OFFICE OF PROJECT DIRECTOR

RAJASTHAN URBAN INFRASTRUCTURE DEVELOPMENT PROJECT (RUIDP)

AVS Building, Jawahar Circle, JLN Marg, Jaipur-302017

HAND BOOK

ON

SEWERAGE SECTOR

FOR

FIELD ENGINEERS

RAJASTHAN URBAN INFRASTRUCUTRE DEVELOPMENT PROJECT

1 INTRODUCTION

Waste Water Sector has so far been a neglected sector and most of the cities being covered with water supply do not have any waste water system or at best some skeleton system in a limited area. The importance of this sector cannot be under estimated keeping in view its impact on general environment and the public health. The sector being in infancy in the state needs to be adopted carefully so as to ensure its success and adoption by the society; and with this view major interventions are proposed in the fifteen towns under RUSDIP.

2 PROACTIVE ACTION BEFORE STARTING OF WORK

The contract agreement should be understood very clearly and ensure required details (i.e. special conditions of the Contract, Technical specifications, drawings and BOQ items including preamble to BOQ etc.) in the contract document for the project. The BOQ of contract agreement should be read thoroughly & understand the item in totality. For under standing of the items, the standard specifications & circulars issued by PMU shall be referred. The quantities should be assessed in accordance to the BOQ well before the NTP for issue of Essentiality certificate and to facilitate the Contractor for timely procurement of material & equipments.

It is very important to envisage and foresee the hindrances and bottlenecks at the very early stage, so as to facilitate smooth and time-bound functioning of a Contract. All concerned personnel of DSC & IPIU and Contractor are required to enlist such issues, take pro-active action and evolve strategies to ensure speedy action as specified below:-

(a) Handing over of hindrance free site to the Contractors

(b) Approval from Forest Department / Land acquisition / Removal of encroachments etc.

(c) Shifting of underground utilities & charged electrical over head lines;

(d) Timely issue of Construction / working drawings.

(e) Timely approval of work plan for the contract and its strong monitoring.

(f) Approvals from Railways like (a) crossings of the Railway lines (b) activities through their lands.

(g) Statuary clearances safeguard compliances as per requirement of the sub-project.

(h) Excise benefit in RUIDP Contracts on the basis of Essentiality Certificate.

(i) Early submissions of designs for proof checking and pursuance for prompt compliance of observations/comments of PMC and proof checker.

(j) Timely foresee the hindrances and bottlenecks, so as to facilitate, smooth and time-bound functioning of a Contract.

(k) Process for Mobilization advance to the Contractor.

(l) Adequate mobilization of Man power, Material, Machinery and finances.

(m) The site should be immediately handed over in writing at the time of issue of Notice to Proceed (NTP). Record should also be made before physically handing over the site.

(n) The delay in shifting of utilities may become major constraint in timely completion of the work. There is needs to have a pro-active approach in advance assessment of the quantum of work and should involve line agencies much before the Letter of acceptance is issued.

2.1 Involvement of line agency

The estimates & necessary approval from the line agencies shall be taken well in advance and should be ready to take up the work of shifting of utilities immediately after the issue of Notice to Proceed. In order to carry out correct assessment of hindrances & utilities at the work site, layout in lime powder should be marked at the site right in the design phase or at the earliest. It should be clearly understood that this is the job of PIU & DSC and contractor can be facilitated greatly if advance actions are taken much before his arrival on the scene.

2.2 Construction Drawing & Designs

2.2.1 For item rate contracts

A list of required designs & construction drawings good for execution (to be provided at the time of issue of NTP) and their issue date to the Contractor should be prepared jointly by the DSC & PIU for item rate contracts. The copy of the issue of drawings should be given to IPMC & PMU. The IPMC will monitor the issue of such drawings for each package.

2.2.2 For Turnkey contracts

A list should be prepared by the DSC & PIU for required designs & construction drawings good for execution to be submitted by the Contractor at the time of issue of NTP for Turnkey contracts. The detailed chart should be prepared and monitored weekly by the PIU for targeted dates of initial submission, joint review by DSC & PIU, approval from IPMC if required, re-submission if required and final approval.

