Phosphorus Removal (EBPR) and Nitrification-Denitrification to biologically remove nitrogen and phosphorus. This involves specialized microorganisms that convert and remove these nutrients.

4. Advanced Oxidation Processes (AOPs)

AOPs generate highly reactive radicals to break down complex organic contaminants in the effluent.

Techniques:

i. Fenton's Reagent: Combines hydrogen peroxide with iron salts to produce hydroxyl radicals that oxidize organic pollutants.

ii. Ozone-Hydrogen Peroxide: Uses a combination of ozone and hydrogen peroxide to enhance oxidation and degrade contaminants.

5. Activated Carbon Adsorption

Activated carbon is used to adsorb residual organic compounds, chemicals, and substances causing taste and odour.

Types:

i. Granular Activated Carbon (GAC): Employed in fixed bed adsorbers for continuous treatment.

ii. Powdered Activated Carbon (PAC): Added in powdered form and then removed from the effluent by sedimentation or filtration.

6. Reverse Osmosis (RO)

- Uses a semi-permeable membrane to remove ions, molecules, and particles from the water. It produces high-quality effluent by separating contaminants from clean water.
- Provides thorough purification and is suitable for producing water for potable use or sensitive discharge requirements.
- Requires significant energy and regular maintenance of membranes.

7. Ion Exchange

- Removes specific ions from the effluent by exchanging them with other ions on a resin or other material.
- Often used for removing hardness, heavy metals, and other specific contaminants.

Types:

i. Cation Exchange: Replaces positively charged ions with hydrogen or sodium ions.

ii. Anion Exchange: Replaces negatively charged ions with hydroxide or chloride ions.

8. Electrodialysis

- Uses an electric field to drive the movement of ions through selective ion-exchange membranes, separating them from the water.
- Useful for desalination and removal of specific ions from wastewater.

9. Constructed Wetlands

Mimics natural wetland processes to further treat wastewater. Plants, soil, and microbial activity work together to remove contaminants.

Types:

i. Surface Flow Wetlands: Water flows over the surface of the wetland, allowing treatment through plant and microbial action.

ii. Subsurface Flow Wetlands: Water flows through a gravel or soil medium, providing treatment through filtration and biological processes.

E. Sludge Handling:

- Sludge Digesters: Facilities where sludge is biologically treated to reduce volume and stabilize organic material.
- Dewatering Equipment: Equipment such as centrifuges or belt presses used to reduce the water content of sludge before disposal.
- Sludge Drying Beds: Used for further dewatering and drying of sludge.

3. Storage and Overflow Facilities

A. Equalization Tanks: Used to temporarily store wastewater to balance flow rates and smooth out variations in flow to the treatment facility.

B. Overflow Structures: Facilities designed to handle excess flows during heavy rainfall or system malfunctions, such as combined sewer overflows (CSOs) or bypass channels.

4. Disposal and Reuse

A. Effluent Discharge: Systems for safely discharging treated wastewater into receiving water bodies, ensuring compliance with environmental regulations.

B. Reuse Systems: Facilities or processes that allow for the beneficial reuse of treated wastewater, such as for irrigation or institutional processes.

5. Ancillary Components

A. Ventilation Systems: Essential for maintaining air quality and preventing the buildup of harmful gases within sewer pipes and treatment facilities.

B. Odor Control Systems: Measures such as scrubbers or biofilters to manage and reduce unpleasant odors from sewer systems and treatment facilities.

C. Safety and Security Systems: Includes fencing, surveillance cameras, and alarm systems to protect the infrastructure from vandalism and ensure safe operations.

D. Instrumentation and Monitoring: Systems for monitoring flow rates, water quality, and operational parameters. Includes sensors, gauges, and data logging equipment.

6. Maintenance and Support Facilities

A. Maintenance Workshops: Facilities equipped for repairing and maintaining sewerage system components and equipment.

B. Staff Facilities: Areas for the staff to work, including office space, restrooms, and storage areas for tools and equipment.

ANNEXURE I

Technical Quality Audit Parameters: Sewerage Schemes

Pre-implementation Stage

Sr. no.	Parameter	Benchmark	Reference document	Indicator	Sub indicators	Max. marks	Marks obtained	Weightage
1	Planning & Design	Technical Framework in comprehensive Planning	DPR	**Part A: General Parameters**				
				1.1) Survey & investigation	1.1.1) Topographic Survey	3		**25%**
					1.1.2.) **Soil investigations such as bearing capacity (SBC) and ground water table / spring water level)**	3		
					1.1.3) Land Acquisition, Forest clearance etc.	3		
					1.1.4) NOC from Railways, Electricity Board, water Resources, Roads, Panchayat	5		
				1.2) Demand and Resource assessment	1.2.1) Population growth, Floating Population, Institutional, Commercial Development & seasonal variation	5		
				1.3) Cost Analysis, Budget planning, timeline estimates	1.3.1) Financial implication with cost index up to implementation period.	3		
					1.3.2) Identification of funding agency with annual budget allocation	3		
				1.4) Framing specification	1.4.1) Identification of suitable materials proposed to be used	3		
					1.4.2) Framing specifications for materials at the time of preparation of estimate/Bid Document	2		

				Part B: Parameters relating to Sewerage System				
				1.5) Preliminary spade work for laying of sewer	1.5.1) Assessment of existing sewer infrastructure and its uses.	5		
				1.6) Selection of technology for network design	1.6.1) Use of latest software for pipe network and drawings.	5		
					1.62) Preparation of L-sections of sewer lines	5		
				Part C: Parameters Relating To Sewage Treatment Plant (STP)				
				1.7) Selection of modern Technologies & equipments and processes	1.7.1) Optimum design of STP with advanced treatment technologies	10		
					1.7.2) Use of modern mechanized/digital equipments such as : (i) Remote Monitoring, (ii) SCADA, (iii) GIS (Geographic Information System), (iv) Smart Pumping Systems, (v) Online effluent Quality Analyzers (vi) Mobile Applications, (vii) Customer Portals (viii) Drone Photography (ix) VFD etc.	10		
					1.7.3) Obtaining consent to establish from State Pollution Control Board	5		
					1.7.4) Preparation of design and drawings by consultant and approval by competent authority of the department.	5		
				1.8) Long term Planning	1.8.1) Future requirement projections such as vacant space for expansion and modular design of STP	4		
					1.8.2) Provision for reuse and disposal of treated effluent with the consent of concerned department	5		
					1.8.3) Provision for sludge management	4		
					1.8.4) Horticulture Planning for Sewage Projects (Pump Houses & STP Sites)	2		
				1.9) Reducing O&M cost	1.9.1) Provision of solar energy	5		
					1.9.2) Provision of automation	5		
						Total	**100**		**25%**

IMPLEMENTATION STAGE

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicators	Max. marks	Marks obtained	Weightage
2	Execution, Inspection and testing	Technical Methodology for implementation and inspection & testing	Contract Agreement and test reports	**Part A: General Parameters**				
				2.1) Use of all construction materials	2.1.1) Procurement of materials such as cement, steel, coarse and fine aggregates, etc. from approved source.	5		40%
					2.1.2) Use of design mix.	5		
					2.1.3) Procurement of pipes and machinery of approved make and manufacturer.	5		
					2.1.4) Carrying out tests at manufactures' premises before dispatch.	5		
				2.2) Supervision by skilled manpower/ TPIA	2.2.1) Deployment of adequate & appropriately qualified personal at site.	5		
				2.3) Documentation and Reporting	2.3.1) Preparation of site inspection and quality control registers.	5		
					2.3.2) Checking of test results by Engineer in Charge.	4		
					2.3.3) Rectification of defects.	5		
					2.3.4) Submission of reports and keeping the record.	4		
				Part B: Parameters Relating to Laying of Sewerage				
				2.4) Conformity to relevant standards /design	2.4.1) Physical inspection of pipes at site before laying.	2		
					2.4.2) Work execution as per originally approved bid document.	10		

				2.5) Making good the dismantled surfaces	2.5.1) Dismantled roads and streets are repaired properly and dismantled material disposal.	10		
				Part C: Parameters relating to Construction of STP				
				2.6) Pumping system efficiency enhancement	2.6.1) Use high efficiency pumps, motors & diffusers/blowers specifically designed for site requirements.	5		
					2.6.2) Installation of various modern equipments as per Bid document.	10		
				2.7) setting up of testing laboratory and consent from Pollution Control Board	2.7.1) Setting up effluent testing laboratories at STP Site.	5		
					2.7.2) Provision for reuse and discharge of treated effluent made and consent obtained from concerned department.	5		
					2.7.3) Obtaining Consent To Operate from State Pollution Control Board.	5		
					Total	**100**		**40%**
					2.4.3) Maintaining slopes for laying of pipes (as per design) for achieving gravitational flow of sewage.	5		

COMMISSIONING

Sr. no.	Parameter	Benchmark	Reference	Indicators	Sub Indicator	Max. marks	Marks obtained	Weightage
3	Commissioning and Hand over	Guidelines for commissioning and handover	Completion report and	**Part A: General Parameters**				10%
				3.1) Guarantee of works	3.1.1) Post commissioning Monitoring and support.	5		
					3.1.2) Withholding of security deposits.	5		
					3.1.3) Submission of Assets completion Plan and completion report by Agency and certificate by Department.	5		
				Part B: Parameters Relating To Sewerage				
				3.2) Testing and functionality	3.2.1) Flushing of pipelines.	5		
					3.2.2) All proposed connection made to the sewer system.	5		
				Part C: Parameters Relating to STP				
				3.3) Testing of system and Functionality of STP	3.3.1) Cleaning of STP.	5		
					3.3.2) Ensuring proper operation of all modern equipments installed at STP, as per bid document, including SCADA, online analyzers and VFD etc.	10		
					3.3.3] Automation of STP operations.	15		
					3.3.4) Ensuring specified quality of treated effluent.	25		
					3.3.5) Preparation of Manual on Standard Operating Methods and Procedures for STP.	10		
					3.3.6) Emergency response mechanism such as stand by arrangement of machinery etc.	10		
					Total	**100**		**10%**

SAFETY AND SECURITY

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicator	Max. marks	Marks obtained	Weightage
4	Safety and Security	Guidelines for Project Management	Bid document	4.1) Adherence to safety standards	**4.1.1) Providing of safety measures such as steps to be taken at the time of deep excavations (Shoring, caution boards, barricading, night signals etc).**	3		5%
					4.1.2) Providing of safety measures such as steps to be first aid & firefighting equipments, safety uniforms, gas release vents etc.	2		
				4.2) Safety measures for workers and users	4.2.1) Access control			
					4.2.2) Detection, alert and remedial measures in case of for chlorine gas leakage, if applicable.	1		
					4.2.3) compliance of safety measures as per provisions of labour laws.	2		
				4.3) Security measures	4.3.1) Physical Security measure.	1		
					4.3.2) Incident response and reporting.	1		
					Total	**10**		**5%**

PROJECT MANAGEMENT

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicator	Max. Marks	Marks obtained	Weigh tage
5	Project Management	Guidelines for Project management	Agreement with Executing Agency	**Part A: General Parameters**				
				5.1) CPM/PERT charts	**5.1.1) Preparation of CPM/PERT Charts for**	10		10%
				Part B: Parameters Relating To Sewerage				
				5.2) Adherence to Time Lines and cost estimates as per Agreement	5.2.1) Adhering to time lines of the project for Sewerage pipelines as per Agreement	10		
					5.2.2) Adhering to cost estimates of the project for Sewerage pipelines as per Agreement	10		
				Part C: Parameters Relating To STP		10		
				5.3) Adherence to Time Lines and cost estimates as per Agreement	5.3.1) Adhering to time lines of the project for Sewage Treatment Plant as per Agreement			
					5.3.2) Adhering to cost estimates of the project for Sewage Treatment Plant as per Agreement	10		
					Total	**50**		**10%**

OPERATION AND MAINTENANCE

	Parameter	Benchmark	Reference	Indicator	Sub Indicator	Max. marks	Marks obtained	Weightage
6.	O&M	Procedure for effective maintenance	Assets management, plans and Manual on SOMP	**Part A: General Parameters**				100%
				6.1) Timely rectification of defects	6.1.1) Grievance redressal and record keeping	5		
					6.1.2) Maintenance schedule development and its compliance	5		
					6.1.3) Availability of spare parts/stand by machinery	5		
					6.1.4) Training and Capacity building	5		
				Part B: Parameters Relating To Sewerage				
				6.2) Proper running of sewers	**6.2.1) Timely jetting/cleaning of sewers and manholes**	**5**		
					6.2.2) Timely running of pumping sets installed at Intermediate Pumping Stations	**5**		
				Part C: Parameters Relating To STP				
				6.3) Effective operation of STP	**6.3.1) Random Sampling of Treated Effluent**	5		
					6.3.2) Ensuring specified Quality of effluent	15		
					6.3.3) Ensuring specified Quantity & Quality of Sludge	10		
					6.3.4] Alarm system for Chlorine gas leak detection	3		
					6.3.5) Deployment of skilled staff for operation and maintenance	5		
					6.3.6) Deployment of adequate staff for O&M	5		
					6.3.7) Running as per operation manuals on SOMP/Design	5		
					6.3.8) Ensuring reuse of treated effluent	10		
					6.3.9) Ensuring appropriate disposal of sludge	5		
					6.3.10) Regular chlorination of effluent	5		
					6.3.11) No penalty of electric bill for low power factors, overload, delayed payments etc.	2		
					Total	**100**		**100%**

Sr. No.	Parameter	Marking Criteria	Weightage (%)	Marks obtained
1	Design and Planning		25*	
2	Execution, Inspection and Testing		40*	
3	Commissioning and Handing over		10*	
4	Safety Measures		5*	
5	Project Management	Adherence to project timelines and Cost Projections	10*	
6	Environmental Measures	Consideration of environmental factors like sustainability, eco-friendly construction practices	5	
7	User Feedback	Feedback from beneficiaries, stakeholders to assess their satisfaction levels	5	
TOTAL			**100**	
1	**Operations and Maintenance**		100*****	
TOTAL				

*The breakup of the weightage is given in the detailed framework for these parameters

* Parameters that are not applicable to a specific project will not be considered in the audit scoring. The weightage will be adjusted accordingly.

ANNEXURE II

Notice for Issuance of Proposed Discharge Standards

File No.HSPCB-09/28/2020-WATER CELL-HSPCB 734

I/161786/2023

HARYANA STATE POLLUTION CONTROL BOARD
C-11, SECTOR-6, PANCHKULA
Ph. 0172-2577870-73
E-mail: hspcbscientific@gmail.com

No.HSPCB/SSC/2023/ **Dated: 03.05.2023**

To
The Director General.
Information, Public Relations & Cultural Affairs Department, Haryana
Chandigarh.

Sub: Notice for issuance of proposed discharge standards of treated sewage for irrigation purposes from Sewage Treatment Plants (STPs).

Kindly refer to the subject noted above.

In continuation of this office letter No.HSPCB/-09/28/2020-Water Cell-HSPCB-I/160271/2023 dated 20.04.2023, I have been directed to enclose herewith an advertisement regarding Notice for issuance of proposed discharge standards of treated sewage for irrigation purposes from Sewage Treatment Plants (STPs) for publication but this was got held up telephonically by HSPCB. Now the modified advertisement needs to be published and the same is enclosed herewith. It may be published in the following leading newspapers on DAVP rates:-

1. Publication in one Hindi and one English Newspaper.

In view of the above, I have been directed to request that this advertisement be published in the above said two newspapers and the bills of the above newspapers on DAVP rates may be sent to this office so that the payment of the above advertisement can be made for newspapers.

DA: Advertisement

Sr. Env Engineer (SSC)
For Chairman

Endst.No. HSPCB/SSC/2023 **Dated 03.05.2023**

A copy of the above is forwarded to the Sr.E.E. (IT). He is requested to upload the advertisement notice on the website of the Board.

Digitally Signed by
Jatinder Pal Singh
Date: 03-05-2023 14:47:55
Reason: Approved

Sr. Env Engineer (SSC)
For Chairman

HARYANA STATE POLLUTION CONTROL BOARD
C-11, SECTOR-6, PANCHKULA
Website – www.hspcb.gov.in
E-Mail:hspcbscientific@gmail.com
Ph:0172-2577870-873

Notice for issuance of proposed standards for discharge into water bodies for re-use of treated sewage from Sewage Treatment Plants (STPs).

Whereas, amongst others, under section 17 of the Water (Prevention & Control of Pollution) Act, 1974, one of the functions of the State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs), constituted under the Water (Prevention & Control of Pollution) Act, 1974 is to plan a comprehensive programme for prevention, control or abatement of pollution of streams and wells in the State and to secure the execution thereof;

Whereas, the cities and the towns are not having adequate system for sewage collection and its treatment and thus entire waste water either falls into rivers or lakes or remains inundated on land causing potential risk to the ground water contamination.

Whereas, this Board is regularly monitoring the water quality of Water Bodies in the State of Haryana and the water quality monitoring results of rivers has indicated that water quality has been affected because of disposal of untreated or partially treated sewage into the water bodies and as a result, there is high concentration of faecal bacteria making the water body unfit for human consumption or for other uses;

Whereas, Haryana State Pollution Control Board has adopted the standard for emission or discharge of Environmental Pollutants as prescribed under Section 3 of Environment (Protection) Rules, 1986 but the standards for discharge of Faecal Coliform in sewage effluent discharging from sewage treatment plants (STPs) has not been prescribed therein;

Whereas, the State Pollution Control Board under section 17 of the Water Act has been mandated with the following functions which inter-alia including;

"(f) to inspect sewage or trade effluents, works and plants for the treatment of sewage and trade effluents and to review plans, specifications or other data relating to plants set up for the treatment of water, works for the purification thereof and the system for the disposal of sewage or trade effluents or in connection with the grant of any consent as required by this Act;

(g) lay down, modify or annul effluent standards for the sewage and trade effluents and for the quality of receiving waters (not being water in an inter-State stream) resulting from the discharge of effluents and to classify waters of the State;

(h) to evolve economical and reliable methods of treatment of sewage and trade effluents, having regard to the peculiar conditions of soils, climate and water resource of different regions and more especially the prevailing flow characteristics of water in streams and wells which render it impossible to attain even the minimum degree of dilution;

(i) to evolve methods of utilization of sewage and suitable of sewage and suitable trade effluents in agriculture;

(j) to evolve efficient methods of disposal of sewage and trade effluents on land, as are necessary on account of the predominant conditions of scant stream flows that do not provide for major part of the year the minimum degree of dilution;

(k) to lay down standards of treatment of sewage and trade effluents to be discharged in to any particular stream taking into account the minimum fair weather dilution available in that stream and the tolerance limits of pollution permissible in the water or the stream, after the discharge of such effluents;

****

(m) to lay down effluent standards to be complied with by persons while causing discharge of sewage or sullage or both and to lay down, modify or annul effluent standards for the sewage and trade effluents;"

Whereas, as per section 3 of the Environment (Protection) Rules, 1986, the State Pollution Control Board can specify more stringent standards from those provided under Section 3 of Environment (Protection) Rules, 1986, depending upon the quality of recipient system and after recording the reasons, thereof, in writing.

Whereas, Board had fixed discharge standard for STPs vide No. HSPCB/ WC-2/2170-2199 dated 02.07.2020 and now, the Board intends and proposes to fix standards for re-use of treated sewage from the STPs for different purposes, under the powers conferred as per Section 3 of the Environment (Protection) Rules, 1986 & Section 17 of Water (Prevention and Control of Pollution) Act, 1974 as under:-

Sr.No.	Parameters	Standards discharge for STPs	Proposed Standards for re-use of treated sewage from STPs for	
			Irrigation Purpose	Industrial processes, construction activities and other non-potable usage
1.	pH	5.5 – 9.0	6.5 - 8.5	6.5 - 8.5
2.	BOD (mg/l)	10	10*	10
3.	COD (mg/l)	50	50*	50
4.	TSS (mg/l)	20	20	10
5.	Total Nitrogen (mg/l)	10	10	10
6.	Total Phosphorus (mg//l)	1	1	1
7.	Faecal Coliform (MPN/100 ml)	<100	<100	<100
8.	Sodium Adsorption Ratio (SAR) meq/l		<10	<10
9.	Residual Sodium Carbonate (RSC), meq/l		< 2.5	< 2.5
10.	Electrical Conductivity (EC), µmhos/cm		<2000	<1200
11.	TDS (mg/l)		1500	750
12.	Boron (mg/l)		1	1
13.	Chloride (mg/l)		100	100
14.	SO4 (Sulphates)		200	200
15.	Fluoride (mg/l)		1	1
16.	Cu (Copper) (mg/l)		0.2	0.2
17.	Fe (Iron) (mg/l)		5.0	5.0
18.	Zn (Zinc)		2.0	2.0
19.	Mn (Manganese) (mg/l)		0.2	0.2
20.	Cr (Chromium) (mg/l)		0.1	0.1
21.	Ni (nickel) (mg/l)		0.2	0.2
22.	Pb (Lead) (mg/l)		0.01	0.01
23.	As (Arsenic) (mg/l)		0.01	0.01
24.	Cd (Cadmium) (mg/l)		0.01	0.01
25.	Co (Cobalt) (mg/l)		0.05	0.05
26.	Li (Lithium) (mg/l)		2.5	2.5
27.	Hg (Mercury) (mg/l)		0.01	0.01

***If the operating agency uses the treated wastewater of STPs entirely for irrigation purposes, then BOD of 30 mg/l and COD of 150 mg/l will be permissible, provided the treated wastewater is not discharged into drain/ nallah/ river/ any other surface water, under any circumstance.**

Therefore, the above notice is issued for receiving objections/ suggestions from all the stakeholders within 15 days. So all the concerned stakeholders are requested to submit their objections/ suggestions if any alongwith reasons to the Chairman of Haryana State Pollution Control Board at above mentioned address so that further necessary action in this regard could be taken.

Chairman

ANNEXURE III

Part A: Checklist for Approval of DPR for a Sewerage Project

Name of Division: _____

Name of Project: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Project title appropriately defined as per the scope of work				
2.	Objective of the project clearly stated				
3.	Project location identified with the appropriate map				
4.	All relevant stakeholders identified				
5.	Project justification provided				
6.	Feasibility study conducted				
7.	Topographic survey done				
8.	Soil investigations such as bearing capacity (SBC) and ground water table / spring water level done				
9.	Environmental Impact Assessment (EIA) conducted				
10.	Land acquisition completed				
11.	Forest clearance obtained				
12.	I. NOC obtained from Railway Department				
	II. NOC obtained from UHBVN/DHBVN				
	III. NOC obtained from I&WRD				

	IV. NOC obtained from PWD/NHAI				
	V. NOC obtained from MC/PRI				
13.	I. Population growth considered for design of sewerage scheme and for STP capacity				
	II. Floating population and seasonal variation considered for deign of sewerage scheme and for STP capacity institutional and commercial development, and seasonal				
	III. Institutional and commercial development considered for design of sewerage scheme and STP capacity				
14.	The existing sewer infrastructure assessed for its usage in the project				
15.	Sewerage design plans developed using the latest software for pipe network and drawings				
16.	L-sections of sewer lines prepared				
17.	STP design optimized with advanced treatment technologies				
18.	Modern mechanized/digital equipment considered: I. Remote Monitoring				
	II. SCADA				
	III. GIS				
	IV. Smart Pumping Systems				
	V. Online effluent quality analysers				
	VI. Mobile Applications				
	VII. Customer Portals				
	VIII. Drone Photography				
19.	Consent to establish obtained from State Pollution Control Board				
20.	Design and drawings prepared by the consultant and approved by competent authority of the department				

21.	Financial implication, with a cost index up to the implementation period, considered				
22.	Funding agency identified				
23.	Annual budget allocation made				
24.	Suitable materials for the project identified				
25.	Specifications for the identified materials framed				
26.	Provision of vacant land for future expansion of STP projected				
27.	Provision for reuse and disposal of treated effluent with the consent of concerned department made				
28.	Provision for sludge management made				
29.	Provision for Horticulture Planning				
30.	Provision of solar energy included				
31.	Provision for automation in the system made				

Note: This check list is required to be appended with the DPR at the time of approval and duly signed by concerned officers/officials

Part B: Checklist for Execution, Inspection, Testing, Commissioning & Handover of a Sewerage Project

Name of Division: _____

Name of Project: _____

Name of Agency: _____

Estimated Cost: _____

Date of Sanction: _____

Date of Award: _____

Contract Value: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	All materials such as cement, steel, coarse and fine aggregates, etc. procured from an approved source				
2.	Use of design mix ensured				
3.	Pipes and machinery of an approved make and manufacturer procured				
4.	Its testing carried out at the manufacturers' premises before dispatch				
5.	High-efficiency pumps and motors, specifically designed for site requirements, selected				
6.	Variable frequency devices (VFDs) installed to optimize energy use				
7.	Rising main of the designed size used, to minimize frictional losses				
8.	Appropriately qualified personnel deployed				
9.	Manpower deployed as per project requirements				
10.	Work being executed as per the originally approved bid document				
11.	Physical inspection of pipes conducted at the site before laying				
12.	Slopes maintained for laying pipes to ensure gravitational flow of sewage				

13.	Dismantled roads and streets repaired properly				
14.	Dismantled material disposed of appropriately				
15.	Site inspection and quality control registers maintained				
16.	Defects identified during inspections rectified				
17.	Reports of defect removal submitted regularly and records maintained				
18.	Effluent testing laboratory set up at the STP site				
19.	Effluent sample testing conducted regularly				
20.	Test results checked by the Engineer in Charge				
21.	Provision for reuse and discharge of treated effluent made and consent obtained from concerned department				
22.	Site inspection and quality control registers prepared and maintained properly				
23.	All test reports submitted				
24.	Electric/ Solar energy made available				
25.	Commissioning procedures completed as per the project specifications				
26.	All systems tested and found operational				
27.	All proposed connections made to the sewer system				
28.	Pipeline flushing and STP cleaning completed				
29.	Specified quality of treated effluent ensured				
30.	Proper operation of all modern equipment installed at STP, as per bid document, including SCADA, online analyzers and VFD etc. ensured				
31.	Automation of STP operations implemented				
32.	Training provided to the operational staff				
33.	All necessary manuals and documentation handed over				
34.	Final inspection report completed and approved				

35.	All deficiencies identified during the commissioning phase addressed				
36.	All required permits and certifications obtained				
37.	The site handed over in a clean and operational condition				
38.	Plan for post-handover support and maintenance				
39.	Assets Completion Plan and completion report submitted by the agency				
40.	The certificate been provided by the department				
41.	Manual on Standard Operating Methods and Procedure for STP prepared				
42.	Emergency response mechanism in place, such as standby machinery arrangements				
43.	Plan for post-commissioning monitoring and support				
44.	Safety measures provided at the time of deep excavations (Shoring, caution boards, barricading, night signals etc).				
45.	Safety equipment and gear provided in good condition				
46.	Emergency response plans in place and regularly updated				
47.	Security measures implemented to protect against unauthorized access				
48.	System in place for reporting and investigating safety incidents				
49.	Providing of safety measures such as first aid kits & firefighting equipment, safety uniforms, gas release vents, etc.				
50.	Monitoring and Surveillance				
51.	Detection, alert, and remedial measures in case of chlorine gas leakage, if applicable				
52.	Compliance of safety measures as per provisions of labour laws				
53.	Compliance to Prohibition of Employment as Manual Scavengers and their Rehabilitation Act ensured				
54.	Physical Security measures taken				

Note: This check list is to be signed by the Executive Engineer and the visiting officers during their visit.

Part C: Checklist for Project Management of Sewerage Project

Name of Division: _____ Estimated Cost: _____ Date of Completion: _____

Name of Project: _____ Date of Sanction: _____ Amount of Completion: _____

Name of Agency: _____ Date of Award: _____

Contract Value: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Preparation of CPM/PERT Charts				
2.	Detailed project plan and schedule in place				
3.	Project timelines and milestones established and tracked				
4.	Allocation of resources and budget in place according to project needs				
5.	Regular project status meetings held and communicated				
6.	Plan for project closure and handover				
7.	All project deliverables reviewed and accepted				
8.	Adhering to timelines of the project for Sewerage Pipelines as per Agreement				
9.	Adhering to timelines of the project for Sewage Treatment Plant as per Agreement				
10.	Adhering to cost estimates of the project for Sewerage Pipelines as per Agreement				
11.	Adhering to cost estimates of the project for Sewage Treatment Plant as per Agreement				

Note: This check list is to be signed by the Executive Engineer and the visiting officers during their visit.

Part D: Checklist for Operation and Maintenance of Sewerage Project

Name of Division: _____

Name of Project: _____

Name of Agency: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Operation and Maintenance manuals made available				
2.	Routine maintenance conducted as per the schedule				
3.	Records of maintenance activities properly maintained				
4.	Emergency response procedures clearly defined and accessible				
5.	Staff training regularly conducted				
6.	Timely jetting/cleaning of sewers and manholes conducted				
7.	Timely running of pumping sets installed at Intermediate Pumping Stations ensured				
8.	All equipment and machinery regularly inspected and calibrated				
9.	System for reporting and addressing operational issues				
10.	Spare parts and supplies adequately stocked				
11.	Performance of the STP (Sewage Treatment Plant) monitored regularly				
12.	Environmental compliance and regulatory requirements continuously met				
13.	Safety procedures and protocols followed during operation				
14.	Clear protocol for handling and disposing of waste generated during maintenance				

15.	Periodic reviews and audits of operation and maintenance practices conducted				
16.	Random Sampling of treated effluent				
17.	Specified quality of effluent generated ensured				
18.	Specified quantity and quality of sludge generated				
19.	Alarm system for chlorine gas leak detection.				
20.	Deployment of skilled staff for operation and maintenance.				
21.	Deployment of required number of staff for operation and maintenance.				
22.	Running as per operation manuals on SOMP/Design.				
23.	Ensuring reuse of treated effluent				
24.	Ensuring appropriate disposal of treated sludge				
25.	Grievance redressal and record keeping.				
26.	Maintenance schedule development and its compliance.				
27.	Availability of spare parts/standby machinery.				
28.	Training and capacity building.				
29.	Regular chlorination of effluent.				
30.	Any penalty on electric bill for low power factor, overload, delayed payments, etc.				

Note: This check list is to be signed by the Executive Engineer and the visiting officers during their visit.

ANNEXURE IV

Reuse of Treated Waste Water Policy, Haryana, 2019

Attached herein

ANNEXURE V

The Mahagram Yojna, Government of Haryana

Attached herein

Quality Assurance Authority

Government of Haryana

Standard Operating Methods and Procedures

For

Technical Quality Assurance

In

Water Supply Project

PREFACE

The QAA has already framed Technical Quality Assurance Parameters outlining indicators and sub-indicators required for Quality Assurance of the projects throughout their lifecycle.

Now the QAA has further developed the Standard Operating Methods and Procedures (SOMPs) for Quality Assurance/Quality Control in the planning & design, construction, operation and maintenance of Water Supply Schemes to have a ready reckoner to ensure that all quality parameters are adhered to during and after the construction of any project.

The Quality Control process focuses on detecting and correcting defects in a product or service. It involves identifying quality issues and taking corrective actions to resolve them. This is carried out by quality control monitors who would conduct inspections, perform tests, and implement necessary corrective measures. Through this systematic approach, the department would be able to identify shortcomings and defects on a real-time basis and shall ensure the delivery of a high-quality product or service.

Whereas the quality Assurance process ensures the delivery of a high-quality product or service throughout its entire life cycle by preventing quality problems from the outset. This comprehensive approach involves the entire organization, from top management to front-line employees, working in tandem to meet quality standards within the timeline and financial outlay. Key aspects of this process include planning, design, execution, delivery, training, documentation, and audits. By focusing on defect prevention, Quality Assurance ensures that the product or service meets the desired standards throughout the deliverable period.

Standard Operating Methods and Procedure (SOMP) for Water Supply Schemes offer numerous advantages such as:

1. Ensures Consistency: SOMPs help standardize procedures across different teams and locations, ensuring that water supply is managed consistently.
2. Improves Efficiency: With a clear set of instructions, operational tasks can be performed efficiently, minimizing downtime and errors.
3. Ensures Safety and Quality: SOMPs ensure that safety standards are met, protecting both workers and consumers. It also helps in maintaining the quality of water by adhering to predefined guidelines for treatment, distribution, and maintenance.
4. Compliance with Regulations: Many water supply systems are governed by national and local laws. SOMPs help ensure that operations comply with legal and environmental regulations.
5. Training and Skill Transfer: SOMPs provide a training guide for new employees and help retain institutional knowledge, ensuring that the system can operate smoothly even if experienced staff is not available.
6. Emergency Management: SOMPs provide clear steps to handle emergency situations, like leaks or contamination, to minimize damage and ensure a swift response
7. Accountability: With documented processes, it's easier to identify who is responsible for different tasks, improving accountability within the organization.

In this respect, the Quality framework relating to all Quality Assurance parameters, indicators, and sub-indicators required in the various stages of water supply projects has been prepared in detailed consultation with the user department responsible for the quality assurance and quality control for

the water supply projects. QAA is further hopeful that State Government departments implementing engineering works and organizations owned and controlled by the State Government would evolve suitable mechanisms to implement the required Quality Assurance plans with the objective of achieving economic and social development of the State and improving the quality of life of the people.

CONTENTS

CHAPTER 1

Part A: Executive Summary

This detailed report covers the comprehensive stages involved in the implementation of a Water Supply Scheme, focusing on critical elements such as design, execution, safety, environmental considerations, and ongoing operations.

1. Planning and Design

The planning and. design phase is the foundation of the project, involving several key activities. First, a thorough water demand analysis is conducted to assess current and future needs, considering population growth, industrial and institutional demands, and seasonal variations. This is followed by the identification and assessment of sustainable water sources, such as rivers, canals, underground aquifers, or reservoirs, ensuring that these sources meet the necessary quality and quantity requirements. The distribution network is then carefully designed to ensure efficient and equitable water distribution, with considerations for pipe materials, sizes, and strategic reservoir placement. Cost estimates and budget planning are essential components, ensuring financial feasibility through careful resource allocation. Finally, community and stakeholder engagement are prioritized during planning to align the design with the needs and expectations of the beneficiaries. Major tasks for Planning and Design are listed below:

- Conduct water demand analysis, considering current and future population growth, industrial demands, and seasonal variations.
- Identify and assess sustainable water sources, ensuring they meet quality and quantity requirements.
- Design the distribution network for efficient and equitable water distribution, considering pipe materials, sizes, and strategic reservoir placement.
- Prepare cost estimates and budget planning for financial feasibility.
- Engage with the community and stakeholders to align the design with local needs and expectations.

2. Execution, Inspection, and Testing

The execution phase marks the beginning of construction, starting with site preparation and the mobilization of labour and materials. Construction activities include laying pipes, installing pumps, constructing reservoirs, and setting up treatment facilities, all of which must strictly adhere to technical specifications. Regular inspections by engineers ensure that materials and workmanship meet the required standards, while hydraulic testing is conducted to identify any leaks or weaknesses in the system. This phase also includes water quality testing to ensure the supply meets health and safety standards. Any issues or deviations from the original design are promptly addressed to prevent delays and maintain quality. Major tasks for Execution, Inspection, and Testing are listed below:

- Begin construction with site preparation and mobilization of labour and materials.
- Carry out construction activities such as laying pipes, installing pumps, constructing reservoirs, and setting up treatment facilities according to technical specifications.
- Conduct regular inspections by engineers to ensure materials and workmanship meet required standards.
- Perform hydraulic testing to identify leaks or weaknesses in the system.
- Conduct water quality testing to ensure compliance with health and safety standards.
- Address any issues or deviations from the original design promptly to prevent delays.

3. Commissioning and Handing Over

Commissioning involves ensuring that the entire system is operational before officially handing it over to the relevant managing authority. The system undergoes rigorous trial runs to verify that all components are functioning as intended, with careful monitoring of flow rates, pressure levels, and water quality. Simultaneously, personnel from the managing entity are trained in system operations, routine maintenance tasks, and troubleshooting procedures. Once the system meets all operational standards, it is formally handed over to the local authority or community organization, along with all necessary documentation, including as-built drawings, operation manuals, and maintenance schedules. Major tasks for Commissioning and Handing Over are listed below:

- Ensure the entire system is operational through rigorous trial runs, monitoring flow rates, pressure levels, and water quality.
- Train personnel from the managing entity in system operations, routine maintenance tasks, and troubleshooting procedures.
- Hand over the system to the local authority or community organization, providing all necessary documentation, including as-built drawings, operation manuals, and maintenance schedules.

4. Safety Measures

Safety is a top priority throughout the project's lifecycle. Occupational safety protocols are implemented to protect workers, including the provision of personal protective equipment (PPE), safety training, and regular site safety audits. Public safety is also ensured by securing the construction site with proper signage, fencing, and traffic management plans. Water quality safety is another critical aspect, with water treatment processes put in place to prevent contamination, and regular monitoring is conducted to meet health standards, reducing the risk of waterborne diseases. Major tasks for Safety Measures are listed below:

- Implement occupational safety protocols to protect workers, including providing personal protective equipment (PPE), safety training, and regular site safety audits.
- Ensure public safety by securing the construction site with proper signage, fencing, and traffic management plans.
- Implement water quality safety measures, including water treatment processes and regular monitoring to meet health standards.

5. Project Management

Effective project management is essential to ensure the project remains on track. This begins with the development of a detailed project schedule that outlines all key activities, milestones, and deadlines. Regular progress reviews help identify potential delays, allowing for corrective measures to be taken as necessary. Resource allocation, including labour, materials, and equipment, is carefully managed, and transparent procurement processes are followed to ensure quality materials. Financial monitoring ensures that the project stays within budget, with contingency plans activated in case of cost overruns. Regular communication with stakeholders, including government bodies, funders, and the community, fosters trust and ensures any concerns are addressed promptly. Major tasks for Project Management are listed below:

- Develop a detailed project schedule outlining key activities, milestones, and deadlines.
- Conduct regular progress reviews to identify potential delays and implement corrective measures as necessary.
- Manage resource allocation, including labour, materials, and equipment, ensuring transparent procurement processes.
- Monitor financial progress to ensure the project stays within budget, with contingency plans for cost overruns.

- Maintain regular communication with stakeholders, including government bodies, funders, and the community, to address concerns promptly.

6. Environmental Measures

Environmental sustainability is a central focus of the Water Supply Scheme. During construction, efforts are made to minimize ecological disruption by carefully managing activities that could harm natural habitats, restoring disturbed areas post-construction, and preserving local flora and fauna. Sustainable water resource management is prioritized to avoid over-extraction and protect the ecosystem, with methods like groundwater recharge and rainwater harvesting incorporated into the design. Waste management practices ensure responsible handling of construction waste, and energy-efficient technologies, such as solar-powered pumps, are considered to reduce the carbon footprint. Water-efficient practices are also promoted to conserve resources. Major tasks for Environmental Measures are listed below:

- Minimize ecological disruption during construction by managing activities that could harm natural habitats, restoring disturbed areas post-construction, and preserving local flora and fauna.
- Prioritize sustainable water resource management to avoid over-extraction and protect the ecosystem, incorporating methods like groundwater recharge and rainwater harvesting.
- Implement waste management practices to handle construction waste responsibly.
- Consider energy-efficient technologies, such as solar-powered pumps, to reduce the carbon footprint.
- Promote water-efficient practices to conserve resources.

8. Operations and Maintenance

The long-term success of the Water Supply Scheme depends on effective operations and maintenance (O&M). A regular preventive maintenance schedule is established to prevent breakdowns, with activities such as cleaning tanks, servicing pumps, inspecting pipes, and testing water quality carried out routinely. Quick response mechanisms are set up to address urgent repairs, and a stockpile of critical spare parts is maintained for emergencies. Financial sustainability for O&M is ensured through a well-planned financial strategy, which may involve user tariffs, government subsidies, or community contributions. Training and capacity building for O&M teams are ongoing, ensuring they have the skills to manage the system efficiently over time. Major tasks for Operations and Maintenance are listed below:

- Establish a regular preventive maintenance schedule to prevent breakdowns, including cleaning tanks, servicing pumps, inspecting pipes, and testing water quality.
- Set up quick response mechanisms for urgent repairs and maintain a stockpile of critical spare parts for emergencies.
- Ensure financial sustainability for operations and maintenance through a well-planned financial strategy, potentially involving user tariffs, government subsidies, or community contributions.
- Provide ongoing training and capacity building for operations and maintenance teams to ensure efficient long-term system management.

7. User Feedback

User feedback is crucial for assessing the scheme's performance and ensuring continuous improvement. After the system is commissioned, community surveys and consultations are conducted to gather feedback on its functionality and effectiveness. This feedback helps identify operational issues, such as inadequate pressure or supply interruptions, allowing for timely adjustments. A customer service framework is established to handle complaints and queries from users, ensuring prompt resolution of any

issues. By analyzing user feedback, continuous improvement processes are implemented, ensuring the system remains responsive to the community's needs. Major tasks for User Feedback are listed below:

- Conduct community surveys and consultations post-commissioning to gather feedback on system functionality and effectiveness.
- Address operational issues identified through feedback, such as inadequate pressure or supply interruptions, promptly.
- Establish a customer service framework to handle complaints and queries from users, ensuring prompt resolution.
- Implement continuous improvement processes based on user feedback to keep the system responsive to community needs.

In conclusion, the Water Supply Scheme is designed with a comprehensive approach that prioritizes sustainability, safety, and user satisfaction. With a strong focus on effective project management, environmental stewardship, and long-term operations, the scheme is expected to provide reliable and safe water delivery to the community for years to come.

Part B: Responsibilities of stakeholders

In the context of ensuring quality assurance for a Water Supply Scheme (WSS), the roles and responsibilities of the key stakeholders—such as the Client Department, Contractor, and other associated parties—are critical in maintaining the project's success and longevity. Here's a detailed breakdown of each stakeholder's responsibilities:

1. Client Department (Owner/Employer):

The Client Department, typically a government agency or private entity that commissions the project, holds overarching responsibility for ensuring that the water supply scheme meets all regulatory, environmental, and quality standards.

Responsibilities:

Project Conceptualization and Planning:

- Oversee the project's initial design, ensuring it aligns with community needs, environmental sustainability, and national/local water supply standards.
- The client must hire qualified designers and consultants to prepare technical documents such as feasibility studies, environmental impact assessments, and detailed project reports.
- The selection of base year for assessment of Population Growth should be based on the likely completion date of the project.

Setting Quality Standards:

- Define specific quality parameters and benchmarks based on regulatory standards, water quality standards (e.g., WHO guidelines, BIS standards in India), and safety requirements.
- Ensure that the technical specifications of materials, such as pipes, valves, and pumps, adhere to industry norms and quality expectations.

Tendering and Selection of Contractor:

- Draft comprehensive tender documents with clear quality standards, performance indicators, and timelines.
- Evaluate and select contractors based on their expertise, technical competency, past performance, and ability to meet the required quality standards.
- Approve subcontractors and suppliers involved in the water supply scheme.

Supervision and Monitoring:

- Organize regular site inspections to ensure compliance with the approved designs, materials, and construction practices.
- Set up independent quality control teams or third-party agencies to monitor on-site activities.
- Ensure that the contractor follows proper procedures for water treatment, distribution system installation, and overall construction quality.

Material Approval:

- Approve materials after conducting appropriate testing or reviewing third-party certifications (e.g., ISI marks or other international certifications).
- Review quality certificates provided by suppliers for key components like pipes, fittings, pumps, and filters.

- Sufficient inventory of the required material for the project which is required to be issued by the client department should be maintained.

Change Management:

- In the event of design changes or unforeseen circumstances (e.g., changes in groundwater level, material shortages, etc.), assess the impact on quality and authorize necessary modifications in consultation with the contractor.

Testing and Quality Audits:

- Oversee water quality tests during various stages of the project, including during commissioning and operation.
- Ensure that treated water meets drinking water quality standards, conducting bacteriological and chemical tests as required.

