International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

An Approach to Preparation of Detailed Project Report for Sewerage Scheme in India

Dr. Jyotirmoy Sarma

Independent Researcher, P-706, Supertech Icon, Nyay Khand 1, Indirapuram, Ghaziabad-201014

Abstract - *In India, majority of urban areas are not covered by sewerage scheme. In urban areas uncovered by sewerage system, households have individual and community toilets with septic tanks. Septic tanks treat sewage partially and outflows from the septic tanks are linked to roadside drains. The road side drains carry partially treated sewage. This is a health hazard to population living in urban areas. The road side drains ultimately discharge sewage to near agricultural field, rivers, streams and water bodies and pollute them. There is an urgent need to improve sanitation situation in the urban areas of India by construction of sewage collection network along with efficient sewage treatment plant. In the research paper, the author high lights the major activities to be performed in preparing detailed project report of a sewerage scheme. The paper can be an useful guidance to concerned officials of government agencies, urban local bodies and engineering students involved in planning and design of sewerage schemes.*

Key Words: Population Projection, Sewer Network, Sewage Pumping Station, Sewage Treatment Plant, System Design Criteria, Material Selection.

1. INTRODUCTION AND CONTEXT

In India, urban areas are facing environmental problem as majority of them are not covered by sewerage scheme. In the urban areas, majority of households have individual and community toilets with septic tanks. Septic tanks can treatment sewage partially and at the same time, outflows from the septic tanks are linked to roadside drains. Thus, the road side drains carry partially treated sewage. This causes health hazard to population living in urban areas. The road side drains ultimately discharge partially treated sewage to nearby agricultural field, rivers, streams and water bodies. Therefore, all agricultural field, rivers, streams and water bodies near urban areas are polluted. There is an urgent need to improve this water and soil pollution problem in the urban areas. Construction of sewage collection network along efficient sewage treatment plant is a solution to this major environmental problem in urban areas. Keeping this in view, different programs are initiated by central and state governments to construct sewerage schemes in urban areas in India. More such programs are likely to be started by governments. But, urban local bodies and government agencies involved in construction schemes lack adequate skills to plan and design sewerage schemes. In the research paper, the author high lights the major activities to be performed in preparing detailed project report of a sewerage scheme. The paper can be an useful guidance to concerned officials of government agencies, urban local bodies and engineering students involved in planning and design of sewerage schemes.

1.1 MAJOR ACTIVITIES FOR PREPARING DETAILED PROJECT REPORT

The major activities to be performed in preparing detailed project report of a sewerage scheme are as below:

i) Preparation of note on back ground of the proposed scheme: The note needs to justify the need of the proposed sewerage scheme with regard to existing sanitation situation of the project area.

ii) Profiling of project area: Profile of the project area needs to include topography, climate and rainfall, ground water table, geology and soil condition, storm water drainage system, important institutions, religious and tourist destinations, population growth trend, population density, industrial profile. Detailed profiling of topography of the project area needs to be done to identify the storm water drainage zones in the project area.

iii) Study of existing sanitation system and sewerage scheme: This needs to includes study of the existing sanitation system in the project area, description of existing sewerage system including existing sewerage zones, alignment of trunk sewers, extent of the project area covered by sewerage system, total length and sizes of trunk sewers and laterals, sewage pumping stations, sewage treatment plants and sewerage house connections.

iv) Evaluation of performance of the existing sanitation system and sewerage scheme: This needs to be done with respect to established service level benchmarks. Functional status of the components of existing sewerage scheme needs to be derived by field investigation. Their rehabilitation needs are to be documented. Evaluation of existing sewerage scheme includes condition assessment of sewers, manholes, sewage pumping stations and sewage treatment plant. Condition assessment of existing large diameter sewers can be done CCTV monitoring.

v) Survey and Investigation: This needs to include geo-technical investigation at locations of major components of the proposed sewerage scheme, environmental investigation and topographical surveys in project area.