2.2.3 Review of drawing & designs

As far as possible there should not be any reason for more then one review of drawing & designs. This depends on the comprehensiveness of the review and the attention paid during the first re-submission. DSC & IPIU should ensure that no case goes beyond one review. If for some reason, it is felt that the case may require more reviews, the submission should be proponed for the period of issue of comments and review. This would be the responsibility of the agency making first submission.

3 SITE MANAGEMENT

3.1 File maintenance

Proper file maintenance should be ensured in PIU office for each contract. All correspondence with the contractor should be carried out on that file.

3.2 Measurement books

The measurement books should be procured in advance and the register should be maintained for the issue & movement of the same. The MBs should be issued only through this register mentioning all relevant details.

3.3 Weekly monitoring of a work plan

It is very important to prepare & weekly monitor a detailed work plan of each Contract identifying minutest activities to the last detail. Successful contract management requires preparation of detailed work plan. If planning is detailed & accurate, half the battle is won. The four M's of Construction Management i.e. Man power, Material, Machinery and Money resources should be thoroughly assessed while approving the work plan of the contractor. This is also most important document under the Contract to implement escalation clause.

3.4 Communication & proper coordination

Lack of communication is not desirable for better performance of the work. There should be proper coordination with the consultants, better rapport between client and contractor, better formal communication systems and proper crisis management.

Contractor should be pressed hard to make initial efforts for procurement of material, equipments, staff to maintain good progress in the very first month, so that pace & momentum in the coming months can be maintained at desired level. The timely payment of the mobilization advance should be ensured to the Contractor.

3.5 Storage of Steel & Cement

These are very vital ingredients for quality construction work but in absence of proper storage, especially during monsoon, cement and steel may rapidly decline in quality and strength.

Care should be taken to protect these materials during wet weather by proper storage and use of any exposed material should be allowed only after conducting fresh tests. use of any apparently affected material should be done after permission of EE IPIU.

3.6 Storage at site

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5m.

Fittings / specials shall be stacked under cover and separated from pipes. Valves and sluice gates shall be placed on blockings.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they should not be

left out on the ground in the sun or overnight under heavy frost or snow conditions.

3.7 Site Clearance

The surplus material lying at site after completion of the work creates inconvenience to the citizens. The incharge package should specifically ensure that after completion of work no surplus material is there and in the ongoing works the surplus material is properly placed. It should be clearly understood that there should be no hindrance in the public safety and traffic convenience and the Contractor shall be compelled to ensure that no public inconvenience is caused due to excavation, stacking of excavated material, storage of material during execution etc.

3.8 In house and on-site Trainings

Consultant of RUSDIP should conduct trainings monthly at every work contract for assurance of quality, safety and environmental & social safeguards. The staff of IPIU, supervising staff of consultant & Contractor, technicians, operators and labour at site should be given on site training so that the personnel engaged on the supervision of the contract should be fully conversant with the safety parameters and environmental & social safeguards, its documentation and techniques of supervision.

3.9 Reporting the Occurrence of Accident

Where any dangerous occurrence or an accident leading to the death of a worker takes place at a construction site, the site in charge should report this occurrence or fatal accident as the case may be, within 4 hours of the happening, by telephone, special messenger or telegram, to EE; Asstt. Construction Manger of town & Team Leader DSC; District Magistrate or Sub-Divisional Magistrate in whose jurisdiction the site lies; The Officer in-charge of the nearest police station; Workmen's Compensation Inspector, or in his absence the Factories Inspector concerned and; the nearest relative of the deceased person, in the case of fatal accident. If in the case of an accident, the injured person subsequently dies due to such accident, the information of his death, wherever known, should be sent by the site in charge to the earlier mentioned authorities, within 24 hours of the death. This procedure will also apply where an accident results in loss of any part of the body or any limb, severe burns or scalds or unconsciousness.