Final Inspection and Approval:

- Conduct a thorough final inspection before commissioning the project to verify compliance with all quality standards.
- Ensure operational tests (such as pump efficiency, pressure, and leak tests) are carried out and that any defects identified are rectified before the project is handed over for use.

Ensuring Regulatory Compliance:

- Ensure that all aspects of the project, from planning to implementation, comply with local and national regulations, including environmental, water quality, and public health guidelines.
- Maintain close coordination with other regulatory bodies such as the Environmental Protection Agency, Health Departments, and Water Regulatory Authorities.

2. Contractor:

- The Contractor is responsible for executing the work as per the designs, specifications, and quality standards set by the Client Department. Their role is critical in ensuring that the project is built to last and functions effectively.

Responsibilities:

Work Execution as per Specifications:

- Implement the construction of the water supply scheme exactly as per the approved design, materials, and methods.
- Ensure that all procedures are followed in accordance with the quality benchmarks set forth by the client.

Material Procurement and Handling:

- Procure materials that meet the approved quality standards (e.g., corrosion-resistant pipes, and durable pumps).
- Verify that the materials supplied by vendors have undergone proper quality testing and have the required certifications.

Implementation of Quality Control (QC) Plan:

- Establish and maintain an internal quality control system with qualified staff responsible for conducting quality checks on materials, processes, and completed work.
- Set up an on-site testing laboratory to conduct regular material tests (e.g., tensile strength of pipes, water leakage tests, pressure tests, etc.).

Coordination with Client and Third Parties:

- Maintain close communication with the Client Department regarding progress updates, challenges, and any deviations from the design or quality requirements.
- Coordinate with third-party quality auditors or inspectors for regular assessments.

Documentation and Reporting:

- Maintain proper records of all quality-related processes, including material tests, inspection reports, daily work logs, and certificates from suppliers.
- Prepare and submit regular reports on the progress and quality of work to the Client Department.

Rectification of Defects:

- Address any defects, quality issues, or non-compliance highlighted during inspections or testing.
- Ensure proper measures are taken to correct the defects and report the corrections back to the client for re-inspection.

Health, Safety, and Environmental Compliance:

- Ensure that workers follow health and safety regulations to prevent accidents and ensure smooth project execution.
- Implement proper waste management practices to avoid environmental damage, including the disposal of construction debris and treatment of wastewater.

Testing and Commissioning:

- Conduct all necessary tests (e.g., pressure testing of pipelines, testing water quality, leak detection, and pump performance tests) prior to final commissioning.
- Handover the system after ensuring that it is in full compliance with the approved quality parameters and is ready for operation.

3. Third-Party Quality Auditors/Consultants:

In many water supply projects, independent third-party consultants or quality assurance teams are engaged to monitor quality.

Responsibilities:

Quality Audits:

- Perform scheduled and surprise audits on the construction site to verify compliance with the quality standards set by the client department.
- Check that the materials used and construction methods align with the approved specifications.

Testing and Certification:

- Conduct third-party tests on materials and completed work, including water quality testing, structural integrity checks, and system performance testing.
- Issue certifications of quality where appropriate, ensuring all testing is documented and reported to both the client and contractor.

Reporting and Recommendations:

- Provide independent reports on the findings during inspections and audits, identifying any discrepancies and recommending corrective measures.
- Suggest improvements in processes, if necessary, to enhance the overall quality of the project.

4. Suppliers (Material and Equipment Providers):

Suppliers are responsible for providing high-quality materials and equipment that meet the specifications required for the water supply scheme.

Responsibilities:

Material Supply:

- Supply materials such as pipes, valves, pumps, and other equipment that meet the specifications provided by the client and contractor.

Quality Certifications:

- Provide proper quality certifications and test reports for all materials supplied, ensuring they comply with the industry standards (e.g., ISI or international standards).

Material Testing:

- Ensure that all materials are tested prior to delivery, with evidence of passing all relevant quality checks (e.g., pressure testing for pipes, durability tests for pumps).

Replacement of Defective Materials:

- Replace any defective or substandard materials immediately when identified during on-site inspections or testing.

5. End Users (Communities/Local Bodies):

- The ultimate users of the water supply scheme, often represented by local governing bodies or community members, also have a role to play.

Responsibilities:

Feedback on Quality:

- Provide feedback on the functioning of the water supply system, particularly regarding water quality, pressure, and system reliability once the system is operational.

Monitoring of Service Levels:

- Continuously monitor the service levels provided by the water supply system and report any issues or concerns to the client or local authorities.

Activities to be performed by the Departmental Officers/Officials and Executing Agency

S No.	Activity	CE	SE	EE	AE	JE	Executing Agency
Planning and Design							
1.	Topographic Survey.			✓	✓	✓	
2.	Land Acquisition, Forest clearance etc.	✓	✓	✓	✓	✓	✓
3.	NOC from Railways, Electricity Board, water Resources, Roads, Panchayat			✓	✓	✓	
4.	Assessment of water requirement			✓	✓	✓	
5.	Source finding and determining available water sources & their lean period discharge		✓	✓	✓	✓	
7.	Assessment of existing water supply infrastructures and their uses.			✓	✓	✓	
8.	Selection of latest software in design	✓	✓				
9.	Selection of modern mechanized/digital equipment	✓	✓				
10.	Framing specifications for above materials	✓	✓	✓			
11.	Preparation of Detailed Project Report along with design, drawings, and cost estimate and its timeline.		✓	✓	✓	✓	
12.	Approval of Detailed Project Report	✓	✓				
13.	Identification of funding agency with annual budget allocation	✓	✓				
14.	Call of tenders and award of work after completing all formalities	✓	✓	✓			
Execution, Inspection and Testing							
15.	Selection of approved source for materials such as aggregates, sand etc.			✓	✓	✓	✓
16.	Submission of design mix and its approval			✓	✓	✓	✓
17.	Procurement of pipes of approved make by the department	✓					
18.	Pre inspection for pipes and machinery at manufacture's premises before dispatch			✓	✓		
19.	Procurement of cement, steel, etc.			✓	✓	✓	✓
20.	Ensuring the execution as per design and specifications, and as per the bid document			✓	✓	✓	✓
21.	Qualified manpower deployment as per requirement			✓	✓	✓	✓
22.	GIS mapping of sources, network and all other infrastructures				✓	✓	

23.	Ensuring the restoration of dismantled road and streets and disposal of dismantled material				✓	✓	✓
24.	Ensuring relevant mandatory tests with required frequency during execution at every stage of construction.			✓	✓	✓	✓
25.	Water sample testing after treatment				✓	✓	✓
26.	Setting up water testing laboratories having all testing equipment relevant to the project requirements and WTP			✓	✓	✓	✓
27.	Preparation of site inspection and quality control registers			✓	✓	✓	✓
28.	Checking of test results by Engineer in Charge			✓	✓	✓	✓
28 (a)	Acceptance of Test Results			✓	✓	✓	
29.	Submission of reports and rectification of defects			✓	✓	✓	✓
30.	Flow testing in pipes after laying at site				✓	✓	✓
31.	Testing of pumping machinery to meet with the required discharge at OHSR				✓	✓	✓
32.	Availability of electric/ Solar energy as per requirements			✓	✓	✓	
Commissioning and Handing over							
33.	Ensuring 100% HH water connections			✓	✓	✓	✓
34.	Ensuring system flushing and disinfection				✓	✓	✓
35.	Ensuring specified Quantity, quality and regularity of water				✓	✓	✓
36.	Ensuring cleaning & disinfection of WTP				✓	✓	✓
37.	Ensuring specified quality and quantity of potable water from WTP				✓	✓	✓
38.	Proper operation of SCADA and online analyzer			✓	✓	✓	✓
39.	Submission of Assets completion Plan and report						✓
40.	Approval of Assets completion Plan and report and certificate			✓			
41.	Preparation of Manual for running of WTP						✓
42.	Ensuring emergency response mechanism			✓	✓	✓	✓
Safety Measures							
43.	Providing of safety measures such as first aid & firefighting equipments, safety uniforms etc.						✓
44.	Monitoring and Surveillance			✓	✓	✓	✓
45.	Controlling the access of unauthorized person in the premises of WTP					✓	✓

46.	Detection, alert and remedial measures in case of chlorine gas leakage if applicable			✓	✓	✓	✓
47.	Incident response and reporting					✓	✓
Operation and Maintenance							
48.	Supply of Specified Quantity and regularity of water upto tail end.				✓	✓	✓
49.	Supply of specified Quality of potable water from WTP and upto tail end			✓	✓	✓	✓
50.	Deployment of skilled staff for operation and maintenance			✓	✓	✓	✓
51.	Deployment of qualified manpower as per requirement			✓	✓	✓	✓
52.	Grievance redressal and record keeping				✓	✓	✓
53.	Maintenance schedule development and its compliance			✓	✓	✓	✓
54.	Availability of spare parts/stand by machinery			✓	✓	✓	✓
55.	Regular disinfection					✓	✓

Note 1: Responsibilities for carrying out above activities by the departmental officers shall be governed by the Technical Sanction Powers vested in them by the Government of Haryana

Note 2: Responsibilities for carrying out pre-inspection for supply of pipes and machinery at the manufacturer's premises by the departmental officers shall be governed by the Departmental Procedure.

CHAPTER 2

Standard Operating Methods and Procedures

For Technical Quality Assurance

1) PLANNING AND DESIGN

1.1) Survey and Investigation

1.1.1) Topographic Survey

A detailed topographic survey is to be conducted for the design and implementation of a water supply scheme to determine terrain features, water sources, and potential pipeline routes.

I. Tools and Equipment

- Total station/GPS equipment/Drone
- Levelling instruments
- Survey rods and tapes
- Field notebooks or data collection devices

II. Pre-Survey Preparation:

- Identify the survey area based on the project plan.
- Review topographic maps, satellite imagery, and other relevant data.
- Ensure that equipment is calibrated and in working order.

III. Site Reconnaissance:

- Conduct a preliminary visit to identify control points, potential obstacles, and access routes.
- Mark control points using GPS or known landmarks.

IV. Establish Control Points:

- Set up temporary benchmarks with GPS or total station.
- Record their coordinates for accurate positioning throughout the survey.
- Cross-check coordinates and elevations using known benchmarks for accuracy.

V. Data Collection and Processing:

- Perform a detailed survey of the terrain, noting elevation changes, natural watercourses, and existing infrastructure.
- Collect data for potential pipeline routes, water storage, treatment plant locations, groundwater table, and Soil Bearing Capacity, etc.
- Download and process survey data using appropriate software (e.g., AutoCAD, GIS).
- Generate contour maps, profile drawings, and layout plans for the water supply scheme.

VI. Reporting:

- Prepare a survey report with key findings, including topographic maps, alignment proposals, and recommendations.

VII. Quality Assurance

- Ensure all measurements are verified and equipment is calibrated before use.
- Cross-check field data with existing topographic information for consistency.

VIII. Documentation

- Maintain field logs and backup data electronically.
- Ensure survey maps are clearly labelled and filed for future reference.

1.1.2) Land Acquisition and Forest Clearance:

A) Land Acquisition

I. Project Identification & Land Requirement:

- Identify the land required for water intake, treatment plants, pumphouses, storage tanks and other related infrastructure.
- Ensure the selected land aligns with the project plan and minimizes environmental impact.

II. Initial Survey & Feasibility Study:

- Conduct a topographic and socio-economic survey of the land to assess its suitability.
- Prepare a feasibility report that includes potential land use, resettlement issues, and environmental factors.

III. Legal Process for Acquisition:

- Approach the local Land Revenue Department to identify ownership.
- The procurement of land may also be added as per the requirement on the e-Bhoomi portal of the Government of Haryana.
- Submit a proposal to the appropriate government authority with details of the land required and the purpose.
- Obtain consent from landowners for gift deed or initiate the compulsory acquisition process as per the Land Acquisition Act.

IV. Compensation and Settlement:

- Calculate compensation as per government guidelines based on land value and any resettlement requirements.
- Negotiate with landowners and provide compensation on time.

V. Transfer of Ownership:

- After compensation, complete the formal transfer of land ownership.
- Obtain all necessary legal documents and records

B) Forest Clearance Procedure

I. Identification of Forest Land:

- Identify if any forest land falls within the project area.
- Ensure minimum disturbance to forest ecosystems and opt for alternative routes where possible.

II. Application for Forest Clearance:

- Prepare the Forest Clearance Proposal as per the Forest Conservation Act, 1980.
- Apply to the Forest Department through the appropriate government portal (e.g., Ministry of Environment, Forest, and Climate Change - MoEFCIII..

III. Environmental Impact Assessment (EIA):

- Conduct an Environmental Impact Assessment to evaluate the potential effects on the ecosystem.
- Submit the EIA report along with the forest clearance proposal.

IV. Compensatory Afforestation:

- Propose compensatory afforestation plans in non-forest areas as mandated by law.
- Coordinate with the Forest Department to identify suitable afforestation sites.

V. Approval Process:

- Obtain approval from the Forest Advisory Committee (FAC) after the submission of reports and clearance applications.
- Follow up on any additional requirements and ensure compliance with forest conservation norms.

VI. Compliance and Monitoring:

- Ensure compliance with all conditions stipulated in the forest clearance.
- Regularly monitor the impact of construction activities on the forest and take corrective measures as needed.

VII. Coordination with Authorities

- Maintain continuous communication with local authorities, landowners, and environmental agencies to facilitate smooth land acquisition and forest clearance processes.

VIII. Documentation and Reporting

- Maintain all legal documents related to land acquisition and forest clearance.
- Report progress to the project management team and regulatory authorities.
- Ensure all land acquisition and forest clearance procedures are completed before construction begins, adhering to local regulations and environmental guidelines.

1.1.3) NOCs from Various State Departments

Obtaining the necessary NOCs from state departments is essential to ensure compliance with legal and technical standards for the Water Supply Scheme. Ensure early engagement with all relevant authorities to avoid project delays.

Railways

I. Application Submission:

- Prepare a detailed project report (DPR) highlighting the need for crossing railway land or tracks.
- Submit an application to the Railway Division Office detailing the proposed work, alignment, and safety measures.

II. Technical Review:

- Coordinate with the Railway's Engineering Department for a technical review of the project plan.
- Ensure compliance with railway safety standards and provide drawings as required.

III. Follow up:

- Regularly follow up with the Railway authorities for site inspections and clarifications.

IV. NOC Issuance:

- Once approved, the Railways will issue the NOC with specific conditions.

HVPNL, UHBVN and DHBVN

I. Application Submission:

- Submit a request for NOC to the HVPNL & UHBVN, and DHBVN for approval of any work that affects electrical infrastructure such as power lines or transformers.

II. Technical Survey:

- Conduct a joint site survey with HVPNL & UHBVN, and DHBVN officials to identify any potential electrical risks or adjustments needed.

III. Compliance:

- Implement any necessary changes to avoid interference with electrical lines or structures, as advised by HVPNL & UHBVN, and DHBVN NOC Issuance:
- After verification, HVPNL & UHBVN, and DHBVN will issue the NOC with specified safety requirements.

Irrigation & Water Resources Department

I. Application Submission:

- Submit a detailed report to the I& WRD outlining the water source, intake points, and usage details for the WSS project.
- Permission for Right of Way should be obtained

II. Environmental Impact Review:

- Conduct an Environmental Impact Assessment (EIA), if required, to ensure minimal impact on local water bodies and ecosystems.

III. Clearance Process:

- Work with the department to finalize water allocation and the sustainable use of resources.

IV.NOC Issuance:

- Once all conditions are met, the department will provide the NOC for using water resources.

Public Works Department & NHAI

I. Application Submission:

- Submit a proposal to the Public Works Department (PWD) or NHAI for laying pipelines along or crossing state roads.

II. Route Inspection:

- Conduct joint inspections with PWD or NHAI officials to ensure that the project does not affect road integrity or traffic.

III. Compliance with Standards:

- Ensure that the road cutting or boring for pipelines follows PWD/ NHAI guidelines and safety standards.

IV. NOC Issuance:

- Upon approval, the PWD/NHAI will issue the NOC with terms on road restoration post-construction.

Panchayats / Local Government

I. Application Submission:

- Submit the project proposal to the local Panchayat or municipal authorities to obtain consent for using community land or facilities for the WSS project.

II. Public Consultation:

- Conduct public hearings, if required, to address any community concerns about the WSS project.

III. Approval Process:

- Coordinate with Panchayat officials to finalize land use and local infrastructure adjustments.

IV. NOC Issuance:

- The Panchayat will issue the NOC once the project aligns with local regulations and community interests.

General Guidelines for All NOCs

I. Documentation:

- Ensure that all required documents such as project plans, land use maps, environmental clearances, safety measures, and Right of Way are included in each NOC application.
- The Right of Way for laying of the underground pipes should be as per the provisions of "The Haryana Underground Pipelines (Acquisition of Right of User in Land) Act, 2008"

II. Follow-up:

- Maintain regular communication with the respective departments to monitor the progress of NOC applications and address any queries.

III. Compliance:

- Adhere to the conditions laid out by each department in the NOC to ensure smooth project execution and avoid delays.

IV. Documentation and Reporting:

- Maintain copies of all NOC applications, approvals, and related correspondence for future reference and audit purposes.

1.2) Demand and Resource Assessment

1.2.1) Population Growth, Industrial Development & Seasonal Variation

I. Population Growth:

- Gather demographic data from census reports and local administrative records.
- Analyse trends in population growth over the past decades using Arithmetic Progression method, Geometric Growth, Incremental increase, etc
- Project future water demand based on population growth projections.

II. Industrial and Institutional Development:

- Identify all major industries and institutions in the region.
- Obtain data on water consumption from these industries and institutions.
- Assess the impact of industrial and institutional water consumption on overall water resources.
- Analyse future water needs based on potential industrial and institutional expansion.

III. Seasonal Variation:

- Gather historical climate and rainfall data from meteorological departments.
- Gather floating population details in case of tourist and religious places.
- Monitor seasonal patterns in water availability (e.g., monsoon, dry season).
- Identify periods of peak water demand and compare with seasonal supply.
- Develop models to predict water shortages during lean periods.

1.2.2) Available Water Sources & Their Lean Period Discharge

I. Surface Water Sources:

- List all surface water sources (rivers, lakes, reservoirs) in the region.
- Record seasonal discharge rates, with particular focus on lean periods (e.g., dry seasons).
- Identify any trends in reduced discharge over the years.

II. Groundwater Sources:

- Map all groundwater sources (wells, aquifers, tube wells, infiltration gallery, percolation well, rainy well. Etc).
- Measure the water table levels and extraction rates regularly.
- Monitor the impact of over-extraction on groundwater recharge rates.

III. Rainwater Harvesting:

- Evaluate the effectiveness of existing rainwater harvesting systems.
- Monitor seasonal variations in rainwater capture and storage.

1.2.3) Discharge Depletion Studies:

I. Data Collection and Impact Analysis:

- Gather historical discharge data for all major water sources.
- Study the impact of climate change on precipitation and water source recharge.
- Analyze changes in land use patterns (e.g., deforestation, urbanization) that may affect discharge.
- Assess the impact of industrial, agricultural, and domestic water usage on discharge rates.
- Identify any unsustainable water extraction practices contributing to depletion.

II. Mitigation Strategies:

- Recommend regulatory measures to control water extraction.
- Propose water-saving technologies and practices for industrial, Institutional, and agricultural sectors.
- Suggest projects to restore natural recharge areas (e.g., reforestation, wetland restoration).
- Propose source sustainability measures.
- Explore artificial recharge methods like groundwater recharge wells.

1.2.4) Assessment of Existing Water Supply Infrastructures and Their Uses

I. Infrastructure Mapping:

- Create a comprehensive inventory of all water supply infrastructure (pipelines, reservoirs, treatment plants, storage tank and any relevant infrastructure).
- Document the age, condition, and capacity of each infrastructure component.

II. Usage Assessment:

- Assess the existing water supply systems serving residential areas.
- Identify any gaps in service coverage, especially in rapidly growing urban areas.
- Evaluate the efficiency of water supply systems catering to industrial and institutional areas, etc.
- Analyze the impact of industrial and institutional or other demands on overall system capacity.
- Assess irrigation systems and their impact on water supply to other sectors.
- Identify areas where water-saving irrigation techniques can be implemented.

III. Efficiency Analysis:

- Conduct a water audit to identify and quantify leakages and losses in the distribution system.
- Recommend repairs or upgrades to minimize wastage of water.

IV. Capacity Upgrades:

- Assess the need for expanding infrastructure to accommodate future demand increases.
- Prioritize infrastructure projects that enhance efficiency and reliability.

V. Future Planning:

- Propose measures to increase the resilience of water supply systems against climate variability.
- Suggest diversification of water sources (e.g., treated wastewater, etc.) to reduce dependency on traditional sources.

1.3) Selection of technology for network design

1.3.1) Use of latest software for Pipe Network and Economic Design of Pumping Mains along with drawings

I. Software Selection and Acquisition

- Define the scope of the water supply scheme, including the size of the network, required hydraulic analysis, and specific design challenges.
- Research software solutions known for pipe network design (e.g., AutoCAD Civil 3D, EPANET, WaterGEMS, Bentley WaterCAD, BIM).
- Prioritize features like hydraulic modelling, pressure analysis, water quality simulation, and 3D visualization.
- Ensure compatibility with existing systems and standards (e.g., GIS integration, CAD formats).
- Evaluate available training resources, user support, and software documentation.
- Acquire the selected software through appropriate procurement channels, ensuring all licenses and updates are included.
- Organize comprehensive training sessions for all relevant personnel (e.g., engineers, draftsmen, project managers) for the software usage.
- Cover essential topics such as basic navigation, advanced design features, and specific functions relevant to water supply schemes.
- Provide access to online tutorials, user forums, and official documentation for self-paced learning.

II. Design Process Using Software

- Use the software to create the preliminary layout of the pipe network, considering topography, population density, and demand points.
- Incorporate existing infrastructure data and proposed new installations.
- Perform hydraulic modelling to ensure the system meets required pressure and flow standards.
- Identify and resolve potential issues like pressure drops, velocity constraints, and pipe sizing.
- Use the software's optimization tools to refine the design, reducing costs and improving efficiency.
- Run multiple simulations to test the design under different scenarios (e.g., peak demand, system failures).

III. Drawing and Documentation

- Use the software to produce detailed, scaled drawings of the pipe network, including plan views, profiles, and cross and longitudinal sections.

- Ensure that all drawings include necessary annotations, legends, and references.
- Compile a comprehensive set of documents including design reports, hydraulic calculations, and material specifications.
- Ensure that all documents are in compliance with local standards and regulatory requirements.

IV. Assessment and Vetting of DPR by the Department/Empanelled Consultant

- Ensure the design aligns with project objectives, technical standards, and codes, while assessing feasibility and suitability for local conditions.
- Evaluate the cost estimates and perform a cost-benefit analysis to ensure financial viability.
- Verify compliance with environmental, safety, and regulatory standards.
- Review the completeness and accuracy of all technical drawings to ensure consistency with the design.
- Provide final approval or suggest necessary modifications for project success.

V. Report Submission:

- Prepare a final report summarizing the design process, including key decisions, assumptions, and results from the hydraulic analysis.
- Submit the report along with the final drawings to relevant authorities for approval.

1.4) Selection of appropriate Technology for treatment of water and Innovation

1.4.1) Optimum Design of WTP with Advanced Treatment Technologies

I. Raw Water Quality Analysis:

- Conduct comprehensive testing of the raw water to identify contaminants and treatment requirements.
- Ensure the design meets all local and national water quality standards and regulations.
- Conduct a full spectrum of water quality tests, including physical, chemical, and biological parameters.
- Monitor and analyze water quality changes across different seasons to anticipate treatment challenges.

II. Selection of Advanced Treatment Technologies (Optional):

- Membrane Filtration (e.g., Reverse Osmosis, Ultrafiltration) for removing dissolved solids, bacteria, and viruses.
- Advanced Oxidation Processes (AOP) for the degradation of organic pollutants and disinfection.
- Activated Carbon Adsorption for the removal of organic compounds, taste, and odor.
- Ion Exchange for hardness removal and demineralization.
- Electrocoagulation for the removal of heavy metals and suspended solids.

III. Optimization Techniques:

- Design energy-efficient processes, such as variable frequency drives for pumps and energy recovery systems.
- Incorporate systems to maximize water recovery and minimize waste.
- Implement automated control systems for real-time monitoring and adjustment of treatment processes.

IV. Assessment and Vetting of DPR by the Department/Empanelled Consultant

- Ensure the design aligns with project objectives, technical standards, and codes, while assessing feasibility and suitability for local conditions.
- Evaluate the cost estimates and perform a cost-benefit analysis to ensure financial viability.
- Verify compliance with environmental, safety, and regulatory standards.
- Review the completeness and accuracy of all technical drawings to ensure consistency with the design.
- Provide final approval or suggest necessary modifications for project success.

1.4.2) Provision of Water Sources Sustainability Measures

I. Sustainable Water Source Management:

- Implement protective measures to prevent contamination of water sources (e.g., buffer zones, pollution control).
- Develop and maintain artificial recharge structures to replenish groundwater sources.
- Promote water conservation measures in the community to reduce pressure on water sources.
- Implement rainwater harvesting systems to supplement water sources during lean periods.

II. Monitoring and Regulation:

- Conduct regular assessments of water source levels, quality, and extraction rates.
- Ensure compliance with water withdrawal permits and regulations to avoid over-extraction.

1.4.3) Assessment of Other Uses of Selected Source:

I. Assessment of Competing Uses:

- Identify all other significant uses of the water source (e.g., agriculture, institutional, industry, recreation), etc.
- Assess how these uses affect the availability and quality of the water for the WTP.

1.4.4) Use of Modern Mechanized/Digital Equipment

i) Remote Monitoring:

- Implement systems to remotely monitor water quality, flow rates, and equipment performance in real-time.

ii) Supervisory Control and Data Acquisition (SCADA):

- Use SCADA systems for centralized control and automation of WTP processes and distribution networks.
- Collect and analyze operational data to optimize performance and predict maintenance needs.

iii) Automated Meter Reading (AMR):

- Deploy AMR (Automatic Meter Reading) technology to improve the accuracy and efficiency of water consumption billing and leak detection

iv) Leak Detection:

- Utilize acoustic sensors and pressure management tools to detect and localize leaks in the distribution system.

v) Geographic Information System (GIS):

- Use GIS for mapping the entire water distribution network, identifying critical assets, and planning maintenance activities.

vi) Smart Pumping Systems:

- Implement smart pumping systems with variable frequency drives and real-time monitoring to optimize energy use and operational efficiency.

vii) Online Water Quality Analyzers:

- Install online water quality analyzers to provide continuous, real-time monitoring of key water quality parameters.

viii) Automated Chlorination:

- Implement automated chlorination systems to ensure accurate and consistent disinfection levels.

ix) Mobile Applications:

- Use mobile apps to facilitate field operations, including real-time data entry, remote monitoring, and maintenance scheduling.

x) Customer Portals:

- Provide customer portals for consumers to access their water usage data, billing information, and service requests online.

xi) Drone Photography:

- Use drones for aerial photography to inspect infrastructure, monitor construction progress, and survey large areas efficiently.

1.5) Cost Analysis, Budget planning and timeline estimates

1.5.1) Financial Implication with Cost Index Up to Implementation Period

I. Initial Cost Estimation:

- Calculate the base cost of the project considering current market rates for materials, labour, and other relevant factors including taxes, etc.

II. Cost Index Application:

- Apply the relevant cost index to project future cost variations due to inflation, material cost escalation, and other economic factors.
- Adjust the financial estimates periodically (e.g., quarterly or annually) up to the end of the implementation period.

III. Contingency Allocation:

- Include a contingency fund to cover unforeseen expenses.

IV. Final Budget Submission:

- Submit the total estimated financial implications, including cost index adjustments, for approval by the relevant authority.

1.5.2) Identification of Funding Agency with Annual Budget Allocation

- Identify potential funding agencies (e.g., government bodies, international organizations, NGOs) that align with the project's goals.
- Prepare and submit a detailed funding proposal outlining the project scope, financial requirements, and implementation timeline.

- Engage with identified agencies to negotiate terms and secure commitments. Establish communication channels for ongoing updates and compliance with agency requirements.
- Coordinate with the funding agency to ensure timely release of funds as per the approved annual budget. Monitor and report on fund utilization regularly.

1.5.3) Period for DPR Approval, Call of Tenders, Award of Work & Implementation

I. DPR Approval:

- Develop the Detailed Project Report (DPR) within specified period
- Submit the DPR to the appropriate authority and obtain approval within specified period.

II. Call of Tenders:

- Draft and finalize tender documents within specified period after DPR approval.
- Advertise the tender and allow a bidding period of specified period.

III. Award of Work:

- Evaluate received bids and finalize the contractor within specified period after the bidding period.
- Award the contract and complete necessary formalities within specified period.

IV. Implementation:

- Initiate the project immediately after the award of work.
- Complete the project implementation within [specified period, e.g., 12-24 months] as per the project plan.
- Regularly monitor the progress and submit progress reports as per the agreed schedule.

1.6) Framing specification

1.6.1) Identification of Suitable Materials Proposed to Be Used

I. Assessment of Project Requirements:

- Assess the specific technical requirements of the project, including pressure ratings, durability, and compatibility with existing infrastructure.
- Consider the environmental impact of materials, such as their sustainability, recyclability, and potential for contamination of water.
- Evaluate the cost-effectiveness of different materials, including initial costs, maintenance, and lifespan.

II. Material Selection:

- Identify suitable materials for pipes and fittings, such as ductile iron, PVC, HDPE, or steel, based on the project's pressure, flow rate, and environmental conditions.
- Choose materials for valves (e.g., cast iron, bronze, stainless steel) that can withstand operational pressures and corrosive environments.
- Select appropriate materials for storage tanks, considering factors such as size, water quality, and climatic conditions. Common materials include concrete, steel, or fiberglass.
- Identify protective coatings and linings to prevent corrosion, scaling, and contamination of water. Options include epoxy coatings, bituminous linings, or cement mortar linings.

III. Supplier Evaluation:

- Ensure that materials are sourced from suppliers who comply with recognized quality standards (e.g., ISO, ASTM, BIS).
- Verify that materials are certified for potable water use and meet the relevant health and safety regulations.

- Evaluate the reliability and reputation of suppliers, including their track record in delivering quality materials on time.

1.6.2) Framing Specifications for Above Materials

I. Technical Specifications:

i. Pipes and Fittings:

- Specify the nominal diameters, wall thickness, and length of pipes.
- Define the material grade and standards that pipes and fittings must adhere to.
- Indicate the pressure class or rating required for different sections of the water supply network.
- Specify the jointing methods (e.g., welded, flanged, push-fit) suitable for the selected materials.

ii. Valves:

- Specify the type (e.g., gate valve, butterfly valve and size of valves required.
- Define the pressure and temperature ratings that valves must withstand.
- Detail the material composition (e.g., body, seat, disc) and applicable standards.

iii. Storage Tanks:

- Specify the capacity and dimensions of storage tanks.
- Define the material type, thickness, and structural integrity standards.
- Specify the type of protective coating or lining and the method of application.

iv. Pumping Machines:

- Specify the pressure and discharge required for pump.
- Specify the rating of motor required in kw/HP.
- Define the material composition.
- Pumping machinery shall be designed as per the provisions of the relevant IS Codes.

II. Quality Assurance:

- Outline the testing protocols (e.g., hydrostatic tests, leak tests, material tests) for each material to ensure compliance with the specifications.
- Define the inspection criteria and procedures for material acceptance, including dimensional checks, surface finish, and mechanical properties.
- Require suppliers to provide relevant certifications, test reports, and compliance documents for all materials delivered.

III. Compliance with Standards:

- Ensure all specifications comply with relevant national and international standards.
- Incorporate any regulatory or statutory requirements related to water quality, safety, and environmental impact into the specifications.

IV. Specification Review and Approval:

- Involve key stakeholders (e.g., engineers, procurement teams, regulatory bodies) in reviewing the specifications to ensure they meet the project's needs.
- Obtain final approval of the material specifications from the project management team or relevant authority before procurement.

1.7) Long term Planning

1.7.1) Future requirement projections

I. Vacant Space Allocation for Expansion:

- Conduct a survey to identify and allocate vacant land near the Water Treatment Plant (WTP) and storage tanks for future expansion.
- Collaborate with local authorities to ensure that the designated expansion areas are protected from incompatible development.
- Reserve adequate space within the project site for the installation of additional units, such as treatment modules, pumps, and pipelines, to meet future demand.

II. Modular Design Approach:

i. Modular WTP Design:

- Design the WTP with modular components that can be easily expanded or upgraded as demand increases.
- Plan for phased construction and installation of treatment units, allowing for incremental expansion in line with demand growth.
- Standardize components to facilitate easy integration of new modules without disrupting existing operations.

ii. Storage Tank Design:

- Design storage tanks with provisions for increasing capacity, such as additional chambers or elevated tanks.
- Ensure that tank design allows for modular expansion, either vertically or horizontally, as demand grows.
- Allocate sufficient space around storage tanks for the installation of additional tanks or expansion of existing ones.

1.7.2) Future development of the area such as industrial growth, education hub etc.

I. Assessment of Future Developments:

- Engage with urban planning and development authorities to gather information on planned developments in the area, such as industrial parks, educational hubs, residential complexes, or commercial zones.
- Analyse projected developments to understand the potential impact on water demand, including the type and scale of industries, expected population growth in educational hubs, and commercial activities.

II. Infrastructure Planning:

- Design the water supply infrastructure with enough capacity to meet the anticipated increase in demand due to future developments.
- Consider factors such as water quality requirements, peak demand periods, and specific needs of different sectors (e.g., high-quality water for industrial processes).
- Plan the pipeline network to cover future development zones, ensuring that the distribution system can be easily extended to new areas without major overhauls.
- Design dedicated pipelines or storage systems for industrial areas with specific requirements, such as higher volumes or specific water quality standards.

III. Environmental and Regulatory Considerations:

- Conduct an EIA to evaluate the potential environmental impact of future developments on the water supply scheme and vice versa. Ensure compliance with environmental regulations.
- Ensure that the design and implementation of the water supply scheme comply with all relevant regulations, including those related to land use, water rights, and public health.

IV. Monitoring and Adaptation:

- Establish a monitoring system to track actual development progress and compare it with projections. Adjust the water supply infrastructure plans accordingly.
- Develop an adaptive management plan to address unforeseen changes in development patterns or water demand.
- This may include modifying or expanding infrastructure, implementing water-saving technologies, or revising supply strategies.

1.7.3) Horticulture Planning for aesthetics of pump-house, storage, and WTP

I. Horticulture planning in pump houses, storage and water treatment plant (WTP) sites is essential with following benefits:

- Maintaining environmental sustainability,
- Reduce dust
- Improve the overall aesthetic and functional value of the facility.
- Erosion control,
- Noise reduction, and
- Temperature regulation.

II. Site Assessment & Planning:

- Identify open areas, buffer zones, and periphery for plantation without obstructing infrastructure.
- Assess soil fertility, drainage, and water availability to support healthy plant growth.
- Ensure safety by avoiding deep-rooted trees near pipelines and structures.
- Select pollutant-absorbing plants to improve air quality and control odours.

III. Selection of Suitable Plants:

- Recommended Plants: Bermuda Grass, Carpet Grass (soil erosion control), Creeping Fig (wall cover), Bougainvillea (natural fence), Hibiscus & Lantana (aesthetic appeal), Lavender & Rosemary (odour reduction), Ficus, Duranta & Clerodendrum (hedges), Bamboo (dust & noise reduction), Neem, Ashoka & Areca Palm (air purification), Aloe Vera, Snake Plant & Spider Plant (indoor air quality), Gulmohar, Cassia & Amaltas (shade trees).
- Plants to Avoid: Banyan & Peepal (aggressive roots), Fruit-bearing trees (hygiene issues), Water-hungry plants (high maintenance).

IV. Protection and Maintenance:

- Tree Guards: Protect young saplings from damage.
- Regular Pruning: Prevents overgrowth near infrastructure.
- Pest & Weed Control: Organic methods to maintain plant health.

V. Environmental and Safety Considerations:

- Maintain safe distance from pipelines/tanks to avoid damage.
- Use fire-resistant plants near electrical zones.

- Prefer native plants for sustainability.
- Restrict plantation near treatment units to maintain hygiene.

VI. Horticulture Planning in Water Supply Projects

- Root Damage Risk: Avoid deep-rooted trees near pipelines.
- High Maintenance & Water Use: Prioritize drought-resistant plants, drip irrigation, and rainwater harvesting.
- Pest Infestation & Wildlife Attraction: Avoid fruit-bearing plants and prevent water stagnation.
- Fire & Safety Hazards: Regular pruning, clearing dry leaves, and maintaining accessibility.
- Space Constraints: Use vertical gardens and designated green zones.
- Hygiene Concerns: Manage organic debris to prevent clogging and contamination

1.8) Reducing O&M cost

1.8.1) Provision of Solar Energy

I. Feasibility Study & System Design:

- Evaluate the site's solar potential using solar radiation data and site-specific conditions.
- Calculate the energy requirements of the water supply scheme, including treatment plants, pumping stations, and other facilities.
- Choose appropriate solar panels and inverters based on energy needs, available space, and budget.
- Develop a layout plan for solar panel installation, ensuring optimal exposure to sunlight and minimal shading.
- Plan how the solar energy system will integrate with existing energy systems, including grid connections or backup power options.

II. Installation and Testing:

- Procure solar panels, inverters, and other necessary equipment. Oversee installation by certified professionals.
- Conduct performance tests to ensure the solar system meets the design specifications and energy requirements.

III. Monitoring and Maintenance:

- Implement a monitoring system to track the performance of the solar energy system, including energy generation and system efficiency.
- Develop a regular maintenance schedule to inspect and clean solar panels, check system components, and address any issues.

1.8.2) Provision of Energy-Efficient Machinery (BEE 2 Star Certified/Star Rated)

I. Energy Efficiency Requirements:

- Identify machinery required for the water supply scheme (e.g., pumps, motors) and their energy efficiency requirements.
- Ensure that selected machinery meets or exceeds BEE certification or equivalent star ratings.

II. Procurement Process:

- Source machinery from suppliers who provide energy-efficient products with verified certification.

- Assess the technical specifications and energy efficiency ratings of machinery to ensure they meet project requirements.

III. Installation and Testing:

- Oversee the installation of energy-efficient machinery according to manufacturer guidelines.
- Test the machinery to confirm that it operates efficiently and meets performance standards.

IV. Ongoing Monitoring:

- Monitor the energy consumption of the machinery to ensure it aligns with efficiency expectations.
- Implement a maintenance program to keep machinery operating at peak efficiency.

1.8.3) Provision of Automation

I. Needs Assessment:

- Identify areas where automation can improve efficiency, such as pumping stations, treatment processes, and monitoring systems.
- Determine how automation systems will integrate with existing infrastructure and control systems.

II. System Design and Selection:

- Select appropriate automation technologies, such as SCADA systems, sensors, and control panels.
- Develop a design plan for automation, including system layout, integration points, and user interfaces.

III. Implementation:

- Oversee the installation of automation equipment and systems, ensuring compliance with design specifications.
- Configure automation systems for optimal performance, including programming control algorithms and setting up communication networks.

IV. Testing and Training:

- Test automation systems to ensure they function correctly and meet operational requirements.
- Train staff on the use of automation systems, including monitoring, troubleshooting, and maintenance procedures.

V. Maintenance and Upgrades:

- Conduct regular maintenance and updates to ensure automation systems remain effective and secure.
- Plan for future upgrades and enhancements to keep pace with technological advancements.

1.8.4) Life Cycle Cost Analysis of Pumping Machinery

I. Initial Cost Assessment:

- Calculate the initial purchase cost of the pumping machinery, including procurement, transportation, and installation.

II. Operating Costs:

- Estimate the cost of energy required to operate the pumps, based on their efficiency and expected usage.

- Include costs for labor, routine operations, and any additional resources needed for pump operation.

III. Maintenance Costs:

- Estimate the cost of routine maintenance, including parts replacement, lubrication, and inspections.
- Factor in potential repair costs for unforeseen breakdowns or malfunctions.

IV. Replacement Costs:

- Calculate the depreciation of the machinery over its expected life span.
- Include costs for eventual replacement or major refurbishment of the machinery.

V. Cost Analysis:

- Compile the total life cycle cost, including initial purchase, operating, maintenance, and replacement costs.
- Compare the life cycle cost of different pumping machinery options to determine the most cost-effective solution.

1.9 Tube Well Design

1.9.1 Site Selection and tubewell design

I. Hydrogeological Survey:

- Conduct a comprehensive hydrogeological survey to assess the site's groundwater potential.
- Identify groundwater availability, depth to the water table, recharge rates, and expected water quality.
- Determine the aquifer's capacity to meet the project's water demand.

II. Aquifer Selection:

- Based on survey results, choose the appropriate aquifer to tap for water extraction.
- The selection depends on factors like the depth of the water table, permeability of the aquifer, and the sustainable yield of the well.
- Calculate the required well depth, diameter, and yield to match the demand for water.
- Design should ensure a balance between extraction and aquifer recharge to avoid over-exploitation.

III. Well Design:

- Design the tube well structure with appropriate specifications, including the diameter, casing, and screen length.
- The diameter should be designed to accommodate the required flow rate and pumping capacity.
- The well screen should be placed in the aquifer zone to allow maximum water inflow while preventing sand or silt from entering the well.
- Consider the static water level, expected drawdown, and pump placement in the well design.

2) EXECUTION, INSPECTION AND TESTING

2.1) Use of all construction materials

2.1.1) Materials such as aggregates, sand etc. from an approved source

I. Material Sourcing

- Obtain materials such as aggregates, sand, and others from sources that have been approved according to project specifications.
- Verify that the sources meet quality standards and have been pre-approved by the relevant authorities or project managers.

II. Quality Assurance

- Conduct regular checks to ensure that materials from approved sources meet the required quality and specifications.
- Maintain records of material source approvals and quality test results.

2.1.2) Use of Design Mix and Weigh Mix

I. Design Mix Preparation

- Prepare concrete or other mixes according to the design mix specified in the project plans.
- Ensure that the mix proportions are accurate and meet the required specifications for strength and durability.

II. Weigh Mix Implementation

- Use weigh batching equipment to measure and mix materials accurately as per the design mix.
- Verify that the weigh mix process is conducted consistently to ensure uniformity and quality.

III. Quality Control

- Regularly test mixed materials for consistency and compliance with design specifications.
- Concreting for Reinforced work should be done in the presence of Junior Engineer/person authorised by Junior Engineer

2.1.3) Procurement of Pipes from Approved Make and Manufacturer

I. Pipe Sourcing

- Procure pipes from manufacturers and brands that are approved according to project specifications and standards.
- Verify the approval status of the make and manufacturer before placing orders.

II. Quality Verification

- Ensure that procured pipes meet the required quality standards and specifications.
- Review documentation such as certificates of compliance and test reports provided by the manufacturer.

III. Record Keeping

- Maintain detailed records of procurement, including manufacturer details, pipe specifications, and delivery information.
- Track and document any issues related to pipe quality or compliance.

2.1.4) Carrying Out Tests at Manufacturer's Premises Before Dispatch

I. Testing Requirements

- Arrange for necessary tests to be conducted at the manufacturer's premises before dispatch, as per project requirements.
- Ensure that tests cover all critical parameters including strength, durability, and compliance with specifications.

II. Test Oversight

- Coordinate with the manufacturer to schedule and oversee testing procedures.
- Review and verify test results to confirm that the products meet the required standards.

III. Documentation and Acceptance

- Obtain and review test reports and certificates from the manufacturer.
- Ensure that only products meeting the required standards are accepted for dispatch.

2.2) Pumping system efficiency enhancement

2.2.1) Use High Efficiency Pumps & Motors Specifically Designed for Site Requirements

I. Selection of Pumps and Motors

- Choose high efficiency pumps and motors that are specifically designed to meet the requirements of the site.
- Ensure that selected equipment meets or exceeds energy efficiency standards and is suitable for the operational demands of the water supply scheme.