Based on output of the topographical survey conducted in project area, sewerage zones of proposed sewerage scheme are to be identified and their boundaries marked.

vi) Projection of Population in Project Area and Sewerage Zones: This starts with finalising design year of the proposed sewerage scheme. Other activities include population forecasting for project area by all population projection methods for design year, selection of population projection method appropriate for the project area, assessment of floating population and population of surrounding areas and ward wise population projection. Population projection methods generally used include arithmetic progression method, geometrical progression method, incremental increase method, growth method and graphical method. The appropriate method of population projection is selected based on comparison of projected population figures by all the methods with available census data. Generally, the projection method, whose projected population figures have minimum variation with past census data is the appropriate method.

vii) Assessment of Sewage Generation in Sewerage Zones: This is done by considering per capita sewage generation from domestic use of water, design population in each sewerage zone, sewage generation from institutions and industries in each sewerage zone.

viii) Finalisation of system design criteria: This is to be done for all components of the proposed sewerage scheme.

ix) Selection of Material: This needs to be done for all major components of the scheme such as pipes for sewers, manholes, pumping machinery and electrical equipment in sewage pumping station, etc.

x) Preparing Outlines of Sewerage Scheme: This activity includes detailing out required rehabilitation and improvement works for all components of existing sewerage scheme. In case of new sewerage scheme, this includes determination of alignment of all trunk and lateral sewers and identification of locations of proposed sewage pumping stations and sewage treatment plants. Before designing sewage treatment plant, an appropriate sewage treatment process will have to be selected. In proposed sewerage scheme of big cities, SCADA (Supervisory Control and Data Acquisition) system for the complete sewerage system needs to be installed at a central location for better control and monitoring.

xi) Hydraulic design of components of proposed sewerage scheme: This activity includes hydraulic design of all components of the proposed sewerage system such as sewer network, sewage pumping stations and sewage treatment plant.

xii) Hydraulic Design of Sewer Network: Hydraulic design of proposed sewer network can be done using computer software such as SewerGems or any suitable software.

xiii) Structural design of components of proposed sewerage scheme: Structural design is needed for civil structures of sewage pumping stations and sewage treatment plant.

xiv) Preparation of estimates of proposed works along with description of cost basis: Latest schedule of rates applicable for the location of the sewerage scheme needs to be used for finding out rates for items of works. For items, whose rates are not available in project location specific schedule of rates, rates from other schedule of rates from other states of the country can be referred. For items, whose rates are not available in any schedule of rates, market rates should be collected. Road restoration works after laying of sewers are very important in any sewerage scheme. It needs to be ensured that all items for road restoration works are included in the cost estimate. Annual operation and maintenance cost of the sewerage scheme also needs to be derived.

xv) Preparation of operation and maintenance plan: This involves study of existing O & M system and preparation of plan for preventive maintenance and break down and emergency maintenance. Plan for both types of maintenance will have to be prepared for all components of the sewerage scheme. The O & M plan needs to include details of disposal and useful utilization of sludge produced in sewage treatment plant, disposal of screenings collected in sewage treatment plant and sewage pumping stations.

xvi) Environmental and social assessment of proposed sewerage scheme: This involves environmental profiling of project area, prediction of impact on environment during construction and operation phase, suggesting mitigation measures of environmental impacts by preparing an environmental management plan.

xvii) Implementation Plan for the sewerage scheme: The implementation plan includes contract packaging of all works of the sewerage scheme for inviting bids for construction and procurement. It also includes proposed institutional arrangement for implementation of capital works and operation maintenance.

1.2 RECOMMENDATION ON SITE SELECTION AND SYSTEMS DESIGN CRITERIA

Site selection criteria of major components of sewerage scheme and design criteria to be used for design of sewerage scheme are listed and detailed below:

i) Selection of locations of sewage pumping stations and sewage treatment plant: In planning for any sewerage scheme, identification of land required for sewage

treatment plant is a critical activity. Preferably, the site of proposed sewage treatment plant should be at a lowest elevation of the urban area so that gravity flow of sewage to the treatment plant is feasible. The locations should also be near to a river or water bodies, where treated sewage can be disposed. The locations can also be near to any industrial area, where treated sewage can be recycled and reused in industries. The main considerations for selection of location of a sewage treatment plant are feasibility for discharge of treated effluent, feasibility for future expansion of the sewage treatment plant, availability of a buffer zone of about 500mm from nearby residential areas to avoid odour problems, availability of access for the vehicles for carrying sludge and screenings and minimum resettlement issues. In any sewerage system, it needs to be ensured that required numbers of sewage pumping stations are minimum. For sewage pumping stations, small plots of land will be have to be identified preferably near road side.