4 QUALITY CONTROL & QUALITY ASSURANCE

4.1 Inspection and Testing of Sewerage Works:

Categories of inspection and test for various materials/equipments have to be clearly under stood from the contract agreement & technical specifications. There are three Inspection category classified as follow;

Category A: The Drawing has to be approved by the Engineer before manufacturing and Testing. The material has to be inspected by the Engineer or by an Inspecting agency approved by the Engineer at the manufacturer's premise before packing and dispatching.

Category B: The drawings of the Equipment have to be submitted and to be approved by the Engineer prior to manufacture. The material has to be tested

by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Engineer before dispatching of the Equipment.

Category C: The material may be manufactured as per standard and delivered to the site.

4.1.1 Dimensions of pipes

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS: 458 for different class of pipes.

The tolerances regarding overall length, internal diameter of pipes or socket and barrel wall thickness shall be as per relevant clauses of IS: 458.

4.1.2 Workmanship and finishing of pipes

Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes upto 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between Engineer and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3.00 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipes throughout its effective length, tested by means of a rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters, 3 mm for every metre run.

4.1.3 Testing of pipes

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.

The specimen of pipes for the following tests shall be selected in accordance with Clause 9.1 of IS: 458 and tested in accordance with the methods described in IS: 3597:

1. Hydrostatic test.
2. Three edge bearing test or sand bearing test.
3. Absorption test.
4. Bursting test.

4.1.4 Marking on pipes

The following information shall be clearly marked on each pipe:

1. Internal diameter of pipe.
2. Class of pipe.
3. Date of manufacture, and
4. Name of manufacturer or his registered trademark or both. Or as specified in the contract agreement

4.2 Pipe bedding

The thickness of granular bedding (once laid) should be physically checked by support engineer and AEn / JEn after going down in the trench. Sieve analysis of the bedding material should be carried out in site laboratory for every lot of material received.

4.2.1 Trench filling &further laying of pipes

The trench filling and further laying of pipes should be taken up only after satisfactory sectional hydraulic testing of the laid pipe line. The test results should be recorded by the support engineer and AEn / JEn. It should be ensured that such hydraulic testing is witnessed in 100% cases by support engineer and AEn / JEn, in 30% cases by XEn & ACM of consultant. In no case a section should be back filled without satisfactory hydraulic testing.

4.2.2 Testing of pipe at Site

In order to maintain high standards of Quality of RCC sewer pipes in waste water at least 1 pipe will be selected by EE & Consultant out of every lot of RCC pipes (size of lot out of which one pipe is to be selected may vary from 200 to 500 in number, as deemed appropriate) on a random basis for special inspection to check reinforcement (Quality and Quantity) by breaking the selected pipe at site and calculating the diameter and weight of reinforcement and test results should be entered in Measurement Book and signed by testing personnel & contractors representative. This test shall be in addition to other tests mentioned in QAQC manual / Third Party Inspection. Proper record of such tests shall be maintained.

The construction engineer of consultant and AEn / JEn should thoroughly check the pipes for any defects before lowering in the trench i.e. surface cracks, visible reinforcement, departure from circularity in the socket ends, broken/fractured mouth edges etc.

It should be ensured that complete construction material for a section has been procured before excavation and the work of manhole, roadside chamber & laying of pipe in that section should be taken up simultaneously.

It should be ensured that open ends of the pipes are suitably plugged to prevent entry of sand/soil and other construction material in the sewers at the end of the day.