II. Installation and Configuration

- Install pumps and motors according to manufacturer specifications and site requirements.
- Configure the equipment to optimize performance based on the specific operational parameters of the site.

III. Maintenance and Performance Monitoring

- Implement a regular maintenance schedule to ensure the continued efficiency of pumps and motors.
- Monitor performance metrics to ensure equipment operates at peak efficiency and address any issues promptly.

2.2.2) Use of Designed Size of Rising Main/Suction Pipe to Minimize Frictional Losses

I. Design and Sizing

- Use pipes of the designed size for rising mains and suction lines as specified in the system design documents.
- Ensure that pipe sizes are calculated to minimize frictional losses and meet the hydraulic requirements of the system.

II. Installation

- Install pipes according to design specifications to prevent any deviation from the intended size and routing.
- Ensure proper alignment and secure fittings to minimize frictional losses and ensure efficient flow.

2.2.3) Provision of Positive Suction Head

I. Design Considerations

- Ensure that the system design includes adequate positive suction head to prevent cavitation and maintain efficient pump operation.
- Calculate the required positive suction head based on the site-specific conditions and operational requirements.

II. Implementation

- Verify that the installation of pumps and associated piping provides the necessary positive suction head.
- Adjust system components or configurations as needed to achieve and maintain the required suction head.

III. Monitoring and Adjustment

- Continuously monitor suction conditions to ensure the positive suction head is maintained.
- Make adjustments to the system as needed to address any changes in suction conditions or operational requirements.

2.3) Supervision by skilled manpower/TPIA

2.3.1) Deployment of Appropriately Qualified Personnel

I. Personnel Selection

- Identify and select personnel with the required qualifications, certifications, and experience for their respective roles in the water supply scheme by department aswell as the contractor.
- Ensure that selected individuals meet the specific qualifications outlined in the project requirements and job descriptions by the contractor.
- Provide necessary training and orientation(if required) to ensure personnel are familiar with project requirements, safety procedures, and operational protocols.

2.3.2) Manpower Deployment as Per Requirement

- Assess project requirements to determine the appropriate number and type of personnel needed at different stages of the water supply scheme.
- Develop a manpower plan that aligns with project timelines and operational needs.
- Ensure deployment of personnel according to the manpower plan, ensuring that staffing levels match the project requirements at all times.
- Continuously monitor manpower deployment to ensure efficiency and effectiveness.
- Make adjustments to personnel assignments as necessary to optimize performance and address any issues.

2.4) Use of modern facilities for construction and treatment

2.4.1) Advance Water Treatment (Optional)

I. Arsenic, Iron, and Fluoride Removal

- Use reverse osmosis (RO) or nanofiltration (NF) membranes to remove dissolved contaminants. Regularly check membrane performance and replace membranes as needed based on manufacturer recommendations and performance data.

- Utilize activated alumina or other adsorbents to target specific contaminants to monitor the saturation levels of adsorbents and regenerate or replace them as necessary.
- Apply ion exchange methods for specific ions like fluoride.
- Regularly monitor and regenerate ion exchange resins according to the manufacturer's guidelines.

II. UV Disinfection

- Ensure UV systems are properly sized for the flow rate and contamination levels. Regularly inspect and clean UV lamps and quartz sleeves.
- Continuously monitor UV dose and intensity. Conduct periodic tests to verify the efficacy of disinfection.

2.4.2) Automated Operation of Pumps/WTP

- Use advanced control software to manage pump operations, water treatment processes, and alarms to ensure that the software is regularly updated and maintained.
- Integrate sensors for real-time monitoring of parameters such as flow, pressure, and water quality.
- Use data from these sensors to automate adjustments and optimize system performance.
- Regularly maintain and calibrate automated systems to ensure accurate operation.
- Perform routine checks and updates to address any software or hardware issues.

2.4.3) Smart Metering and Leakage Detection

I. Smart Metering

- Install smart meters at consumer endpoints and key points in the distribution network. Ensure proper calibration and data connectivity.
- Use metering data to monitor water use, generate consumption reports, and identify potential issues.

II. Leakage Detection (Optional)

- Continuously monitor network pressure and flow rates to detect irregularities that may indicate leaks.
- Develop and execute a protocol for rapid response to detected leaks, including repair procedures and system adjustments.

2.4.4) GIS Mapping of Sources, Network, and All Other Infrastructures

I. GIS Data Collection

- Collect spatial data using GPS and other mapping technologies to ensure that data is accurate and up-to-date.
- Integrate GIS data with other operational systems to provide a comprehensive view of the water supply network.

II. Data Management

- Regularly update GIS maps to reflect changes in the infrastructure, such as new installations or modifications.
- Ensure that GIS data is accessible to relevant stakeholders and that it supports operational and strategic planning.

2.5) Conformity to relevant standards

2.5.1) Work Executed as Per Approved Bid Document

I. Compliance with Bid Specifications

- Ensure all work is carried out according to the specifications and requirements outlined in the approved bid document.
- Verify that materials, methods, and workmanship meet the standards detailed in the bid document.

II. Quality Control and Inspections

- Conduct periodic inspections to ensure work complies with bid document specifications.
- Address any discrepancies or deviations promptly and make necessary corrections to align with the approved document.
- Document all inspections, findings, and corrective actions taken.
- Maintain accurate records of changes or variations from the bid document.
- Prepare and submit regular progress reports detailing adherence to the bid document and any issues encountered.

III. Execution of Horticulture Development:

- Follow proper guidelines for horticulture planning as outlined in the bid document/estimate, keeping in mind the aesthetic appeal, safety, plantation techniques, and maintenance and upkeep.

2.6) Marking good the dismantled services

2.6.1) Dismantled roads and streets are repaired properly and dismantled material disposal.

- Ensure that all dismantled roads and streets are repaired promptly and to the existing standards.
- Use appropriate materials and techniques for road and street repair, ensuring a smooth and durable finish.
- Conduct a final inspection of repaired areas to confirm that repairs meet quality and existing standards.
- Follow environmental regulations and guidelines for the disposal of dismantled materials.
- Sort and separate materials for recycling or proper disposal as required.
- Restore the site to its original condition or as specified in the project plan, including clearing debris and ensuring proper site grading.
- Document the completion of site restoration and obtain necessary approvals or sign-offs as required.

2.7) Pre & Post Inspections of all materials

2.7.1) Physical Inspection of Pipes at Site Before Laying

I. Inspection Procedures

- Conduct a thorough visual inspection of pipes at the site before installation to heck for any visible defects, damage, or inconsistencies with project specifications.
- Verify that pipes are clean, free of debris, and properly stored to prevent damage before laying.

- Check that the pipes have been sourced from approved manufacturers and match the project requirements.

III. Documentation

- Record inspection results and any issues identified during the inspection.
- Document actions taken to address any defects or discrepancies, and maintain records for future reference.

2.7.2) Ensure Required Frequency of Tests During Implementation

I. Testing Schedule & Execution

- Develop and implement a testing schedule that aligns with project requirements and regulatory standards to ensure that testing is conducted at the required intervals throughout the implementation phase.
- Conduct tests according to the defined schedule and ensure adherence to approved methods and procedures.
- Ensure that testing personnel are qualified and follow standard testing protocols.

II. Reporting and Compliance

- Document test results and compare them with the required standards.
- Address any deviations or non-compliance issues promptly and take corrective actions as necessary.

2.7.3) Water Sample Testing After Treatment

I. Sample Collection & Testing

- Collect water samples after treatment/tubewell. Use clean, sterilized containers and follow standard procedures for sample collection.
- Ensure the sample is properly handled to prevent contamination.
- Perform water quality tests to assess parameters such as chemical composition, microbial contamination, and physical properties.
- Use accredited laboratories or approved methods for accurate and reliable testing results.

II. Results and Actions

- Analyse test results and compare them with regulatory standards for potable water quality.
- Take corrective actions if test results indicate non-compliance with quality standards and retest as needed.

2.7.4) Non-Destructive Testing of Concrete Structures (Where Applicable)

- Apply non-destructive testing (NDT) methods such as ultrasonic testing, radiographic testing, or impact echo testing to assess the integrity of concrete structures.
- Select appropriate NDT methods based on the type of concrete structure and the specific aspects to be evaluated.
- Conduct NDT following established protocols and standards. Ensure that testing equipment is calibrated and maintained in good condition.
- Record test data and observations accurately.
- Evaluate NDT results to determine the condition of the concrete structures and identify any defects or issues.
- Prepare and submit detailed reports on the findings, including recommendations for repairs or further investigation if necessary.

2.8) Setting up of testing laboratory

2.8.1) Setting Up Water Testing Laboratories at Site of WTP

I. Laboratory Design and Setup

- Design the laboratory layout to accommodate essential equipment, sample preparation areas, and testing stations. Ensure the space is compliant with safety and operational standards.
- Equip the laboratory with necessary testing instruments, glassware, and chemicals required for water quality analysis.

II. Installation and Calibration

- Install testing equipment according to manufacturer guidelines and operational requirements. Ensure proper calibration of instruments to maintain accuracy in testing.
- Implement a maintenance schedule for regular calibration and servicing of laboratory equipment.

III. Staff Training and Operations

- Train laboratory personnel in Standard Operating Methods and Procedures, safety protocols, and testing methodologies.
- Establish and document operational procedures for sample handling, testing, and reporting.

2.8.2) Setting Up Water Testing Laboratories at District and State Level

I. Laboratory Planning and Infrastructure

- Plan and develop laboratory facilities at district and state levels, including necessary infrastructure, equipment, and support systems.
- Ensure that laboratories are equipped to handle a range of water quality tests and are compliant with relevant regulations.

II. Equipment and Facility Setup

- Procure and install advanced testing equipment and analytical instruments based on the scope of testing required at district and state levels.
- Set up appropriate facilities for sample storage, preparation, and disposal.

III. Operational Procedures and Staffing

- Develop Standard Operating Methods and Procedures for laboratory operations, including sample collection, testing, data management, and reporting.
- Recruit and train qualified staff to operate and manage the laboratories effectively.

2.8.3) Ensuring NABL Accreditation of Water Testing Laboratories at District/State Level

I. Accreditation Preparation

- Review the National Accreditation Board for Testing and Calibration Laboratories (NABL) guidelines and ensure that laboratories meet all accreditation requirements.
- Implement necessary quality management systems, including documentation, Standard Operating Methods and Procedures, and record-keeping practices.

II. Application and Assessment

- Prepare and submit the application for NABL accreditation, including all required documentation and evidence of compliance with NABL standards.
- Coordinate with NABL assessors during the assessment process and address any findings or recommendations from the assessment.

III. Continuous Improvement and Compliance

- Monitor and maintain NABL accreditation standards through regular internal audits, staff training, and process improvements.
- Ensure ongoing compliance with NABL requirements and address any issues that arise to maintain accreditation status.

2.9) Functionality & testing of pipes, discharge measurement of Pumps

2.9.1) Flow Testing in Pipes After Laying at Site

I. Pre-Test Preparations

- Inspect the laid pipes for any visible defects or damage before commencing flow testing to ensure that all joints and connections are properly sealed.
- Confirm that all necessary equipment for flow testing, including flow meters and pressure gauges, is calibrated and ready for use.

II. Flow Testing Procedure

- Conduct flow tests by introducing water into the system and measuring flow rates and pressures at various points to ensure that the testing is performed according to the project specifications and relevant standards.
- Record the flow rates, pressures, and any anomalies observed during testing.

III. Analysis and Documentation

- Analyze the test results to ensure that the pipe system is operating as expected and meets design requirements.
- Document the test results, including any issues or deviations, and take corrective actions as necessary. Maintain records for future reference and compliance.

2.9.2) Testing of Pumping Machinery to Meet Required Discharge

I. Pumping Machinery Setup

- Ensure that pumping machinery is installed and aligned according to manufacturer specifications and system requirements.
- Verify that all connections, including inlet and outlet pipes, are properly secured and that the system is free of leaks.

II. Discharge Testing Procedure

- Operate the pumping machinery and measure the discharge rates at the Overhead Service Reservoir (OHSR) using appropriate instruments.
- Compare the measured discharge rates with the required specifications to ensure that the machinery is performing as expected.

III. Performance Evaluation and Documentation

- Evaluate the performance of the pumping machinery based on the discharge test results. Address any discrepancies or performance issues by adjusting or servicing the equipment.
- Document the test results, including discharge rates and any corrective actions taken. Maintain records for performance tracking and future reference.

2.9.3) Availability of Electric/Solar Energy as Per Requirements

I. Energy Source Assessment

- Assess the energy requirements of the water supply system and ensure that the available electric and solar energy sources meet these requirements.
- Verify the capacity and reliability of the energy sources to ensure continuous and adequate power supply.

II. System Integration

- Integrate electric and solar energy systems with the water supply infrastructure to ensure that energy systems are properly configured to support the operation of pumps, treatment facilities, and other components.
- Implement backup energy solutions, such as generators, if necessary, to ensure uninterrupted operation during power outages.

III. Monitoring and Maintenance

- Continuously monitor the performance of electric and solar energy systems to ensure they are operating efficiently and meeting energy needs.
- Perform regular maintenance and inspections of energy systems to prevent and address any issues.
- Document maintenance activities and monitor energy usage to ensure compliance with requirements.

2.10) Documentation and Reporting

2.10.1) Preparation of Site Inspection and Quality Control Registers

- Create site inspection and quality control registers to document inspection activities, quality control measures, and test results to ensure that registers are formatted to capture all relevant information, including dates, inspection details, and personnel involved.
- Record details of site inspections, including observations, issues identified, and actions taken.
- Document quality control measures and tests conducted, including test types, results, and any deviations from standards.
- Maintain these records in an organized and accessible manner for future reference.

2.10.2) Checking of Test Results by Engineer in Charge

I. Test Results Review & Verification

- Review test results to ensure these meet the required standards and project specifications.
- Cross-check test results with project requirements and quality control standards.
- Address any discrepancies or issues identified during the review process.

II. Approval and Documentation

- Approve test results that meet the required standards and document the review process to ensure that any corrective actions or follow-up requirements are noted and communicated to the appropriate teams.

2.10.3) Rectification of Defects

I. Defect Identification

- Identify and document defects or non-compliance issues discovered during inspections and testing. Classify defects based on their severity and impact on the project.

II. Rectification Plan

- Develop a plan to address and rectify identified defects. Include detailed steps for correction, responsible personnel, and a timeline for completion.

III. Implementation and Verification

- Implement corrective actions as per the rectification plan. Conduct follow-up inspections and tests to ensure that defects have been properly addressed and that corrections meet project standards.

2.10.4) Submission of Reports and Keeping the Record

- Prepare comprehensive reports on-site inspections, quality control activities, test results, and defect rectification. Include relevant data, observations, and corrective actions taken.
- Submit reports to the relevant stakeholders, including project managers, quality control teams, and regulatory authorities to ensure reports are submitted in a timely manner and include all required information.
- Maintain detailed records of all inspections, test results, defect rectification activities, and reports to ensure that records are organized, secure, and easily accessible for future reference and compliance audits.

2.11) Tubewell Drilling and Development

2.11.1) Drilling Process

I. Preparation of Drilling Site:

- Clear the site and ensure all necessary permits and permissions are in place.
- Mobilize the required drilling equipment, including drilling rigs, pumps, pipes, and casings.
- Arrange for drilling fluids, safety equipment, and provisions for managing drill cuttings and water waste.

II. Drilling Method:

- Select the most suitable drilling technique based on site conditions such as Rotary and Percussion Drilling.
- Ensure that drilling is done in a controlled manner to minimize disturbance to surrounding soil and prevent well collapse.

III. Casing Installation:

- Once drilling reaches the target depth, install a casing pipe of suitable material as per design to protect the borehole and prevent contamination.
- Ensure that the casing is sealed at the bottom and grouted to prevent contamination from surface water or materials entering the borehole.

IV. Screen Installation:

- Install a well screen, usually made of stainless steel or PVC, at the aquifer zone to allow water to flow in while filtering out sand and fine particles.
- Ensure the screen has an appropriate slot size for the specific soil and aquifer conditions.

2.11.2 Development of the Tube Well

I. Well Development:

- After the well is drilled and the casing and screen are installed, develop the well by techniques such as Surging, Airlifting, and Pumping to remove fine particles from the surrounding formation.

II. Pumping and Water Quality Testing:

- Conduct test pumping to assess the well's performance.
- Monitor water recovery rate after test pumping to ensure the aquifer recharges adequately.
- Collect water samples during test pumping to assess the quality.

2.11.3 Completion and Maintenance

I. Sealing of Borehole and Disinfection:

- Properly seal the top of the borehole to prevent contamination from surface runoff, insects, or debris entering the well.
- Install a sanitary seal to protect the well from pollutants and contaminants that could seep into the groundwater.
- Before commissioning the well, disinfect it to eliminate any bacteria or pathogens introduced during the drilling and development processes.

II. Installation of Pump:

- Select a suitable pump based on the well depth, yield, and water demand.
- Install a submersible pump for deeper wells or a hand pump for shallow, community-level installations.
- Ensure the pump's capacity matches the well's sustainable yield to avoid over-pumping, which could cause the aquifer to dry out.

3) COMMISSIONING AND HANDOVER

3.1) Testing the functionality

3.1.1) 100% Household (HH) Water Connections

- Install 100% HH water connections using approved materials and methods, ensuring proper pressure and flow at each household.
- Conduct a quality check after installation to ensure that connections are secure, leak-free, and fully operational.
- Maintain accurate records of all households connected, including location, connection date, and AADHAR card of the head of the house.
- Regularly report on progress towards achieving 100% HH water connections to relevant authorities.

3.1.2) System Flushing and Disinfection

I. Flushing Schedule:

- Establish a routine flushing schedule, typically quarterly or semi-annually, to remove sediment and biofilms from the system.
- Perform flushing immediately before commissioning or when water quality issues are detected.

II. Disinfection Procedure:

- Use chlorine or other approved disinfectants to disinfect pipelines and storage tanks after flushing.
- Ensure adequate contact time for the disinfectant to effectively neutralize pathogens.

III. Monitoring and Documentation:

- Test the water quality after flushing and disinfection to ensure it meets safety standards.
- Document all flushing and disinfection activities, including dates, locations, and water quality results.

3.1.3) Specified Quantity, Quality, and Regularity of Water

- Ensure the specified quality and quantity at each household regularly.
- Regularly assess water demand and adjust supply to ensure consistent delivery of the specified quantity to all households.

I. Quality Assurance:

- Conduct regular water quality tests at various points in the distribution system to ensure compliance with national standards.
- Implement measures to prevent contamination, such as regular maintenance of pipelines and storage tanks.

II. Supply Regularity:

- Maintain a reliable water supply schedule, with minimal interruptions.
- Develop contingency plans to address supply disruptions promptly, ensuring minimal impact on households.

3.2) Testing of System and Functionality of WTP

3.2.1) Cleaning and Disinfection of Water Treatment Plant

- Establish a regular cleaning schedule for all WTP components, including filters, tanks, and pumps.
- Use appropriate cleaning agents and methods for different parts of the WTP, ensuring no residue remains that could contaminate the water.

- Use chlorine or other approved disinfectants to disinfect the WTP after cleaning.
- Follow safety guidelines to protect workers and prevent contamination during the disinfection process.
- Inspect the WTP components after cleaning and disinfection to ensure they are functioning correctly.
- Test the treated water for quality before resuming distribution.

3.2.2) Specified Quality and Quantity of Potable Water from WTP

I. Quality Control:

- Adjust treatment processes as needed to maintain water quality, including coagulation, filtration, and disinfection
- Ensure it meets drinking water standards, including parameters such as turbidity, pH, and contaminant levels.

II. Quantity Control:

- Use flow meters and other monitoring tools to ensure the WTP produces the required quantity of water.
- Align water production with demand forecasts, ensuring that peak demand periods are adequately met.

III. Documentation and Compliance:

- Maintain detailed records of water quality tests, production volumes, and any adjustments made to the treatment process.
- Ensure that all water quality and quantity standards comply with national regulations and industry best practices.

3.2.3) Proper Operation of SCADA and Online Analyser

- Ensure that the SCADA system is properly configured to monitor key parameters such as flow rates, pressure, and water quality.
- Continuously monitor data from the SCADA system to detect any anomalies or inefficiencies in real-time.
- Regularly calibrate and maintain online analyzers to ensure accurate readings of water quality parameters.
- Integrate online analyzer data with the SCADA system for real-time monitoring and control of the treatment process.
- Keep SCADA software and online analyzers updated with the latest versions to enhance functionality and security.
- Provide ongoing training for operators on how to use SCADA systems and online analyzers effectively.

3.3) Submission of Assets management Plan and completion certificate

3.3.1) Submission of Assets Completion Plan and Completion Report by Agency and Certificate by Department

I. Assets Completion Plan:

- Prepare a detailed inventory of all assets created or upgraded as part of the water supply scheme.
- Submit the Assets Completion Plan to the relevant department, outlining the status of each asset, any outstanding work, and final costs.

II. Completion Report:

- The executing agency prepares a comprehensive Completion Report, detailing the project scope, timelines, outcomes, and any challenges encountered.
- Arrange for final inspections by relevant authorities to verify that the project has been completed according to the specifications.
- Submit the Completion Report along with any required supporting documentation to the department for review.

III. Certification:

- The department reviews the Completion Report, conducts any necessary site inspections, and verifies that all project requirements have been met.
- Upon satisfactory review, the department issues a formal Completion Certificate, signifying the official closure of the project.

3.3.2) Preparation of Manual on Operating Procedure for WTP

I. Content Development:

- Compile all relevant operating procedure related to the WTP, including those for water treatment processes, equipment operation, maintenance, safety protocols, and emergency response.
- Incorporate industry best practices, regulatory guidelines, and lessons learned during the project into the manual.

II. Manual Structuring:

- Organize the manual into clear, logical sections, each covering specific aspects of WTP operations (e.g., daily operations, periodic maintenance, troubleshooting).
- Ensure that the manual is written in clear, concise language, with diagrams, flowcharts, and checklists to aid understanding.

III. Review and Approval:

- Circulate the draft manual to key stakeholders, including WTP operators, engineers, and management, for review and feedback.
- Revise the manual based on feedback and obtain final approval from the relevant authority or department.

IV. Distribution and Training:

- Distribute the approved manual to all relevant personnel at the WTP.
- Conduct training sessions to familiarize staff with the contents of the manual and ensure proper adherence to the procedures.

3.3.3) Emergency Response Mechanism

I. Risk Assessment:

- Conduct a thorough risk assessment to identify possible emergencies, including natural disasters (floods, earthquakes), system failures (pump breakdowns, pipeline bursts), and contamination incidents.
- Prioritize risks based on their likelihood and potential impact on the water supply system.

II. Emergency Response Plan:

- Develop detailed response protocols for each identified risk, outlining the steps to be taken in the event of an emergency.

- Establish a clear communication plan, including emergency contact numbers, communication channels, and protocols for notifying stakeholders, including local authorities, affected communities, and emergency services.
- Allocate necessary resources, such as backup power, emergency water supplies, and repair materials, to be readily available in case of an emergency.

III. Training and Drills:

- Conduct regular training sessions for all personnel involved in the water supply system on emergency response procedures.
- Organize periodic emergency drills to test the effectiveness of the response plan and identify areas for improvement.

IV. Monitoring and Review:

- Utilize SCADA systems and other monitoring tools to detect potential emergencies in real-time, allowing for swift action.
- After any emergency, conduct a review to evaluate the response, identify lessons learned, and update the emergency response plan as needed.

3.4) Guarantee of works

3.4.1) Post-Commissioning Monitoring and Support

I. Initial Monitoring:

- Conduct a thorough inspection and performance evaluation of the water supply system immediately after commissioning to ensure all components are functioning as intended.
- Collect baseline data on key performance indicators (e.g., water quality, flow rates, energy consumption) for future comparisons.

II. Ongoing Monitoring:

- Schedule regular inspections of the system, including WTP, pipelines, storage tanks, and distribution networks, to detect any issues early.
- Continuously monitor system performance using SCADA and other monitoring tools, focusing on water quality, quantity, and distribution efficiency.

III. Support and Adjustments:

- Provide ongoing technical support to the operations team, including troubleshooting assistance and advice on optimizing system performance.
- Make necessary adjustments to the system based on monitoring data, such as calibrating equipment, adjusting treatment processes, or fine-tuning distribution schedules.

IV. Reporting and Documentation:

- Prepare regular reports on the system's performance, highlighting any issues, corrective actions taken, and recommendations for improvement.
- Establish a feedback loop with the project stakeholders to address any concerns and implement suggested improvements.

3.4.2) Withholding of Security Amount

I. Contractual Agreement:

- Include a clause in the contract that specifies the amount of security to be withheld and the conditions under which it will be released.

- Define the specific milestones or conditions that must be met for the release of the security amount, such as successful project completion, defect-free period, and submission of all required documentation.

II. Withholding Process:

- Withhold the agreed percentage of the contract value from the final payment to the contractor as security.
- Clearly document the withholding of the security amount and communicate the reasons and conditions for its release to the contractor.

III. Evaluation Period:

- Monitor the water supply system during the defect liability period to ensure there are no defects or issues arising from the contractor's work.
- Conduct a final inspection at the end of the defect liability period to verify that all work has been completed to the required standard and that no defects remain.

IV. Release of Security Amount:

- Issue a formal completion certificate to the contractor, indicating that all contractual obligations have been met and the project is officially closed.

4) SAFETY AND SECURITY

4.1) Adherence to safety standards

4.1.1) Provision of Safety Measures

I. Safety Equipment:

- Install first aid kits at key locations throughout the Water Treatment Plant (WTP) and other operational areas. Ensure these kits are regularly checked and replenished.
- Provide c types such as CO2 extinguishers/dry chemical extinguishers/fire extinguishers, fire hoses, and other firefighting equipment at designated spots within the facility.
- Regularly inspect and maintain this equipment to ensure it is in working condition.
- Issue safety uniforms to all staff, including hard hats, gloves, safety boots, high-visibility vests, and any other personal protective equipment (PPE) required based on job roles.

II. Training and Awareness:

- Conduct mandatory training sessions for all employees on the proper use of safety equipment, first aid, fire safety, and emergency procedures.
- Organize regular safety drills, including fire drills and emergency evacuations, to ensure that all personnel are familiar with safety protocols and can respond effectively in case of an emergency.

4.1.2) Monitoring and Surveillance

I. Surveillance Systems:

- Install closed-circuit television (CCTV) cameras at critical points such as entry/exit points, storage tanks, and control rooms. Ensure 24/7 monitoring by trained personnel.
- Set up a central monitoring station where all CCTV footage is streamed and monitored. Designate staff to oversee this station, ensuring any suspicious activity is immediately reported.
- Implement a secure data storage system for retaining surveillance footage for a predetermined period, allowing for post-incident analysis if necessary.

II. Regular Inspections:

- Perform regular inspections of the monitoring systems and surveillance equipment to ensure they are functioning correctly. Address any issues promptly to avoid security lapses.
- Establish protocols for responding to security breaches detected via surveillance, including immediate lockdown procedures and notifying security personnel.

4.2) Safety measures for workers and users

4.2.1) Access Control

I. Controlled Access Points:

- Establish controlled access points at all entrances and exits of the WTP and related facilities, utilizing barriers, gates, or turnstiles as necessary.
- Require all employees, contractors, and visitors to use ID cards, access badges, or biometric systems to gain entry. Implement a visitor registration system to track all non-employee entries.
- Designate certain areas within the facility as restricted, limiting access to only those personnel with specific clearance levels.

II. Monitoring Access:

- Maintain detailed logs of all entries and exits, particularly in restricted areas, ensuring that any anomalies are promptly investigated.
- Real-time Monitoring: Integrate access control systems with surveillance cameras for real-time monitoring, enabling immediate detection of unauthorized access attempts.

4.2.2) Detection, Alert, and Remedial Measures for Chlorine Gas Leakage

I. Chlorine Detection Systems:

- Install chlorine gas detectors in areas where chlorine is stored, handled, or used. Ensure detectors are regularly calibrated and maintained.
- Connect chlorine detectors to an alarm system that provides both visual and audible alerts in case of leakage to ensure alarms are loud enough to be heard throughout the facility.

II. Response Protocol:

- If a chlorine leak is detected, initiate immediate evacuation protocols, guiding all personnel to safe zones.
- Implement containment measures to isolate the affected area and prevent the spread of chlorine gas.
- Use appropriate neutralizing agents or procedures to safely neutralize the chlorine gas, following established safety protocols.
- Notify emergency services immediately if the leak poses a significant risk to health and safety or if additional support is required.

4.3) Security measures

4.3.1) Physical Security Measures

- Erect secure fencing around the facility's perimeter. Consider using additional physical barriers, such as bollards or gates, to prevent unauthorized vehicle access.
- Install security lighting around the perimeter and key access points to deter unauthorized activities during low-light conditions.
- Employ security personnel to conduct regular patrols around the facility, particularly during non-operational hours.
- Conduct regular inspections of all physical security measures, including fences, gates, and barriers, to ensure they are intact and functioning as intended.
- Promptly repair any damage to physical security infrastructure to prevent potential security breaches.

4.3.2) Incident Response and Reporting

I. Incident Response Team:

- Establish an incident response team responsible for handling security breaches, unauthorized access, or other incidents.
- Upon detection of an incident, the response team should take immediate action to contain the situation, secure the area, and ensure the safety of personnel.

II. Incident Documentation:

- Maintain a comprehensive incident log that records the date, time, nature, and response to each security incident. Include details of any damage, theft, or breaches that occurred.
- Gather and secure any evidence related to the incident, such as CCTV footage, physical evidence, and witness statements.

III. Incident Reporting:

- Report the incident to facility management and other relevant internal stakeholders. Include a summary of the incident, actions taken, and any recommendations.
- If necessary, report the incident to local law enforcement or regulatory authorities. Provide all relevant information to assist in any external investigation.
- After each incident, conduct a thorough review to assess the effectiveness of the response, identify any gaps in security, and implement corrective actions to prevent future occurrences.

5) OPERATION AND MAINTENANCE

5.1) Compliance with prescribed deliverable

5.1.1) Supply of Specified Quantity and Regularity of Water Up to Tail End

I. Flow Monitoring:

- Install flow meters at strategic points within the distribution network, particularly at the head and tail end, to monitor water quantities.
- Utilize SCADA systems for real-time monitoring of water flow and pressure to detect any discrepancies or issues in the distribution system.

II. Pressure Management:

- Implement pressure regulation mechanisms, such as pressure-reducing valves, to ensure consistent pressure throughout the network, especially at the tail ends.
- Conduct regular inspections and adjustments to ensure that water pressure and flow rates meet the specified standards across the entire distribution network.

III. Supply Schedule:

- Develop and adhere to a strict water supply schedule, ensuring that all consumers receive water at the designated times with the specified quantity.
- Inform consumers of the supply schedule and any planned outages or maintenance activities that might impact regular supply.

IV. Flushing Schedule:

- Establish a routine flushing schedule, typically quarterly or semi-annually, to remove sediment and biofilms from the system.
- Perform flushing immediately before commissioning or when water quality issues are detected.

V. Disinfection Procedure:

- Use chlorine or other approved disinfectants to disinfect pipelines and storage tanks after flushing.
- Ensure adequate contact time for the disinfectant to effectively neutralize pathogens

VI. Leak Detection:

- Utilize acoustic sensors and pressure management tools to detect and localize leaks in the distribution system.

VII. Supply Regularity:

- Maintain a reliable water supply schedule, with minimal interruptions.
- Develop contingency plans to address supply disruptions promptly, ensuring minimal impact on households.

5.1.2) Supply of Specified Quality of Potable Water from WTP to Tail End

I. Water Quality Monitoring:

- Perform regular water quality tests at multiple points, including the WTP, midpoints, and tail end, to ensure compliance with potable water protocol
- Install online water quality analyzers at key points to continuously monitor parameters such as turbidity, pH, chlorine residuals, and microbial content.

II. Treatment Process Optimization:

- Operate the WTP according to the operating procedures to ensure consistent water treatment processes, including filtration, disinfection, and chemical dosing.

- Conduct regular maintenance of WTP equipment to prevent any degradation in water quality due to malfunctioning equipment.
- Regularly inspect and repair leaks within the distribution network to prevent contamination and maintain water quality up to the tail end.
- Implement periodic flushing of pipelines to remove sediments and maintain water quality throughout the network.

5.2) Effective running of Machinery /WTP

5.2.1) Deployment of Skilled Staff for Operation and Maintenance

- Establish minimum qualification and experience requirements for operational and maintenance staff based on job roles.
- Provide training to all staff on operation manuals, ensuring they understand and adhere to standard procedures.
- Conduct regular audits to ensure that operations are being conducted as per the manuals.

5.2.2) Deployment of Required Number of Staff for Operation and Maintenance

- Conduct a detailed analysis of the operational and maintenance workload, taking into account the size of the WTP, distribution network, and other facilities.
- Develop a staffing matrix that outlines the number of personnel required for each shift, role, and department.
- Ensure that the matrix covers all critical functions, including operations, maintenance, quality control, and administration.
- Determine the required number of staff based on the size, complexity, and operational hours of the WTP and distribution network.
- Implement shift schedules that ensure round-the-clock coverage by adequately trained staff, including during weekends and holidays.
- Develop and maintain shift schedules that ensure 24/7 coverage of the WTP and other critical infrastructure. Consider implementing rotation policies to prevent staff burnout and maintain high performance.
- Identify and train backup staff who can step in during absences or emergencies, ensuring that operations and maintenance activities continue uninterrupted.

5.2.3) Running as Per Operation Manuals and Protocol

I. Access to Operation Manuals:

- Ensure that all operation manuals and protocol are up-to-date, accessible, and distributed to all relevant staff members. Maintain both physical and digital copies for easy reference.
- Conduct regular training sessions to familiarize staff with the operation manuals and protocol. Emphasize the importance of following these procedures to maintain system efficiency and safety.

II. Adherence Monitoring:

- Implement routine audits to ensure that operations are being carried out according to the manuals and protocol. Use checklists and logs to document adherence during daily operations.

III. Continuous Improvement:

- Encourage staff to provide feedback on the operation manuals and protocol, highlighting any areas that could be improved for clarity or efficiency.

- Review and update the operation manuals periodically to incorporate lessons learned, technological advancements, or changes in regulations. Ensure that all staff are informed of any updates and receive training on new procedures as necessary.

5.3) Timely rectification of defects

5.3.1) Grievance Redressal and Record Keeping

- Establish multiple channels for consumers to lodge complaints, including a hotline, online portal, and physical complaint boxes/register.
- Set and communicate clear timelines for acknowledging and resolving grievances, with a focus on prompt action.
- Maintain detailed records of all grievances received, actions taken, and resolution status. Ensure these records are regularly updated and accessible for review.
- Periodically analyze grievance records to identify recurring issues and areas for improvement within the water supply system.

5.3.2) Maintenance Schedule Development and Compliance

- Develop a preventive maintenance schedule based on manufacturer recommendations, industry best practices, and operational experience.
- Prioritize maintenance for critical components such as pumps, motors, filters, and chemical dosing systems.
- Conduct regular checks to ensure compliance with the maintenance schedule, documenting any deviations or delays.
- Review and adjust the maintenance schedule based on operational feedback and emerging issues.
- Ensure regular trimming, pruning, and pest control of vegetation around the area to not compromise with operational efficiency.

5.3.3) Availability of Spare Parts and Standby Machinery

I. Inventory Management:

- Maintain a stock of critical spare parts, including those with long lead times, to address equipment failures promptly.
- Ensure the availability of standby machinery, such as backup pumps and generators, to be deployed in case of primary equipment failure.

II. Regular Audits:

- Conduct regular audits of spare parts and standby machinery to ensure that inventory levels are adequate and items are in working condition.
- Establish and maintain strong relationships with suppliers to ensure quick replenishment of spare parts and machinery as needed.

5.3.4) Training and Capacity Building

- Implement ongoing training programs focused on technical skills, safety procedures, and emerging technologies relevant to water supply operations.
- Encourage staff to obtain relevant certifications, enhancing their expertise and ensuring adherence to industry standards.
- Organize or participate in workshops and seminars to expose staff to best practices and new developments in the water supply sector.
- Develop mentorship programs to pair less experienced staff with seasoned professionals, fostering knowledge transfer and skill development.

5.3.5) Regular Disinfection

- Implement a routine disinfection schedule for the WTP, storage tanks, and pipelines to prevent microbial contamination.
- Use chlorine or other approved disinfectants according to specified dosages and contact times, ensuring effective disinfection without compromising water quality.
- Conduct water quality tests after disinfection to verify that disinfection processes are effective and water remains safe for consumption.

5.3.6) No panelty of electric bill for non-installation of capacitor, overload, delayed payments etc.

I. Capacitor Installation:

- Ensure capacitors are installed and maintained to correct power factor, preventing penalties related to low power factor.
- Conduct regular inspections of electrical systems to verify the correct functioning of capacitors and other power management devices.

II. Overload Prevention:

- Monitor electrical load to prevent overloading of circuits, which could lead to equipment damage and penalties.
- Implement preventive measures, such as automatic load shedding or alarms, to avoid overloading and ensure compliance with electrical regulations.

III. Timely Payments:

- Implement a system to ensure timely payment of electricity bills, avoiding penalties due to delayed payments.
- Set up alerts or reminders to ensure bills are paid on time, and address any billing discrepancies immediately.

CHAPTER 3

List of relevant IS Codes and Manuals for Water Supply Projects

Category	IS Code	Description
Cast Iron (CI) Pipes	IS 1536	Cast Iron Pressure Pipes for Water, Gas, and Sewage
	IS 1537	Vertically Cast Iron Pressure Pipes
	IS 7181	Ductile Iron Pipes for Water, Gas, and Sewage
Ductile Iron (DI) Pipes	IS 8329	Centrifugally Cast Ductile Iron Pressure Pipes
	IS 9523	Ductile Iron Fittings for Pressure Pipes
Steel Pipes	IS 3589	Electrically Welded Steel Pipes for Water and Sewage
	IS 1239 (Part 1)	Mild Steel Tubes, Tubulars, and Wrought Steel Pipe Fittings
	IS 1978	Line Pipe Specification for Seamless or Electric Welded Steel Pipes
Polyethylene (PE) and PVC Pipes	IS 4984	High-Density Polyethylene (HDPE) Pipes for Potable Water Supplies
	IS 4985	Unplasticized PVC (UPVC) Pipes for Potable Water Supplies
	IS 7634 (Part 1)	Code of Practice for Laying of Polyethylene Pipes
Asbestos Cement (AC) Pipes	IS 1592	Asbestos Cement Pressure Pipes
Concrete Pipes	IS 458	Precast Concrete Pipes (with and without reinforcement)
	IS 783	Code of Practice for Laying of Concrete Pipes
Galvanized Iron (GI) Pipes	IS 1239 (Part 1)	Mild Steel Tubes and Wrought Steel Pipe Fittings
	IS 4736	Hot-Dip Zinc Coatings on Mild Steel Tubes
Valves and Fittings	IS 778	Copper Alloy Gate, Globe, and Check Valves for Waterworks
	IS 10805	Butterfly Valves for General Purposes
	IS 7834	Threaded Polypropylene (PP) Pipe Fittings for Water Supply
General Practices	IS 2065	Code of Practice for Water Supply in Buildings
	IS 1172	Code of Basic Requirements for Water Supply, Drainage, and Sanitation
	IS 12330	Precast Concrete Pipes with Flexible Joints
Testing and Commissioning	IS 3114	Code of Practice for Laying of Cast Iron Pipes
	IS 8321	Code of Practice for Handling, Storage, and Transportation of Pipes
Centrifugal Pumps	IS 1520	Horizontal Centrifugal Pumps for Clear, Cold Water
	IS 5120	Code of Practice for Selection, Installation, and Maintenance of Centrifugal Pumps
	IS 9137	Code for Acceptance Tests of Centrifugal, Mixed Flow, and Axial Pumps
	IS 1710	Horizontal Centrifugal Pumps (End Suction)
	IS 6595 (Part 1)	Vertical Turbine Pumps for Clear, Cold Water
	IS 5659	Code for Pumps for Water Supply
Submersible Pumps	IS 8034	Submersible Pump sets for Clear, Cold Water
	IS 9283	Motor for Submersible Pumps
Reciprocating Pumps	IS 5120	Code of Practice for Selection, Installation, and Maintenance of Reciprocating Pumps
Deep Well Turbine Pumps	IS 1710	Deep Well Turbine Pumps

	IS 11346	Deep Well Pumps - Methods of Test
Pump Testing and Performance	IS 9137	Code for Acceptance Tests of Centrifugal, Mixed Flow, and Axial Flow Pumps
Motor Protection	IS 4029	Guide for Testing Three-Phase Induction Motors
Pump Accessories	IS 5120	Selection, Installation, Operation and Maintenance of Pumps and Accessories
Pump Performance Standards	IS 9079	Performance Tests for Centrifugal Pumps
General Design of WTP	IS 8419 (Part 1)	Requirements for Plant Layout, Design, and Construction of Water Treatment Plants
	IS 10617 (Part 1)	Guide for Structural Design of Water Treatment Units
Water Quality	IS 10500	Drinking Water - Specification
	IS 3025 (Part 1-56)	Methods of Sampling and Testing (Physical and Chemical) of Water and Wastewater
	IS 1622	Methods of Sampling and Microbiological Examination of Water
Concrete Structures	IS 3370 (Part 1-4)	Code of Practice for Concrete Structures for the Storage of Liquids
	IS 456	Code of Practice for Plain and Reinforced Concrete
Pumps for WTP	IS 1520	Horizontal Centrifugal Pumps for Clear, Cold Water
	IS 8034	Submersible Pump sets for Clear, Cold Water
Filters and Clarifiers	IS 8419 (Part 2)	Code of Practice for Design and Construction of Settling Tanks and Filters
	IS 8419 (Part 3)	Code of Practice for Design of Filtration Units in Water Treatment Plants
Chemical Dosing Systems	IS 8419 (Part 4)	Code of Practice for Chemical Dosing Units in Water Treatment Plants
Disinfection Systems	IS 8419 (Part 5)	Code of Practice for Design of Chlorination Systems for Disinfection
Storage Tanks for Treated Water	IS 3370	Code of Practice for Concrete Structures for the Storage of Liquids
Electrical Installations	IS 732	Code of Practice for Electrical Wiring Installations (System Voltage Not Exceeding 650 V)
Instrumentation and Control	IS 15769	General Requirements for Instruments for Automatic Monitoring of Water Quality
Cast Iron Pipe Fittings	IS 1538	Specifications for fittings for Cast Iron Pipes
Ductile Iron Pipe Fittings	IS 9523	Specifications for ductile iron pipes and fittings
Asbestos Cement Pipe Fittings	IS 1626 (Part 2)	Specifications for asbestos cement pipes and joints
Cast Iron Pipe Fittings	IS 1538	Specifications for fittings for Cast Iron Pipes
Ductile Iron Pipe Fittings	IS 9523	Specifications for ductile iron pipes and fittings
PVC Pipe Fittings	IS 7834	Specifications for PVC pipe fittings used for potable water
	IS 14182	Specifications for solvent cement used for PVC pipes and fittings
HDPE Pipe Fittings	IS 8008 (Part 1 to 3)	Specifications for HDPE fittings
	IS 4984	Specifications for HDPE pipes for potable water supply
Steel Pipe Fittings	IS 1239 (Part 2)	Specifications for mild steel tubes, tubulars, and other fittings
	IS 1239 (Part 2)	Specifications for socket welding and fittings for steel pipes
Copper Pipe Fittings	IS 4985	Specifications for copper pipes and fittings
GI Pipe Fittings	IS 1239 (Part 2)	Specifications for galvanized iron pipes and fittings
UPVC Pipe Fittings	IS 10124 (Part 1-1.3)	Specifications for UPVC pressure pipes and fittings

Gate Valves	IS 14846	Specifications for gate valves for water supply systems
Globe Valves	IS 778	Specifications for globe valves
Check Valves	IS 5312	Specifications for check valves
Ball Valves	IS 9890	Specifications for ball valves
Air Release Valves	IS 14845	Specifications for air release valves for waterworks purposes
Pressure Reducing Valves	IS 10681	Specifications for pressure reducing valves
Safety Valves	IS 4038	Specifications for safety valves for low and medium pressure
Electric Motors	IS 325	Specifications for three-phase induction motors
Submersible Motors	IS 14220	Specifications for submersible motors for borehole pumps
High-Efficiency Motors	IS 12615	Energy-efficient induction motors
Flameproof Motors	IS 2148	Specifications for flameproof motors used in hazardous locations
Low-Voltage Switchgear and Control gear	IS 8623 (Part 1-3)	Specifications for low-voltage switchgear and control gear assemblies
Electrical Control Panels	IS 60947	Specifications for electrical control panels for industrial use
Motor Control Centres (MCC)	IS 13947	Specifications for motor control centers (MCC)

Manuals Used in Water Supply Systems (WSS) and Water Treatment

1. Manual on Water Supply and Treatment

Published by the Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Housing and Urban Affairs, Government of India which provides detailed guidelines on planning, design, operation, and maintenance of water supply systems and water treatment plants.