ii) Design period of different project components: Overall, design period of 30 years is generally considered for designing a new sewerage system. However, component wise design periods of the sewerage scheme considered are as below:

- 30 years for collection system or sewer network
- 30 years for civil works of sewage pumping stations.
- 15 years for pumping machinery and electrical equipment in sewage pumping stations.
- 30 years for sewage treatment plant. But, construction may be done in a phased manner as at the initial stage, flow of sewage to treatment plant will be less and it will be uneconomical to build the full capacity plant in one step.
- 30 years for effluent disposal and utilisation arrangement.

iii) Per capita sewage generation: Sewer network needs to be designed to carry a minimum per capita sewage flow of 100 lpcd. For design of a sewerage scheme, sewage quantity is generally worked out by considering a per capita water supply of 135 lpcd and a per sewage generation of 108 lpcd. The value of 108 lpcd is 80% of a per capita water supply of 135 lpcd, which is generally considered.

iv) Peak factor in design of sewer network: For design of sewer network, peak factors to be considered depend on population of the sewerage zone. The following are the peak factors:

- 3 for population up to 20,000
- 2.5 for a population between 20,000 to 50,000
- 2.25 for population between 50000 to 750000
- 2 f - 2 for population above 750000

v) Minimum and Maximum Velocity of Flow in Sewer: A minimum velocity of 0.60 m/sec and a maximum velocity of 2.75 m /sec are generally adopted. Sewers are designed on the assumption that although silting might occur at minimum flow, silt would be flushed out during peak flows. If due to un avoidable circumstances, minimum velocity of 0.6 m/s cannot be achieved, temporary flushing arrangement is to be done through mobile tanker or mobile jetting machine.

vi) Minimum Diameter of Sewer: Minimum pipe diameter shall be 200 mm for ease of maintenance.

vii) Depth of Flow: Sewers are not designed to run full. The maximum depth of flow should be 0.8 full at ultimate peak flow for all pipe diameters.

viii) Changes in Diameter and Direction: In design of sewer network, transition from larger to smaller diameters cannot be made. In transition from smaller to higher diameter, the crowns of sewers need to be kept continuous. In no case, the hydraulic flow line in the large sewers shall be higher than the incoming sewer. Thus, the crown of outgoing sewer shall not be higher than the crown of incoming sewer. Manhole needs to be provided at each change of direction. Sewer must be in straight line between each manhole. The channels in manholes at junctions and bends shall be smooth with gradual transitions to avoid turbulence and deposition of solids.

ix) Depth of sewer below ground level: Minimum sewer depth without protection needs to be 1.00 m to the top of the pipe. The maximum depth in sewer can be decided as per site condition, to minimise number of pumping stations.

x) Bedding: For laying sewers, four classes namely A, B, C, and D of beddings are used. Design of bedding needs to be done as per latest CPHEEO manual.

xi) Manholes: For inspection, cleaning and testing of sewers, manholes need to be provided at every change of alignment, gradient, diameter and at junction of sewers. Spacing of manhole to be constructed depends on size of sewer. The spacing requirement is 30m for sewer size up to 900mm, 75m for sewer size between 900mm and 1000mm and 100m for sewer size above 1000mm. Again the size of manhole depends on its depth. The recommended manhole sizes are 900mm for depth up to 1.65m, 1200mm for depth between 1.65m and 2.3m, 1500mm for depth above 2.3m. Manholes are usually constructed directly over the sewer. They may be circular, rectangular or square in shape. Manholes should be of such size that will allow necessary cleaning and inspection. Due to lesser cost, circular manholes are generally proposed. PVC encapsulated cast Iron footrests are provided for entry into manholes. For manhole covers, heavy duty steel fibre reinforced concrete

covers (SFRC) of 560mm internal diameter conforming to IS 12592, are provided.

xii) Drop Manholes: Drop manholes are provided where a sewer connects with another sewer and difference in levels of water line at peak flows and invert level of branch line is more than 600 mm.

xiii) House Service Sewer Connection Chamber: Sewer Connections or House Service Connections is an important component of sewerage scheme. Pipe diameter of connections shall be minimum 100 mm. All house service connections shall be made to the nearest or accessible manhole. House service connection chambers along with connecting pipes to manholes should be constructed during laying of sewers. Otherwise, side walls of manholes can be damaged during providing pipe connections.

xiv) Nala Tapping Works: Nala trapping works are essential components of sewerage system in India. Each part of the urban areas may not be covered by sewerage system due to topographical reasons. As a result, some drains may carry sewage in them. Sewage flowing in drains needs to be tapped and diverted to nearest sewage pumping stations.

xv) Design Criteria of Sewage Pumping Stations: The hydraulic criteria adopted in the design of pumping stations are as below:

- Peak factors of 2 to 3 are considered deriving design peak flows.
- Velocity in pumping mains range from 1 to 2.4 meter per second.