4.3 Hydrostatic Test:

Entire section of the sewer shall be proved by water tight by filling in pipes with water to the level of **1.50 m.** above the top of the highest pipe in the stretch and heading the water up for the period of one hour. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For water tightness, the average quantity

added should not exceed 1 litre / hour / 100 linear metres / 10 mm nominal internal diameter. Pipe size wise water loss allowable in 1 hour & ½ an hour in 100 mtr length is summarized in table below:-

Table showing allowed water losses in different size sewer lines during hydro testing

S.No.	pipe internal dia(in mm)	volume of water loss allowed in **1 hour in 100 mtr length(in lit)**	volume of water loss allowed in **1/2 an hour in 100 mtr length(in lit)**
1	150	15.00	7.50
2	200	20.00	10.00
3	250	25.00	12.50
4	300	30.00	15.00
5	350	35.00	17.50
6	400	40.00	20.00
7	450	45.00	22.50
8	500	50.00	25.00
9	600	60.00	30.00
10	700	70.00	35.00
11	800	80.00	40.00
12	900	90.00	45.00
13	1000	100.00	50.00
14	1100	110.00	55.00
15	1200	120.00	60.00
16	1400	140.00	70.00

Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good. The pipes shall be broken to check the reinforcement as per IS 458 for every 500 m length of pipes.

Water Tightness test for Manhole: The entire height of the manhole shall be tested for water tightness as per CPHEEO Manual, by closing both the incoming and outgoing ends of the sewer and filling the manhole with water and the drop in water level not more than 50 mm per 24 hours shall be permitted.

4.4 Flow Test

After completion of entire network of the sewer line, flow test to be carried out.

4.5 Witness various tests during construction by end user

Officers of end user line agency should be encouraged to witness various tests during construction and should be formally invited at the time of network testing before finalization of the work and issue of completion certificate. The defects noticed should be jointly recorded and corrective action taken immediately.

4.6 Water Tightness test

All hydraulic structures, such as sewer lines, joints , manholes etc., or any other liquid containers shall have to be tested for water tightness. The Contractor shall give all such hydraulic tests by making his own arrangements

for water filling and disposal of water after the test and shall repeat this test, if necessary, until the requisite test results are obtained without any claim for extra cost or compensation. The water tightness test shall be conducted as specified in IS: 4127- 1967. If any such hydraulic structure or fixture is found to be unsatisfactory at the time of giving this test the Contractor shall either repair or demolish and construct the same as directed such that the structure is made absolutely water tight and declared as satisfactory by the Engineer. The decision of the Engineer will be taken as final. The Contractor may use at the time of construction, for increasing the water tightness, approved proprietary chemicals only with the express permission of the Engineer to serve the purpose of the Contractor to facilitate such type of work for his own convenience and advantage. But in all such cases, the Contractor will not be entitled to any extra rate. The Contractor shall see that every effort is made to make structures and fixtures water tight, by resorting to such chemicals and making efficient use of proportion and grading of materials etc., as provided originally in the Specifications.

5 EXECUTION OF SEWER LINE WORK

5.1 General

During construction full care needs to be taken for diverting traffic and for fencing and safety of the excavation sites. The excavated materials may have to be transported to other suitable sites (to maintain flow of traffic) and transported back for refilling of trenches. The provisions for properly supporting the trenches should be taken.

The issues related to safety, excavation in different strata, underground water conditions, shifting of under ground utilities, on site testing, backfilling of tranches, road restoration should be properly attended in the technical specifications, estimates and BOQ.

In case of road restoration, provision for restoration of complete road width should be preferred and incorporated in the estimates and BOQ.

All necessary tests should be listed and carried out with due diligence, and detailed in the technical specifications of the bid document. Particular attention should be given to specified field tests:

The surface drains should not be connected to the sewer systems as they also carry rain water, solid wastes and silt which tend to choke the sewers.

5.2 Priority in Sewer Construction Program –

Priority should be in such a way that the system can be commissioned as soon as possible and early benefits can be delivered to the public.

- Provisions of flow in designs of sewerage system should be kept looking to the future requirement.
- Works should be generally started at the downstream end of the systems.
- Engineers shall develop a program for construction and commissioning according to the priorities.
- Necessary instructions to the sewer contractors should be issued as to what lines they will be responsible to take up on a priority basis and ensure the execution in accordance to the given priority.