2. Manual on Operation and Maintenance of Water Supply Systems

Focuses on procedures and best practices for the operation and maintenance of water supply infrastructure, including pipelines, reservoirs, and pumping stations.

3. Manual on Water Treatment Plant Operations

Covers the operations of water treatment plants, addressing coagulation, filtration, disinfection, and other treatment processes.

4. Manual on Sewerage and Sewage Treatment

By CPHEEO, this manual includes guidelines for the design, construction, and operation of sewerage systems and sewage treatment plants.

5. BIS (Bureau of Indian Standards) Codes

Numerous IS codes are used for various components of water treatment, such as IS 10500 (Drinking Water Quality), IS 3025 (Methods of Water Testing), and IS 1622 (Bacteriological Examination of Water).

6. WHO Guidelines for Drinking-Water Quality

Provides international standards for drinking water quality and safety, essential for water supply systems.

7. National Jal Jeevan Mission Guidelines

Issued by the Ministry of Jal Shakti, these guidelines focus on rural water supply, ensuring the availability of safe drinking water.

8. Manual on Design of Water Supply Pipe Networks

Discusses methodologies and best practices for designing efficient water supply pipe networks for urban and rural areas.

9. Operation and Maintenance Manual for Municipal Water Systems

Provides guidelines on the maintenance of municipal water systems, including pump maintenance, valve operation, and water quality monitoring.

10. Water Quality Monitoring and Surveillance Manual Focuses on procedures for monitoring and ensuring water quality in supply systems.

CHAPTER 4

Description of Components of Water Supply Scheme

WATER SOURCES

The following types of water sources can be combined to create a reliable, diversified Water Supply Scheme based on the region's geography, climate, and population needs.

A. Surface Water Sources

1. Rivers and Streams: Rivers are one of the most common surface water sources for WSS. They provide continuous and abundant water flow. However, they may require extensive treatment due to pollution and suspended solids.

2. Lakes and Reservoirs: Natural lakes or man-made reservoirs collect water through rainfall, snowmelt, or river inflow. Reservoirs are particularly reliable for storing large amounts of water during dry seasons.

3. Canals: Canals are artificial channels that divert water from rivers or reservoirs. They provide a perennial source of water, making them an excellent option for water supply schemes, though they may have periodic closures for maintenance.

4. Ponds and Tanks: Small-scale local water bodies like ponds or irrigation tanks can be used in rural areas. These usually require proper treatment before consumption.

B. Groundwater Sources

1. Wells: Wells tap into groundwater aquifers. Depending on the depth, they are classified as shallow or deep wells. They are a common and reliable source, especially in rural areas. However, over-extraction can lead to depletion or contamination.

2. Borewells and Tubewells: Borewells are deep, narrow wells drilled into the ground to extract water from deep aquifers. These are suitable where groundwater is plentiful and offer a consistent source of water.

3. Springs: Natural springs are sources of water that emerge from the ground, often found in hilly areas. They are typically clean and require minimal treatment, though their yield can be seasonal.

3. Ranney Well Structure: This involves the collection of rainwater after seepage in the ground.

C. Rainwater Harvesting

1. Rooftop Rainwater Harvesting: Water collected from rooftops is stored in tanks or reservoirs and used for domestic consumption or groundwater recharge. It is highly effective in areas with seasonal rainfall.

2. Surface Runoff Harvesting: This involves collecting rainwater from surfaces such as fields, roads, or paved areas and storing it for later use. This can supplement water supply during dry periods.

D. Recycled and Treated Water

Wastewater Treatment Plants: Treated wastewater or greywater can be reused for non-potable purposes such as irrigation, industry, or flushing. While not a primary drinking water source, it helps conserve freshwater by recycling water for secondary uses.

F. Artificial Recharge to Groundwater

Recharge Pits and Wells: Artificial recharge involves directing rainwater or treated wastewater into the ground to replenish groundwater levels. It helps maintain water supply from wells and borewells in areas experiencing groundwater depletion.

Considerations for Selecting Water Sources:

Quality: Surface water typically requires more treatment due to contamination risks, while groundwater is often cleaner but may have higher mineral content.

Quantity: Ensure the source can meet current and future demand without being overexploited.

Accessibility: Proximity to the community or the treatment plant is crucial to minimizing transmission costs.

Sustainability: Long-term viability of the source must be ensured, considering seasonal variations, recharge rates, and environmental impact.

INTAKE STRUCTURES OF WATER SUPPLY SCHEME

Intake structures are critical components of a Water Supply Scheme (WSS) that help in extracting water from surface sources such as rivers, lakes, and reservoirs. There are different types of intake structures depending on the type of water source, the quantity of water required, and the water quality. Below are the main types of intake structures used in WSS:

A. River Intake Structures: These are used to draw water directly from rivers or streams.

1. Direct River Intake: Water is directly drawn from the riverbed using pumps or gravity. This type is commonly used in small or medium-scale water supply schemes.

2. Intake Towers or Piers: These are vertical structures built near the bank of the river. Water enters through screens at various levels, allowing water intake from different depths, depending on the water level in the river.

B. Canal Intake Structures: These are built along irrigation or water supply canals to withdraw water.

1. Sluice Gate Intake: Water is diverted from the canal through a sluice gate or weir structure. A control gate allows the regulation of water flow into the intake channel.

2. Lateral Intake: Water is drawn from the side of the canal using screens to prevent debris from entering the system.

C. Reservoir/Lake Intake Structures: These are designed to collect water from reservoirs or lakes where water levels are relatively stable.

1. Submerged Intake: The intake pipe or structure is placed below the water level to draw water from a stable depth, ensuring consistent water quality.

2. Tower or Shaft Intake: A vertical shaft or tower with multiple inlets at different depths, allowing flexibility in drawing water from varying water levels.

3. Floating Intake: A floating pipe or platform connected to an intake pipe. The floating design ensures water is always drawn from the top layers, even as the water level fluctuates.

D. Pond Intake Structures: These are used to extract water from small ponds, tanks, or local water bodies.

Types:

1. Simple Pipe Intake: A basic pipe structure is laid on the pond bed, fitted with a strainer or screen to prevent debris entry.

2. Elevated Intake: Pipes are laid at an elevated level to avoid drawing muddy or contaminated water from the bottom.

E: Infiltration Gallery: These are a system of perforated pipes or galleries laid horizontally below the riverbed or lake bottom to collect filtered water.These are commonly used where surface water is highly turbid or where the water source has high silt content.

F. Offshore Intake Structures (for lakes and large reservoirs): The structures built offshore to draw water from a distance away from the shore, where the water quality is better.

1. Pipeline with Intake Crib: A pipeline extending from the shore to a structure (crib) located deep in the water body. The crib is equipped with screens to filter out large debris.

2. Floating Intakes: These can be used in lakes or reservoirs where water levels fluctuate significantly.

G: Wet Well Intake Structures: It is a chamber or well-constructed along the water source, where water is collected and pumped to the treatment plant.

1. Wet Well with Sump: Water is collected in a sump or chamber and pumped out. It is typically located close to the water source.

2. Dry Well: A separate structure adjacent to the intake chamber that houses the pumps and equipment to avoid submergence.

Factors Influencing the Choice of Intake Structures:

Water Source: Rivers, lakes, reservoirs, and canals each require different intake designs.

Water Quality: If the water source has high turbidity, structures like infiltration galleries or offshore intakes are preferred.

Water Quantity: Large water demand may require more SOMPhisticated intake systems, such as intake towers.

Topography: The terrain of the water source site will impact the design and type of intake structure.

Maintenance and Accessibility: Intake structures should be designed to allow easy access for cleaning, repairs, and control of water flow.

Each type of intake structure is designed to suit specific water sources and local conditions, ensuring an efficient, sustainable, and safe water supply.

WATER TREATMENT PLANT (WTP)

1. Pre-Treatment Facilities (**Screening for Grit Removal):**

- Mechanical screens to remove large debris, leaves, and other materials before water enters the treatment process.
- Grit chambers or sedimentation tanks to remove sand, silt, and small particles that can damage equipment.

2. Water Treatment Components

Coagulation and Flocculation: Mixing chambers where chemicals (e.g., alum, ferric chloride) are added to destabilize particles and form flocs with slow mixing to allow flocs to grow and settle.

Sedimentation Tanks: Large tanks where flocs settle out of the water by gravity with facility for sludge collection and removal of settled particles.

Aeration Unit: The aeration unit in a water treatment system plays a crucial role in improving water quality by adding oxygen and removing undesirable gases and impurities.

Traditional Filtration:

- Slow sand filtration for small schemes to remove remaining suspended solids and turbidity along with backwashing systems to clean the filters periodically.
- Rapid sand filters or other media filters to remove remaining suspended solids and turbidity along with backwashing systems to clean the filters periodically.
- Mechanical filtration involves physically removing particles and sediments from water by passing it through a filter medium

Advanced Filtration:

- Activated Carbon filtration to remove organic compounds, chlorine, and other chemicals by adsorption.
- Reverse Osmosis (RO) filtration to remove dissolved salts, minerals, and other impurities by forcing water through the membrane at high pressure.
- Ultrafiltration (UF) with larger pores than RO to remove bacteria, viruses, and larger dissolved substances while allowing smaller molecules like water and salts to pass through.
- Ultraviolet (UV) filtration uses ultraviolet light to disinfect water by inactivating bacteria, viruses, and other pathogens.
- Ion Exchange involves exchanging ions in the water with ions in a resin bed to remove dissolved ionic impurities, such as hardness-causing calcium and magnesium ions.
- Distillation involves boiling water to produce steam, which is then condensed back into water, leaving behind impurities.
- Ceramic Filtration uses porous ceramic materials to filter out bacteria, protozoa, and some suspended particles.

3. Post-Treatment and Storage

Clear Water Reservoir: Storage tanks or reservoirs for treated water before distribution and provides buffer capacity for demand fluctuations and emergency situations.

Disinfection: Disinfection in storage to maintain water quality during distribution.

4. Chemical Handling and Storage

Chemical Feed Systems: Dosing equipment for coagulants, disinfectants, pH adjusters, and other treatment chemicals includes storage tanks, feeders, and monitoring systems.

Safety and Containment: Spill containment areas, ventilation, and personal protective equipment (PPE) for handling chemicals is a safety protocol for mixing and dosing chemicals.

5. Sludge Handling and Disposal

Sludge Thickening: Gravity thickening tanks or mechanical thickeners to reduce water content in sludge.

Dewatering: Belt presses, centrifuges, or drying beds to further reduce the volume of sludge for disposal.

Sludge Disposal: Safe disposal methods such as landfilling, composting, or incineration in compliance with environmental regulations.

6. Instrumentation and Control

SCADA System: Supervisory Control and Data Acquisition (SCADA) for real-time monitoring and control of the treatment process includes sensors, flow meters, and automated control valves.

Water Quality Monitoring: Online analyzers and laboratory testing for parameters like turbidity, pH, chlorine levels, and pathogen indicators.

Alarms and Emergency Systems: Alarm systems for detecting failures or abnormal conditions for Emergency shutdown protocols and backup systems.

CLEAR WATER PUMPING MACHINERY

1. Clear Water Reservoir: A tank or reservoir that stores treated water after it has been processed by the water treatment plant which provides a buffer to meet varying water demand and ensures a steady supply to the distribution system.

2. Pumping StationA building or structure that houses the pumping machinery and associated equipment designed to protect the equipment from environmental factors and provide a controlled environment for operation and maintenance.

3. Pumps

3.1 Centrifugal Pumps

Single-Stage Centrifugal Pumps used for general water transfer applications where the required pressure is moderate which consists of a single impeller, making it simple and efficient for low to medium head applications.

Multistage Centrifugal Pumps: Used when higher pressure is needed, as in long-distance water transfer or when lifting water to higher elevations contains multiple impellers in series, each adding pressure to the water.

Vertical Turbine Pumps: Ideal for pumping water from deep wells, reservoirs, or rivers which onsists of multiple stages with impellers stacked vertically, suitable for high-head, low-flow applications.

Submersible Pumps: Installed underwater, typically in wells or sumps. The motor is sealed to prevent water ingress, making them suitable for deep wells or situations where surface space is limited.

3.2 Positive Displacement Pumps

Reciprocating Pumps: Includes piston, diaphragm, or plunger pumps. It is used for precise flow control and high-pressure applications, though they are less common in large-scale WSS due to complexity.

Rotary Pumps: Includes gear pumps, screw pumps, and vane pumps suitable for situations requiring consistent flow rates at relatively high pressures, though more common in industrial applications than in WSS.

3.3 Peristaltic Pumps

Hose Pumps: Used for dosing chemicals in water treatment processes. It is operated by compressing a hose to push fluid, ideal for handling corrosive or abrasive fluids.

3.4 Axial Flow Pumps: It moves water in a direction parallel to the pump shaft, used in low-head, high-flow applications like flood control or in large water bodies where the elevation difference is minimal.

3.5 Mixed Flow Pumps

Combines the features of centrifugal and axial flow pumps. It is uitable for medium head and high flow applications, often used in irrigation and drainage systems.

3.6 Jet Pumps Uses a combination of a centrifugal pump and an ejector to draw water from deep sources. It is commonly used in domestic water supply for wells where water levels fluctuate.

3.7 Booster Pumps: Installed in series with existing pumps to increase water pressure, typically in long pipelines or when elevating water to higher storage tanks. It is used in situations where pressure must be increased at a particular point in the water supply system.

3.8 Diaphragm Pumps: Used for dosing chemicals or handling fluids with suspended solids which operates with a flexible diaphragm and is often used in water treatment plants.

3.9 Self-Priming Pumps: Designed to re-prime itself under suction lift conditions without the need for manual priming. It is useful in applications where the pump may lose prime and require re-priming frequently.

3.10 Screw Pumps: Utilizes one or multiple screws to move water, commonly used in handling viscous fluids or water with suspended solids, though not as common in clear water applications.

3.11 Air-Lift Pumps: Operates by injecting compressed air into the water column, causing the water to rise due to the lower density mixture. They are typically used in specific applications like well rehabilitation or aeration.

These pumps are selected based on specific criteria such as required flow rate, head, efficiency, maintenance requirements, and the nature of the water being pumped (e.g., raw water, treated water, wastewater).

4. AC Motors

4.1 Squirrel Cage Induction Motor

- The most common type of AC motor used with water pumps.
- Features a rotor made of laminated iron and copper or aluminum bars, enclosed in a cylindrical cage.
- Reliable, cost-effective, and requires minimal maintenance.
- Used with centrifugal pumps, submersible pumps, and other types of water pumps in various applications, including municipal water supply and irrigation.

4.2 Wound Rotor Induction Motor

- Has a rotor with windings connected to external resistors or control systems.
- Offers better starting torque and speed control compared to squirrel cage motors.
- Suitable for applications requiring high starting torque and variable speed control, such as large water pumps in industrial or high-lift applications.

4.3 Synchronous Motor

- Operates at a constant speed that is synchronized with the frequency of the AC power supply.
- Provides precise speed control and high power factor.
- Used in high-power pump systems where speed precision is crucial, such as in large water treatment plants or high-capacity pumping stations.

4.4 Submersible Motors

- Designed to operate underwater and are typically used in submersible pumps.
- Sealed to prevent water ingress and ensure reliable operation in submerged conditions.
- Commonly used in deep well pumps, borehole pumps, and other water lifting applications where the motor is located below the water level.

4.5 Vertical Motors

- Mounted vertically with the pump shaft extending downward into the well or pump chamber.
- Often used with vertical turbine pumps and deep well pumps.
- Suitable for applications where space is limited or where the pump needs to be positioned deep within a well or reservoir.

4.6 Horizontal Motors

- Mounted horizontally with the pump shaft extending horizontally from the motor.
- Commonly used with centrifugal pumps and other horizontal pump configurations.
- Ideal for surface-mounted pumps where space allows for horizontal motor installation.

4.7 Explosion-Proof Motors

- Designed to operate safely in hazardous environments where flammable gases or vapors may be present.
- Constructed with features that prevent ignition of explosive materials.
- Used in industrial pumping applications where the potential for explosive atmospheres exists, such as in certain water treatment facilities or chemical processing plants.

4.8 Solar-Powered Motors

- Powered by solar energy, often used in conjunction with solar panels and batteries.
- Ideal for remote or off-grid locations where conventional power sources are unavailable.
- Used in rural water supply systems, irrigation, and other applications where renewable energy is preferred.

The selection of the motor type for water pumps depends on factors such as the required power, operational environment, speed control needs, and efficiency considerations. Each motor type has its advantages and is chosen based on the specific requirements of the water supply scheme.

5. Panel board and Drives

5.1 Main Circuit Breaker (MCB) or Main Switch

- The primary device that controls the power supply to the entire panel board.
- Provides overcurrent protection and allows for manual switching of the entire panel off or on.
- Used to isolate the panel board from the main power supply during maintenance or in case of emergency.

5.2 Circuit Breakers

- Protect individual circuits from overcurrent or short circuits.
- Automatically disconnects the circuit when an overload or fault condition is detected.
- **Miniature Circuit Breakers (MCBs):** Protect against overloads and short circuits.
- **Residual-Current Circuit Breakers (RCCBs) or Residual-Current Devices (RCDs):** Protect against earth faults and leakage currents.
- **Moulded Case Circuit Breakers (MCCBs):** Used for higher current protection and can be adjusted for different trip settings.

5.3 Busbars

- Conductive bars that distribute electrical power to various circuits within the panel board.
- Made of materials like copper or aluminium.

- Carry electrical current from the main supply to the circuit breakers and other components.

5.4 Neutral Busbar

- A bar where all neutral wires from different circuits are connected.
- Provides a common return path for electrical current.
- Ensures proper operation of the neutral line in the electrical distribution system.

5.5 Earth Busbar or Ground Busbar

- A bar where all ground wires (earth wires) are connected.
- Provides a common ground connection for safety and fault protection.
- Ensures proper grounding and helps in preventing electrical shock or fire hazards.

5.6 Terminals and Lugs

- Connection points where incoming and outgoing wires are attached.
- Lugs are used to connect wires to busbars and other components securely.
- Facilitate the secure connection of wires to the panel board components.

5.7 Metering Equipment

- Devices used to measure electrical parameters like voltage, current, power, and energy consumption.
- **Energy Meters:** Measure the total energy consumption.
- **Ammeters:** Measure current flow.
- **Voltmeters:** Measure voltage levels.
- Used for monitoring and managing energy usage in the electrical system.

5.8 Indicator Lights: Lights that show the status of various components or circuits (e.g., power on, fault indication) and provide visual indication of operational status and help in troubleshooting.

5.9 Alarm Systems: Audible or visual alarms that alert users to fault conditions, such as overloads or equipment failures. They are used for early warning and prompt response to electrical issues.

5.10 Control Switches: Switches that control various aspects of the electrical system, such as turning specific circuits on or off. They allow for manual operation and control of individual circuits.

5.11 Enclosure

- The housing that protects the internal components of the panel board from dust, moisture, and physical damage.
- Typically made from metal or plastic, with varying degrees of protection based on the environmental conditions (e.g., IP rating).
- Ensures safety and durability of the panel board components.

5.12 Auxiliary Devices

- Additional components like surge protectors, timers, or relays that provide extra functionality or protection.
- Enhance the operation and safety of the electrical distribution system.

5.13 Variable Frequency Drives (VFDs): Devices that control the speed and torque of the electric motors driving the pumps and allows for energy-efficient operation by adjusting the pump speed according to demand.

6. Control Valves

6.1 Check Valves: Installed on the discharge side of the pump to prevent backflow of water when the pump is not operating which ensures that the system remains pressurized and prevents water hammer.

6.2 Gate Valves: Used to isolate the pump for maintenance or repairs. It allows for complete shutdown of flow without affecting other parts of the system.

6.3 Pressure Relief Valves: Protects the pump and piping system from excessive pressure by releasing water when pressure exceeds a set threshold.

6.4 Air Release Valves: Installed at high points in the piping to release trapped air, preventing airlocks and ensuring efficient pump operation.

7. Priming System (if applicable)

7.1 Priming Tank: A small tank that holds water to fill the pump casing and suction line before starting the pump which ensures that the pump is fully primed and ready to operate without air pockets.

7.2 Vacuum Pump: A device used to evacuate air from the pump casing and suction line during priming. It is commonly used in pumps that are not self-priming.

8. Control Systems

8.1 Pump Control Panel: The central control unit that manages the operation of the pumps. It includes start/stop controls, motor protection relays, and status indicators.

8.2 SCADA System Integration: Allows for remote monitoring and control of the pumping station through Supervisory Control and Data Acquisition (SCADA). It provides real-time data on pump performance, pressure, flow rates, and system status.

9. Pressure Monitoring and Regulation

9.1 Pressure Gauges: Installed on both the suction and discharge sides of the pump to monitor pressure levels, they help in adjusting the operation of the pump to maintain desired pressure.

9.2 Flow Meters: Devices that measure the volume of water being pumped through the system are used for monitoring pump efficiency and managing water supply.

10. Backup Systems

10.1 Standby Pumps: Additional pumps that can be brought online in case of failure or maintenance of the primary pumps ensure continuous water supply even during emergencies.

10.2 Emergency Power Supply:

- Generators or Uninterruptible Power Supplies (UPS) to provide power during electrical outages.
- Ensures that pumps continue to operate even when the main power supply is unavailable.

11. Maintenance Equipment

11.1 Cranes/Hoists: Installed in the pump house for lifting and handling heavy pump components during maintenance or repairs.

11.2 Lubrication Systems for ensuring that moving parts of the pump and motor are adequately lubricated to reduce wear and tear.

12. Safety and Environmental Controls

12.1 Safety Interlocks: Prevent the pump from starting if certain conditions are not met (e.g., insufficient suction pressure, open gate valve) and protect the equipment and personnel from potential hazards.

12.2 Noise and Vibration Control: Equipment such as silencers, vibration dampers, and soundproofing materials to minimize noise and vibrations and ensure a safe and comfortable working environment in the pump house.

PIPES FOR RISING MAINS AND DISTRIBUTION SYSTEM

1. Ductile Iron (DI) Pipes

- High strength and durability, with excellent resistance to pressure surges and external loads.
- Good corrosion resistance, especially when coated with a protective layer (e.g., cement mortar lining, bituminous coating).
- Ductility allows for some flexibility in installation, reducing the risk of cracks and fractures.
- Commonly used in rising mains for urban water supply systems due to their reliability and long service life.
- Suitable for areas with heavy traffic loads or unstable ground conditions.

2. Steel Pipes

- High tensile strength, making them suitable for high-pressure applications.
- Available in various diameters and wall thicknesses, allowing customization based on specific project needs.
- Corrosion protection is required, typically through coatings (e.g., epoxy, polyethylene) or cathodic protection.
- Used in long-distance water conveyance and in areas where high pressure and external loads are present.
- Preferred for large-diameter rising mains in industrial or urban settings.

3. Polyvinyl Chloride (PVC) Pipes

- Lightweight and easy to handle, reducing transportation and installation costs.
- Corrosion-resistant, making them ideal for areas with aggressive soils or where chemical resistance is important.
- Available in different pressure ratings (e.g., Class PN 6, PN 10, PN 16) to suit various pressure requirements.
- Often used in small to medium-sized rising mains in rural or suburban areas.
- Suitable for systems where moderate pressure is expected and where cost-effectiveness is a priority.

4. High-Density Polyethylene (HDPE) Pipes

- Flexible, allowing them to absorb pressure surges (water hammer) and adapt to ground movements.
- Excellent resistance to corrosion, abrasion, and chemical attack.
- Available in long lengths, reducing the number of joints and potential leak points.
- Ideal for rising mains in areas with difficult terrain, seismic activity, or corrosive environments.
- Used in both rural and urban settings, especially where long, continuous runs are required.

5. Cast Iron (CI) Pipes

- Historically used in water supply systems, with good strength and durability.
- Heavier and more prone to corrosion compared to ductile iron, but still used in certain contexts.
- Requires internal and external coatings to extend service life.

- Less commonly used in modern installations, but may still be found in older systems.
- Used in areas where traditional materials are preferred or where existing systems are being extended.

8. Asbestos Cement (AC) Pipes (Note: Limited Use)

- Lightweight and corrosion-resistant, historically used in water supply systems.
- Concerns about health risks from asbestos have led to a decline in their use.
- Still found in some older installations but being phased out.
- Not recommended for new installations due to health concerns.
- May still be encountered during maintenance or renovation of older systems.

9. Galvanized Iron (GI) Pipes

- Steel pipes coated with zinc to prevent rusting.
- Less commonly used in modern water supply systems due to issues with corrosion and scaling.
- Generally used in older systems or for temporary installations.
- Not preferred for rising mains due to durability concerns.

10. Concrete Pipes

10.1 Prestressed Concrete Pipes (PCCP):

- Prestressed with steel wires for added strength, ideal for high-pressure applications.
- Heavy and requires specialized handling and installation.

10.2 Reinforced Concrete Pipes (RCP):

- Reinforced with steel bars for additional strength.
- More commonly used in large-diameter applications or gravity flow systems rather than pressure distribution networks.

10.3 Applications:

- Typically used in large-scale distribution networks or in transmission mains rather than local distribution.
- Suitable for high-pressure areas or where long service life is a priority.
- Each type of pipe has its specific advantages and is chosen based on factors such as pressure requirements, environmental conditions, cost, and the expected lifespan of the installation.
- Proper selection and installation are crucial to ensuring the reliability and efficiency of rising mains in water supply schemes

RAW WATER STORAGE TANKS

1. Ground-Level Storage Tanks

1.1 Reinforced Concrete Tanks:

- Constructed from reinforced concrete, these tanks are durable and can be built to hold large volumes of water.
- Suitable for large-scale storage where land is available.
- Can be designed as rectangular or circular tanks, depending on site requirements.

1.2 Earthen Reservoirs:

- Large basins lined with impermeable materials (e.g., clay, HDPE liners) to prevent water loss through seepage.
- Typically used for very large volumes of water storage, often in rural or agricultural areas.
- Requires significant land area and regular maintenance to prevent contamination.

1.3 Steel Tanks:

- Made from welded or bolted steel plates, these tanks can be built relatively quickly and are available in various sizes.
- Often coated or lined to prevent corrosion and ensure water quality.
- Suitable for both small and medium storage volumes.

2. Elevated Storage Tanks

2.1 Water Towers:

- Elevated tanks supported by towers or stilts, designed to provide water at a higher elevation to maintain pressure in the distribution system.
- Typically constructed from steel or concrete, with a spherical or cylindrical shape.
- Suitable for areas where pressure needs to be maintained without relying on pumps.

3. Underground Storage Tanks

3.1 Reinforced Concrete Tanks:

- Constructed below ground level, these tanks are durable and protect the stored water from environmental contamination.
- Typically used in areas with limited land availability or for aesthetic reasons.
- Requires waterproofing and proper drainage to prevent water ingress from surrounding soil.

4. Raw Water Lagoons/Ponds

4.1 Earthen Ponds:

- Natural or man-made depressions lined with impermeable materials to store large volumes of raw water.
- Often used in agricultural settings or where large-scale water storage is required.
- Requires significant land area and regular maintenance to manage siltation, vegetation, and contamination.

4.2 Lined Reservoirs:

- Similar to earthen ponds but lined with synthetic liners (e.g., HDPE) to prevent seepage.
- Used in areas where soil permeability is high or where water conservation is critical.
- Can be designed to store seasonal or floodwater for later use.

Each type of raw water storage tank has its own advantages and is chosen based on factors like storage capacity, land availability, environmental impact, and cost. Proper design, construction, and maintenance are essential to ensure the reliability and safety of the water supply system.

METERS AND VALVES

1. Service Pipe

- A small-diameter pipe that connects the water main (usually in the street) to the household plumbing system.
- Typically made from materials like Polyethylene (PE), Copper, or Galvanized Iron (GI).
- The service pipe is usually buried underground and is responsible for delivering water to the household from the main distribution line.

2. Corporation Stop (Tap)

- A valve installed at the junction where the service pipe connects to the water main.
- Controls the flow of water from the main into the service pipe.
- Typically operated by the water utility during installation, maintenance, or in cases where the water supply needs to be shut off.

3. Curb Stop (Shut-off Valve)

- A valve installed on the service line, usually near the property boundary or the curb.
- Allows the homeowner or utility workers to shut off the water supply to the household for maintenance, repairs, or emergencies.
- Often housed in a curb box or valve box for protection and easy access.

4. Water Meter

- A device that measures the volume of water used by the household.
- Typically installed between the curb stop and the household plumbing system.
- Can be located indoors (in a basement) or outdoors (in a meter box or pit).
- Some meters are equipped with remote reading capabilities, allowing the water utility to monitor usage without entering the property.

5. Meter Box or Pit

- A protective enclosure for the water meter, usually installed underground.
- Provides easy access to the water meter for reading, maintenance, or replacement.
- Often made of plastic, concrete, or metal, with a removable lid for access.

6. Pressure Reducing Valve (PRV) (Optional)

- A valve that reduces and regulates the water pressure entering the household plumbing system.
- Used in areas where the water pressure from the main supply is too high, which can damage household appliances and plumbing.
- Typically installed after the water meter but before the household plumbing system.

7. Check Valve (Non-Return Valve) (Optional)

- A valve that prevents backflow of water from the household plumbing system into the main water supply.
- Ensures that water flows in only one direction, protecting the main supply from potential contamination.
- Often required by building codes in certain areas to maintain water quality.

8. Backflow Preventer (Optional)

- A device that prevents contamination of the public water supply by stopping the reverse flow of water from the household back into the main.
- Required in some areas to protect against cross-connections, where non-potable water might mix with the potable supply.
- Installed after the water meter and before the household plumbing system.

9. Riser Pipe

- A vertical pipe that connects the underground service pipe to the household plumbing system.
- Used to bring water from the service line up to the level of the household plumbing, typically entering the house through the foundation wall or floor.
- Made from the same material as the service pipe (e.g., PE, copper, or GI).

10. Indoor Plumbing System

- The network of pipes, fittings, and fixtures inside the house that distribute water to various taps, appliances, and outlets.
- Typically made of materials like copper, PVC, PEX, or CPVC, depending on local building codes and preferences.
- Includes taps, faucets, and other fixtures where water is drawn for use.

11. Tap or Faucet

- The end fixture where water is drawn for use within the household.
- Can be installed in kitchens, bathrooms, laundry rooms, and outdoor areas.
- Available in various designs and materials, with features like aerators to control flow and reduce water usage.

12. Aerator (Attached to the Tap)

- A small device attached to the tip of the faucet that mixes air with the water stream.
- Reduces water consumption by controlling the flow rate while maintaining sufficient pressure.
- Helps prevent splashing and improves the efficiency of water use.

13. Gaskets and Seals

- Rubber or silicone components used to create watertight seals at joints and connections in the plumbing system.
- Prevents leaks and ensures a secure, reliable connection between different components.

14. Pipe Insulation (Optional)

- Insulation material applied to pipes to prevent heat loss and protect against freezing in cold climates.
- Helps maintain water temperature and reduces energy costs for hot water systems.

TYPES OF PIPE JOINTS IN WATER SUPPLY SCHEMES

1. Butt-Welded Joint

- Involves welding the ends of two pipes together.
- Creates a strong, seamless connection, typically used for steel pipes.
- Suitable for high-pressure applications.
- Large-diameter pipelines, industrial settings, and areas where a permanent, strong connection is required.

2. Socket Welded Joint

- The pipe end is inserted into a recessed area of a fitting, and the joint is sealed by welding.
- Provides a strong, leak-proof connection.
- Used in smaller diameter pipelines and high-pressure systems

3. Flanged Joint

- Two flanges are bolted together with a gasket in between to ensure a tight seal.
- Allows for easy assembly, disassembly, and maintenance.
- Commonly used in pipelines where sections need to be frequently disconnected, such as in pump stations and treatment plants.

4. Screwed (Threaded) Joint

- Pipes are connected using threaded ends screwed into matching fittings.
- Easy to assemble and disassemble but may not be suitable for high-pressure applications.
- Typically used in small-diameter pipelines, domestic plumbing, and temporary installations.

5. Push-Fit Joint

- Pipes are simply pushed into fittings with no need for additional tools, often sealed with O-rings.
- Allows for quick and easy installation.

- Used in plastic piping systems, particularly for low to medium-pressure applications in domestic and commercial settings.

6. Compression Joint

- Involves tightening a nut to compress a ring onto the pipe, creating a seal.
- Does not require heat or special tools, making it easy to use.
- Suitable for connecting pipes in water distribution systems, especially where flexibility is needed.

7. Grooved Joint

- Pipes have grooves cut into their ends, and a coupling with a gasket is clamped around them.
- Allows for some flexibility and quick assembly.
- Common in fire protection systems and in areas where rapid assembly or disassembly is required.

8. Bell and Spigot (Socket and Spigot) Joint

- One pipe end is flared (bell) and the other is inserted into it (spigot), with a gasket ensuring a tight seal.
- Commonly used for gravity flow systems.
- Widely used in cast iron, ductile iron, and PVC pipe systems, particularly in sewerage and stormwater systems.

9. Mechanical Joint

- Uses a bolted gland to compress a gasket onto the pipe, forming a seal.
- Allows for easy installation and disassembly.
- Frequently used in ductile iron pipe systems for water distribution.

10. Slip Joint

- Consists of a socket with an O-ring or gasket that slides over the end of the pipe.
- Provides flexibility and can accommodate slight movement.
- Commonly used in plastic piping systems like PVC or CPVC.

11. Electrofusion Joint

- Utilizes fittings with embedded heating elements that are electrically heated to fuse the joint.
- Provides a strong, leak-proof connection.
- Used in polyethylene (PE) and other plastic piping systems, particularly for gas and water supply.

12. Solvent Cement Joint

- Pipes and fittings are chemically fused using solvent cement, creating a strong bond.
- Used primarily with plastic pipes such as PVC, CPVC, and ABS.
- Suitable for domestic and industrial water supply systems.

TYPES OF FITTINGS IN WATER SUPPLY SCHEMES

1. Elbows: Used to change the direction of the pipe run, typically at 90° or 45° angles. They are common in all types of pipelines to navigate around obstacles or to change the flow direction.

2. Tees: Allows for the splitting or combining of flow, with one inlet and two outlets (or vice versa). Also used in branching off main pipelines or combining flows from two pipes.

3. Reducers: Used to connect pipes of different diameters. They're common in systems where the flow needs to be managed by changing the pipe size.

4. Couplings: Connect two pipes in a straight line. They are available as rigid or flexible types, depending on the need for movement or flexibility, and are used to join pipes in most piping systems.

5. Caps: Used to close the end of a pipe. Often installed in systems that may need future extensions.

6. Unions

- Similar to couplings but allow for easy disassembly without cutting the pipe.
- Used in areas where regular maintenance is required.

7. Adapters

- Used to connect pipes with different types of ends (e.g., threaded to plain end).
- Common in systems requiring transitions between different types of joints.

8. Flanges

- Provides a method of connecting pipes, valves, pumps, and other equipment to form a piping system.
- Used where a connection may need to be easily disassembled, such as in water treatment plants.

9. Bends

- Used to change the direction of the flow, similar to elbows but typically with a larger radius.
- Used in pipelines where a gradual change in direction is needed.

10. Crosses

- Similar to tees but with four branches.
- Used in water distribution systems where flow needs to be divided into multiple directions.

11. Valves

- Devices used to control the flow of water through the pipeline.
- Gate valves, ball valves, butterfly valves, check valves, etc.
- Installed at key points to regulate, isolate, or control water flow.

The proper selection and installation of joints and fittings are crucial for ensuring the reliability, durability, and efficiency of water supply systems. Each joint and fitting type has specific applications depending on the material of the pipes and the requirements of the system.

ANNEXURE I

Technical Quality Audit Parameters: Drinking Water Supply Schemes

Pre-implementation Stage

S.No.	Parameter	Benchmark	Reference	Indicator	Sub indicators	Max. marks	Marks Obtained	Weightage
1	Planning & Design	Technical Framework in comprehensive Planning	DPR	1.1) survey & investigation	1.1.1) Topographic Survey	4		25 %
					1.1.2) Land Acquisition, Forest clearance etc.	4		
					1.1.3) NOC from Railways, Electricity Board, Water Resources, Roads, Panchayat	4		
				1.2) Demand and Resource assessment	1.2.1) Population growth, Industrial Development & seasonal variation.	4		
					1.2.2) Available water sources & their lean period discharge	2		
					1.2.3) Discharge depletion studies	2		
					1.2.4) Assessment of existing water supply infrastructures and their uses.	2		
				1.3) Selection of technology for network design	1.3.1) Use of latest software for Pipe Network and Economic Design of Pumping Mains along with drawings	10		
				1.4) Selection of appropriate Technology for treatment of water & Sewage and Innovation	1.4.1) Optimum design of WTP with advanced treatment technologies.	10		
					1.4.2) Provision of water sources sustainability measures	5		
					1.4.3) Assessment of other uses of selected source and raw water testing	1		
					1.4.4) Use of modern mechanized/digital equipments such as:i) Remote Monitoring, ii) SCADA, iii) Automated Meter Reading (AMR), iv) Leak Detection, v) GIS (Geographic Information System), vi) Smart Pumping Systems vii) Online Water Quality Analyzers, vii) automated	10		

					chlorination viii) Mobile Applications ix) Customer Portals x) Drone Photography etc.			
				1.5) Cost Analysis, Budget planning and timeline estimates	1.5.1) Financial implication with cost index upto implementation period.	2		
					1.5.2) Identification of funding agency with annual budget allocation	3		
					1.5.3) Period for DPR approval, call of tenders, award of work & its implementation etc.	5		
				1.6) Framing specification	1.6.1) Identification of suitable materials proposed to be used	5		
					1.6.2) Framing specifications for above materials	10		
				1.7) Long term Planning	1.7.1) Future requirement projections such as vacant space for expansion and modular design of WTP and storage tanks	1		
					1.7.2) Future development of the area such as industrial growth, education hub etc.	1		
					1.7.3) Horticulture Planning for aesthetics of pump-house, storage, and WTP	1		
				1.8) Reducing O&M cost	1.8.1) Provision of solar energy	1		
					1.82.) Provision of energy efficient machinery such as BEE certified/star rated	1		
					1.8.3) Provision of automation	1		
					1.8.4) Life cycle cost analysis of pumping machinery	1		
				1.9) Tube Well Design	1.9.1) Site Selection and tubewell design as per the project requirements	10		
					Total	**100**		**25%**

IMPLEMENTATION STAGE

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicators	Max. marks	Marks obtained	Weightage
2	Execution, Inspection and testing	Technical Methodology for implementation and inspection & testing	Contract Agreement and test reports	2.1) Use of all construction materials	2.1.1) Materials such as aggregates, sand etc. from approved source	2		40%
					2.1.2) Use of design mix and weigh mix	2		
					2.1.3) Procurement of piped of approved make and manufacturer	2		
					2.1.4) Carrying out tests at manufacture's premises before dispatch	2		
				2.2) Pumping system efficiency enhancement	2.2.1) Use high efficiency pumps & motors specifically designed for site requirements	3		
					2.2.2) Use of designed size of rising main/Suction pipe to minimize frictional losses	3		
					2.2.3) Provision of positive suction head	3		
				2.3) supervision by skilled manpower/TPIA	2.3.1) Deployment of appropriately qualified personal	2		
					2.3.2) Manpower deployment as per requirement	2		
				2.4) Use of modern facilities for construction and treatment	2.4.1) Advance water treatment such as Arsenic, Iron, Fluoride membrane filtration, UV disinfection etc.	4		
					2.4.2) Automated operation of Pumps/WTP	4		
					2.4.3) Smart metering and leakages detection	4		
					2.4.4) GIS mapping of sources, network and all other infrastructures	2		
				2.5) Conformity to relevant standards	2.5.1) Work executed as per approved bid document	10		
				2.6) Making good the dismantled surfaces	2.6.1) Dismantled roads and streets are repaired properly and dismantled material disposal.	5		

				2.7) Pre & Post Inspections of all materials	2.7.1) Physical inspection of pipes at site before laying	2		
					2.7.2) Ensure requires frequency of tests during implementation	2		
					2.7.3) Water sample testing after treatment	4		
					2.7.4) Non-Destructive testing of concrete structures, where applicable	2		
				2.8) setting up of testing laboratory	2.8.1) Setting up water testing laboratories at site of WTP	4		
					2.8.2) Setting up of water testing laboratories at district and state level	4		
					2.8.3) Ensuring NABL accreditation of water testing laboratories at district/state level	4		
				2.9) Functionality & testing of pipes, discharge measurement of Pumps	2.9.1) Flow testing in pipes after laying at site	2		
					2.92) Testing of pumping machinery to meet with the required discharge	4		
					2.9.3) Availability of electric/ Solar energy as per requirements	4		
				2.10) Documentation and Reporting	2.10.1) Preparation of site inspection and quality control registers	2		
					2.10.2) Checking of test results by Engineer in Charge	2		
					2.10.3) Rectification of defects	2		
					2.10.4) Submission of reports and keeping the record	2		
				2.11) Tubewell Drilling and Development	2.11.1 Drilling Process	4		
					2.11.2) Development of the Tube Well	3		
					2.11.3) Completion and Maintenance	3		
Total						**100**		**40%**

COMMISSIONING

Sr. no.	Parameter	Benchmark	Reference	Indicators	Sub Indicator	Max. marks	Marks obtained	Weightage
3	Commissioning and Hand over	Guidelines for commissioning and handover	Completion report	3.1) Testing the functionality	3.1.1) 100% HH water connections	20		15%
					3.1.2) System flushing and disinfection	5		
					3.1.2) Specified Quantity, quality and regularity of water	20		
				3.2) Testing and Functionality of WTP	3.2.1) Cleaning & disinfection of WTP	5		
					3.2.2) Specified quality and quantity of potable water from WTP	10		
					3.2.3) Proper operation of SCADA and online analyzer	10		
				3.3) Submission of Assets management Plan and completion certificate	3.3.1) Submission of Assets completion Plan and completion report by Agency and certificate by Department	5		
					3.3.2) Preparation of Manual on Standard Operating Methods and Procedure for WTP	5		
					3.3.3) Emergency response mechanism	5		
				3.4) Guarantee of works	3.4.1) Post commissioning Monitoring and support	10		
					3.4.2) Withhold of security amount	5		
					Total	**100**		**15%**

SAFETY AND SECURITY

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicator	Max. marks	Marks obtained	Weightage
4	Safety and Security	Guidelines for Safety and Security		4.1) Adherence to safety standards	4.1.1) Providing of safety measures such as first aid & firefighting equipments, safety uniforms etc.	3		5%
					4.1.2) Monitoring and Surveillance	2		
				4.2) Safety measures for workers and users	4.2.1) Access control	1		
					4.2.2) Detection, alert and remedial measures in case of chlorine gas leakage if applicable	2		
				4.3) Security measures	4.3.1) Physical Security measure	1		
					4.3.2) Incident response and reporting	1		
					Total	**10**		**5%**