- Wet well volume, V = 0.25 x Q/N (Considering design year flow)

(Considering design year flows)

Where Q = pumping rate in cu m/hr of largest pump installed for cascade arrangement.

N = No of starts and stops per hour considering manual start and stop.

- Maximum wastewater level in the wet well will be 200mm lower than the maximum level of sewage in the lowest incoming sewer to avoid surcharge.
- Velocity through the screen is 0.9 meter per second at peak flow.

xvi) Design Criteria of Sewage Pumping Main: Rising mains deliver sewage discharged from a pumping station to a sewage treatment plant or manhole of a receiving gravity sewer. The size of the rising main is determined after a comparative study of construction and pumping costs for several pipe sizes. Hazen- Williams formula is used for computing frictional losses.

xvii) Selection of Sewage Treatment Process: Selection of sewage treatment process is a critical activity. The different sewage treatment process options includes Conventional Activated Sludge Process (ASP), Trickling Filter (TF), Waste Stabilization Pond (WSP), UASB+ Final Polishing Pond (UASB + FPU), UASB + Extended Aeration System (UASB + EAS), Moving Bed Biofilm Reactor (MBBR), Sequencing Batch Reactor (SBR), Membrane BioReactor (MBR). The criteria for evaluating sewage treatment technologies are low capital and O & M costs, low land area requirements, ease in operation and maintenance, treated sewage quality to meet mandatory treatment standards, minimum energy consumption, simplicity to construct and operate. Generally life cycle cost analysis is carried out to select a sewage treatment process. From observations in different sewerage projects in India, it has been found that sequencing batch reactor (SBR) treatment process is an useful treatment process as space requirement is less and quality of treated sewage suitably meets the regulation requirements.

xviii) General Provisions in Sewage Treatment Plant: The required general provisions in sewage treatment plant includes provision of mat screens, grit removal, sludge disposal, biogas collection and use in single fuel generator, standby generators, office and laboratory facilities and minimum 5 year operation and maintenance requirement in the construction contract.

1.3 MATERIAL SELECTION FOR SCHEME

Selection criteria of material of major components of any sewerage scheme are mentioned below:

i) Pipe Material for Sewer Network: Different pipe materials such as concrete, uPVC, CI, DI, HDPE and GRP can be used for sewers. For sewer size up to and including 300 mm dia, preference can be given to uPVC pipes, as they are more resistant to crown corrosion compared to concrete sewers and have less potential leaking joints. For use of concrete or reinforced concrete pipe as sewer, it needs to be ensured that high density sulphur resistant cement is used in production of the pipes. If this particular type of cement is not used, lifetime of concrete sewers cannot be expected of more than 30 years. Thus, recommendations can be made for use of uPVC and RCC NP2 concrete pipes with rubber gasket joint for pipe size up to 300 mm diameter and RCC NP3 for higher sizes.

ii) Pipe Material for Rising Mains: Use ductile iron pipes with cement mortar lining can be recommended for use as rising mains in sewerage scheme. Sulphate resistant cement should be used in providing internal cement mortar lining in ductile iron pipes. Due to superior metallurgical properties, ductile iron pipes with cement mortar lining possess numerous distinct advantages over other pipe

materials. In India, apart from ductile iron pipes, GRP (Glass Fibre Reinforced) pipes are also used as rising main in sewerage schemes.

1.4 CONCLUSION

The technical details as mentioned above can be useful as guide lines for preparing detailed project report of any sewerage schemes. By performing all the activities required for preparing a detailed project report, all necessary details for the report will become available. The details will have to be compiled suitably to complete the detailed project report. The compiled details will be different for different sewerage schemes.

REFERENCES

[1] MoHUA, Govt. of India, CPHEEO, Manual on Sewerage and Sewage Treatment Systems, 2013.

Disclaimer: The findings and conclusions presented in the paper are personal opinion of the author.