- Contractors should not be permitted to take up the construction program in an arbitrary manner. The following order of priorities may be assigned:

  a. City wise priority:

  - Outfall sewer
  - Trunk sewers
  - Main sewers
  - Branch sewers
  - Lateral sewers

  b. Package wise priority:

  - Priority as mentioned above starting from down stream to upstream.

  c. Priorities in Lateral sewers:

  - Laterals which can be commissioned earlier and those areas covering maximum population from downstream to upstream
  - Second priority to the areas in order of their population
  - Last priority to less populated areas (ie. Less than 50% habitation)
  - No laterals should be laid in the areas where there is no water supply or inadequate water supply
  - No laterals should be laid in areas where habitation has not developed.

It should ensure and make all out efforts that no incomplete work of main sewers, Branch sewers, Trunk sewers, & Outfall sewers are left in the sewer works taken up under RUIDP.

5.3 Alignment –

Before assigning work L section from each lateral to outfall should be rechecked so that any short coming in flow is checked and rectified before execution.

The alignment and bed level of trench should be checked before laying of granular base for pipes.

Laying of pipes as per design gradient is the most important factor for successful working of sewerage networks. Therefore the all concerned Engineers should ensure that the pipes have been laid as per the designed gradient in all sections of sewer line.

The alignment and gradient of the pipes, once laid in trench should be checked regularly and this fact should be recorded every day in the site instruction book.

Executive Engineer/ assistant construction Manager of Consultant should also witness at least 30% of work. Any defect in the alignment and gradient should be pointed out and corrected immediately.

5.4 Barricading, diversions, display boards for safety

The adequate & proper barricading shall be provided at site to have proper safety and facilitation to traffic / inhabitants in their day to day activities and should be decided by the Engineer in-charge to follow adequate safety measures based on prevailing site conditions.

It should be ensured that the barricading has been carried out properly and display boards for diversion, warning, work in progress, schedule of completion of activity in the area are displayed at required places and proper lighting arrangement at work sites are made during night for convenience & safety of the public.

Proper safety arrangements in trenches, access to trench, proper stacking of construction material, immediate disposal of surplus excavated material should be ensured during construction.

(a) For excavated sites close to public roads/pathways, the area notice boards should have lights during darkness hours.

(b) Barriers or covering should be provided to excavations, shafts, pits and openings having a vertical fall distance of more than 2 metres, except during the period necessary for the access of persons and movement of plant, equipment and materials.

5.5 Shoring

As far as possible, the installation of shores should be done from the surface. The trench jack or horizontal braces should never be used as a ladder for getting in or out of a trench as they are not designed to take vertical load.

Timbering work

5.5.1 Wooden shoring

Polling boards, walling and struts shall be suitably designed to meet different soil conditions that might be encountered in excavating trenches / pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and / or delay that might be caused

in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

Engineer may order portions of shoring to be left in the trenches / pits at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused to buildings, cables, gas- mains, water-mains, sewers, etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason, whatsoever for the shoring which may have been left in.

5.5.2 Steel plate shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench / pit excavation the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, walling, etc., as per the instructions, manner and method directed by Engineer. Contractor shall supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Specification.

5.5.3 Removal of shoring

When the removal of shoring is planned, the possible collapse of trench sides should be anticipated. The newly installed utility line will then be safeguarded in the normal course by being covered with loose or compact fill before the shores are removed. If the trench is likely to cave in on removal of the shores, it can be filled up to the bottom with horizontal brace. It is a safe way for the worker to go down on the ladder and remove this brace, after which additional trench space can be filled up to the next horizontal brace or screw jack.

If the trench is to stay after the removal of shoring, the ladder should not be removed till all work within the trench is completed and the newly installed utility line has been protected or covered.

Laying of SEWER LINE

5.6 Manholes & Manhole Cover

5.6.1 Manholes

Design of sewerage networks is only indicative in respect of actual location of manhole and street chamber, which needs to be decided at the site as per site conditions. It is therefore required that before starting the work in a section, the location of manhole and street chamber should be decided by the officer not below the rank of AEn and proper record of such decision should be maintained. While deciding location of manhole chamber AEN will ensure that no water pipe line is passing through it.