OPERATION & MAINTENACE

S.No.	Parameter	Benchmark	Reference document	Indicator	Sub Indicator	Max. marks	Marks obtained	Weightage
5	Operation and maintenance	Procedure for effective maintenance	Assets management plan and manual on SOMP	5.1) Compliance to prescribed deliverable	5.1.1) Supply of Specified Quantity and regularity of water upto tail end.	20		100 %
					5.1.2) Supply of specified Quality of potable water from WTP and upto tail end	20		
				5.2) Effective running of Machinery /WTP/STP	5.2.1) Deployment of skilled staff for operation and maintenance	5		
					5.2.2) Deployment of required number of staff for operation and maintenance	5		
					5.2.3) Running as per operation manuals on Standard Operating Methods and Procedure	5		
				5.3) Timely rectification of defects	5.3.1) Grievance redressal and record keeping	10		
					5.3.2) Maintenance schedule development and its compliance	10		
					5.3.3) Availability of spare parts/stand by machinery	10		
					5.3.4) Training and Capacity building	5		
					5.3.5) Regular disinfection	5		
					5.3.6) No panelty of electric bill for non-installation of capacitor, overload, delayed payments etc.	5		
					Total	**100**		**100%**

Sr. No.	Parameter	Marking Criteria	Weightage (%)	Marks obtained
1	Design and Planning		25*	
2	Execution, Inspection and Testing		40*	
3	Commissioning and Handing over		15*	
4	Safety Measures		5*	
5	Project Management	Adherence to project timelines and Cost Projections	5	
6	Environmental Measures	Consideration of environmental factors like sustainability, eco-friendly construction practices	5	
7	User Feedback	Feedback from beneficiaries, stakeholders to assess their satisfaction levels	5	
		TOTAL	**100**	
1	**Operations and Maintenance**		100*****	
		TOTAL	**100**	

*The breakup of the weightage is given in the detailed framework for these parameters

* Parameters that are not applicable to a specific project will not be considered in the audit scoring. The weightage will be adjusted accordingly

ANNEXURE II
Part A: Checklist for Approval of DPR for a Water Supply Project

Name of Division: _____

Name of Project: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Project title appropriately defined as per the scope of work				
2.	Objective of the project clearly stated				
3.	Project location identified with the appropriate map				
4.	All relevant stakeholders identified				
5.	Project justification provided				
6.	Feasibility study conducted				
7.	Topographic survey along with L-section of the line completed				
8.	Land acquisition completed				
9.	Forest clearance obtained				
10.	I. NOC obtained from Railway Department				
	II. NOC obtained from UHBVN/DHBVN				
	III. NOC/ROW obtained from I&WRD				
	IV. NOC obtained from PWD/NHAI				
	V. NOC obtained from MC/PRI				
11.	I. Population growth considered for design of Water Supply Scheme				
	II. Floating population and seasonal variation considered for design of Water Supply Scheme				
	III. Institutional and commercial development considered for design of Water Supply Scheme				

12.	The existing Water Supply Infrastructure assessed for its usage in the project				
13.	Available water sources and their lean period discharge identified				
14.	Depletion studies of the discharge for the water sources conducted				
15.	Water Supply Scheme design plans developed using the latest software for pipe network and drawings				
16.	WTP design optimized with advanced treatment technologies				
17.	Assessment and Vetting of DPR by the Department/Empaneled Consultant done				
18.	Water Sources sustainability measures provisions included				
19.	Other uses of the selected source assessed				
20.	Quality parameter of raw water tested				
21.	Modern mechanized/digital equipment considered: I. Remote Monitoring				
	II. SCADA				
	III. Automated Meter Reading (AMR)				
	IV. GIS				
	V. Online Water Quality Analsyer				
	VI. Automated Disinfection				
	VII. Smart Pumping Systems				
	VIII. Mobile Applications				
	IX. Customer Portals				
	X. Drone Photography				
22.	Financial implication, with a cost index up to the implementation period, considered				
23.	Funding agency identified				
24.	Annual budget allocation made				

25.	Suitable materials for the project identified				
26.	Specifications for the identified materials framed				
27.	Provision of vacant land for future expansion of WTP and storage tanks provided				
28.	Provision for Horticulture Development				
29.	Provision of solar energy included				
30.	Provision for energy efficient machinery and its automation included				

Note: This check list is required to be appended with the DPR at the time of approval and duly signed by concerned officers/officials

Part B: Checklist for Execution, Inspection, Testing, Commissioning & Handover of a Water Supply Project

Name of Division: _____

Name of Project: _____

Name of Agency: _____

Estimated Cost: _____

Date of Sanction: _____

Date of Award: _____

Contract Value: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	All materials such as cement, steel, coarse and fine aggregates, etc. procured from an approved source				
2.	Use of design mix ensured				
3.	Concreting for Reinforced work carried out in the presence of Junior Engineer/person authorised by Junior Engineer				
4.	Pipes and machinery of an approved make and manufacturer procured				
5.	Its testing carried out at the manufacturers' premises before dispatch				
6.	High-efficiency pumps and motors, specifically designed for site requirements, selected				
7.	Variable frequency devices (VFDs) installed to optimize energy use				
8.	Rising main/Suction pipe of the designated size used				
9.	Positive Suction Head made				
10.	Manpower deployed as per project requirements				
11.	Deployed manpower appropriately qualified				

12.	Processes for advanced water treatment provided: I. Arsenic				
	II. Iron				
	III. Fluoride				
	IV. Membrane Filtration				
	V. UV Disinfection				
13.	Automated operation of the pumping machinery and the WTP done				
14.	Smart metering and leakages detection devices provided				
15.	Sources, network and all other infrastructures are GIS mapped				
16.	Work being executed as per the originally approved bid document				
17.	Dismantled roads and streets repaired				
18.	Dismantled material disposed of appropriately				
19.	Slopes maintained for laying pipes to ensure gravitational flow of water				
20.	Physical inspection of pipes conducted at the site before laying				
21.	Site inspection and quality control registers maintained				
22.	Required number of tests during construction ensured				
23.	Water sample tested after treatment				
24.	Non- destructive test of concrete structures performed				
25.	Defects identified during inspections rectified				
26.	Reports of defect removal submitted regularly, and records maintained				
27.	Water testing laboratory set up at the WTP site				
28.	Water sample testing conducted regularly				
29.	Test results checked by the Engineer in Charge				
30.	Flow testing in pipes performed after laying at site				
31.	Pumping machinery tested to meet with required discharge at OHSR				
32.	Electric/ solar energy made available				

33.	Site inspection and quality control registers prepared and maintained properly				
34.	All test reports submitted				
35.	Commissioning procedures completed as per the project specifications				
36.	All systems tested and found operational				
37.	100% household water connection provided				
38.	Pipeline flushing completed				
39.	Cleaning and disinfection of WTP completed				
40.	Specify quality and quantity of portable water from WTP ensured				
41.	Regular specified quantity of water ensured				
42.	Specified quantity of water at tail-end ensured				
43.	SCADA and online analyzers operating properly				
44.	Automation of WTP operations implemented				
45.	Training provided to the operational staff				
46.	All necessary manuals and documentation handed over				
47.	Final inspection report completed and approved				
48.	All deficiencies identified during the commissioning phase addressed				
49.	All required permits and certifications obtained				
50.	The site handed over in a clean and operational condition				
51.	Plan for post-handover support and maintenance				
52.	Assets Completion Plan and completion report submitted by the agency,				
53.	The completion certificate provided by the department				
54.	Manual on Standard Operating Procedure for WTP prepared				
55.	Emergency response mechanism in place, such as standby machinery arrangements				
56.	Plan for post-commissioning monitoring and support				

57.	Security amount retained				
58.	Safety protocols established and communicated to the team				
59.	Safety equipment and gear provided in good condition				
60.	Emergency response plans in place and regularly updated				
61.	Security measures implemented to protect against unauthorized access				
62.	System in place for reporting and investigating safety incidents				
63.	Safety measures such as first aid kits & firefighting equipment, safety uniforms, gas release vents, etc. provided				
64.	Detection, alert, and remedial measures in case of chlorine gas leakage, if applicable				
65.	Physical Security measures taken				

Note: This check list is to be signed by the Executive Engineer and the visiting officers during their visit.

Part C: Checklist for Operation and Maintenance of Water Supply Project

Name of Division: _____

Name of Project: _____

Name of Agency: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Operation and Maintenance manuals made available				
2.	Routine maintenance conducted as per the schedule				
3.	Records of maintenance activities properly maintained				
4.	Emergency response procedures clearly defined and accessible				
5.	Staff training regularly conducted				
6.	All equipment and machinery regularly inspected and calibrated				
7.	System for reporting and addressing operational issues				
8.	Spare parts and supplies adequately stocked				
9.	Specified quality of portable water from WTP supplied				
10.	Specified quantity of water supplied regularly up to tail end				
11.	Disinfection and testing of water sample done regularly				
12.	Performance of the WTP (Water Treatment Plant) monitored regularly				
13.	Safety procedures and protocols followed during operation				
14.	Periodic reviews and audits of operation and maintenance practices conducted				

15.	Alarm system for chlorine gas leak detection.				
16.	Deployment of skilled staff for operation and maintenance.				
17.	Deployment of required number of staff for operation and maintenance.				
18.	Grievance redressal and record keeping.				
19.	Maintenance schedule development and its compliance.				
20.	Availability of spare parts/standby machinery.				
21.	Training and capacity building.				
22.	Regular chlorination of effluent.				
23.	Any penalty on electric bill for low power factor, overload, delayed payments, etc.				

Note: This check list is to be signed by the Executive Engineer and the visiting officers during their visit.

s

Quality Assurance Authority

Government of Haryana

Standard Operating Methods

and Procedures For

Technical Quality Assurance

In

Irrigation Project

PREFACE

The Government of Haryana has constituted an Authority, namely the 'Quality Assurance Authority' (QAA) for the purposes of quality assurance in engineering works implemented by the State Government and by organizations owned and controlled by the State Government vide notification no. 18/07/2022-3FICW/24265 dated 4th April 2023 published in Haryana government gazette vide no. 16-2023, Chandigarh, Tuesday, April 18th, 2023,

The QAA has already framed Technical Quality Assurance Parameters outlining indicators and sub-indicators required for Quality Assurance of the projects throughout their lifecycle. Now the QAA has further developed the Standard Operating Methods and Procedures (SOMPs) for Quality Assurance/Quality Control in the planning & design, construction, operation and maintenance of Irrigation Schemes for the purpose of having a ready reckoner to ensure that all quality parameters are adhered to during and after the construction of any project.

The Quality Control process focuses on detecting and correcting defects in a product or service. It involves identifying quality issues and taking corrective actions to resolve them. This is carried out by quality control monitors who would conduct inspections, perform tests, and implement necessary corrective measures. Through this systematic approach, the department would be able to identify shortcomings and defects on a real-time basis and shall ensure the delivery of a high-quality product or service.

The Quality Assurance process ensures the delivery of a high-quality product or service throughout its entire life cycle by preventing quality problems from the outset. This comprehensive approach involves the entire organization, from top management to front-line employees, working together to meet quality standards within the timeline and financial outlay. Key aspects of this process include planning, design, execution, delivery, training, documentation, and audits. By focusing on defect prevention, Quality Assurance ensures that the product or service meets the desired standards throughout the delivery period.

Standard Operating Methods and Procedure (SOMPs) for an Irrigation scheme offer numerous advantages such as:

1. Ensures Consistency: SOMPs help standardize procedures across different teams and locations, ensuring that canal water supply is distributed equitably.
2. Improves Efficiency: With a clear set of instructions, operational tasks can be performed efficiently, minimizing downtime and errors.
3. Ensures Safety and Quality: SOMPs ensure that safety standards are met, protecting both workers and consumers.
4. Compliance with Regulations: Many irrigation schemes are governed by national and local laws. SOMPs help ensure that operations comply with legal, forest and environmental regulations.

5. Training and Skill Transfer: SOMPs provide a training guide for new employees and help retain institutional knowledge, ensuring that the system can operate smoothly even if experienced staff are not available.

6. Emergency Management: SOMPs provide clear steps to handle emergency situations like leaks or breaches in canals to minimize damage and ensure a swift response.

7. Accountability: With documented processes, it's easier to identify who is responsible for different tasks, improving accountability within the organization.

In this respect, the Quality framework relating to all Quality Assurance parameters, indicators, and sub-indicators required in the various stages of irrigation projects have been prepared in detailed consultation with the user department responsible for the quality assurance and quality control for the irrigation projects. QAA is further hopeful that State Government departments implementing engineering works and organizations owned and controlled by the State Government would evolve suitable mechanisms to implement the required Quality Assurance plans with objective of achieving economic and social development of the State and improving the standard of life of the people.

Chairperson

QAA Haryana

CONTENTS

CHAPTER 1

Part A: Executive Summary

The Canal Irrigation Project is designed to meet the critical water requirements for agriculture in the region, providing a sustainable, efficient, and environmentally friendly solution for water distribution. The project involves multiple phases, each addressing specific aspects from planning and execution to operation and maintenance.

1. Planning and Design

The planning and design phase forms the foundation of the project, ensuring the system's efficiency, sustainability and long-term viability. A detailed feasibility study assesses water resources, topography, and soil characteristics, providing a clear understanding of the area's hydrological patterns. Using hydraulic modelling, the canal system is designed for optimal water distribution, incorporating features like embankments and gates to control flow and minimize water losses. The design also accounts for future expansion with provisions for integrating advanced automation technologies such as remote monitoring and sensor systems. Major tasks for Planning and Design are listed below:

- Conduct topographical surveys, soil assessments, hydrological studies, and climate impact evaluations.
- Analyze water requirements for agricultural areas and other users.
- Create detailed drawings and specifications for canal structure, embankments, control gates, and distribution networks.
- Calculate the required canal capacity based on water flow, seasonal variations, and future scalability.
- Plan for future inclusion of automated flow control, monitoring systems, and sensor technology.

2. Execution, Inspection, and Testing

During the execution phase, the canal and its appurtenant structures are constructed using sustainable materials and modern techniques to ensure durability and efficiency. Regular inspections are carried out throughout the construction process to ensure compliance with design specifications, safety standards, and quality control measures. Testing follows the construction phase, with water flow tests evaluating the hydraulic efficiency of the canal, detecting any blockages or leaks, and verifying the integrity of the structures. Necessary adjustments are made to ensure the system's functionality before commissioning. Major tasks for Execution, Inspection, and Testing are listed below:

- Clear land, level areas, and prepare foundations for canal construction.
- Select sustainable construction materials such as lining materials, concrete, and reinforcement.
- Build embankments, control gates, cross regulators, head regulators, bridges and other hydraulic structures.
- Conduct inspections at each construction phase to ensure compliance with design and safety standards.
- Perform water flow tests, check for leaks, and assess structural integrity before completion.

3. Commissioning and Handing Over

The commissioning phase involves running controlled water flows through the canal system to assess its full operational capacity. All mechanical and structural components, such as gates and control structures, are tested under actual working conditions. Following successful testing, the system is handed over to the operating authority with complete documentation, including operation manuals, maintenance schedules, and emergency response protocols. In addition, personnel are trained in the operation of the system to ensure seamless and effective water distribution. Major tasks for Commissioning and Handover are listed below:

- Test water flow throughout the entire canal system under various conditions.
- Adjust gates, flow control systems, and structural elements based on testing results.
- Train local authorities or operating personnel on the operation and maintenance of the canal.
- Prepare and hand over technical documentation, including maintenance schedules, operational manuals, and safety procedures.
- Officially transfer the canal system to the managing authority.

4. Safety Measures

Safety is prioritized throughout the project, starting from construction to the operational phase. During construction, strict safety protocols are followed, including the use of personal protective equipment (PPE) and the enforcement of safety guidelines on-site. Public safety measures include the installation of fences, barriers, and safety signage along the canal, especially near high-risk areas. Emergency response plans are developed, with contingencies for structural failures, floods, and other potential hazards, ensuring the safety of both workers and the public. Major tasks for Safety Measures are listed below:

- Identify potential risks related to construction, operation, and public safety.
- Implement safety measures, such as PPE use, first-aid stations, and proper site supervision.
- Install fences, warning signs, and barriers around high-risk areas along the canal.
- Develop emergency procedures for potential accidents, such as flooding or structural failure.
- Train staff and conduct safety drills to ensure preparedness for emergencies.

5. Project Management

The project management framework ensures timely completion, cost control, and effective coordination among all stakeholders. A detailed project schedule with clear milestones guides the construction process, with regular progress reviews to track completion and address any delays. Financial audits are conducted periodically to ensure that the project remains within budget, while procurement plans help avoid unnecessary expenditures. Communication channels are maintained between contractors, government agencies, and the local community to address concerns related to land acquisition, water rights, and the environmental impact of the project. Major tasks for Project Management are listed below:

- Create a detailed project schedule with milestones for each phase (planning, construction, commissioning, etc.).
- Monitor and manage the project budget, ensuring that expenditures align with projections.
- Oversee procurement of materials and manage contracts with vendors and contractors.
- Facilitate communication between stakeholders, including government bodies,

contractors, and local communities.

- Conduct regular reviews of progress and adjust project plans as needed to stay on schedule.

6. Environmental Measures

Environmental sustainability is a critical component of the project. During construction, measures are implemented to prevent soil erosion and reduce ecological disruption. Lined canals and proper grading ensure that water losses through evaporation and seepage are minimized, contributing to water conservation. Additionally, efforts are made to protect local biodiversity, including maintaining wildlife crossings and restoring natural habitats. To further reduce the environmental footprint, reforestation initiatives are launched in areas affected by the project, ensuring long-term ecological balance. Major tasks for Environmental Measures are listed below:

- Conduct an environmental impact assessment (EIA) to evaluate effects on local ecosystems.
- Implement measures such as canal lining, vegetative buffers, and proper grading to prevent soil erosion.
- Ensure the canal is designed to reduce seepage, evaporation, and water wastage.
- Plan for wildlife crossings, preserve aquatic habitats, and restore any disrupted ecosystems.
- Use eco-friendly materials and construction methods, and initiate reforestation or habitat restoration where needed.

7. Operation and Maintenance

A comprehensive operation and maintenance (O&M) plan ensure the long-term efficiency and functionality of the canal system. This plan includes regular inspections of embankments, control gates, and other hydraulic structures, along with desilting operations and repairs to any damaged components. Preventive maintenance is prioritized to reduce the likelihood of major disruptions. Trained personnel are responsible for monitoring the system, ensuring efficient water distribution, and responding promptly to any operational issues that may arise. Major tasks for Operation and Maintenance are listed below:

- Conduct regular inspections of the canal structures, embankments, and water control systems.
- Periodically remove silt, debris, and vegetation that might obstruct water flow.
- Ensure sluice gates, weirs, and other water control structures function properly.
- Respond to any structural damage or operational inefficiencies with timely repairs.
- Check for contamination or changes in water quality that may impact agricultural use.

8. User Feedback

An end-user feedback mechanism is established to continuously improve the system's performance based on the experiences of the local farming community. Farmers and water user associations are consulted through regular surveys and feedback sessions to gauge the system's effectiveness in terms of water availability, timing, and distribution. This feedback is crucial for making adjustments to operational protocols and identifying areas for improvement, ensuring that the canal system continues to meet the agricultural needs of the community. Major tasks for User Feedback are listed below:

- Regularly gather feedback from farmers, water user associations, and local communities.
- Evaluate the effectiveness of water distribution in meeting agricultural needs based on user input.
- Establish a system for addressing user complaints related to water access, distribution timing or system malfunctions.
- Collect and analyse data on water usage patterns, distribution efficiency, and system performance.

- Use feedback and data to make adjustments to operational protocols, water release schedules, and system upgrades.

In conclusion, this Canal Irrigation Project is designed and managed with a focus on sustainability, efficiency, and user satisfaction. Through careful planning, execution, and continuous monitoring, the project provides a reliable canal water supply for agriculture while minimizing environmental impact and ensuring long-term operational success.

Part B: Responsibilities of stakeholders

In the context of ensuring quality assurance for an Irrigation Canal Project, the roles and responsibilities of the key stakeholders—such as the Client Department, Contractor and other associated parties—are critical in maintaining the project's success and longevity. Here's a detailed breakdown of each stakeholder's responsibilities:

1. Client Department (Owner/Employer):

The Client Department, typically a government agency or private entity that commissions the project, holds overarching responsibility for ensuring that the water supply scheme meets all regulatory, environmental, and quality standards.

Responsibilities:

Project Conceptualization and Planning:

- Oversee the project's initial design, ensuring it aligns with community needs environmental sustainability.
- The client must hire qualified designers and consultants to prepare technical documents such as feasibility studies, environmental impact assessments, and detailed project reports.

Setting Quality Standards:

- Define specific quality parameters and benchmarks based on regulatory standards, water quality standards (e.g., WHO guidelines, BIS standards in India), and safety requirements.
- Ensure that the technical specifications of materials, such as cement, sand , coarse aggregates, water etc. adhere to norms and quality standards.

Tendering and Selection of Contractor:

- Draft comprehensive tender documents with technical specifications, quality standards, performance indicators, and timelines.
- Evaluate and select contractors based on their expertise, technical competency, past performance, and ability to meet the required quality standards.
- Approve subcontractors and suppliers involved in the irrigation Projects, Supervision

and Monitoring:

- Organize regular site inspections to ensure compliance with the approved designs, materials, and construction practices.
- Set up independent quality control teams or third-party agencies to monitor on-site activities.
- Ensure that the contractor follows proper procedures for water treatment, distribution system installation, and overall construction quality.

Material Approval:

- Approve materials after conducting appropriate testing or reviewing third-party certifications (e.g., ISI marks or other international certifications).
- Review quality certificates provided by suppliers for all the key Components. Testing

and Quality Audits:

- Oversee the construction work and its quality during various stages of the project, including during commissioning and operation.

- Ensure the testing of materials used in the construction work as per design and

Standards. Final Inspection and Approval:

- Conduct a thorough final inspection before commissioning the project to verify compliance with all quality standards and design parameters.

Ensuring Regulatory Compliance:

- Ensure that all aspects of the project, from planning to implementation, comply with state and national regulations, including environmental guidelines.
- Maintain close coordination with other regulatory bodies such as National Green Tribunal, Environmental Protection Agency and Water Regulatory Authorities.

2. Contractor:

- The Contractor is responsible for executing the work as per the design, specifications, and quality standards set by the Client Department. Their role is critical in ensuring that the project is built to last and function effectively.

Responsibilities:

Work Execution as per Specifications:

- Implement the construction of the irrigation scheme exactly as per the approved design, materials, and methods.
- Ensure that all procedures are followed in accordance with the design and quality benchmarks set forth by the client.

Material Procurement and Handling:

- Procure materials that meet the approved quality standards.
- Verify that the materials supplied by vendors have undergone proper quality testing and have the required certifications.

Implementation of Quality Control (QC) Plan:

- Establish and maintain an internal quality control system with qualified staff responsible for conducting quality checks on materials, processes, and completed work.
- Set up an on-site testing laboratory to conduct regular material Tests, Coordination

with Client and Third Parties:

- Maintain close communication with the Client Department regarding progress updates, challenges, and any deviations from the design or quality requirements.
- Coordinate with third-party quality auditors or inspectors for regular Assessments,

Documentation and Reporting:

- Maintain proper records of all quality-related processes, including material tests, inspection reports, daily work logs, and certificates from suppliers.
- Prepare and submit regular reports on the progress and quality of work to the Client Department.

Rectification of Defects:

- Address any defects, quality issues, or non-compliance highlighted during inspections or testing.
- Ensure proper measures are taken to correct the defects and report the corrections

back to the client for re-inspection.

Health Safety, and Environmental Compliance:

- Ensure that workers follow health and safety regulations to prevent accidents and ensure smooth project execution.

Testing and Commissioning:

- Conduct all necessary tests prior to final commissioning.
- Handover the system after ensuring that it is in full compliance with the approved design and quality parameters and is ready for operation.

3. Third-Party Quality Auditors/Consultants:

In many water supply projects, independent third-party consultants or quality assurance teams are engaged to monitor quality.

Responsibilities:

Quality Audits:

- Perform scheduled and surprise audits on the construction site to verify compliance with the quality standards set by the client department.
- Check that the materials used and construction methods align with the approved specifications.

Testing and Certification:

- Conduct third-party tests on materials and completed work, including water quality testing, structural integrity checks, and system performance testing.
- Issue certifications of quality where appropriate, ensuring all testing is documented and reported to both the client and contractor.

Reporting and Recommendations:

- Provide independent reports on the findings during inspections and audits, identifying any discrepancies and recommending corrective measures.
- Suggest improvements in processes, if necessary, to enhance the overall quality of the project.

4. Suppliers (Material and Equipment Providers):

Suppliers are responsible for providing high-quality materials and equipment that meet the specifications required for the irrigation scheme.

Responsibilities:

Material Supply:

- Supply materials such as cement, coarse aggregates, fine aggregates, water, admixtures, HDPE Films, PVRs etc. that meet the prescribed specifications provided by the client and contractor.

Quality Certifications:

- Provide proper quality certifications and test reports for all materials supplied, ensuring they comply with the ISI standards.

Material Testing:

- Ensure that all materials are tested prior to delivery, with evidence of passing all relevant quality checks

Replacement of Defective Materials:

- Replace any defective or substandard materials immediately when identified during on-site inspections or testing.

5. End Users (Farming Community/WUAs): The ultimate users of the irrigation scheme, often represented by farming community / WUAs also have a major role to play.

Responsibilities:

Feedback on Quality:

- Provide feedback on the functioning of the irrigation scheme once the system is

Operational Monitoring of Service Levels:

- Continuously monitor the service levels provided by irrigation scheme and report any issues or concerns to the client or local authorities.

Activities to be performed by the Departmental Officers/Officials and Executing Agency

Sr. No.	Activity	CE	SE	EE	AE	JE	Executing Agency
Planning and Design							
1.	Sector wise requirement of canal water			✓	✓	✓	
2.	Assessment of availability of water			✓	✓	✓	
3.	Notify water allowance in case of new canal	✓	✓	✓			
4.	Source finding and determining available water sources & their lean period discharges		✓	✓	✓	✓	
5.	Flood Impact Assessment			✓	✓	✓	
6.	Seepage assessment due to waterlogging			✓	✓	✓	
7.	Assessment of existing infrastructures.			✓	✓	✓	
8.	Topographic Survey.			✓	✓	✓	
9.	Land Availability			✓	✓	✓	
10.	Specifying NOC from Forest, Railways, Electricity Board, PHED, Roads, Panchayat			✓	✓	✓	
11.	Preparation of Pre-Feasibility Report and Rough Cost Estimate			✓	✓	✓	
12.	Approval of Standing Technical Committee or Competent Authority	✓	✓	✓			
13.	Obtaining Administrative Approval of the project	✓	✓	✓			
14.	Initiating the process of the NOCs from Forest, Railways, Electricity Board, PHED, Roads, Panchayat, etc. for utilities			✓	✓	✓	
15.	Selection of latest software in design	✓	✓	✓			
16.	Selection of modern mechanized/digital equipment	✓	✓	✓			
17.	Framing technical specifications for materials	✓	✓	✓	✓		
18.	Preparation of Detailed Project Report along with design, drawings cost estimate and its timeline.			✓	✓	✓	
19.	Approval of Detailed Project Report	✓	✓				
20.	Identification of funding agency and annual budget allocation	✓	✓	✓			
21.	Obtaining NOCs and clearing all utilities			✓	✓	✓	
22.	Preparation of bids, call of tenders and award of work after completing all formalities	✓	✓	✓			
23.	Preparation of Execution Plan and fixing of timelines & milestones as per contract agreement			✓	✓	✓	
Execution, Inspection and Testing							
24.	Selection of approved source for materials such as cement,			✓	✓	✓	✓

	aggregates, sand, steel etc.						
25.	Submission of design mix and its approval	✓	✓	✓	✓	✓	✓
26.	Pre inspection and tests for equipment and machinery at manufacture's premises before dispatch			✓	✓		✓
27.	Procurement and testing of construction materials such as cement, aggregates, steel, etc.			✓	✓	✓	✓
28.	Ensuring the execution as per design and specifications, and as per the bid document			✓	✓	✓	✓
29.	Qualified manpower deployment as per requirement			✓	✓	✓	✓
30.	GIS mapping of sources and all other infrastructures			✓	✓	✓	✓
31.	Ensuring the disposal of dismantled material			✓	✓	✓	✓
32.	Setting up material testing laboratories having all testing equipment relevant to the project requirements.			✓	✓	✓	✓
33.	Ensuring relevant mandatory tests with required frequency during execution at every stage of construction.			✓	✓	✓	✓
34.	Preparation of site inspection and quality control registers.			✓	✓	✓	✓
35.	Supervision and inspection of Work by the Executing Wing	✓	✓	✓	✓	✓	
36.	Inspections by Internal Vigilance Wing of the department	✓	✓	✓	✓		
37.	Checking of test results by Engineer in Charge			✓	✓	✓	✓
38.	Submission of reports and rectification of defects			✓	✓	✓	✓
39.	Conducting of tests of concrete, soil, etc.			✓	✓	✓	✓
40.	Testing of pumping machinery to meet with the required discharge if applicable			✓	✓	✓	✓
41.	Flow testing of canal/distributaries/minors			✓	✓	✓	✓
42.	Availability of electric/ solar energy as per requirements			✓	✓	✓	
43.	Submission of reports and maintaining the record			✓	✓	✓	
Commissioning and Handing over							
44.	Ensuring specified discharge and regularity of canal water			✓	✓	✓	✓
45.	Ensuring cleaning of canal, distributaries and minors.			✓	✓	✓	✓
46.	Ensuring specified discharge of canal water at the tail-ends.			✓	✓	✓	✓
47.	Adjustments of Flow Control Systems			✓	✓	✓	✓
48.	Ensure proper working of SCADA			✓	✓	✓	✓
49.	Submission of Assets Completion Plan and Report						✓
50.	Approval of Assets Completion Plan & Report and certificate			✓	✓	✓	

51.	Preparation of Manual for running of canal system			✓	✓	✓	
Safety Measures							
52.	Providing of safety measures such as first aid & firefighting equipment, safety uniforms etc.						✓
53.	Monitoring and Surveillance			✓	✓	✓	✓
54.	Controlling the access of unauthorized person at canal sites				✓	✓	✓
55.	Incident response and reporting				✓	✓	✓
Operation and Maintenance (may vary as per agreement for O&M)							
56.	Supply of Specified discharge of canal water upto tail end.			✓	✓	✓	✓
57.	Deployment of skilled staff for operation and maintenance			✓	✓	✓	✓
58.	Formation of WUAs			✓	✓	✓	
59.	Deployment of adequate manpower			✓	✓	✓	✓
60.	Ensuring emergency response mechanism			✓	✓	✓	✓
61.	Maintenance schedule development and its compliance			✓	✓	✓	✓
62.	Availability of spare parts/ standby machinery			✓	✓	✓	✓
63.	Training and capacity building			✓	✓		
64.	Grievance redressal and record keeping			✓	✓	✓	✓

Note: The activities are to be approved/decided at various levels in accordance with Government guidelines and instructions, as well as the authority vested in them, in addition to the aforementioned.

CHAPTER 2

SOMPs for Irrigation Canal and Drainage Project

1.) PLANNING AND DESIGN

1.1) Demand and Resource Assessment

1.1.1) Sector-Wise Requirement of Canal Water

A. Data Collection:

- Gather historical data on water usage in different sectors, including agriculture, industry, and residential areas.
- Consult local authorities and stakeholders to estimate future water requirements for planned industrial developments.
- Assess seasonal variation in water demand, particularly during peak agricultural seasons and industrial usage periods.

B. Sectoral Analysis:

- Analyze the water requirement data sector-wise, distinguishing between peak and lean seasons.
- As per total requirement, fix the water allowance for the construction of the new canal
- Prioritize sectors based on their criticality to the region's economy and social well- being.
- Adjust the irrigation and water distribution schedule to accommodate high-demand periods.

C. Documentation and Reporting:

- Prepare a detailed report outlining the sector-wise water requirements and seasonal variations.
- Use this analysis to plan the canal discharge and storage requirements.

1.1.2) Available Water Sources & Their Lean Period Discharges

A. Usage Analysis:

- Assess the current usage of water in parent channels for various purposes such as irrigation, industrial, institutional, and domestic use, etc.

B. Optimization Strategies:

- Develop strategies to optimize water usage in the existing infrastructure, ensuring equitable distribution.
- Implement measures to improve water efficiency such as water saving technologies and better management practices.

C. Lean Period Analysis:

- Analyse historical data to determine the discharge rates during lean periods (e.g., dry seasons or droughts).
- Monitor current discharge rates during lean periods to compare with historical data.

D. Documentation and Reporting:

- Document the findings and prepare a report detailing the lean period discharge rates.
- Recommend measures to mitigate the effects of high silt content and low discharge

during the lean period.

1.1.3) Discharge Depletion Studies

A. Data Collection:

- Monitor and record the discharge rates at multiple points along the canal and drainage system over time.
- Collect historical data on discharge rates for comparison.

B. Analysis of Contributing Factors:

- Identify possible factors leading to discharge depletion, such as seepage, evaporation, unauthorized withdrawals, or blockages.
- Assess the impact of seasonal variations, climatic changes, and human activities on discharge rates.

C. Mitigation Planning:

- Develop strategies to reduce discharge depletion, such as canal lining, improved water management practices, and monitoring systems.
- Implement regular maintenance schedules to address blockages and unauthorized withdrawals.

Reporting: Prepare a detailed report on discharge depletion trends, contributing factors, and proposed mitigation measures.

1.1.4) Flood Impact Assessment

A. Historical Flood Data Analysis:

- Review historical records of flooding in the project area, including frequency, intensity, and impact.
- Identify flood-prone areas along the canal and drainage system.

B. Hydrological Modelling:

- Use hydrological models to simulate flood scenarios based on various rainfall patterns and discharge rates.
- Identify areas at risk of flooding and potential weak points in the canal and drainage system.

C. Flood Mitigation Measures:

- Develop flood mitigation strategies, such as constructing embankments, widening canals, and installing floodgates.
- Prepare an emergency response plan in coordination with local authorities and communities.

D. Reporting and Documentation:

- Document the flood risk assessment and proposed mitigation measures in a comprehensive report.
- Regularly update the flood assessment based on new data and observations.

1.1.5) Seepage Assessment due to Waterlogging

A. Initial Site Analysis and Data Collection:

- Conduct a preliminary site survey to gather topographical and hydrological data, focusing on areas prone to seepage due to waterlogging.
- Review historical data on local groundwater levels, soil types, and seasonal rainfall patterns to assess waterlogging risks.

B. Soil and Geotechnical Analysis:

- Perform soil testing to determine permeability, porosity, and moisture retention characteristics to evaluate the risk of seepage.
- Conduct geotechnical analysis to identify any subsurface layers that may contribute to seepage or hinder drainage, especially in areas with a high water table.

C. Modelling and Prediction of Seepage Flow:

- Use hydrological and geotechnical models to simulate seepage flow, accounting for soil properties, canal design, and groundwater dynamics.
- Predict potential seepage rates and waterlogging scenarios under varying conditions, such as peak flow or heavy rainfall, to guide design choices.

D. Designing Mitigation Measures:

- Integrate mitigation measures into the canal design, such as impermeable linings, cutoff walls, or drainage channels, to minimize seepage due to waterlogging and high ground water levels.
- Plan for supplementary drainage solutions, such as interceptor drains or relief wells, to control waterlogging in areas identified as high-risk.

E. Documentation and Review:

- Document all findings, design assumptions, and recommended mitigation measures in a seepage and waterlogging assessment report.
- Submit the report to the design review team for validation and integration into the project's overall design, ensuring it meets regulatory and project standards.

1.1.6) Assessment of Water in Existing Canals/Distributaries/Minors/Drains

A. Water Level Monitoring:

- Regularly measure water levels in the existing canals, distributaries, minors, and drains.
- Record variations in water levels over time, especially during peak irrigation seasons.

B. Usage Analysis:

- Assess the current usage of water in these channels for various purposes such as irrigation, domestic use, and industrial use.
- Identify any unauthorized or inefficient water usage practices.

C. Optimization Strategies:

- Develop strategies to optimize water usage in the existing infrastructure, ensuring equitable distribution.
- Implement measures to improve water efficiency, such as water-saving technologies and better management practices.

D. Documentation:

- Prepare a report detailing the current water levels, usage patterns, and optimization strategies.
- Include recommendations for improving water management in the existing infrastructure.

1.1.7) Assessment of Existing Infrastructure and its uses

A. Infrastructure Inspection:

- Conduct a thorough inspection of the existing irrigation and drainage infrastructure, including canals, distributaries, drains, and control structures.

- Identify any signs of wear and tear, damage, or obstructions.

B. Usage Evaluation:

- Evaluate how the existing infrastructure is being used, including the effectiveness of water distribution and drainage.
- Identify areas where the infrastructure is underutilized or overburdened.

C. Improvement Planning:

- Develop plans for upgrading or repairing the existing infrastructure to improve its efficiency and capacity.
- Consider the integration of new technologies or methods to enhance the performance of the infrastructure.

D. Reporting:

- Document the findings of the infrastructure assessment, including recommendations for improvements.
- Prepare a maintenance and upgrade schedule to ensure the longevity and effectiveness of the infrastructure.

1.2) Approval of STC or Competent Authority

1.2.1) Preliminary Survey

A. Survey Area Identification:

- Define the boundaries of the project area for the irrigation and canal project.
- Identify key locations for potential canal routes, water sources, and irrigation zones.

B. Field Survey:

- Conduct a preliminary field survey to collect data on terrain, soil quality, and land use.
- Engage local authorities and landowners to gather relevant historical and geographical data.

C. Data Compilation:

- Document survey results, including topographic features, water availability, and environmental conditions.
- Create preliminary maps and reports for review by the project planning team.

1.2.2) Land Availability, NOCs applicable for utilities

A. Land Availability Assessment:

- Identify the land required for the project, including canals, distributaries, and support infrastructure.
- Verify ownership status through land records, revenue departments, and local bodies.
- Specify whether the Government land is available for the project, or it has to be acquired and to what extent.

B. Identification of required NOCs

- Specify all necessary No Objection Certificates (NOCs) required for forest clearance, and all other utilities affected by the project execution.

1.2.3) Preparation of Pre-Feasibility Report

A. Data Collection:

- Compile data from the preliminary survey, land availability, NOCs for utilities, and environment impact studies.
- Evaluate water demand, crop patterns, and potential irrigation benefits for the region.

B. Technical and Financial Analysis:

- Conduct an analysis of the technical feasibility, including canal design, water sources, and flow capacities.
- Prepare a financial analysis, estimating costs and benefits of the project.

C. Drafting the Report:

- Develop the pre-feasibility report, covering technical, financial, environmental, and social aspects.
- Include recommendations on whether to proceed to the next stage based on feasibility.

1.2.4) Preparation of Rough Cost Estimate

A. Cost Estimation Process:

- Estimate the costs for land acquisition, construction, materials, labor, and administrative expenses.
- Break down costs for each major component of the project: canals, distributaries, and irrigation systems.

B. Contingency and Inflation:

- Include contingencies for unforeseen expenses and inflation over the project timeline.
- Review previous similar projects to benchmark cost estimates.

C. Report Submission:

- Prepare a comprehensive rough cost estimate document.
- Submit to the Standing Technical Committee (STC) or Competent Authority for review and approval.

1.2.5) Approval of Standing Technical Committee (STC) or Competent Authority

A. Submission of Reports:

- Present the pre-feasibility report including the approximate cost of the project to the STC or the Competent Authority.
- Ensure that all necessary supporting documents, including land availability status, are included.

B. Technical Review:

- Participate in the review process, addressing any queries or concerns raised by the committee.
- Make revisions to the reports as per the recommendations of the STC or the Competent Authority.

C. Approval and Next Steps:

- Obtain formal approval from the STC or the Competent Authority for proceeding

with the project.

- Document the approval and communicate with relevant stakeholders to initiate the detailed project report (DPR) phase.

1.3) Cost Analysis, Administrative Approval, Budget Planning, and Timeline Estimates

1.3.1) Financial Implication with Cost Index Up to Implementation Period and Administrative Approval

A. Cost Estimation:

- Develop a project cost estimate based on the project's scope, including costs for land acquisition, and contingencies, etc.
- Create a cost index that accounts for inflation, market price fluctuations, and other economic factors that could affect costs during the project's implementation period.
- Regularly review and update the cost index to reflect changes in market conditions, ensuring that the budget remains accurate throughout the project's timeline.

B. Financial Analysis:

- Prepare a detailed breakdown of all project costs, categorizing them into capital expenditure (CAPEX), operating expenses (OPEX), and maintenance costs.
- Allocate a contingency budget to cover unforeseen expenses, typically 5-10% of the total project cost.
- Compile the financial data into a comprehensive report, highlighting key financial implications, potential risks, and mitigation strategies.

C. Administrative Approval:

- Obtain Administrative approval for the project from the competent authority or the government.

1.3.2) Identification of Funding Agency and Annual Budget Allocation

A. Funding Agency Identification:

- Identify potential government funding sources, including central and state government schemes, grants, and subsidies.
- Explore funding opportunities from international development agencies, such as the World Bank, Asian Development Bank, or bilateral donors.
- Consider public-private partnerships (PPP) as a funding option, especially for large- scale projects.

B. Proposal Preparation:

- Prepare a comprehensive DPR that outlines the project's objectives, scope, financial requirements, and expected outcomes.
- Submit the DPR along with a funding application to the identified agencies, ensuring that all necessary documentation and justifications are included.

C. Annual Budget Allocation:

- Work closely with the funding agency to secure annual budget allocations, aligned with the project's implementation schedule.

- Track the allocation and utilization of funds, ensuring that expenditures align with the project's financial plan.
- Provide regular financial reports to the funding agency, detailing budget usage, milestones achieved, and any variances from the planned expenditure.

1.3.3) Timeline for DPR Approval

A. DPR Approval Timeline:

- Submit the DPR to the relevant authority or funding agency for review and approval.
- Engage with the reviewing body to address any queries or required modifications to the DPR.
- Set a target date for DPR approval, Call of Tenders, Award of Work & Its Implementation depending on the project's complexity and scale.

1.4) Survey and Initiate the Process for Land Acquisition and NOCs for utilities

1.4.1) Topographic Survey

I. Planning the Survey:

- Identify the project area, the starting point, and the endpoint of the canal/drain.
- Define the scope of the topographic survey including L-Section (Longitudinal Section) of the canal/drain.
- Prepare a detailed survey plan, outlining the methodologies to be used, including equipment, personnel, and timeline.
- Use high-precision instruments like Total Station, GPS, and droned for data collection.

II. Data Collection:

- Use high-precision instruments like Total Station, GPS, and Drones for data collection.
- Conduct the survey along the centerline of the proposed canal/drain capturing ground levels at regular intervals.
- Ensure that all major geographical features (rivers, roads, railway lines, buildings, etc.) are recorded accurately.
- Measure and record the existing land use, vegetation, and other environmental factors that may impact the canal / drain construction.

III. Preparation of L-Section:

- Plot the L-Section of the canal/ drain based on the data collected during the survey.
- Ensure that the L-Section includes details like natural surface levels (NSL), bed levels, water level, and proposed cross- sections.

IV. Verification and Validation:

- Cross-check the survey data with existing maps and previous surveys.
- Validate the accuracy of the L-Section with the help of a qualified surveyor.

V. Documentation:

- Prepare detailed survey reports, including topographic maps, L-Sections, and relevant drawings.
- Archive the data in both digital and physical formats for future reference.

1.4.2) Initiation of the process of Land Acquisition and Forest Clearance

A. Land Acquisition Process:

- Initiate the land acquisition process in compliance of the relevant laws and regulations.
- Engage with landowners to negotiate and finalize compensation and rehabilitation if necessary.
- Obtain consent from the landowners and prepare the necessary documentation for land transfer.

B. Monitoring and Compliance:

- Ensure compliance with all land acquisition and environmental regulations.
- Keep a record of all communications, and agreements with the stakeholders, obtained during the process.

1.4.3) Initiate the process for NOCs from Forest, Railways, Electricity Board, PHED, Roads and Panchayat, etc.

A. Identification of Stakeholders:

- Identify all the stakeholders whose infrastructure or services may be affected by the project.
- This may include Railways, Electricity Board, Public Health Engineering Department (PHED), Roads Department, and local Panchayats etc.

B. Application for NOCs:

- Prepare and submit detailed project reports to the relevant authorities, highlighting the potential impact of the project on their infrastructure or services.
- Request the necessary NOCs from each authority, ensuring that the application is complete with all required documents, including survey maps, plans, and environmental assessments.

C. Follow-Up and Negotiation:

- Engage with the concerned authorities to follow up on the NOC applications.
- Address any concerns or objections raised by the authorities and make necessary modifications to the project plan if required.

1.5) Selection of Technology

1.5.1) Use of Latest Software for Design and Drawings

A. Software Selection:

- Determine the specific needs of the project, such as hydraulic analysis, structural design, topographic mapping, and drawing creation.
- Review the latest software available in the market, such as AutoCAD, Civil 3D, HEC- RAS, ArcGIS, STAAD Pro, and other relevant tools.
- Choose software that best meets the project requirements, is user-friendly, and is supported by the necessary hardware and expertise.

B. Software Installation and Setup:

- Ensure that the chosen software is installed on all relevant workstations.
- Customize software settings to align with project-specific requirements, such as unit measurements, layer structures, and templates.
- Regularly update the software to its latest version to benefit from the latest features,

security updates, and bug fixes.

C. Training and Skill Development:

- Organize training sessions for the project team to ensure they are proficient in using the selected software.
- Provide access to technical support and resources such as user manuals, online tutorials, and workshops to address any challenges.
- Encourage team members to obtain certifications in the relevant software to enhance their skills and ensure high-quality work.

D. Design and Drawing Development:

- Use software like Civil 3D, HEC-RAS, or MIKE 11 for topographic surveys, hydraulic modeling, and canal design.
- Utilize tools such as STAAD Pro for structural analysis and design of canals, bridges, cross – drainage works and drainage systems.
- Develop detailed design drawings using AutoCAD or similar software, ensuring all components of the irrigation and drainage system are accurately represented.
- Create 3D models to visualize the design and detect any potential issues before construction begins.

E. Quality Control and Review:

- Use the software's built-in validation tools to check for errors, inconsistencies, or design flaws.
- Conduct peer reviews of the designs and drawings to ensure accuracy and compliance with project specifications and standards.
- Make necessary adjustments based on feedback and re-run simulations or analyses as needed.

F. Documentation and Archiving:

- Maintain detailed records of all design files, simulation results, and drawings, including version history and modification logs.
- Store the final design and drawing files in a secure and organized manner, both digitally and in hard copies, if necessary, for future reference.
- Regularly back up all design-related files to prevent data loss.

G. Collaboration and Integration:

- Utilize software that allows for collaboration among team members, such as cloud- based platforms or shared project files.
- Ensure that the selected software can integrate with other tools used in the project, such as GIS systems, project management software, and database systems.

H. Continuous Improvement:

- Collect feedback from the design team on the software's effectiveness and areas for improvement.
- Stay informed about advancements in design software and tools, and be ready to adopt new technologies that can enhance project outcomes.

1.6) Optimum Design and Selection of modern equipment and processes

1.6.1) Optimum design of canal, distributaries, minors, drains, and its appurtenant works/structures etc.

A. Design Considerations

- Analyze historical and projected water demand in the service area to determine peak flow requirements.
- Select appropriate cross-sectional shapes (e.g., trapezoidal, rectangular) to optimize flow and reduce erosion.
- Establish a gradient that prevents stagnation while minimizing the risk of erosion.
- Create a detailed longitudinal profile indicating critical points of elevation change.
- Conduct soil tests to assess permeability, soil type, and compaction characteristics.
- Decide on appropriate construction materials (e.g., cement, aggregates, steel, concrete, stone, etc.) based on soil conditions to minimize seepage.

B. Design Methodology

- Utilize Total Stations or GPS technology for accurate mapping of the terrain.
- Collect rainfall data, watershed characteristics, and existing water flow conditions for optimum design.
- Determine flow rates and velocities.
- Calculate energy losses due to friction and turbulence to optimize canal dimensions.
- Choose durable materials considering local availability and environmental impact.
- Ensure all designs adhere to relevant IS codes for structural integrity and safety.
- Evaluate various design options based on cost, efficiency, and sustainability to select the optimal solution.

1.6.2) Use of modern mechanized/digital equipment

Equipment Overview

1. Sensor Paver
    - Automatically paves canal surfaces with precise thickness and smoothness.
    - Reduces labour costs and improves the durability of canal linings.
2. Automated Gates
    - Controls water flow automatically based on preset criteria or real-time data.
    - Minimizes manual operation and enhances responsiveness to changing water levels.
3. Flow Meters
    - Measures the flow rate of water within canals and irrigation systems.
    - Provides accurate data for efficient water distribution and usage monitoring.
4. Laser Land Levelling Equipment
    - Uses laser technology to ensure even leveling of agricultural fields.
    - Improves irrigation efficiency and reduces water wastage.
5. Remote Sensing and GIS
    - Employs satellite imagery and GIS mapping for land and water resource management.
    - Enhances planning accuracy and resource allocation by providing comprehensive spatial data.

6. Drip and Sprinkler Irrigation
    - Delivers water directly to the roots of plants or uniformly across the field.
    - Minimizes evaporation and runoff, ensuring efficient water use.
7. Soil Moisture Sensors
    - Provides real-time data on soil moisture levels.
    - Facilitates precise irrigation scheduling, preventing overwatering and promoting healthy crop growth.
8. Automation and Control System of Gates
    - Integrates with sensors to automate gate operations based on flow requirements.
    - Enhances water management efficiency and reduces the need for manual monitoring.
9. Weather Stations
    - Monitors climatic conditions such as temperature, humidity, and rainfall.
    - Informs irrigation practices and helps prevent overwatering or under-watering.

1.6.3 Provision for Horticulture Planning

I. Survey and Assessment

- Assess soil type, water retention capacity, groundwater levels, terrain, and vacant land availability along canals/drains, embankments, catchment area, etc
- Map erosion-prone areas where plantation can help in soil stabilization.
- Ensure that selected species do not obstruct water flow or interfere with canal structures

II. Selection of Plantation Area

- Plantation areas should be prioritized based on their ecological and functional significance. Green belt development should be focused along canal embankments to reduce the risk of soil erosion and enhance slope stability.
- In addition, pockets near canal junctions, lock gates, and pumping stations should be identified for decorative landscaping to enhance the aesthetics of these functional spaces and improve public perception of the project.
- No plantation should be carried out on the inner side and top of the banks of the canal and drains.

III. Plant Species Selection

- The selection of plant species must align with local climatic conditions, and soil type.
- Trees such as Neem, Peepal, Jamun, Arjun, and Gulmohar are suitable due to their deep-rooted nature, shade-providing characteristics, and soil-binding properties. Such trees should preferably be planted along the surplus land strips along the canal so that these do not cause any hinderance to the usage of service road and any damage to the canal banks.
- Shrubs like Bougainvillea, Hibiscus, Ficus, and Jatropha serve dual purposes of erosion control and ornamental enhancement. Ground cover plants, including Bermuda grass and Carpet grass, should be introduced to stabilize embankments and provide a uniform green cover. These should be planted at the outer slopes of canals.
- Seasonal and perennial flowering plants can be planted at key locations for visual appeal at the free land area available at canal structures such as bridges, bridge-cum-falls, head regulators, cross regulators, siphon, aqua ducts, etc.
- In non-interference zones, fruit-bearing trees like Mango, Guava, and Amla can be planted for ecological benefits and to support biodiversity.

- Avoid plants like Eucalyptus, Poplar, Rubber Plant, Silver Oak, etc along the canals as these are suitable in the water logged areas only due to high consumption of water.

1.7) Framing Specifications and Technical Sanction of Estimate

1.7.1) Identification of Materials Proposed to Be Used

A. Material Requirements Analysis:

- Determine the specific material requirements based on the type of construction, environmental conditions, water quality, and the load-bearing capacity needed.
- Consider the durability, life cycle, and environmental impact of materials. Preference should be given to materials that are sustainable and have low environmental footprints.

B. Material Identification:

- Identify materials such as concrete, steel, geotextiles, HDPE, PVC, and other polymers suitable for canals, pipelines, and drainage structures.
- For specific requirements, identify materials like corrosion-resistant alloys, eco-friendly composites, and advanced sealing compounds.
- Shortlist reliable vendors who supply the identified materials, ensuring they meet quality and industry standards.

1.7.2) Framing Specifications for Above Materials

A. Specification Documentation:

- Develop detailed technical specifications for each material, including composition, physical properties, dimensions, tolerances, and quality standards.
- Define the performance criteria that the materials must meet, including strength, durability, resistance to corrosion, and environmental impact.
- Ensure all specifications are in compliance with national and international construction codes and standards.

B. Approval of Design and Drawings:

- The optimum design and drawings of the work approved by the competent authority.

1.7.3) Technical Sanction of Detailed Estimate

- As per cost analysis, approved Design & Drawings, and finalized technical specifications, the detailed estimate of the work shall be prepared and get sanctioned from the competent authority.

1.8) Clearance of all requisite NOCs, Award of Work, and Project Management

1.8.1) NOCs obtained and clearance of all utilities

- Ensure that all the NOCs from Forest Department, Railways, Electricity Board, Public Health Engineering Department (PHED), Roads Department, and local Panchayats etc. are obtained and the work site is cleared of all encumbrances.
- Once the NOCs are obtained, document them thoroughly and include them in the project's legal and administrative files.
- Ensure that all conditions mentioned in the NOCs are adhered to during the project execution.

1.8.2) Award of Work and Contract Agreement

- Develop detailed tender documents, including bill of quantities (BQQ) technical specifications, project timelines, financial terms, and conditions.
- Announce the tender in relevant public domains, allowing sufficient time for bidders to prepare and submit their proposals (usually 1-2 months).
- Accept the technical bids and the financial bids in compliance of the tender eligibility criteria.
- Evaluate the bids based on technical competence, financial stability, and compliance with tender requirements.
- Finalize and approve L-1 agency and its tender rates as per the evaluation of the bids.
- After obtaining all NOCs and site clearance, award the work to the selected bidder within a predefined period as per the bid document and sign the contract agreement.

1.8.3) Project Management, Execution Plan, and fixing of Timelines/Milestones as per Contract Agreement

A. Implementation Timeline:

- Coordinate with the contractor to establish a project start date, ensuring that all prerequisites (permits, clearances, site preparation) are in place.
- Develop a detailed implementation schedule with key milestones, including project initiation, construction phases, testing, and final commissioning.
- Implement regular monitoring mechanisms to track progress against the project timeline, and report to stakeholders on a monthly or quarterly basis.
- Aim for project completion within the agreed timeframe, depending on quantum of work and project's scale.

B. Contingency Management:

- Establish protocols for managing delays, including regular progress reviews, identifying bottlenecks, and implementing corrective actions.
- After project completion, conduct a review to assess the overall implementation process, identify lessons learned, and document best practices for future projects.

1.9) Long-Term Planning

1.9.1) Future Requirement Projections such as Land for Remodeling

A. Future Demand Analysis:

- Population Growth and Agricultural Needs: Project future water demands based on anticipated population growth, agricultural expansion, and industrial development.
- Environmental Changes: Consider the impact of climate change, land use changes, and water availability on future needs.

B. Land Requirement Projections:

- Based on future demand analysis, identify areas where additional land may be required for the expansion or remodelling of the irrigation and drainage systems.
- Develop a strategy for acquiring necessary land, including potential negotiation with

landowners, government agencies, and other stakeholders.

C. Strategic Planning:

- Create long-term remodelling plans for the irrigation and drainage systems, incorporating future land requirements and technological advancements.
- Ensure that the long-term plans align with regional development plans and water management strategies.

D. Monitoring and Adjustment:

- Conduct periodic reviews of long-term plans to adjust for any changes in demand projections or land availability.
- Ensure that long-term plans are flexible enough to adapt to unforeseen changes in demand or environmental conditions.

1.10) Reducing Operation and Maintenance (O&M) Costs

1.10.1) Provision of Energy-Efficient Machinery such as BEE Certified/Star Rating

A. Identification of Energy-Efficient Machinery:

- Prioritize machinery and equipment that are BEE-certified or have a high star rating for energy efficiency.
- Conduct energy audits to identify existing equipment that can be replaced with more energy-efficient alternatives.

B. Procurement Process:

- Choose vendors who provide energy-efficient machinery that meets project requirements and has a proven track record of reliability.
- Perform a cost-benefit analysis to justify the initial investment in energy-efficient machinery by calculating long-term savings.

C. Implementation:

- Ensure that energy-efficient machinery is properly installed and commissioned according to manufacturer guidelines.
- Train operators and maintenance staff on the efficient use and maintenance of the machinery to maximize energy savings.

1.10.2) Provision of Solar Energy

A. Solar Energy Feasibility Study:

- Conduct a feasibility study to determine the suitability of solar energy installations, considering factors such as sunlight availability, land area, and energy needs.
- Identify appropriate solar technologies, such as photovoltaic panels or solar water pumping systems, that align with project goals.

B. Design and Integration:

- Design the solar energy system to meet the specific energy needs of the irrigation and drainage systems.
- Integrate the solar system with existing power infrastructure, ensuring compatibility and reliability.

C. Installation and Maintenance:

- Engage qualified contractors to install the solar energy system according to industry best practices and safety standards.
- Develop a maintenance plan for the solar energy system, including regular inspections, cleaning, and performance monitoring.

D. Monitoring and Reporting:

- Implement a system to monitor the performance of the solar installation, including energy production and cost savings.
- Provide regular reports on the solar energy system's performance, highlighting energy savings and environmental benefits.

1.10.3) Provision of Automation

A. Automation Needs Assessment:

- Determine which processes, such as water flow regulation, monitoring, and reporting, can be automated to improve efficiency and reduce costs.
- Review available automation technologies, such as SCADA systems, IoT sensors, and automated control systems.

B. System Design and Procurement:

- Design an automation system tailored to the project's specific needs, ensuring that it integrates seamlessly with existing infrastructure.
- Select reliable vendors for the supply of automation equipment, ensuring that they meet technical specifications and have a track record of successful implementations.

C. Implementation and Integration:

- Implement the automation system according to the design specifications, ensuring minimal disruption to ongoing operations.
- Ensure that the automation system is fully integrated with the irrigation, canal, and drainage system's existing controls and data management systems.

D. Training and Support:

- Provide comprehensive training to operators and maintenance personnel on the use and troubleshooting of the automation system.
- Establish a support system for troubleshooting and maintaining the automation system, including access to technical experts and spare parts.

E. Monitoring and Optimization:

- Continuously monitor the automation system's performance to identify areas for further optimization and cost savings.
- Regularly update and upgrade the automation system to incorporate new technologies and improve efficiency.

2.) EXECUTION, INSPECTION, AND TESTING

2.1) Use of all construction materials

2.1.1) Selection of materials such as cement, aggregates, steel etc. from approved source and its testing

A. Source Identification:

- Utilize materials only from suppliers listed on the approved vendor list.
- Ensure that each material source is verified for quality and consistency as per project requirements.

B. Material Testing:

- Conduct regular sampling and testing of materials at the source before procurement to ensure compliance with project specifications.
- Obtain certification from the supplier confirming the quality and specification of the materials.

C. Approval and Documentation:

- Submit material samples and test results to the relevant authorities or project engineers for approval.
- Maintain records of all materials procured, including source details, test results, and certifications.

2.1.2) Use of Batch Mix Plant and Design Mix

A. Batch Mix Plant Setup:

- Use only approved batch mix plants that meet project specifications and have the required capacity.
- Ensure the batch mix plant is properly calibrated before commencing operations to guarantee accurate mix proportions.

B. Design Mix Approval:

- Prepare a design mix based on the project's structural and durability requirements.
- Conduct trial mixes to validate the design mix, ensuring it meets the required strength and workability.
- Submit the trial mix results to the engineer-in-charge for approval before commencing full scale production.

C. Production Monitoring:

- Continuously monitor the batch mix plant during production to ensure consistency in the mix.
- Perform regular testing of the mix during production to confirm adherence to the design mix.

2.2) Procurement and Efficiency enhancement of Pumping machinery (Lift Irrigation)

2.2.1) Procurement of Machinery from Approved Manufacturers

A. Manufacturer Selection:

- Procure machinery only from manufacturers on the approved list.
- Ensure that the selected manufacturers have a proven track record and meet the technical specifications required for the project.

B. Pre-Procurement Inspection:

- Conduct a pre-procurement inspection at the manufacturer's facility to assess the quality of the machinery.
- Verify that the machinery complies with the project's technical requirements and standards.

C. Documentation and Approval:

- Ensure that detailed technical specifications and compliance certificates are provided by the manufacturer.
- Obtain necessary approvals from project engineers or relevant authorities before finalizing the procurement.

2.2.2) Carrying Out Tests for Machinery at Manufacturer's Premises Before Dispatch

A. Testing Plan:

- Develop a testing schedule in coordination with the manufacturer.
- Outline specific test procedures based on the machinery type, including performance, load testing, and safety checks.

B. On-Site Testing:

- Conduct a Factory Acceptance Test at the manufacturer's premises with the presence of qualified personnel to verify the machinery's compliance with specifications.
- Test the machinery under simulated operational conditions to ensure it meets the required performance standards.

C. Approval and Dispatch:

- Review and approve test reports generated during FAT.
- Provide authorization for the machinery's dispatch only after successful completion and approval of all tests.

2.2.3) Use High-Efficiency Pumps & Motors Specifically Designed for Site Requirements

A. Site Requirement Analysis:

- Assess the specific pumping and motor requirements based on the project's irrigation and drainage needs.
- Select equipment that offers the highest efficiency while meeting the operational requirements.

B. Vendor Selection:

- Choose vendors who provide pumps and motors that meet high-efficiency standards (such as IE3 or higher for motors).
- Conduct a technical evaluation of the selected equipment to ensure it meets site- specific requirements.

C. Installation and Testing:

- Ensure that pumps and motors are installed correctly to optimize performance.
- Test the equipment after installation to confirm that it operates efficiently and meets the required performance standards.

2.2.4) Life Cycle Cost Analysis of Pumping Machinery

A. Cost Analysis Parameters:

- Include the purchase price, installation, and commissioning costs of the machinery.
- Factor in energy consumption, maintenance, and repair costs over the machinery's operational life.
- Consider disposal, decommissioning, or recycling costs.

B. Life Cycle Cost Calculation:

- Sum the initial, operating, and end-of-life costs to calculate the total life cycle cost.
- Compare the life cycle costs of different machinery options to determine the most cost- effective choice.

C. Decision Making:

- Select the machinery that offers the best balance between initial cost and long-term operational savings.
- Maintain a record of the life cycle cost analysis for reference and future decision- making.

2.3) Use of modern facilities for construction

2.3.1) Use of Advanced Machinery for Canal Lining

A. Machinery Selection:

- Choose machinery that utilizes the latest technology for canal lining, such as automated lining machines or slip-form pavers.
- Ensure the machinery meets the technical specifications required for the specific canal design and construction conditions.

B. Operational Efficiency:

- Provide operators with specialized training on the advanced machinery to maximize efficiency.
- Continuously monitor the performance of the machinery during operation to ensure it is functioning optimally.

C. Maintenance:

- Implement a preventive maintenance schedule to keep the machinery in optimal working condition.
- Ensure the availability of critical spare parts to minimize downtime.

2.3.2) Electric/ Automated Operation of Pumping Machinery and Control Gates

A. System Design:

- Design an automated system that integrates electric pumps, control gates, and monitoring equipment.
- Utilize programmable logic controllers (PLCs) or other advanced control systems to automate operations.

B. Installation and Integration:

- Ensure that all components are installed correctly and are fully integrated with the control systems
- Test and calibrate the system to ensure accurate and reliable operation.

C. Operational Training:

- Provide comprehensive training for operators on the use of the automated system, including troubleshooting and emergency procedures.

- Implement a system for continuous monitoring and adjustment of operations to optimize performance.

2.3.3) Use of Laser Land Levelling Equipment

A. Equipment Selection:

- Choose laser land levelling equipment that provides high precision and reliability.
- Ensure the equipment is suitable for the specific type of soil and land conditions of the project area.

B. Operation and Training:

- Train operators on the correct use of laser levelling equipment, including calibration and maintenance procedures.
- Implement best practices for operating the equipment to achieve the desired levelling accuracy.

C. Quality Control:

- Continuously monitor the accuracy of the land levelling during operations to ensure it meets the project specifications.
- Conduct a final inspection after levelling to confirm that the land is prepared according to the required standards.

2.34) Use of Soil Moisture Sensors

A. Selection and Installation of Sensors:

- Select soil moisture sensors based on site-specific conditions, such as soil type and expected irrigation requirements.
- Install sensors at designated locations along the canal or irrigation network to capture representative soil moisture data.

B. Calibration and Testing of Sensors:

- Calibrate each sensor to ensure accurate readings based on site conditions.
- Conduct initial testing to validate sensor accuracy, recording baseline data for future comparison.

C. Monitoring and Data Collection:

- Collect soil moisture data at regular intervals, especially before and after irrigation cycles.
- Monitor data to assess soil moisture levels, ensuring that irrigation schedules meet crop and soil requirements.

D. Reporting and Adjustments:

- Document soil moisture readings and any adjustments made to irrigation schedules based on sensor data.
- Submit regular reports to the project engineer, highlighting any areas that require special attention.

2.4) Conformity to relevant standards for execution of work and ensuring safety

2.4.1) Work Executed as per Bid Document

A. Bid Document Review:

- Thoroughly review the bid document to understand the project's specifications, conditions, and quality requirements.

- Develop a detailed plan to ensure that all work meets the bid document's requirements.

B. Execution Monitoring:

- Conduct regular inspections during construction to verify that the work is being carried out as per the bid document.
- Implement a quality assurance process to ensure that all materials, workmanship, and construction methods comply with the bid specifications.

C. Documentation:

- Maintain detailed records of all inspections, tests, and approvals to demonstrate compliance with the bid document.
- Obtain final approval from the project engineer or relevant authority after completing the work as per the bid document.

2.4.2) All Hydraulic Design Parameters ensured during the construction of canal and other structures as per approved design & drawings

A. L-Section Review:

- Peruse the L-section and approved design & drawings to understand the required longitudinal slope, side slopes, and other hydraulic design parameters for canal construction and other hydraulic structures.
- Conduct a detailed survey and marking of the site to ensure accurate implementation of the slopes.

B. Construction Monitoring:

- Continuously monitor the longitudinal and side slopes during excavation and construction to ensure it matches the design specifications.
- Utilize advanced equipment, such as laser levelling or GPS-guided machinery to maintain accurate slopes.

C. Final Verification:

- Conduct a final survey after construction to verify that the slopes meet the L-section requirements.
- Make any necessary adjustments before finalizing the construction if the slopes are not as per the L-section.

2.4.3) Providing of safety measures such as first aid & firefighting equipment, safety uniforms etc. during execution

A. First Aid Facilities:

- Equip all work sites with a fully stocked first aid kit containing supplies as per OSHA (or relevant local authority) standards.
- Ensure that at least two personnel at each site are trained in basic first aid and CPR.

B. Firefighting Equipment:

- Install appropriate firefighting equipment (e.g., fire extinguishers, fire blankets) at strategic locations throughout the work area.
- Conduct regular inspections and maintenance of firefighting equipment to ensure they are in working condition.
- Train all personnel in the use of firefighting equipment and conduct regular fire drills.

C. Safety Uniforms:

- Provide all personnel with safety uniforms, including high-visibility vests, helmets, gloves, and steel-toed boots.
- Ensure that personnel wear the appropriate safety gear at all times while on site.
- Regularly inspect safety uniforms for wear and tear and replace them as needed.

2.4.4 Execution of Horticulture Development:

- Follow proper guidelines for horticulture planning as outlined in the bid document/estimate, keeping in mind the aesthetic appeal, safety, plantation techniques, and maintenance and upkeep.
- Efficient irrigation systems should be established to ensure adequate water supply while minimizing wastage.
- For trees, small irrigation channels or recharge pits should be created nearby to promote deep root growth and enhance water retention. Mulching with organic materials such as dry leaves, straw, or coir pith should be implemented to retain soil moisture, suppress weed growth, and improve soil structure.

2.5) Supervision by skilled manpower / Internal Vigilance Wing /TPIA

2.5.1) Adequate deployment of appropriately qualified personnel for supervision and conducting the inspections

A. Roles and Responsibilities Assignment:

- Designate adequate qualified personnel within the work executing wing to oversee specific aspects of project execution, including quality, safety, and adherence to design parameters and technical specifications.

B. Inspection Scheduling and Coordination:

- Schedule regular inspections to monitor key project phases, including material procurement, construction milestones, design parameters, structural parameters, and quality checks.
- Coordinate with project managers to ensure inspections are timely and aligned with critical project stages, preventing delays or rework.

C. Standards and Compliance Check:

- Ensure all inspection activities are performed in compliance with relevant standards, codes, technical specifications, and approved design & drawings.
- Inspect construction methods, materials, and safety measures to verify compliance with established guidelines and quality benchmarks.

D. Documentation of Findings and Observations:

- Record all inspection findings, noting any deviations, defects, or issues requiring corrective action.
- Document observations with photographic evidence, measurements, and test results where applicable, maintaining thorough records for accountability.

E. Issue Resolution and Follow-Up:

- Communicate any non-compliance issues or defects identified during inspections to the project execution team promptly.
- Track corrective actions taken, and conduct follow-up inspections to verify resolution and ensure adherence to standards.

F. Reporting to Project Management:

- Prepare detailed inspection reports summarizing findings, corrective actions taken, and any recommendations for improving future work.
- Submit reports to project management and relevant stakeholders for review, enabling informed decision-making and continuous improvement.

2.52) Inspections Conducted by Internal Vigilance Wing of the Department

A. Scheduling and Coordination:

- Coordinate with the Internal Vigilance Wing to schedule inspections, ensuring that inspection timelines align with critical project milestones.
- Provide the necessary work related documents and site access to the inspection team.

B. Inspection Scope and Focus:

- Ensure that inspections cover key aspects of the project, such as design parameters, construction quality, compliance with technical specifications, timelines, and adherence to safety standards.
- Assist the inspection team by providing information on project plans, materials, and construction techniques used.

C. Findings and Recommendations:

- Document the inspection findings and recommendations provided by the Internal Vigilance Wing.
- Address any issues or corrective actions identified during the inspection and document the actions taken.

D. Reporting and Follow-Up:

- Submit a detailed report summarizing the inspection results, actions taken, and any ongoing issues requiring attention.
- Schedule follow-up inspections if required to verify corrective actions.

2.53) Inspections Conducted by Third Party Inspection Agency

A. Engagement and Documentation:

- Engage a Third-Party Inspection Agency (TPIA) with expertise in canal systems and construction quality assurance.
- Share all relevant project documents, plans, and specifications with the TPIA before the inspection.

B. Inspection Process and Guidelines:

- Facilitate the TPIA's on-site inspections, ensuring access to critical areas of the canal and construction zones.
- Ensure that inspections are conducted as per predefined guidelines, including quality checks on materials, structural integrity, and safety practices.

C. Report and Compliance Check:

- Obtain a detailed report from the TPIA outlining inspection findings, compliance status, and any deviations from project specifications.
- Address identified issues promptly, implementing recommended actions and updating project records accordingly.

D. Final Review and Certification:

- Submit the TPIA's final report to the project management team for review and approval.
- Ensure that the TPIA provides a certification of compliance once all issues are resolved,

as part of the project quality documentation.

2.6) Pre & Post Inspections of all materials and pumping machinery

2.6.1) All Laboratory Testing of Concrete and Soil

A. Testing Plan:

- Develop a schedule for the testing of concrete and soil samples based on construction milestones.
- Identify the types of tests required, such as compressive strength tests for concrete and compaction tests for soil.

B. Sample Collection:

- Collect samples of concrete and soil at regular intervals during construction for laboratory testing.
- Ensure that samples are properly handled and transported to the laboratory to prevent contamination or damage.

C. Testing and Reporting:

- Conduct all required tests at an accredited laboratory following standard procedures.
- Document the test results and compare them against the project specifications to ensure compliance.

D. Corrective Actions:

- If any test results indicate non-compliance, take immediate corrective action, such as adjusting the mix design or improving soil compaction methods.
- Conduct retests after corrective actions to ensure compliance before proceeding with further construction.

2.6.2) Testing of Pumping Machinery at Manufacturer's Premises

A. Testing Plan:

- Coordinate with the manufacturer to develop a testing plan that includes all required performance and quality checks.
- Ensure that the testing plan is documented and agreed upon by both the manufacturer and the project team.

B. On-Site Testing:

- Conduct the tests at the manufacturer's premises with the presence of qualified project personnel.
- Verify that the machinery performs according to the specifications, including load tests, efficiency tests, and safety checks.

C. Test Reporting:

- Document the results of all tests conducted at the manufacturer's premises.
- Obtain approval from the project engineer or relevant authority before authorizing the machinery's dispatch.

2.6.3) Ensure Required Frequency of Tests During Implementation

A. Testing Schedule:

- Establish a testing schedule that outlines the frequency of tests for materials, equipment, and construction work as per project specifications and norms.
- Ensure that the testing schedule complies with industry standards and the

project's quality assurance plan.

B. Test Execution:

- Conduct tests at the required frequency during the project to monitor ongoing compliance with specifications.
- Use the testing results to monitor the quality of materials and workmanship throughout the project.

C. Documentation and Reporting:

- Maintain detailed records of all tests conducted, including dates, results, and any corrective actions taken.
- Provide periodic reports to project stakeholders, summarizing the testing results and highlighting any issues.

2.7) Setting Up Testing Laboratories at Site

2.7.1) Setting Up Testing Laboratories at Site as per Bidding Document

A. Laboratory Setup Planning:

- Review the bidding document to understand the specific requirements for on-site laboratories, including equipment, space, and personnel.
- Choose an appropriate location on-site for the laboratory, ensuring it is easily accessible and has the necessary utilities.

B. Equipment Procurement and Installation:

- Procure all required laboratory equipment as specified in the bidding document, ensuring that it meets the required standards.
- Install the equipment according to manufacturer guidelines, ensuring that the laboratory is fully operational.

C. Staffing and Training:

- Deploy appropriately qualified laboratory technicians and staff to operate and maintain the equipment.
- Provide necessary training to laboratory personnel to ensure they are proficient in conducting tests and handling the equipment.

D. Laboratory Operations: Establish standard

2.8) Testing of Flow in Canal, and Pumping Machinery

2.8.1) Flow Testing in Canals/Distributaries/Minors

A. Preparation for Testing:

- Select appropriate locations for flow testing along the canal/distributary/minor.
- Use standardized flow measurement equipment such as current meters, weirs, or ultrasonic flow meters.
- Ensure all flow measurement equipment is properly calibrated according to manufacturer specifications before testing.

B. Conducting Flow Tests:

- Perform initial flow measurements to establish baseline data.
- Conduct flow tests at regular intervals and during different operational conditions to monitor consistency.
- Record all flow measurements, including the date, time, location, and flow rate.

C. Analysis and Reporting:

- Compare the measured flow rates with the designed flow capacities to identify any discrepancies.
- If necessary, adjust canal gates, valves, or other flow control mechanisms to achieve the required flow rates.
- Compile flow test data and submit a report to the project engineer, highlighting any issues or required adjustments.

2.8.2) Testing of Pumping Machinery to Meet the Required Discharge at Required Head

A. Pre-Test Preparation:

- Confirm the required discharge and head as per project specifications.
- Ensure that all necessary instrumentation (e.g. pressure gauges, flow meters) is properly installed and calibrated.

B. Pumping Machinery Testing:

- Start the pump and allow it to stabilize under normal operating conditions.
- Measure the discharge rate at the required head using flow meters or other appropriate devices.
- Simultaneously measure the head to ensure it meets the project specifications.
- Conduct tests at different operational conditions (e.g., varying flow rates and head pressures) to confirm the machinery's capability.

C. Analysis and Reporting:

- Compare the measured discharge and head against the specified requirements.
- If discrepancies are found, adjust the pump settings or consider modifications to the system to meet the required performance.
- Record all test results, and prepare a report detailing the performance of the pumping machinery for submission to the Engineer-in-Charge.

2.8.3) Availability of Electric Energy as per Requirements

A. Energy Requirement Assessment:

- Calculate the total energy requirement based on the operational needs of the pumping machinery, control systems, and other electrical components.
- Verify that the existing power supply infrastructure can meet the calculated energy demands.

B. Ensuring Power Availability:

- Coordinate with the local power utility to ensure a consistent and reliable power supply is available.
- Install backup power systems, such as generators or solar power units, to ensure continuous operation during power outages.
- Implement an energy monitoring system to track power usage and detect any fluctuations or shortages in supply.

C. Reporting and Documentation:

- Maintain records of energy consumption, including peak usage times and any incidents of power shortages.
- Develop and document an action plan for addressing any identified power supply

issues.

- Conduct regular reviews of the energy supply situation and make adjustments as necessary to ensure uninterrupted operations.

2.9) Rectification of Defects, Documentation and Reporting

2.9.1) Preparation of Site Inspection and Quality Control Registers

A. Register Setup:

- Create registers that include fields for date, time, location, inspection type, observations, actions taken, and personnel involved.
- Decide whether to maintain physical registers, digital logs, or both, depending on the project's documentation requirements.

B. Documentation During Inspections:

- During each site inspection, the inspecting officer should document all findings, including observations related to construction quality, material usage, and adherence to project specifications.
- Record any identified issues, required corrective actions, and the responsible parties for each action.

C. Maintenance and Review:

- Ensure that registers are updated regularly and all entries are complete and accurate.
- Conduct periodic reviews of the registers to ensure that all required inspections and quality control measures have been performed and documented.

2.9.2) Checking of test results/defects/site & inspection registers by Engineer in Charge

A. Test Result Submission:

- Submit all test results (e.g., for materials, equipment, flow rates) to the Engineer-in- Charge promptly after testing.
- Ensure that test results are accompanied by proper documentation, including test methods, sample details, and testing conditions.

B. Review Process:

- The Engineer-in-Charge should review the test results to verify that they meet the project's specifications and quality standards.
- If necessary, the Engineer-in-Charge may request additional testing or re-testing to confirm the results.

C. Approval or Rectification:

- Once satisfied with the test results, the Engineer-in-Charge should sign off on the results and approve the continuation of work.
- If the test results indicate non-compliance, the Engineer-in-Charge should document the issues and instruct the responsible parties to undertake corrective actions.

2.9.3) Rectification of Defects

A. Defect Identification:

- Document all identified defects, including their nature, location, and potential impact on the project.
- Notify the relevant contractors or personnel responsible for rectifying the defect as soon as it is identified.

B. Rectification Process:

- Develop a corrective action plan outlining the steps required to rectify the defect, including timelines and responsibilities.
- Implement the corrective actions promptly to prevent delays in the project schedule.

C. Verification and Documentation:

- After rectification, the Engineer-in-Charge should inspect the work to verify that the defect has been properly addressed.
- Document the rectification process, including before-and-after photographs, and update the site inspection and quality control registers.

2.9.4) Submission of Reports and Maintaining the Records

A. Report Preparation:

- Prepare detailed reports on all inspections, tests, rectifications, and other quality control activities, including all supporting documentation.
- Ensure that reports are structured according to project standards, with clear sections for each aspect of the work.

B. Submission Protocol:

- Submit reports to the relevant authorities, including the Engineer-in-Charge, project management team, and other stakeholders, within the specified timelines.
- Ensure that receipt of the report is acknowledged by the receiving parties.

C. Record Keeping:

- Archive all reports in a secure and organized manner, both digitally and physically, ensuring that they are easily accessible for future reference.
- Adhere to the project's document retention policy, ensuring that all records are kept for the required duration.

3.) COMMISSIONING AND HANDING OVER

3.1) Testing the functionality of Canal System and Pumping Machinery

3.1.1) System Cleaning

A. Initial Inspection for Cleaning Requirements:

- Conduct a thorough inspection of the entire canal system to identify debris, sediments, or other blockages.
- Assess the condition of inlets, outlets, and any flow control structures to ensure they are free from obstructions.

B. Cleaning Procedures:

- Remove all visible debris, sediments, and blockages using appropriate cleaning equipment.
- Clear any vegetation grown within the canal that could obstruct water flow.

C. Post-Cleaning Inspection and Reporting:

- Inspect the canal after cleaning to verify that all obstructions have been removed.
- Document the cleaning process, including the methods used, areas cleaned, and any issues identified.
- Submit a report to the project engineer for review before proceeding to testing.

3.12) Testing of Discharge under Various Conditions

A. Setting up Test Conditions:

- Identify different scenarios for discharge testing, such as low, medium, and high-flow conditions.
- Position flow measurement devices strategically along the canal to capture discharge rates during each test condition.

B. Testing Process:

- Simulate various discharge levels by adjusting flow control systems and monitoring the resulting flow rates.
- Record flow rates and other parameters at designated points along the canal under each discharge condition.

C. Analysis and Reporting:

- Analyse the test results to confirm that the canal meets design specifications for all discharge conditions.
- Document and submit a detailed report of test results, including any discrepancies or potential improvements to ensure reliable performance.

3.1.3) Ensuring no Leakage and minimum Seepage

A. Leakage and Seepage Inspection:

- Conduct inspections of the canal system to identify any signs of leakage or seepage.
- Use modern technologies to detect and assess leakages or seepages.

B. Rectification:

- Promptly repair any identified leaks or seepages using appropriate methods such as sealing, lining, or patching.
- Implement preventive measures to prevent the likelihood of future leakages.

C. Monitoring and Documentation:

- Continuously monitor the system for any recurring issues.

- Document all leakage and seepage issues, including the location, extent of damage, and actions taken for rectification.

3.1.4) Ensuring Required Discharge at Required Head by Pumping Machinery

A. Performance Testing:

- Regularly test pumping machinery to verify that it meets the required discharge and head specifications.
- Calibrate pressure gauges, flow meters, and other related instruments to maintain accuracy in measurements.

B. Adjustment and Maintenance:

- Adjust pump settings to achieve the desired discharge and head.
- Implement a preventive maintenance schedule to keep pumps in optimal working condition, minimizing the risk of performance issues.

C. Reporting:

- Document and report the performance of the pumping machinery, noting any deviations from the required specifications and actions taken.

3.1.5) Adjustment of Flow Control Systems

A. Calibration of Control Equipment:

- Calibrate gates and any automated control systems to ensure accurate flow regulation.
- Test the operation of each flow control structure to verify responsiveness and accuracy.

B. Flow Adjustment Procedures:

- Adjust flow control settings incrementally to achieve specified discharge rates across different operational conditions.
- Monitor flow rates in real-time to make necessary adjustments for consistent flow throughout the system.

C. Documentation of Adjustments:

- Record all adjustments made to the flow control systems, including dates, settings, and conditions.
- Generate an adjustment report and submit it for review to the project engineer.

3.1.6) Handover the System to the Concerned Operational Authorities

A. Handover Preparation:

- Verify that all cleaning, testing, and adjustment activities have been completed and documented.
- Compile a comprehensive handover package, including all reports, inspection records, testing data, and maintenance instructions.

B. Final Inspection and Walkthrough:

- Conduct a final inspection of the canal system with representatives from the operational authorities.
- Address any last-minute concerns, clarifications, or training requests raised by the operational team.

C. Official Handover Documentation:

- Prepare a formal handover document detailing the canal's current condition, operational status, and maintenance schedule.
- Obtain signatures from both the contractor and the receiving operational authority to

complete the handover.

3.2) Asset Management and System Operation

3.2.1) Submission of Asset Management Plan and Completion Certificate

A. Asset Management Plan Preparation:

- Prepare an inventory of all assets, including machinery, infrastructure, and any other significant items.
- Develop a maintenance and inspection schedule for all assets to ensure their longevity and optimal performance.
- Estimate future maintenance costs and budget accordingly.

B. Submission:

- Submit the asset management plan to the relevant authorities or project management team for review and approval.
- Prepare and submit a completion certificate once all project activities are finished, indicating that the project has been completed to specification.

C. Record Keeping: Maintain a copy of the asset management plan and completion certificate in the project's records for future reference.

3.3) Guarantee of Works in Defect Liability Period

3.3.1) Post-Commissioning Monitoring and Support

- Establish key performance metrics to monitor the system's efficiency, including flow rates, pump performance, and leak detection.
- Conduct regular inspections of the system post-commissioning to identify any issues early.
- Provide technical support to operators and users to resolve any operational issues.
- Implement a maintenance schedule to prevent system deterioration and ensure long-term reliability.
- Prepare periodic reports on the system's performance, identifying any issues and the corrective actions taken.
- Use the data collected from monitoring activities to improve system performance over time.

3.3.2) Withholding Security Amount

A. Assessment of Obligations:

- Review the contract to identify all obligations that must be fulfilled before the release of the security amount.
- Conduct a final inspection to verify that all work has been completed to the required standards.

B. Clearance Process:

- Ensure that the defect liability period has been satisfactorily completed without any outstanding issues.
- Obtain final approval from the Engineer-in-Charge or relevant authorities confirming that all conditions have been met.

C. Release of Security:

- Prepare the necessary documentation to release the security amount.
- Process the final payment after ensuring all contractual and project requirements have been fulfilled.

4.) SAFETY AND SECURITY

4.1) Adherence to Safety Standards

4.1.1) Providing Safety Measures

D. First Aid Facilities:

- Equip all work sites with a fully stocked first aid kit containing supplies as per OSHA (or relevant local authority) standards.
- Ensure that at least two personnel at each site are trained in basic first aid and CPR.

E. Firefighting Equipment:

- Install appropriate firefighting equipment (e.g., fire extinguishers, fire blankets) at strategic locations throughout the work area.
- Conduct regular inspections and maintenance of firefighting equipment to ensure they are in working condition.
- Train all personnel in the use of firefighting equipment and conduct regular fire drills.

F. Safety Uniforms:

- Provide all personnel with safety uniforms, including high-visibility vests, helmets, gloves, and steel-toed boots.
- Ensure that personnel wear the appropriate safety gear at all times while on site.
- Regularly inspect safety uniforms for wear and tear and replace them as needed.

4.1.2) Monitoring and Surveillance

A. Routine Inspections:

- Conduct routine inspections of all canal and drainage structures, including gates, sluices, and embankments, to identify potential risks or damage.
- Utilize drones or CCTV systems for continuous monitoring of hard-to-reach areas.

B. Data Logging:

- Maintain a log of all inspection activities, noting the date, time, personnel involved, and any issues observed.
- Use digital tools for real-time monitoring and data analysis to predict and prevent potential failures.

C. Reporting:

- Immediately report any irregularities, such as water leakage or structural damage, to the relevant authorities.
- Prepare detailed reports for significant findings and submit them to management for review.

4.2) Safety measures for workers and users

4.2.1) Access Control

A. Access Points:

- Designate official entry and exit points for all personnel and vehicles accessing the site.
- Install barriers, gates, and security checkpoints at all access points.
- Identification Badges:
- Issue identification badges to all personnel authorized to access the site.

- Ensure that all personnel display their badges visibly while on site.

B. Visitor Management:

- Maintain a visitor log at all access points, recording the name, purpose, and time of entry and exit of all visitors.
- Escort all visitors by authorized personnel at all times while on site.

C. Access Restrictions:

- Restrict access to sensitive areas, such as control rooms and storage facilities, to only those with necessary clearance.
- Implement electronic access control systems where applicable, including keycards and biometric systems.

4.3) Security measures to prevent unauthorized access

4.3.1) Physical Security Measures

A. Perimeter Security:

- Install fencing or walls around critical infrastructure, such as pumping stations and control centers.
- Implement lighting and surveillance systems along the perimeter to deter unauthorized access.

B. Alarm Systems:

- Equip key infrastructure with alarm systems to detect unauthorized access or tampering.
- Ensure alarm systems are connected to a central monitoring station with immediate response capabilities.

C. Patrols:

- Organize regular patrols by security personnel to monitor the physical integrity of the site and deter potential threats.
- Document all patrol activities and report any findings.

4.3.2) Emergency Response and Reporting specially in case of outbreak of canal

A. Emergency Response Team:

- Form an emergency response team trained in dealing with canal breaches and other emergencies.
- Conduct regular training exercises and simulations to ensure preparedness.

B. Incident Reporting:

- Immediately report any incident, such as a canal breach, to the emergency response team and management.
- Use a standardized incident reporting form to document the details, including the time, location, and nature of the incident.

C. Containment Measures:

- Initiate containment measures as per the emergency response plan, including closing gates, diverting water flow, and deploying sandbags or barriers.
- Coordinate with local authorities and emergency services for additional support if required.

D. Post-Incident Review:

- After resolving the incident, conduct a post-incident review to identify the cause and assess the effectiveness of the response.
- Implement corrective actions to prevent recurrence and update the emergency response plan as necessary.

5.) OPERATION AND MAINTENANCE

5.1) Compliance to prescribed deliverables

5.1.1) Flow of Specified design discharge in Canal//Distributaries/Minors up to Tail End

A. Monitoring Water Levels:

- Install and regularly maintain water level gauges at key points along the canal/minor/distributaries/ minors.
- Use automated systems where available to monitor real-time flow data and adjust water levels as needed.

B. Flow Adjustments:

- Make adjustments to control structures (e.g., gates, weirs) to maintain the desired flow rate.
- Conduct regular inspections to prevent and address blockages or leaks that could disrupt flow.

C. Communication with Stakeholders:

- Notify downstream users in advance of any planned changes in flow that could impact water availability.
- Maintain open lines of communication with water user associations (WUAs) to ensure equitable distribution.

5.1.2) Ensuring Operational Parameters for Pumping Machinery and Use of Automation and SCADA (Wherever Applicable)

A. Operational Parameters:

- Regularly monitor and record the operational parameters of pumping machinery, such as pressure, flow rate, and power consumption.
- Set alarms within SCADA systems to alert operators of any deviations from the desired operational parameters.

B. Maintenance of SCADA Systems:

- Perform routine checks and updates on SCADA systems to ensure they are functioning correctly.
- Train operators in the use of SCADA systems to monitor and control water distribution effectively.

C. Automation Best Practices:

- Implement automation protocols for starting/stopping pumps/gates and adjusting flow rates based on real-time data.
- Ensure backup systems are in place to take over in the event of SCADA system failure.

5.1.3) Regular Cleaning of System

A. Routine Cleaning Schedule:

- Establish a regular cleaning schedule based on the canal's usage, sediment deposition rate, and surrounding environmental conditions.
- Use mechanical dredging, manual cleaning, or automated cleaning systems depending on the size and type of canal or drainage system.
- Properly dispose of debris, silt, and vegetation removed from the system according to environmental regulations.

- Detailed procedure and guidelines for de-silting and cleaning of canals has been attached as Annexure-IV

B. Inspection Before and After Cleaning:

- Inspect the canal system to identify areas with significant siltation, debris accumulation, or blockages.
- After cleaning, inspect the canal to ensure that all identified issues have been addressed.

C. Record Keeping:

- Maintain records of cleaning activities, including dates, methods used, and the condition of the canal before and after cleaning.
- Submit cleaning records to the project management team for review and documentation.

D. Seepage Monitoring:

- Assess the seepage impact due to water-logged area in case of construction of new canal.
- Conduct regular inspections of the canal and drainage system to identify areas with visible signs of seepage.
- Use piezometers and other instruments to measure seepage rates at various locations.

E. Analysis of Seepage Data:

- Analyse the collected data to determine the extent and impact of seepage on the overall running of system.
- Identify the causes of seepage, such as soil type, canal lining conditions, and construction quality.

F. Mitigation Measures:

- Recommend and implement measures to reduce seepage, such as canal lining (concrete, geomembrane, soil-cement, bentonite, compacted earth lining) soil compaction and maintenance of existing linings.
- Monitor the effectiveness of these measures and adjust strategies as needed.
- Seepage Control through Trench Drains by installation of drainage trenches parallel to the canal, filled with permeable material, to intercept and redirect seepage water.
- Construction of Cutoff Walls along the canal alignment as vertical impermeable barriers.
- Injection of chemical grouts into the canal bed or embankment to seal voids and reduce permeability for repairing localized seepage issues.

5.1.4 Maintenance of Horticultural Assets and Aesthetics

A. Pruning and Trimming

- Regular pruning of trees and shrubs to maintain shape and health.
- Remove dead or weak branches to prevent falling hazards near canal structures.
- Conduct seasonal pruning of flowering shrubs for better bloom cycles..

B. Pest and Disease Control

- Implement integrated pest management (IPM) using bio-pesticides and neem-based sprays.
- Regularly monitor plants for infestations and take corrective actions without harming

aquatic ecosystems.

C. Lawn and Green Space Maintenance:

- Conduct periodic mowing of grass areas along canals and embankments.
- Regular weeding and fertilization to maintain green cover and soil health.
- Use organic fertilizers to promote sustainable plant growth.

D. Structural Elements for Aesthetic Finishing

- Paved walkways & seating areas in public interaction zones for aesthetic appeal, especially in urban areas.
- Decorative fences and bollards to protect landscaped areas from encroachment.
- Signboards and nameplates for plant species to promote awareness among the public.

3.4 Structural Elements for Aesthetic Finishing

5.2) Effective running of Canal and Machinery/STP

5.2.1) Deployment of Skilled Staff for Operation

A. Staff Qualifications:

- Define the necessary qualifications and experience required for personnel operating irrigation and drainage systems.
- Regularly assess staff skills and provide additional training as needed.

B. Assignment of Roles:

- Assign roles and responsibilities based on staff expertise and experience.
- Ensure that all key positions are filled by personnel with the requisite skills and knowledge.

5.2.2) Deployment of Adequate Number of Staff for Operation

A. Staffing Plan:

- Develop a staffing plan that outlines the required number of personnel for each shift and location.
- Adjust staffing levels based on seasonal demand and operational needs.

B. Staff Scheduling:

- Implement a rotation schedule to ensure continuous coverage, including during weekends and holidays.
- Monitor staff attendance and address any shortages promptly to avoid operational disruptions.

5.2.3) Formation of Water User Associations (WUA)

A. Formation of WUAs:

- Engage with local farmers and stakeholders to form WUAs in accordance with relevant legal and regulatory frameworks.
- Provide guidance and support during the WUA formation process, including the drafting of bylaws and the election of office bearers.

B. Capacity Building:

- Organize training sessions for WUA members on their roles and responsibilities, water management practices, and conflict resolution.
- Facilitate regular meetings between WUA members to discuss issues, share

knowledge, and plan water distribution.

Note: For Construction/O&M of STP, the SOMP for Sewerage Projects of Public Health Engineering Department may be referred.

5.3) Maintenance Process, and Emergency Response System

5.3.1) Maintenance Schedule Development and Its Compliance

A. Maintenance Planning:

- Develop a comprehensive maintenance schedule for all canals, pumping stations, gates, and associated infrastructure.
- Include both routine maintenance (e.g., cleaning, lubrication) and preventive maintenance (e.g., inspections, repairs) in the schedule.

B. Compliance Monitoring:

- Assign maintenance tasks to specific teams and track their completion using a maintenance log or digital system.
- Conduct periodic audits to ensure compliance with the maintenance schedule and address any lapses.

5.3.2) Availability of Spare Parts / Standby Machinery if Required

A. Inventory Management:

- Maintain an inventory of critical spare parts for all key machinery and equipment.
- Regularly review and update the inventory to ensure that all necessary parts are available.

B. Standby Machinery:

- Keep standby machinery, such as pumps and generators, ready for deployment in case of equipment failure.
- Conduct routine checks and maintenance on standby machinery to ensure it is operational when needed.

5.3.3) Emergency Response System

- Conduct a risk assessment to identify potential emergencies such as floods, equipment failures, or extreme weather events.
- Develop an emergency response plan tailored to each identified risk, detailing actions to be taken during an emergency.
- Establish a notification system to alert relevant personnel and stakeholders in case of an emergency.
- Designate an emergency response team responsible for coordinating the response efforts.
- Conduct regular emergency drills to ensure all personnel are familiar with the response procedures.
- Provide ongoing training for the emergency response team and other key personnel.

5.3.4) Penalties Levied on Electricity Bills Due to Incorrect Power Factor, Load, or Related Issues

A. Power Factor Monitoring:

- Regularly monitor the power factor of all pumping machinery and other electrical equipment using power factor meters.

- Install power factor correction devices, such as capacitors, where necessary to maintain an optimal power factor.

B. Load Management:

- Ensure that electrical loads are balanced across all phases to avoid overloading and related penalties.
- Use automation systems to manage peak load periods and reduce the risk of penalties.

C. Penalty Review:

- Review electricity bills monthly to identify any penalties related to power factor, load, or other issues.
- Investigate the cause of any penalties and take corrective action to prevent recurrence.

5.3.5) Training and Capacity Building

A. Training Programs:

- Organize regular training programs for staff on topics such as equipment operation, maintenance procedures, safety protocols, and emergency response.
- Include both classroom-based learning and hands-on training to reinforce practical skills.

B. Capacity Building Initiatives:

- Encourage staff to participate in workshops, seminars, and conferences related to irrigation management.
- Collaborate with educational institutions and industry experts to provide specialized training opportunities.

C. Performance Evaluation:

- Assess the impact of training programs through regular performance evaluations.
- Identify areas for further training or skill development and adjust training programs accordingly.

5.3.6) Grievance Redressal and Record-Keeping

A. Grievance Submission:

- Set up a formal grievance submission process, allowing users to report issues via written forms, phone calls, or online platforms.
- Ensure that all grievances are acknowledged within 24 hours and logged for further action.

B. Grievance Resolution:

- Assign grievances to the appropriate department or personnel for investigation and resolution.
- Aim to resolve grievances within a defined timeframe, typically within 7 days, and communicate the outcome to the complainant.

C. Record-Keeping:

- Maintain detailed records of all grievances, including the nature of the complaint, actions taken, and the resolution provided.
- Use these records to identify patterns or recurring issues and take proactive measures to prevent future grievances.

CHAPTER 3

List of relevant IS Codes for Irrigation Projects

Sr. No.	Category	IS Code	Description
1.	Cement- Grade 33	IS 269:2015	Specification for Ordinary Portland Cement (33 Grade).
2.	Cement (OPC) – Grade 43	IS 8112:2013	Specification for 43 grade Ordinary Portland Cement. Specifies physical and chemical requirements for OPC Grade 43.
3.	Cement- Grade 53	IS 12269:2013	Specification for Ordinary Portland Cement (53 Grade).
4.	Concrete Aggregates	IS 383:2016	Specification for coarse and fine aggregates from natural sources for concrete.
5.	Concrete	IS 456:2000	Code of practice for plain and reinforced concrete.
6.	Fresh Concrete	IS 1199 (Part 1-3):2018	Fresh Concrete - Methods of Sampling, Testing and Analysis
7.	Hardened Concrete	IS 516 (Part-5): 2021	Hardened Concrete - Methods of Test
8.	Polyethylene Water Supply Pipe	IS 4984:2016	Polyethylene Pipes for Water Supply - Specification
9.	Reinforcement Steel	IS 1786:2008	Specification for high strength deformed steel bars and wires for concrete reinforcement.
10.	Structural Steel	IS 2062:2011	Hot Rolled Medium and High Tensile Structural Steel - Specification
11.	Bricks	IS 1077:1992	Specification for common burnt clay building bricks.
12.	Stone Masonry	IS 1597 (Part 1):1992	Code of practice for construction of stone masonry – Rubble stone masonry.
13.	Stone Masonry	IS 1597 (Part 2):1992	Code of practice for construction of stone masonry – Ashlar masonry.
14.	Sand for Masonry Water	IS 2116:1980	Sand for Masonry mortars - Specification
15.	Geotextiles and Geomembranes	IS 13162 (Part 1-5):1991-1992	Geotextiles – Methods of test and specification.
16.	Bitumen for Waterproofing	IS 1580:1991	Specification for bitumen felts for waterproofing and damp-proofing.
17.	Stone Slabs	IS 1129:1972	Specification for stone slabs used for canal lining and other cross-drainage works.
18.	Admixtures for Concrete	IS 9103:1999	Specification for admixtures for concrete.
19.	Gabions and Mattress Wire	IS 16014:2012	Specification for hexagonal wire mesh products for gabions and revet mattresses.
20.	Earthen Materials	IS 1498:1970	Classification and identification of soils for general engineering purposes.
21.	Mortar for Brick Masonry	IS 2250:1981	Code of practice for preparation and use of masonry mortars.

22.	Sand for Masonry Mortar	IS 2116:1980	Specification for sand for masonry mortars.
23.	Lime	IS 712:1984	Specification for building limes used in mortars for brickwork.
24.	Stone Masonry	IS 1597 (Part 1):1992	Code of practice for construction of stone masonry – Rubble stone masonry (often used in conjunction with brick).
25.	Waterproofing Materials	IS 1580:1991	Specification for bitumen felts for waterproofing and damp-proofing.
26.	Cement Concrete Lining	IS 3873:1993	Laying cement concrete/stone slab lining on canals – Code of practice (if used in conjunction with brick lining).
27.	Common Burnt Clay Bricks	IS 1077:1992	Specification for common burnt clay building bricks. Specifies classification, dimensions, and physical requirements.
28.	Burnt Clay Perforated Bricks	IS 2222:1991	Specification for burnt clay perforated building bricks. Used for non-load bearing structures like canal lining.
29.	Fly Ash Clay Bricks	IS 13757:1993	Specification for burnt clay fly ash building bricks. Provides specifications for bricks with improved durability.
30.	Heavy Duty Burnt Clay Bricks	IS 2180:1988	Specification for heavy-duty burnt clay building bricks. Used in situations requiring higher strength bricks.
31.	Brickwork	IS 2212:1991	Code of practice for brickwork. Covers materials, construction methods, and quality of brickwork.
32.	Burnt Clay Hollow Bricks	IS 3952:1988	Specification for burnt clay hollow bricks used in walls and other structures. Applicable where lighter bricks are needed.
33.	Class Designation of Bricks	IS 3102:1971	Specification for classification of burnt clay solid bricks based on compressive strength and water absorption.
34.	Methods of Test for Bricks	IS 3495 (Parts 1-4):1992	Methods of tests of burnt clay building bricks, covering compressive strength, water absorption, efflorescence, and warpage.
35.	Calcium Silicate Bricks	IS 4139:1989	Specification for calcium silicate bricks used in masonry. Used for specific engineering requirements.
36.	Fireclay Refractory Bricks	IS 4860:1968	Specification for fireclay refractory bricks used in construction where heat resistance is necessary.
37.	Fly Ash-Lime Bricks	IS 12894:2002	Specification for fly ash-lime bricks used in general construction and masonry applications, including canal lining.
38.	Sand-Lime Bricks	IS 4139:1989	Specification for sand-lime bricks (calcium silicate bricks) used for various structural applications.
39.	Methods of Physical Tests for Cement	IS 4031 (Parts 1-15):1996	Methods of physical tests for hydraulic cement, covering fineness, soundness, setting time, strength, and more.
40.	Chemical Analysis of Cement	IS 4032:1985	Method of chemical analysis of hydraulic cement. Provides procedures for determining the chemical composition of cement.
41.	Packing and Marking of Cement Bags	IS 8041:1990	Specification for rapid hardening Portland cement (often used in conjunction with OPC for quick setting

			applications).
42.	Concrete Mix Proportioning	IS 10262:2019	Guidelines for concrete mix proportioning. Ensures optimal use of OPC Grade 43 in concrete mix design for canal lining.
43.	Cement Sampling	IS 3535:1986	Methods of sampling hydraulic cement. Specifies the procedures for obtaining representative samples for testing.
44.	Storage of Cement	IS 4082:1996	Recommendations on stacking and storage of cement in construction sites. Ensures proper storage to maintain the quality of OPC Grade 43.
45.	Safety Code for Handling of Cement	IS 4926:2003	Code of practice for ready-mixed concrete. Ensures safety and quality during the handling and use of OPC Grade 43 in ready-mix concrete.
46.	Concrete Practices for Water Structures	IS 3370 (Part 1-4):2009	Code of practice for concrete structures for the storage of liquids, relevant to the use of OPC Grade 43 in canal lining.
47.	Maintenance of Canals	IS 4839 (Part 1-3):1992	Code of practice for maintenance of Canals
48.	Technologies for Water Reuse Systems	IS 17665 Part 1-2):2021	Guidelines for Performance Evaluation of Treatment Technologies for Water Reuse Systems Part 1 General
49.	Treated Waste Water Reuse	IS 17664:2021	Code of practice for Adaption of Irrigation Systems and Practices to treated wastewater
50.	Lined Canals- Design	IS 10430: 2000	Criteria for design of lined canals and guidelines for selection of type of lining.
51.	Lining of Water Courses and Field Channels	IS 12379:1988	Code of practice for Lining of Water Courses and Field Channels
52.	Lined Canals-Drainage system	IS 9429:1999	Code of practice for drainage system for canal lining.
53.	Project Management	IS 15883 (Part 1-12):2016	Code of practice for Construction Project Management
54.	Project Planning	IS 4410 (Part-II):1967	Glossary of terms Relating to River Valley Projects
55.	Water pipelines-Laying	IS 3042:1965	Code of practice for laying of water pipelines.
56.	Concrete Lining – Repair and Maintenance	IS 4839:1990	Code of practice for repair and maintenance of concrete linings on canals.
57.	Surface runoff Drainage- Grading and Paving	IS 3043: 1987	Code of practice for earthing (relevant to grading for surface water runoff)
58.	Drainage system-Stormwater Management	IS 1172: 1993	Code of basic requirements for water supply, drainage and sanitation, including stormwater management.
59.	Drainage System – Materials	IS 458:2003	Precast concrete pipes (with and without reinforcement) – Specification.

60.	Drainage System– Installation of drains	IS 8498:1977	Code of practice for installation of surface drains and laying of drainage channels.
61.	Drainage System– Sanitary Pipes Drains	IS 5329:1983	Code of practice for sanitary pipe drains.
62.	Drainage System – Under Drainage	IS 4558:1983	Code of practice for under drainage of lined canals (applicable to subsurface drainage systems).
63.	Drainage System – Quality Control	IS 12584:1989	Guidelines for quality control during construction of drainage systems.
64.	Drainage System – Maintenance	IS 1742:1983	Code of practice for maintenance of building drainage systems.
65.	Drainage System – Design of Small Waterways	IS 5330:1984	Guidelines for the design of surface drainage systems in rural and urban areas.
66.	Irrigation Drainage – General Design	IS 8835:1978	Guidelines for planning and layout of surface drainage systems for agricultural land.
67.	Irrigation Drainage – Subsurface Drainage	IS 7526:1992	Code of practice for design and installation of subsurface drains in irrigation projects.
68.	Irrigation Drainage – Open Drains	IS 7112:1973	Criteria for design of unlined canals and drains in alluvial soils.
69.	Irrigation Drainage – Soil Drainage	IS 9451:1994	Guidelines for lining of irrigation canals and drains in expansive soils.
70.	PVC and HDPE Pipes	IS 4985:2000	Specification for unplasticized PVC pipes for potable water supplies.
71.	Screen and Casing Pipe	IS 12818:2010	Unplasticized Polyvinyl Chloride (PVC-U) Screen and Casing Pipes for Bore/Tubewells - Specification
72.	Precast Concrete Pipe	IS 458:2021	Precast Concrete Pipes (with and without Reinforcement)
73.	Polyethylene Sewerage Pipe	IS 14333:2022	Polyethylene Pipes for Sewerage and Industrial Chemicals and Effluent - Specification
74.	PE Pipes for Sprinkler	IS 17425:2020	Quick Coupled Polyethylene Pipes and fittings for Sprinkler Irrigation system - Specification
75.	Plastic Pipe for Water Supplies	IS 7634 (Part-1):2012	Choice of materials and General Recommendations for Plastic pipe work for Potable Water Supplies
76.	Laying and Jointing of Polyethylene Pipes for Water Supply	IS 7634 (Part-2):2012	Plastics Pipes Selection, Handling, Storage and Installation for Potable Water Supplies (Polyethylene Pipe)
77.	Laying and Jointing of UPVC Pipes for Water Supply	IS 7634 (Part-3):2012	Plastics Pipes Selection, Handling, Storage and Installation for Potable Water Supplies (UPVC pipe)
78.	PVC and HDPE Pipes	IS 14333:1996	Specification for high-density polyethylene (HDPE) pipes for sewerage and drainage.
79.	Rubber Seals	IS 5382:1985	Specification for rubber sealing rings for gas mains, water mains, and sewers.
80.	Non-Return Valve	IS 5312 (Part 1):2004	Code of practice for Swing Check Type Reflux (Non-Return) Valves for water works purposes
81.	Strainer Filter	IS 12785:1994	Code of practice for Irrigation Equipment - Strainer Type Filters

82.	Butterfly Valve	IS 13095:2020	Code of practice for Butterfly Valves for General Purposes
83.	Media Filter	IS 14606:1998	Code of practice for Irrigation Equipment - Media Filters
84.	Hydro Cyclone Filter	IS 14743:1999	Code of practice for Irrigation Equipment - Hydrocyclone Filters
85.	Laying of Pipe	IS 783:1985	Code of practice for Laying of Concrete Pipes
86.	Geological Exploration	IS 15736:2007	Code of practice for Geological Exploration by Geophysical Method (Electrical Resistivity)
87.	PV Modules	IS 14286:2010	Code of practice for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules

CHAPTER 4

DESCRIPTION OF COMPONENTS

1. WATER SOURCES

Following types of water sources can be combined to create a reliable, diversified Water Supply Scheme based on the region's geography, climate, and population needs.

A. Surface Water Sources

I. Rivers and Streams: Rivers are one of the most common surface water sources for WSS. They provide continuous and abundant water flow. However, they may require extensive treatment due to pollution and suspended solids.

II. Lakes and Reservoirs: Natural lakes or man-made reservoirs collect water through rainfall, snowmelt, or river inflow. Reservoirs are particularly reliable for storing large amounts of water during dry seasons.

III. Canals: Canals are artificial channels that divert water from rivers or reservoirs. They provide a perennial source of water, making them an excellent option for water supply schemes, though they may have periodic closures for maintenance.

IV. Ponds and Tanks: Small-scale local water bodies like ponds or irrigation tanks can be used in rural areas. These usually require proper treatment before consumption.

B. Groundwater Sources

I. Wells: Wells tap into groundwater aquifers. Depending on the depth, they are classified as shallow or deep wells. They are a common and reliable source, especially in rural areas. However, over-extraction can lead to depletion or contamination.

II. Borewells and Tubewells: Borewells are deep, narrow wells drilled into the ground to extract water from deep aquifers. These are suitable where groundwater is plentiful and offer a consistent source of water.

III. Springs: Natural springs are sources of water that emerge from the ground, often found in hilly areas. They are typically clean and require minimal treatment, though their yield can be seasonal.

C. Rainwater Harvesting

I. Rooftop Rainwater Harvesting: Water collected from rooftops is stored in tanks or reservoirs and used for domestic consumption or groundwater recharge. It is highly effective in areas with seasonal rainfall.

II. Surface Runoff Harvesting: This involves collecting rainwater from surfaces such as fields, roads, or paved areas and storing it for later use. This can supplement water supply during dry periods.

III. Rainy Well Structure: This involves the collection of rainwater after seepage in the ground.

D. Snowmelt (in mountainous regions)

Glacier-fed Rivers and Streams: In mountainous regions, snowmelt from glaciers can provide a perennial source of water. These rivers and streams are generally reliable, but seasonal variations may affect availability.

2. TYPES OF CANAL SYSTEM

A canal system is a man-made waterway constructed for purposes such as irrigation, drainage, navigation, or water supply. Below are the main components of a canal system along with brief descriptions:

I. Main Canal: The primary channel that carries water from a water source (river, reservoir, or dam) to the distribution network. It is designed to convey a large volume of water and is usually the longest and widest part of the canal system.

II. Branch Canal: A secondary canal that diverges from the main canal to distribute water to different areas. Branch canals are typically smaller in size compared to the main canal and deliver water to sub-areas within the command region.

III. Distributary Canal: These are smaller canals branching off from branch canals. Their role is to distribute water directly to the fields or specific areas in need of irrigation. They ensure uniform distribution of water to farmers.

IV. Field Channels (Watercourses): These are small channels that convey water from the distributary canals to the individual fields or irrigation units. They form the last stage of the canal system, ensuring water reaches the crops.

V. Headworks: Structures located at the head of the main canal to divert water from the river or reservoir into the canal system. These may include weirs, barrages, and sluice gates to control water flow into the canal.

VI. Canal Head Regulator: A control structure located at the entrance of the main canal. It regulates the flow of water into the canal, ensuring the proper amount of water is released according to demand.

VII. Cross Regulator: A structure built within the canal to regulate the flow of water along its length. It helps maintain the desired water level and flow rate in the canal, especially in downstream sections.

VIII. Escape: A structure that allows excess water to be discharged from the canal system into a natural water body like a river or drain, preventing overflow and damage to the canal.

IX. Falls: A structure that dissipates the energy of water when the canal descends a steep slope. Falls prevent erosion and ensure safe flow of water along a steep gradient.

X. Aqueduct: A structure that carries the canal over a natural drainage or another watercourse. Aqueducts prevent interference between the canal and natural waterways.

XI. Siphon: A hydraulic structure that allows the canal to pass under obstacles, such as roads or rivers, by using a closed conduit, ensuring the continuous flow of water.

XII. Bridges: Structures that allow roads, railways, or other infrastructure to cross over the canal without disrupting its flow.

XIII. Check Dams: Small dams built within the canal system to increase the water level and control flow in specific sections. These are often used in smaller canal systems to enhance water distribution.

XIV. Drainage Inlets and Outlets: These structures allow excess or surplus water from the canal to drain into natural water bodies or discharge zones, ensuring the canal does not become waterlogged.

3. CANAL LINING

Canal lining is the process of applying a material or layer to the interior surface of a canal to prevent water loss through seepage, reduce erosion, and enhance the efficiency of water delivery. Various types of canal linings are used based on factors like soil type, canal size, and budget. Here's a brief description of different types of canal lining:

I. Concrete Lining: A durable and rigid lining made of reinforced or plain concrete. It provides a strong barrier against seepage and erosion and is commonly used in large canals and areas with high water flow.

II. Brick Lining: A lining made of bricks laid in mortar, providing a sturdy and aesthetically pleasing surface. It is often used in smaller canals or where historical or architectural considerations are important.

III. Plaster Lining: A smooth plaster coating applied to the canal bed and sides. It is typically used as a final finishing layer over other linings to provide a smooth surface and enhance water flow.

IV. Geomembrane Lining: A synthetic, flexible membrane made from materials like PVC, HDPE, or EPDM. It is used to create a waterproof barrier and is effective in preventing seepage in both small and large canals.

V. Clay Lining: A lining made from compacted clay or soil with high clay content. It is a low-cost method used in areas where clay is readily available and provides a natural seal against seepage.

VI. Asphalt Lining: A lining made of asphalt or bituminous materials that create a flexible, waterproof surface. It is durable and resistant to weathering, making it suitable for areas with moderate to high flow conditions.

VII: Riprap Lining: A lining made of large, irregularly shaped rocks or stones placed along the canal bed and sides. It provides erosion control and stability but is less effective at preventing seepage compared to other linings.

VIII: Gravel Lining: A lining made of compacted gravel or crushed stone. It is used to control erosion and can provide some degree of seepage control, though it is less effective than more impermeable linings.

IX: Tiled Lining: A lining made of ceramic or concrete tiles laid in a pattern to create a smooth, durable surface. It is often used in decorative or specialized canal applications.

X. Flexible Membrane Lining: A type of lining made from flexible, synthetic materials like rubber or synthetic fabrics that can conform to the shape of the canal and provide a waterproof barrier.

Each type of canal lining offers specific advantages and is selected based on factors such as water flow conditions, soil characteristics, budget, and maintenance requirements.

4. TYPES OF LARGE DAMS

I. Reservoir: The artificial lake created behind the dam, where water is stored. It holds the water during times of excess flow and releases it as needed for power generation, irrigation, or water supply.

II. Dam Body: The main structure of the dam that holds back the water. It can be made of concrete, earth, or rockfill. The type and size of the dam body depend on the location, water pressure, and purpose of the dam.

III. Spillway: A structure designed to release excess water from the reservoir in a controlled manner to prevent overtopping. It helps regulate the water level in the reservoir during floods or high inflow periods.

IV. Sluice Gate: A gate mechanism located at the bottom or side of the dam, used to release water from the reservoir when needed for downstream uses or to empty the reservoir for maintenance.

V. Powerhouse: In hydroelectric dams, the powerhouse contains turbines and generators that convert the energy of flowing water into electricity. It is typically located at the base of the dam.

VI. Penstock: A large pipe or tunnel that carries water from the reservoir to the turbines in the powerhouse. The high-pressure water drives the turbines, producing hydroelectric power.

VII. Crest: The top edge or uppermost part of the dam. It often serves as a roadway or access path, and its height determines the maximum level of water storage.

VIII. Outlet Works: Structures that release water from the reservoir for various purposes such as irrigation, water supply, or environmental flow. They are often located at different heights to control water release at various levels.

IX. Abutments: The sides of the valley or cliffs on which the dam structure rests. They support the dam's weight and are critical for the stability of the dam.

X. Foundation: The underlying ground or rock on which the dam is built. A strong foundation is essential for the stability and safety of the dam, as it must withstand the pressure of the water stored in the reservoir.

XI. Intake Structure: A structure that controls the entry of water into the penstock or other conveyance systems. It ensures that water flows smoothly to the turbines or for other uses without carrying debris.

XII. Diversion Tunnel: A tunnel built to divert water away from the dam site during construction or in emergencies. It allows water to bypass the dam during times when the reservoir is being filled or maintained.

XIII. Cut-off Wall: A structure located below the dam to prevent seepage of water through the foundation or abutments. It ensures that the dam remains watertight and prevents erosion or structural weakening.

XIV. Gallery: A tunnel or passage built within the dam for inspection, maintenance, and drainage. It allows access to the internal parts of the dam for monitoring and repairs.

XV. Riprap: A layer of large stones or rocks placed on the upstream side of the dam or along the reservoir shore to protect the dam from erosion caused by waves and water currents.

XVI. Drainage System: A system of pipes or drains within the dam structure that collects and removes seepage water to prevent buildup of water pressure within the dam, ensuring its stability.

5. TYPES OF DAMS

I. Gravity Dam: A dam that relies on its own weight to resist the horizontal pressure of water. It is made from concrete or stone and is usually massive and thick. The weight of the structure prevents it from being pushed over by the water.

II. Arch Dam: A curved dam that transfers the water pressure to the abutments (the valley sides). It is usually constructed in narrow canyons or gorges and uses less material than gravity dams due to its shape.

III. Buttress Dam: A dam with a sloping face that is supported by triangular buttresses spaced at intervals along the downstream side. It reduces the volume of materials needed and transfers water pressure to the ground.

IV. Earthfill (Embankment) Dam: Made from natural materials like soil, sand, clay, or rock, these dams rely on their bulk to hold back water. They are often wide and constructed with a waterproof core.

V. Rockfill Dam: Similar to earthfill dams but built primarily with rocks and boulders, with an impermeable membrane or clay core to prevent water seepage. The rocks give stability and allow drainage.

6. IRRIGATION DRAINAGE SYSTEM

I. Surface Drainage: A method that removes excess water from the soil surface using shallow ditches or channels. Surface drainage helps manage water in areas with heavy rainfall or over-irrigation by directing runoff to natural water bodies or drainage channels.

II. Subsurface Drainage: A system that removes excess water from below the soil surface using underground pipes or tile drains. These pipes, typically perforated, collect water from the soil and convey it to an outlet, preventing waterlogging in the root zone of crops.

III. Main Drain: The largest channel in the drainage network that collects water from smaller ditches or subsurface drains and directs it to a natural watercourse, river, or reservoir. It ensures the efficient removal of excess water from the entire area.

IV. Field Drains: Smaller ditches or drains constructed at field level to collect excess water from the crop area and direct it to larger drains. These are typically shallow and spaced throughout the field to prevent standing water.

V. Drainage Outlet: The point where water is discharged from the drainage system into a river, canal, or reservoir. The outlet must be properly designed to prevent backflow and allow for smooth water discharge.

VI. Collector Drains: Medium-sized drains that collect water from field drains and direct it to the main drain. They act as an intermediary between small field drains and larger water channels.

VII. Drainage Pumping Stations: Pumping stations are used in flat or low-lying areas where gravity alone cannot move water through the drainage system. Pumps lift water from lower areas into higher channels or natural water bodies.

VIII. Weirs and Gates: Control structures installed in the drainage channels to regulate water flow. They help manage water levels within the system and prevent flooding or excessive draining.

IX. Leaching System: A subsurface drainage feature used in areas with high salinity. The system flushes salts from the soil by applying excess irrigation water, which dissolves salts and carries them away through the drainage system.

X. Drainage Ditches: Shallow, excavated channels used to collect and remove surface water. They help redirect water to larger drains or natural watercourses.

7. IRRIGATION CROSS- DRAINAGE WORKS

I. Aqueduct: A structure that carries an irrigation canal over a natural drainage channel, like a river or stream. The canal is elevated, and water flows below it. This prevents the canal from being disrupted by natural watercourses.

II. Super Passage: Similar to an aqueduct, but here the drainage flows over the canal in a bridge-like structure. The canal runs beneath the drainage, allowing the natural flow of water above it.

III. Siphon Aqueduct: A combination of a siphon and an aqueduct, where the irrigation canal is carried over the drainage, but the drainage is also carried under the canal using a siphon. This prevents interference between the two systems.

IV. Level Crossing: A structure where both the canal and the drainage meet at the same level. Gates or regulators are used to manage the flow of both watercourses and prevent overflow from one to the other.

V. Canal Siphon: A siphon allows the canal to pass under a natural drainage system, typically a river or stream, by using an underground pipe or conduit. This structure allows the canal to continue its course without interruption.

VI. Inverted Siphon: Similar to a canal siphon, but specifically designed for areas where the natural drainage level is lower than the canal. The water from the canal is siphoned down and then up again to maintain its flow.

VII. Culvert: A small structure that allows natural drainage to pass under an irrigation canal or road. Culverts are typically used for smaller streams or drainage channels and prevent obstruction of the natural watercourse.

VIII. Syphon (Siphon Drainage): A structure where the natural drainage is diverted under the canal using a pipe or tunnel. It is designed to carry drainage water across a canal at a different elevation without disturbing the canal flow.

8. VARIOUS TYPES OF CANAL OUTLETS

I. Head Sluice: A control structure located at the beginning of a canal or its branches. It regulates the flow of water from the canal into smaller distributaries or directly to fields. It often features adjustable gates to control the volume of water released.

II. Turnout: An outlet structure that allows water to flow from the main canal into a smaller distributary or field channel. It typically includes a sluice gate or valve to control the flow rate and volume of water.

III. Regulator: A structure installed along the canal to regulate water flow and maintain the desired water level. Regulators can include gates, valves, or other mechanisms to control the release of water into distributaries or outlets.

IV. Check Structure: A device used to control or block the flow of water in a canal. It helps to maintain desired water levels and can include gates or barriers to prevent backflow or manage water distribution.

V. Syphon Outlet: An outlet structure that uses siphon principles to transfer water from a higher canal to a lower field or channel. It typically involves a pipe or conduit that allows water to flow under gravity through a siphoning action.

VI. Culvert Outlet: A pipe or conduit structure that allows water to pass through a canal embankment or road, directing it to fields or another water body. Culverts help manage water flow without disrupting the canal's structure.

VII. Drop Structure: A structure that allows water to drop from a higher to a lower elevation, often used to manage changes in canal gradient. It includes a drop channel and a pool to dissipate energy and prevent erosion.

VIII. Outlet Weir: A structure with a weir crest that allows water to flow out of the canal in a controlled manner. It helps regulate the water level in the canal and directs water to downstream areas.

IX. Turbine Outlet: An outlet structure that incorporates a turbine mechanism to regulate water flow. The turbine can be adjusted to control the volume and rate of water released from the canal.

X. Regulating Gate: A gate mechanism installed at the outlet to control the amount of water released from the canal. It can be manually or automatically operated to adjust the flow rate based on demand.

9. VARIOUS COMPONENTS OF DRIP (MICRO) IRRIGATION.

I. Drip Emitters: Devices that release water in small, controlled amounts directly to the soil near the plant roots. Emitters can be adjustable or fixed-flow and are designed to deliver water slowly to minimize evaporation and runoff.

II. Drip Tubing (or Drip Line): Flexible tubing through which water flows from the main line to the emitters. It is laid out along the rows of plants and contains the emitters that release water directly to the soil.

III. Mainline (or Main Pipe): The primary pipeline that transports water from the water source to the drip system. It is usually made from durable materials like PVC or polyethylene and supports the entire irrigation system.

IV. Submain (or Submain Pipe): A smaller pipeline that branches off from the mainline and distributes water to the drip tubing. It helps to deliver water evenly to different sections of the irrigation system.

V. Filter: A device that removes debris and particulates from the water before it enters the drip system. Filters are crucial to prevent clogging of the emitters and maintain system efficiency.

VI. Pressure Regulator: A device that controls and maintains the water pressure within the drip irrigation system. It ensures that water is delivered at the correct pressure, preventing damage to components and uneven distribution.

VII. Pressure Compensating Valve: A valve that maintains consistent water flow and pressure across different emitters, regardless of changes in pressure along the system. This ensures uniform water distribution.

VIII. Backflow Preventer: A device that prevents contaminated water from flowing back into the clean water supply. It is essential for maintaining water quality and preventing cross-contamination.

IX. Drip Tape: A type of thin, flexible tubing with built-in emitters that is used for row crops or in short-length applications. It is often used in annual crops and provides efficient water delivery.

X. End Caps: Caps placed at the end of the drip tubing or tape to close the system and prevent water from flowing out at the end. They help maintain system pressure and prevent leaks.

XI. Flush Valves: Valves installed at low points in the system to allow for the removal of debris and sediment that can accumulate over time. Flushing helps to maintain system efficiency.

XII. Control Valves: Valves used to control the flow of water to different sections of the irrigation system. They can be manually operated or automated to regulate watering schedules and amounts.

XIII. Fertigation System: A system that allows for the addition of fertilizers and other nutrients directly into the irrigation water. It enables precise nutrient delivery and efficient use of fertilizers.

10. VARIOUS COMPONENTS OF SPRINKLER (MICRO) IRRIGATION.

I. Sprinklers: Devices that distribute water over the field in the form of droplets or mist, simulating rainfall. Sprinklers can be stationary or rotating and come in various designs suited for different types of crops and field sizes.

II. Pipes (Mainline and Lateral Lines): Tubing that transports water from the source to the sprinklers. Mainlines are the primary pipes carrying water from the source, while lateral lines distribute water to individual sprinklers.

III. Pump: A mechanical device that increases the pressure of the water to ensure it reaches the sprinklers effectively. Pumps are crucial for systems where water pressure from the source is insufficient.

IV. Pressure Regulator: A device that controls and maintains consistent water pressure within the irrigation system. It ensures that sprinklers operate at optimal pressure, improving distribution uniformity and preventing damage.

V. Filter: A component that removes debris and particulates from the water before it reaches the sprinklers. This prevents clogging and ensures smooth operation of the system.

VI. Control Valves: Valves that manage the flow of water to different sections of the sprinkler system. They can be manually operated or automated to control watering schedules and amounts.

VII. Timer/Controller: An automated device that schedules and controls the operation of the sprinkler system. It can be programmed to run at specific times and durations, ensuring efficient water use.

VIII. Backflow Preventer: A device that prevents contaminated water from flowing back into the clean water supply. It is essential for maintaining water quality and preventing cross-contamination.

IX. Nozzle: The part of the sprinkler that directs the flow of water into a spray pattern. Nozzles come in various sizes and types to produce different spray patterns and flow rates.

X. Head (Sprinkler Head): The component of the sprinkler that includes the nozzle and disperses water over the field. It can be designed for specific applications, such as pop-up heads for lawns or impact heads for larger areas.

XI. Swing Joint: A flexible connection between the sprinkler and the pipe, allowing the sprinkler to adjust its position and movement. It helps prevent damage from physical impacts and facilitates maintenance.

XII. Risers: Vertical pipes or tubes that elevate the sprinkler head above the ground level, ensuring the water is distributed evenly over the crops. Risers can be fixed or adjustable in height.

XIII. Pressure Gauge: A device used to measure the water pressure within the system. It helps monitor and adjust pressure to ensure optimal sprinkler performance.

XIV. Valve Box: A protective enclosure that houses the control valves and other components of the irrigation system. It allows for easy access and maintenance.

11. VARIOUS COMPONENTS OF LIFT IRRIGATION.

I. Water Source: The source from which water is extracted for irrigation, such as rivers, lakes, or reservoirs. The quality and quantity of water from this source are crucial for the system's efficiency.

II. Pump: The mechanical device used to lift water from the source to the irrigation system. Pumps are essential for creating the pressure needed to move water to higher elevations.

III. Pump House: A structure that houses the pump and its associated equipment. It provides protection and space for maintenance and operation.

IV. Lift Irrigation Pipeline: The network of pipes that transport water from the pump to the field or irrigation area. It includes both the rising main (for lifting water) and the distribution pipes.

V. Pressure Regulator: A device used to control and maintain the water pressure within the irrigation system. It ensures that the water pressure is consistent and suitable for efficient distribution.

VI. Filter: A component that removes debris and particulates from the water before it enters the irrigation system. This prevents clogging of pipes and other irrigation components.

VII. Distribution System: The network of pipes or channels that distributes water from the main pipeline to the individual fields or crops. It includes smaller pipes or channels that lead to various parts of the irrigation area.

VIII. Control Valves: Valves used to manage and regulate the flow of water within the irrigation system. They allow for control over which sections receive water and at what flow rate.

IX. Reservoir (if applicable): A storage facility where water is collected and held before it is distributed to the fields. It helps manage water supply and can serve as a buffer for varying water demands.

X. Field Outlets: Structures that allow water to flow from the distribution system into the fields. They ensure proper water distribution and can be adjustable to regulate flow rates.

Xi. Drop Structure

- A structure that allows water to flow from a higher elevation to a lower elevation safely, usually including a drop channel and a pool to dissipate energy and prevent erosion.
- A drop structure used to transition water from a lift pipeline to a field canal.

XII. Flow Meter

- A device used to measure the amount of water flowing through the system. It helps monitor and manage water usage and distribution efficiency.
- Digital or mechanical flow meters.

XIII. Water Level Indicator

- A device that monitors the water level in the reservoir or storage tank. It provides information for managing water supply and preventing overflow or shortages.
- Float switches or electronic sensors.

XIV. Maintenance and Control Systems

- Systems and tools used for the regular upkeep and operation of the lift irrigation system. This includes monitoring equipment, repair tools, and control panels.
- Control panels for operating pumps and monitoring systems.

12. ELECTRIC MOTORS FOR LIFT IRRIGATION

I. Induction Motors

- The most commonly used type of electric motor for lift irrigation. They operate on the principle of electromagnetic induction and are known for their robustness and reliability. They come in two types: squirrel cage and wound rotor.
- A 3-phase squirrel cage induction motor powering a centrifugal pump.

II. Submersible Motors

- Motors designed to operate underwater and are used in submersible pumps for deep well irrigation. They are encased in a waterproof housing to protect them from water and debris.
- A submersible motor installed in a deep well to lift water from underground sources.

III. Vertical Motors

- Motors that are mounted vertically, often used with vertical shaft pumps. They are ideal for applications where space is limited, and they efficiently handle high lift irrigation.
- A vertical motor used with a vertical turbine pump in a deep well.

IV. Horizontal Motors

- Motors mounted horizontally, typically used with horizontal shaft pumps. They are commonly used in surface irrigation systems and are known for their simplicity and ease of maintenance.
- A horizontal motor driving a centrifugal pump for irrigation.

V. Variable Frequency Drive (VFD) Motors

- Motors controlled by a variable frequency drive that adjusts the speed and torque of the motor based on irrigation needs. VFDs enhance energy efficiency and provide precise control over water delivery.
- A VFD-controlled motor adjusting pump speed based on real-time water demand.

VI. Explosion-Proof Motors

- Motors designed to operate safely in hazardous environments where flammable gases or vapors may be present. They are used in areas with potential explosive conditions.
- An explosion-proof motor used in a pump station in an agricultural area with flammable materials.

VII. Single-Phase Motors

- Motors that operate on a single-phase power supply, suitable for small-scale irrigation systems or where three-phase power is unavailable. They are typically used for lower horsepower applications.
- A single-phase motor driving a small centrifugal pump for a residential irrigation system.

VIII. Three-Phase Motors

- Motors that operate on a three-phase power supply, providing more power and efficiency compared to single-phase motors. They are commonly used for larger irrigation systems requiring higher horsepower.
- A three-phase motor used in a large-scale lift irrigation system with a high-capacity pump.

IX. High-Efficiency Motors

- Motors designed to operate with higher efficiency, reducing energy consumption and operational costs. They are ideal for systems where energy savings are a priority.
- A high-efficiency motor used in an energy-efficient lift irrigation system to minimize electricity use.

X. AC Motors

- Alternating current (AC) motors that are widely used in irrigation systems due to their durability and consistent performance. They are available in various types, including induction and synchronous motors.
- An AC motor used in a surface pump for agricultural irrigation.

XI. DC Motors

- Direct current (DC) motors that offer variable speed control and are used in specialized irrigation applications. They are less common in large-scale systems but useful for specific needs.
- A DC motor used in a solar-powered irrigation system.

13. ARTIFICIAL RECHARGING OF GROUND WATER

Artificial recharge of groundwater involves various methods and structures designed to increase the amount of water entering the groundwater system. Here are brief descriptions

of various types of structures used for artificial recharge:

I. Recharge Pits

- Shallow excavations filled with permeable material, such as gravel or crushed rock, that facilitate the infiltration of surface water into the groundwater system. They are often used in urban areas to capture rainwater.
- A pit filled with gravel placed in a parking lot to capture and recharge stormwater.

II. Recharge Wells

- Deep wells specifically constructed to inject water directly into the groundwater aquifer. They are used to transfer water from surface sources into the aquifer, often using high-pressure pumps.
- A well injecting treated wastewater into an aquifer to replenish groundwater levels.

III. Percolation Pits: Similar to recharge pits, but usually larger and deeper, designed to capture and allow the infiltration of water from rain or runoff into the soil and groundwater.

IV. Infiltration Trenches: Long, narrow trenches filled with gravel or other permeable materials that capture and direct surface runoff into the groundwater. They are used to manage stormwater and enhance recharge.

V. Check Dams: Small barriers built across streams or channels to slow down water flow and allow it to infiltrate into the ground. They help in recharging groundwater and reducing soil erosion.

VI. Bandhara: Similar to check dams but typically constructed across larger riverbeds or streams in arid regions. They capture and store water during the rainy season, allowing it to percolate into the ground.

VII. Permeable Pavements

- Pavements made from materials that allow water to pass through and infiltrate into the ground below. They are used in urban areas to reduce runoff and enhance groundwater recharge.
- Permeable concrete or pavers used in parking lots or walkways to facilitate water infiltration.

VIII. Soak Pits: Small, deep pits filled with stones or other porous materials designed to capture and allow the infiltration of surface water into the soil and groundwater.

IX. Check Dams: Small, often temporary, structures built across streams or small rivers to slow down the flow of water and allow it to infiltrate into the groundwater. They help in reducing soil erosion and enhancing recharge.

X. Sand Dams: Dams built across seasonal riverbeds to capture and store sand and water. The sand acts as a filter, allowing water to percolate into the groundwater while storing water in the sand for later use.

XI. Water Harvesting Pits: Pits designed to collect and store rainwater runoff for later infiltration into the ground. They are often used in combination with other recharge structures.

XII. Artificial Recharge Basins: Large, shallow basins designed to capture and store surface runoff or treated wastewater, allowing it to slowly infiltrate into the groundwater. They are often used in larger-scale recharge projects.

ANNEXURE -I

Technical Quality Audit Parameters for Irrigation Canal and Drainage

PRE-IMPLEMENTATION STAGE

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub indicators	Max. marks	Marks Obtained	Weightage
1	Planning & Design	Technical Framework in comprehensive Planning	DPR	1.1) Demand & Resource assessment	1.1.1) Sector-Wise requirement for Irrigation, Industrial Development & seasonal variation.	5		**25 %**
					1.1.2) Available water sources & their lean period discharges	2		
					1.1.3) Discharge depletion studies	1		
					1.1.4) Flood impact assessment in Canal	3		
					1.1.5) Seepage assessment due to water logging	3		
					1.1.6) Assessment of water in existing canals/distributaries/minors/drains and their uses.	3		
					1.1.7) Assessment of existing infrastructure and its uses	2		
				1.2) Approval of STC or Competent Authority	1.2.1) Preliminary Survey	2		
					1.2.2) Land Availability, Identification of NOCs applicable for utilities	1		
					1.2.3) Preparation of Pre-Feasibility Report	2		
					1.2.4) Preparation of Rough Cost Estimate	2		
					1.2.5) Approval of Standing Technical Committee (STC) or Competent Authority	2		
				1.3) Cost Analysis, Administrative Approval, Budget planning and Timeline estimates	1.3.1) Financial implication with cost index up to implementation period and Administrative Approval	3		
					1.3.2) Identification of funding agency with annual budget allocation	2		
					1.3.3) Timeline for DPR approval	5		

				1.4) Survey & Initiate Process for Land Acquisition and NOCs for utilities	1.4.1) Topographic Survey	5		
					1.4.2) Land Acquisition, Forest clearance etc.	5		
					1.4.3) Initiate the Process for NOC from Railways, Electricity Board, PHED, Roads and Panchayat	3		
				1.5) Selection of technology	1.5.1) Use of latest software for design and drawings	5		
				1.6) Optimum Design, and Selection of modern equipment and processes	1.6.1) Optimum design of canal, distributaries, minors, drains, and its appurtenant works/structures etc.	8		
					1.6.2) Use of modern mechanized / digital equipment such as: i) sensor paver, ii) automated gates, iii) Flow meters, iv) Laser land levelling equipment, v) Remote sensing and GIS, vi) Drip and Sprinkler irrigation, vii) soil moisture sensors, viii) automation and control system of gates, ix) weather stations	4		
					1.6.3) Provision for Horticulture Planning	2		
				1.7) Framing specifications and Technical Sanction of Estimate	1.7.1) Identification of material proposed to be used	5		
					1.7.2) Framing specifications for above materials	5		
					1.7.3) Technical Sanction of Detailed Estimate	2		
				1.8) Clearance of all requisite NOCs, Award of Work, and Project Management	1.8.1) NOCs obtained and clearance of all utilities	5		
					1.8.2) Award of Work and Contract Agreement	2		
					1.8.3) Project Management, Execution Plan, and fixing of timelines/milestones as per the contract agreement	2		
				1.89 Long term Planning	1.9.1) Future requirement projections such as land for remodeling	2		
				1.10) Reducing O&M cost	1.10.1) Provision of energy efficient machinery such BEE certified/star rating	3		
					1.10.2) Provision of solar energy	2		
					1.10.3) Provision of automation	2		
					TOTAL (PLANNING AND DESIGN)	**100**		**25 %**

IMPLEMENTATION STAGE

S.No.	Parameter	Benchmark	Reference	Indicator	Sub Indicators	Max. marks	Marks Obtained	Weightage
2	Execution, Inspection and testing	Technical Methodology for implementation and inspection & testing	Contract Agreement and test reports	2.1) Use of all construction materials	2.11) Selection of materials such as cement, aggregates, steel etc. from approved source and its testing	2		40%
					2.12) Use of batch mix plant and design mix	10		
				2.2) Procurement and Efficiency enhancement of Pumping machinery (Lift Irrigation)	2.21) Procurement of machinery from approved manufacturer	10		
					2.22) Carrying out tests for machinery at manufacture's premises before dispatch	4		
					2.23) Use of high efficiency pumps & motors specifically designed for site requirements	4		
					2.24) Life cycle cost analysis of pumping machinery	2		
				2.3) Use of modern facilities for construction	2.31) Use of advance machinery for Canal Lining.	5		
					2.32) Electric/automated operation of Pumping machinery and control gates, etc.	5		
					2.33) Use of laser land levelling equipment	2		
					2.34) Use of soil moisture sensors	2		
				2.4) Conformity to relevant standards for execution of work and ensuring safety and horticulture development	2.41) Work executed as per bid document	8		
					2.42) All Hydraulic Design Parameters ensured during the construction of canal and other structures as per approved design & drawings	5		
					2.43) Providing safety measures such as first aid & firefighting equipment, safety uniforms etc. during execution	1		
					2.4.4) Execution of Horticulture Development	2		
				2.5 Supervision by skilled manpower / Internal Vigilance Wing /TPIA	2.51) Adequate deployment of appropriately qualified personnel for supervision and conducting the inspections	1		
					2.52) Inspections conducted by Internal Vigilance Wing of the Department	1		
					2.53) Inspections conducted by Third Party Inspection Agency	2		

				2.6) Pre & Post Inspections of all materials, and Pumping Machinery	2.61) All laboratory testing of concrete and soil	10		
					2.62) Testing of machinery at manufacturer's premises	3		
					2.63) Ensure required frequency of tests during implementation	2		
				2.7) Setting up of testing laboratory at site	2.71) Setting up testing laboratories at site as per bidding document	5		
				2.8) Testing of Flow in Canal, and Pumping Machinery	2.81) Flow testing in Canal/distributaries/minors	2		
					2.82) Testing of pumping machinery to meet with the required discharge at required head	2		
					2.83) Availability of electric energy as per requirements	2		
				2.9) Rectification of Defects, and Documentation & Reporting	2.91) Preparation of site inspection and quality control registers	2		
					2.92) Checking of test results/defects/site and inspection registers by Engineer in Charge	2		
					2.93) Rectification of defects	2		
					2.94) Submission of reports and maintaining the records	2		
					TOTAL (EXECUTION, INSPECTION, TESTING)	**100**		**40 %**

COMMISSIONING AND HANDING OVER

S.No.		Benchmark	Reference	Indicators	Sub Indicator	Max. marks		Weightage
3	Commissioning and Handing over	Guidelines for commissioning and handing over	Completion report	3.1) Testing the functionality of Canal System and Pumping Machinery	3.11) System Cleaning	10		15%
					3.12) Testing of discharge under various conditions	20		
					3.13) Ensuring no leakage and minimum seepage	15		
					3.14) Ensuring required discharge at required head by pumping machinery	10		
					3.1.5) Adjustment of flow control systems	5		
					3.1.6) Handover the system to the concerned Operational Authorities	5		
				3.2) Submission of Assets management Plan and completion certificate	3.21) Submission of Assets management Plan and completion certificate	10		
				3.3) Guarantee of works in Defect Liability Period	3.31) Post commissioning Monitoring and support	10		
					3.32) Withholding security amount	5		
					3.3.3) Removal of Defects in Defect Liability Period	10		
					TOTAL (COMMISSIONING AND HANDOVER)	**100**		**15 %**

SAFETY AND SECURITY

Sr. no.	Parameter	Benchmark	Reference	Indicator	Sub Indicator	Max. marks	Marks Obtained	Weightage
4	Safety and Security	Guidelines for Safety and Security	Bid Document	4.1) Adherence to safety standards	4.11) Providing of safety measures such as first aid & firefighting equipment, safety uniforms etc.	2		5%
					4.12) Monitoring and Surveillance	2		
				4.2) Safety measures for workers and users	4.21) Access control	1		
				4.3) Security measures to prevent unauthorized access	4.31) Physical Security measure	2		
					4.32) Emergency response and reporting specially in case of outbreak of canal	3		
TOTAL (SAFETY AND SECURITY)						**10**		**5 %**

OPERATION AND MAINTENANCE

S.No.	Parameter	Benchmark	Reference document	Indicator	Sub Indicator	Max. marks	Marks Obtained	Weightage
5	Operation and maintenance	Procedure for effective maintenance	Assets management plan and manual on SOMP	5.1) Compliance to prescribed deliverable	5.11) Flow of Specified Design Discharge in canal/distributaries/minor up to tail end	20		100 %
					5.12) Ensuring operational parameters for pumping machinery and use of automation; and SCADA (wherever applicable)	10		
					5.13) Regular Cleaning of System	10		
					5.14) Maintenance of Horticultural Assets and Aesthetics	5		
				5.2) Effective running of Machinery /STP	5.21) Deployment of skilled staff for operation	5		
					5.22) Deployment of adequate number of staff for operation	5		
					5.23) Formation of WUA	5		
				5.3) Maintenance Process, and Emergency Response System	5.3.1) Maintenance schedule development and its compliance	5		
					5.3.2) Availability of spare parts/standby machinery if required	5		
					5.3.3) Emergency Response Planning	10		
					5.3.4) Penalties levied on electricity bills due to incorrect power factor, load, or related issues	10		
					5.3.5) Training and Capacity building	5		
					5.3.6) Grievance redressal and record-keeping	5		
					TOTAL (OPERATION AND MAINTENANCE)	**100**		**100 %**

Sr. No.	Parameter	Marking Criteria	Weightage (%)	
1	Design and Planning		25*	
2	Execution, Inspection and Testing		40*	
3	Commissioning and Handing over		15*	
4	Safety Measures		5*	
5	Project Management	Adherence to project timelines and Cost Projections	5	
6	Environmental Measures	Consideration of environmental factors like sustainability, eco-friendly construction practices	5	
7	User Feedback	Feedback from beneficiaries, stakeholders to assess their satisfaction levels	5	
		TOTAL	**100**	
1	**Operations and Maintenance**		100*****	
		TOTAL	**100**	

*The breakup of the weightage is given in the detailed framework for these parameters

* Parameters that are not applicable to a specific project will not be considered in the audit scoring. The weightage will be adjusted accordingly.

ANNEXURE II
Part A: Checklist for Approval of DPR of an Irrigation Project

Name of Division: _____

Name of Project: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Sector-wise requirement for Irrigation, Industrial Development, Institutional, and Domestic, etc. considering seasonal variations, assessed				
2.	Available water sources identified, and their lean period discharges and raw water silt content tested				
3.	Discharge depletion studies carried out				
4.	Flood Impact Assessment for the project area conducted				
5.	Seepage Assessment due to waterlogging along canal conducted				
6.	The water in existing canals, distributaries, minors, and drains assessed along with its current uses				
7.	Existing infrastructure evaluated for their condition and current usage				
8.	Topographic survey and Planning completed				
9.	Project Report Prepared				
10.	Rough Cost Estimate prepared				
11.	Approval of STC or competent authority issued				
12.	Administrative Approval and Budget allocation accorded				
13.	Land acquisition process initiated				
14.	Forest clearance applied				
15.	I. NOC from Railway Department applied				
	II. NOC from UHBVN/DHBVN applied				
	III. NOC from PHED applied				

	IV. NOC from PWD/NHAI applied				
	V. NOC from PRI applied				
16.	Latest software used for design and drawing preparation				
17.	Irrigation potential likely to be created/enhanced				
18.	Optimum design of canals, distributaries, minors, and drains prepared				
19.	Selection of modern mechanized and digital equipment included: I. Sensor Pavers				
	II. Automated Gates				
	III. Flow Meters				
	IV. Laser Land Leveling Equipment				
	V. Remote Sensing and GIS				
	VI. Soil Moisture Sensors				
	VII. Automation and Control of Gates				
	VIII. Weather Stations				
20.	Suitable materials for the project identified and proposed				
21.	Technical Specifications for above materials framed				
22.	Preparation of Detailed Project Report along with design, drawings cost estimate and its timeline.				
23.	Provision for horticulture and aesthetics planning				
24.	Financial implications, including cost indexing up to the implementation period addressed				
25.	Funding agency identified and the annual budget allocated				
26.	Future land requirements for remodeling of project assessed				
27.	Energy-efficient machinery and equipment, such as BEE-certified or star-rated, provided in the project				
28.	Provision for solar energy included in the project				
29.	Project designed with automation features for operational efficiency				

Note: This checklist is required to be appended with the DPR at the time of approval and duly signed by the concerned officers/officials.

Part B: Checklist for Execution, Inspection, Testing, Commissioning & Handover of an Irrigation Project

Name of Division: _____ Estimated Cost: _____ Date of Completion: _____

Name of Project: _____ Date of Sanction: _____ Actual Cost at Completion: _____

Name of Agency: _____ Date of Award: _____ Contract Value: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Detailed Soil investigation, design, and drawings completed				
2.	Detailed Survey and checking of structural safety of existing structures conducted				
3.	Design, drawings, machinery, and specification of materials approved				
4.	Cost Analysis and Detailed Estimate prepared and approved				
5.	Technical Sanction, Quantities of items, and DNIT approved				
6.	Bids prepared, Tender notice issued, and Technical & Financial Bids evaluated				
7.	Land acquisition completed				
8.	NOC for Forest Clearance obtained and work site cleared of the forest				
9.	All NOCs for utilities obtained and site cleared from all encumbrances				
10.	Award of work and signing of Contract Agreement				
11.	Project management, Execution Plan, timelines, and milestones as per contract agreement fixed in consultation with contractor				
12.	Layout planning made and testing of materials conducted				
13.	Use of design mix and batch mix plant ensured				

14.	Ensure that all materials such as cement, coarse and fine aggregates, steel etc. procured from an approved source				
15.	Machinery and Equipment of an approved make and manufacturer procured				
16.	Tests of machinery carried out at the manufacturers' premises before dispatch				
17.	High-efficiency pumps and motors, specifically designed for site requirements selected				
18.	Work executed/being executed as per the originally approved bid document and contract agreement				
19.	Ensure that trees/plants are planted as per horticulture provisions in the project				
20.	Appropriately qualified technical personnel deployed				
21.	Adequate Manpower deployed as per project requirements				
22.	Safety measures for personnel and machinery in place during construction				
23.	Personal protective equipment (PPE) provided and used by all personnel				
24.	All Hydraulic Design Parameters ensured during the construction of canal and other structures as per approved design & drawings				
25.	Advanced machinery used for canal lining				
26.	Electric or automated operation in place for pumping machinery and control gates				
27.	Laser land leveling equipment utilized for construction				
28.	Soil moisture sensors in use for irrigation efficiency				
29.	Debris/Waste material generated during the construction properly disposed of in compliance with environmental regulations				
30.	Testing laboratory set up at the site as per the bidding document				
31.	Laboratory tests for concrete and soil carried out as per project requirements				

32.	Tests conducted at the required frequency during the implementation phase				
33.	Site inspection and quality control registers maintained regularly				
34.	Inspection by Higher Authorities conducted				
35.	Inspection by Internal Vigilance Wing conducted				
36.	Inspection by TPIA conducted				
37.	Defects identified during inspections rectified				
38.	Reports of removal of defects submitted regularly and records maintained				
39.	Flow testing conducted in the canal, distributaries, and minors				
40.	Life cycle cost analysis of pumping machinery conducted				
41.	Pumping machinery tests conducted to ensure that the required discharge and head are met				
42.	Availability of electric energy sufficient for operational requirements				
43.	Environmental safeguards and pollution control measures implemented				
44.	Canal bed thoroughly cleared from any debris				
45.	Testing of discharge under various discharge conditions conducted				
46.	Minimum seepage and no leakage ensured throughout the system				
47.	Required discharge at the required head by the pumping machinery achieved				
48.	Performance of SCADA and other automated control systems validated				
49.	Submission of the Assets Management Plan and the completion certificate				
50.	Standard Operating Procedure (SOP) for running of canal prepared and implemented				
51.	Final site inspection conducted prior to the project handover				

52.	Post-commissioning monitoring and support provided to ensure smooth operation				
53.	Security Deposit retained till the successful completion of the specified defect lability period				
54.	Staff adequately trained for operating and maintaining the system post-handover				
55.	Maintenance manuals and SOPs handed over to the operational team				
56.	All safety systems including emergency shutdown mechanisms tested and verified				
57.	Final walk through and inspection of the entire system conducted with stakeholders				
58.	All records, drawings, and documentation related to the project handed over to the client				
59.	Final quality check and rectification of any remaining defects completed				
60.	Electrical system, including backup power sources tested and confirmed as operational				
61.	Performance tests for all mechanical and electrical components conducted				
62.	Spare parts inventory list provided to the operations team for future maintenance				
63.	Legal and regulatory compliance certifications obtained before handover				
64.	Providing of safety measures such as first aid kits & firefighting equipment, safety uniforms, etc.				
65.	Monitoring and Surveillance				
66.	Security measures implemented to protect against unauthorized access				
67.	Physical Security measures taken				

68.	Emergency evacuation plans established and communicated to all personnel				
69.	Regular safety drills conducted for all staff				
70.	System in place for reporting and investigating safety incidents				
71.	Safety audits and inspections conducted periodically				
72.	Emergency response and reporting mechanism, particularly, for canal breach, overflow or breakdown established				

Note: This checklist is required to be signed by the Executive Engineer in charge of the work and other officers during their visit.

Part C: Checklist for Operation and Maintenance of an Irrigation Project

Name of Division: _____ Cost of Project at Completion: _____

Name of Project: _____ Date of Completion: _____

Name of Agency: _____

Sr. No.	Questionnaire	Yes	No	N/A	Remarks
1.	Flow of specified design discharge in canals/distributaries/minors up to the tail end ensured				
2.	Operational parameters for pumping machinery and the use of automation and SCADA (where applicable) monitored and maintained				
3.	Skilled staff deployed for operation				
4.	Adequate number of staff deployed for operation and supervision				
5.	Water Users Association (WUAs) formed				
6.	Emergency response plan in place				
7.	Regular maintenance and upkeep of trees/plants ensured				
8.	Maintenance schedule developed and followed				
9.	Availability of spare parts and standby machinery if required				
10.	Performance of all automated systems regularly reviewed				
11.	Penalties for low power factors, load issues, or related electricity bill issues addressed				
12.	Routine inspections and preventive maintenance tasks conducted				
13.	System for tracking and managing maintenance requests				
14.	Operational manuals and SOPs regularly updated and accessible to staff				
15.	Training and capacity-building programs for staff implemented				

16.	System in place for reporting and managing equipment failures or malfunctions				
17.	Energy efficiency measures monitored and optimized				
18.	System for regular calibration and testing of measurement instruments/ methods for efficient regulation established				
19.	Process for regular review and update of safety protocols				
20.	Grievance redressal system and proper record-keeping				
21.	Stakeholder engagement and communication strategies in place				

Note: This checklist is required to be signed by the Executive Engineer in charge of the work and other officers during their visit.

ANNEXURE III
Guidelines to Overcome Bottlenecks in the Drainage System

It is generally observed that various types of bottlenecks in the course of drainage system and the resultant lack of proper connectivity with the final disposal point, results into inefficient drainage of the area.

To ensure efficient water management and prevent issues like flooding, waterlogging, and drainage failures, Haryana needs a structured approach to upgrading and maintaining its drainage infrastructure.

The following guidelines outline clear and actionable measures to address common inefficiencies and bottlenecks in the State's drainage system.

1. Siltation and Sediment Accumulation

Sediment accumulation in drainage systems reduced their capacity, leading to water stagnation and flooding. To counter this issue regular desilting programs must be implemented.

- Inspect and check all drains well before the cleaning period and prepare the proposals.
- Conduct desilting of all silted drains before the onset of rainy season by manual labour or mechanical methods
- Use mechanized dredging and advanced silt removal techniques for large water channels depending upon bed width, condition of the drain (dry/wet) and quantum of silt/weed.
- All the internal clearance works of drains should invariably be completed prior to the onset of rainy season every year.
- The removed silt/debris/weed should be disposed off at the outer slopes of the canal embankments or in the pits along the drains in the adjoining vacant land. It should not be placed at the inner edges or on top of the banks.

2 Choked Water Bays of Cross Drainage Structures

Choking of water bays of cross drainage works in the drains due to heavy siltation and weed growth often causes obstructions to the free and smooth flow of flood water, thereby resulting into the overflow of the drains in the upstream reaches.

- Inspect all cross drainage works across the drains prior to the onset of the rainy season.
- Ensure that water bays of all cross drainage works such as bridges, cause ways, siphons, aquaducts, etc are clear from all debris, silt, jungle, weed, etc. In addition to it, the capacity of water bays should be sufficient to carry the free flow of design discharge of the drain.

3. Encroachment on Drainage Paths

It has been observed that in the large drains/nadies, the water course between the embankments is encroached upon by the nearby inhabitants for illegal construction and agriculture which results into flooding and overflow of these drains and nadies. Consequently, the connectivity of the flood water to the disposal drains/rivers is compromised.

- Conduct regular land surveys and mapping to identify encroachments along drainage channels.
- Enforce strict penalties and legal action against unauthorized construction on natural drainage pathways for removal of the encroachments.
- Establish green buffer zones along drains where construction is prohibited.
- Develop strict zoning regulations that mandate minimum distance requirements between buildings and drainage infrastructure.

4. Strengthening Drainage Infrastructure

With the passage of time and large scale urban development, the existing drainage infrastructure may be insufficient to cater to the resultant discharge in the drains and the review of the existing system may be necessary.

- Conduct hydrological studies to redesign undersized or outdated drainage systems.
- Increase the capacity of major urban and rural drains by widening and deepening existing channels.
- Implement reinforced concrete lining in critical sections of stormwater drains to prevent erosion.
- Develop master drainage plans for rapidly expanding big cities.
- Ensure every new residential and commercial development includes proper drainage provisions before approval.
- Replace open drains with underground pipelines in high-traffic urban areas to prevent waste accumulation and blockages.
- Construct separate drainage networks for rainwater and sewage to prevent overflows.

5. Managing Solid Waste & Preventing Drain Blockages

Near heavily populated areas, it is commonly seen that solid waste and garbage is dumped haphazardly in the drains which results into choking of drainage pass of the system. To overcome this, strict waste disposal regulations and waste segregation and recycling programs should be implemented:

- Install garbage screens at drain entry points to filter out solid waste before it enters the drainage system.
- Ban the dumping of plastic waste, construction debris, and garbage into stormwater drains, particularly in urban drains.
- Introduce heavy fines and penalties for industries that dispose of untreated waste in drainage systems.
- Strengthen waste segregation at the household and commercial levels to reduce non-biodegradable waste entering drains.
- Encourage recycling initiatives to minimize waste accumulation.

6. Industrial & Agricultural Pollution in Drains

- Mandate industries to install Effluent Treatment Plants (ETPs) before releasing wastewater.
- Conduct periodic inspections and impose fines for non-compliance.

7. Adapting to Urbanization & Climate Change

- Restrict excessive concrete paving in cities to allow groundwater percolation.
- Revive natural wetlands, ponds, and lakes to absorb and regulate stormwater.

8. Upgrading Sewerage Systems in Urban Areas

- Expand existing STPs and build new facilities in growing urban centers.
- Mandate wastewater treatment before discharge into natural drains.
- Upgrade city planning to ensure separate networks for sewage and rainwater.
- Implement new drainage designs that prevent sewage overflow during heavy rains.

9. Waterlogging due to High Groundwater Table

- Construct subsurface drainage systems to channel excess water away from low-lying areas.
- Use recharge wells and infiltration trenches to manage excess water efficiently.

10. Lack of Coordination Between Stakeholders

- Create a single body response system for managing drainage infrastructure, involving irrigation & water resources department, public health department, urban local bodies, and municipal corporations, etc.
- Ensure that NOC is obtained from IW&R Department for constructing any structure upon the drain by the concerned department/local body so as to comply with the design parameters of the drain for maintaining its smooth and efficient flow.

11 Implement a Robust Monitoring System:

- Use AI-based drainage monitoring systems to track water levels and blockages in real time.
- Develop a mobile-based reporting system for citizens to report drainage issues.
- Ensure to implement the checking of estimated data and execution of works by the internal vigilance wing of the department at the three stages viz prior to start of work, during execution, and upon completion of work.

12. Developing Flood & Disaster Management Plans

- Install automated flood monitoring sensors in high-risk drainage zones.
- Develop early warning systems for heavy rainfall predictions to prevent urban flooding.
- Build dedicated floodwater reservoirs to store excess rainwater and prevent overflow, wherever possible.

13. Promoting Community Participation & Awareness

- Organize awareness campaigns about proper waste disposal and the importance of clean drainage systems.
- Engage schools, colleges, and local communities in maintaining and monitoring drainage health.

ANNEXURE - IV

De-silting and Internal Cleaning of Canals

1. Objective

The primary objective of de-silting and cleaning irrigation canals is to maintain the smooth and uninterrupted flow of water by removing accumulated silt, debris, and other obstructions. This process ensures the efficiency and longevity of the canal system while preventing water stagnation, overflow, and damage to canal structures. Proper canal maintenance enhances irrigation efficiency, reduces water loss, and prevents potential flooding or breaches that could affect agricultural productivity.

2. Pre-Cleaning Preparations

2.1 Survey & Inspection

- Before beginning the de-silting and cleaning process, a thorough survey and inspection of the canal system should be conducted. This involves identifying sections with heavy silt accumulation, excessive vegetation growth, structural weaknesses, or potential blockages.
- Field engineers or maintenance teams should assess the overall condition of the canal, marking critical areas that require immediate attention.
- Drones, remote sensing technology, or manual inspection can be used to determine the severity of silt deposits and identify specific sections that require mechanical intervention. Additionally, water flow measurements should be taken to evaluate any decline in discharge capacity due to sedimentation.

2.2 Approval & Planning

- Once the survey is complete, a detailed plan must be developed, outlining the scope of work, estimated timelines, manpower requirements, and necessary equipment.

- Approvals from relevant water management authorities and local governing bodies should be obtained before the commencement of work. If required, water flow in the canal should be temporarily stopped or diverted to allow for effective de-silting operations.
- The planning process should also involve coordination with local farmers, water user associations, and stakeholders who depend on the canal for irrigation purposes. Their input can help optimize scheduling and minimize disruptions to agricultural activities.

2.3 Notification to Stakeholders

- It is essential to inform all relevant stakeholders about the upcoming cleaning operations. Notices should be issued to farmers, local communities, and canal users regarding the timeline and expected duration of the work. If water supply will be affected, alternative arrangements should be suggested to minimize inconvenience.
- Clear communication is important in preventing conflicts or misunderstandings amongst the farming community during the cleaning process.

3. Cleaning & De-silting Process

3.1 Manual Cleaning (For Small Canals)

- For smaller irrigation canals and areas with light to moderate silt accumulation, manual cleaning is often the most effective method. Laborers equipped with hand tools such as shovels, hoes, and rakes can be deployed to remove debris, loose silt, and weeds from the canal bed and banks.
- Workers should ensure that the removed material is deposited at designated disposal sites away from the canal to prevent it from being washed back into the watercourse. Additionally, regular clearing of floating debris and obstructions at gates of bridge-cum-falls, head regulators, cross regulators, siphons, and culverts should be conducted to maintain consistent water flow.

3.2 Mechanical De-silting (For Large Canals & Heavy Silt Deposits)

- For large irrigation canals or sections with extensive silt buildup, mechanical de-silting is necessary to ensure efficient and timely removal of sediments. Excavators, draglines, backhoes, and suction dredgers can be used to extract silt and accumulated debris from the canal bed.
- When using heavy machinery:

i) The depth and slope of the canal should be maintained to prevent excessive erosion or structural instability.
ii) De-silting should be carried out gradually to avoid sudden alterations in water flow patterns.
iii) Care must be taken to ensure that mechanical operations do not damage canal embankments or structures such as bridges and siphons.

3.3 Weed & Vegetation Control

- Uncontrolled growth of aquatic weeds and vegetation can obstruct water flow and reduce the efficiency of the canal. To address this issue, both manual and mechanical methods can be used to remove unwanted plants from the canal and its surroundings.
- In cases where vegetation regrowth is a concern, approved eco-friendly herbicides may be applied under strict supervision to prevent long-term blockages. However, chemical use should be minimal to avoid adverse effects on the environment and agricultural activities.

3.4 Waste & Silt Disposal

- Proper disposal of silt and debris is critical to maintaining a clean and functional canal. The removed material should be transported to designated disposal sites or repurposed for land reclamation, soil enhancement, or outer slopes of embankments for its strengthening, wherever feasible.
- The silt/debris/weed/jungle removed from the inner section of the canal should not be disposed off at the inner edges and top of the embankments so as to prevent falling into the canal resulting in obstruction to the flow of water.
- Silt with high organic content can be utilized for agricultural purposes after appropriate treatment.

4. Post-Cleaning Activities

4.1 Final Inspection

- Once the de-silting and cleaning activities are completed, a final inspection should be conducted to ensure that all identified problem areas have been addressed.
- Field Engineers should verify the depth and width of the cleaned canal, check for any remaining obstructions, and assess the improvement in water flow.

4.2 Canal Strengthening & Maintenance

- To ensure the long-term stability of the canal, necessary reinforcement measures should be implemented. These may include:
  i. Repairing damaged embankments and lining.
  ii. Strengthening canal banks using stone pitching or grass turfing to prevent erosion.
  iii. Installing silt traps and sediment control structures to minimize future silt accumulation.

4.3 Record Keeping & Reporting

- All de-silting and cleaning activities should be documented, including:
  i. The length and sections of the canal cleaned.
  ii. The volume of silt and debris removed.
  iii. The methods used for cleaning.
  iv. Any structural repairs or reinforcements made.

  This data should be compiled into a report and submitted to the concerned authorities for future reference and planning.

5. Environmental Considerations

- Waste disposal should be carried out in an eco-friendly manner, ensuring that pollutants do not re-enter the water system.
- Sensitive areas with aquatic life should be protected to prevent ecological disturbances.
- The use of chemicals or herbicides should be carefully regulated to prevent contamination.

6. Frequency of De-silting & Cleaning

- Routine internal de-silting and cleaning should be performed annually or before the start of the irrigation season to ensure efficient and equitable distribution of canal water.
- Emergency cleaning may be required to be conducted as a result of extreme weather events such as heavy rainfall or floods that cause unexpected siltation and blockages.

  By following these standardized procedures, irrigation canals can be maintained efficiently, ensuring reliable water supply for agriculture while minimizing environmental impact and maintenance costs.

ANNEXURE - V

Micro-Irrigation Techniques

Micro-irrigation is a highly efficient method of irrigation that delivers water directly to the root zone of plants in controlled amounts. This approach minimizes water wastage, enhances crop productivity, and reduces soil erosion.

By adopting micro-irrigation techniques, farmers can optimize water usage, improve plant health, and ensure sustainable agricultural practices.

1. Types of Micro-Irrigation Techniques

Micro-irrigation encompasses various methods, each designed to suit different crop requirements, soil conditions, and geographical areas. The following are the primary techniques used in modern agriculture.

1.1 Drip Irrigation

- Drip irrigation is one of the most efficient methods, ensuring water is supplied directly to plant roots in small, precise quantities. This technique involves a network of main and sub-main pipelines that distribute water through drip laterals equipped with emitters or drippers. The inclusion of filters prevents clogging, while pressure regulators maintain uniform water distribution.
- This method significantly reduces water consumption, with an efficiency of up to 90%. It also minimizes weed growth, prevents soil erosion, and is adaptable to all soil types. Drip irrigation is widely used in fruit orchards such as mango, citrus, and grapes, as well as in vegetable farming, including tomatoes, cucumbers, and peppers. It is also an essential system for greenhouses and polyhouses, where precise water control is required.

1.2 Sprinkler Irrigation

Sprinkler irrigation mimics natural rainfall by spraying water over crops through sprinklers mounted on pipes or stands. This system is particularly beneficial for covering large fields efficiently.

Different types of sprinkler systems are available based on irrigation needs. Fixed sprinklers provide a permanent irrigation solution for extensive fields, while portable sprinklers allow for flexible movement. Rotating sprinklers ensure even water distribution, and rain gun sprinklers offer high-pressure water coverage for larger areas.

The advantages of sprinkler irrigation include reduced labor costs, prevention of soil compaction, and temperature regulation for crops. It is commonly used for cereal crops such as wheat and maize, as well as for pastures, lawns, and plantations like tea and coffee.

- The system must distribute water evenly without excessive runoff or under irrigation.
- Pressure regulation devices must be installed to avoid over-spraying or damage to crops.
- The system should allow for easy disassembly and reinstallation for seasonal use.

1.3 Micro-Sprinkler Irrigation

Micro-sprinkler irrigation is a refined version of conventional sprinklers, delivering water at low pressure over a small radius. This technique is particularly useful for delicate crops and orchards where excessive water pressure could damage plants.

With its ability to save more water than standard sprinklers, micro-sprinkler irrigation is ideal for sandy and loamy soils. It prevents water runoff and ensures deep-root watering. This method is widely used for flower crops like roses and marigolds, as well as for fruit plantations, including papaya and banana. It is also a preferred irrigation system for small nurseries and greenhouses.

1.4 Bubbler Irrigation

Bubbler irrigation is designed to deliver water at a high flow rate directly to the root zone, forming small water pools around the plant base. This system is particularly beneficial for trees, shrubs, and ornamental gardens.

The main advantage of this method is that it significantly reduces deep percolation losses while preventing soil erosion. This technique is commonly used for tree crops like coconut and guava, as well as in horticultural and landscaping applications.

1.5 Subsurface Drip Irrigation (SDI)

Subsurface drip irrigation (SDI) is an advanced technique where drip lines are buried below the soil surface, ensuring that water reaches the roots directly without any surface evaporation.

This method eliminates water losses due to evaporation and reduces weed growth, as the soil surface remains dry. SDI is particularly effective in improving crop health, as it prevents excessive leaf wetting, which can lead to fungal diseases. It is widely used for high-value crops such as grapes and olives, as well as in greenhouses and dry, arid regions where water conservation is a priority.

2. Benefits of Micro-Irrigation

The implementation of micro-irrigation techniques brings multiple benefits to agriculture, enhancing productivity and sustainability. One of the primary advantages is water conservation, as these systems can reduce water consumption by 30–70% compared to traditional irrigation methods. This efficiency leads to increased crop yield by providing a consistent moisture supply essential for healthy plant growth.

Micro-irrigation also reduces labour costs through automation, minimizing manual intervention in the irrigation process. Furthermore, it prevents soil erosion by delivering water at low pressure, reducing runoff and nutrient loss. Another key benefit is the control of weeds and plant diseases, as water is applied only to the root zone, preventing unwanted weed growth and reducing the spread of fungal infections caused by excessive moisture on leaves.

3. Design Criteria for Micro-Irrigation Systems

3.1 Water Source and Quality

- The system should be designed considering available water sources, such as wells, reservoirs, or rivers.
- Water quality (TDS, pH, and suspended particles) must be tested to prevent clogging of emitters and pipes.

3.2 System Layout

- The system should be planned to cover the root zone of plants with minimal losses.
- The layout must include mainlines, sub-mainlines, laterals, and emitters in an optimal arrangement.

3.3 Pressure Requirements

- Different emitters require specific operating pressure ranges:
- Drip irrigation: Low pressure (1-2 kg/cm^2)
- Sprinkler irrigation: Medium pressure (2-4 kg/cm^2)
- Proper selection of pipes, valves, and pumps ensures uniform pressure throughout the system.

3.4 Selection of Emitters

- Drippers (emitters) should be chosen based on flow rate, clogging resistance,
- and pressure compensation.
- The standard recommends:
- Online drippers for orchards and vineyards.
- Inline drippers for row crops.
- Micro-sprinklers for wider wetting patterns.

4. Installation Guidelines

4.1 Components of the Micro-Irrigation System

A standard micro-irrigation system consists of:

- Water Source (Tube well, canal, reservoir, or storage tank)
- Pumping Unit (Centrifugal/submersible pump based on pressure requirements)
- Filtration System (Sand filters, screen filters, or disc filters to prevent clogging)
- Mainline and Sub-mainlines (PVC, HDPE, or LLDPE pipes for water distribution)
- Laterals (Flexible PE pipes carrying water to emitters)
- Emitters/Drippers (Low-flow devices delivering water directly to plant roots)
- Control Valves and Pressure Regulators (To maintain uniform pressure)

4.2 Installation Steps

- Proper trenching and alignment for mainlines and laterals.
- Use of correct fittings and connectors to prevent leakage.
- Placement of filters at the inlet to prevent debris from entering the system.
- Testing of pressure and flow rate before operation.

5. Operation and Maintenance

5.1 System Operation

- Operate the system at recommended pressure to avoid over-irrigation or under-irrigation.
- Schedule irrigation based on soil moisture levels and crop requirements.
- Use automation (timers and sensors) for efficiency.

5.2 Maintenance Practices

- Regular flushing of pipes and laterals to remove sediments.
- Cleaning of filters weekly to avoid clogging.
- Inspection of emitters for blockages and replacement of faulty units.
- Checking pipe leaks and repairing damaged sections promptly.

6. Performance Evaluation and Troubleshooting

6.1 System Performance Checks

- Measure flow rate and uniformity coefficient to ensure proper functioning.
- Monitor soil moisture levels to determine irrigation efficiency.

6.2 Common Issues and Solutions

Problem	Cause	Solution
Low water pressure	Clogged filters or pipe leaks	Clean filters and repair leaks
Uneven water distribution	Improper emitter placement	Adjust emitter spacing
Drippers blocked	High sediment content in water	Install a filtration unit
Over-irrigation	Excessive flow rate	Use pressure-compensating emitters

Despite its numerous advantages, micro-irrigation presents some challenges that must be addressed for effective implementation. One significant challenge is the high initial installation cost. However, government subsidies and incentives can help farmers adopt these systems more affordably.

Another issue is the clogging of emitters due to sediment and impurities in the water supply. This problem can be mitigated through regular maintenance and the use of high-quality filters. Additionally, micro-irrigation systems are dependent on a stable power supply, which can be a constraint in remote areas. A viable solution to this issue is the adoption of solar-powered micro-irrigation systems.

The successful implementation of micro-irrigation also requires skilled labour for installation and maintenance. Training programs for farmers and technicians can help bridge this knowledge gap, ensuring that these systems function efficiently.

7. Environmental and Economic Considerations

- Encourages water conservation and reduction in fertilizer runoff.
- Helps increase crop yield with minimal water use.
- Reduces operational costs by minimizing labour and electricity consumption.

8. Future of Micro-Irrigation

The future of micro-irrigation is promising, with technological advancements driving its evolution. The integration of the Internet of Things (IoT) and artificial intelligence (AI) is enabling the development of smart irrigation systems. These systems use sensors to monitor soil moisture and weather conditions, automatically adjusting water supply based on real-time data.

Another innovation shaping the future of irrigation is the use of solar-powered micro irrigation systems, which provide an environmentally friendly and cost-effective solution for farmers in remote areas. Additionally, precision farming techniques are gaining momentum, allowing for data-driven irrigation strategies that optimize water use and crop health.

By embracing these advancements, the agricultural sector can achieve improved water management, higher productivity, and sustainable farming practices. Micro-irrigation is not just a method of irrigation—it is a transformative approach that ensures food security while conserving one of our most precious resources: water.