5.6.2 Manhole Covers

In case the outer ring of Man Hole cover is of M.S.; it should be non-corroded and of specified thickness. The specifications given in contract for manhole cover and frame of heavy duty steel fiber reinforced concrete conforming to I.S. 12592 (part I & II). The thickness of the M.S. Sheet around the periphery of the cover should be minimum 2 mm and the exposed surface of M.S. sheet should be given suitable treatment with anti corrosive paint or coating.

Looking to susceptibility to corrosion of M.S. ring, cast iron ring should be preferred except otherwise it is mentioned in Contract Agreement.

a) It should be ensured that the manhole cover is flushed with outside frame.

b) RCC cover on the manholes should be finished in all sides to avoid inconvenience or injury to the person going inside manhole.

c) The channel at bottom of manhole should be in curve shape when the flow takes 90 degree bend.

5.6.3 Backfilling and compaction in trenches

Restoration of road, in case of trenches excavated for laying of sewer lines is a critical activity in the project. It is our responsibility that these excavated trenches are backfilled and compacted to required standards with in the shortest possible time to avoid public inconvenience. Backfilling in prescribed thickness of layers & compaction to required density is very important. Any sub standard work will result settlement in the trench in near future and will be liable for criticism from all circles. Proper care is therefore required to be taken at every level to ensure refilling of trench and restoration of road to desired standards. There should not be wide gap between the length of excavated trench and the refilling of trench in the works. This should be minimized and ensured that only minimum trench length is kept open with all safety measures.

The following procedure should be adopted for backfilling and compaction:

(a) Laboratory test should be conducted for different nature of soils to be backfilled in the trench by Standard Proctor Test and maximum dry density at Optimum Moisture Content should be worked out.

(b) The trench should be refilled in the layers not more than 15 cm and should be compacted by mechanical means in top 1.5 m and rammed

manually with rammer below 1.5 m depth (portion in which timbering is there) so as to achieve the desired dry density.

(c) The field density should be checked for every layer by sand replacement method or core cutter method. The sand replacement method is easier and requires less effort in comparison to core cutter method.

(d) The water content ratio shall be gauged quickly by calcium carbide method. It is difficult to use oven drying method in case of determination of field density in trenches located at several places and it takes time too.

(e) It is therefore advised that required number of these equipments should be kept at site by the Contractors so that field density can be checked immediately and work is not held up due to this reason.

(f) It is also desired that in each package where restoration of work is to be done, the backfilling and compaction to required standards should be carried out on one stretch of road in the presence of Executive Engineer IPIU for setting up an example and for enforcing the procedure in the remaining work of refilling of trenches. This effort should be repeated regularly.

5.7 Separation of sewer lines and its manholes from water supply lines-

More care needs to be taken in maintaining adequate separation of water lines and sewer while laying new water lines/sewers. Pollution in water pipe line from sewers/drains can endanger human health. It is of utmost importance that all measures are taken to prevent it. Stipulated measures for protection against pollution of water supply lines due to sewer lines & its near man holes should be followed in accordance to Water Supply and Treatment Manual (clause 10.11 page 389).

The maximum possibility of pollution in water supply lines is when these lines pass through manholes of sewers. Therefore this condition should be totally avoided and during construction of manhole. It should be ensured that no water pipe line passes through Manhole.

Connectivity from house to the sewer line should be encouraged & ensured to all consumers as soon as line is commissioned, so that the consumers are benefited without delay. The CAAP activities shall be started from the very beginning to target the desired house connections.

Any construction defect causing road repair, choking in sewer lines etc. should be taken care of by RUIDP through the concerned contractor during defect liability period (one year after completion of work).

Proper safety arrangements like barricading, timbering in trenches, access to trench, proper stacking of construction material, immediate disposal of surplus excavated material should be ensured during construction.

6 SAFETY

In addition to the Cost, Time & Quality, the safety is also one of the important components of the construction management. The safety should not be compromised in any construction activity. The term "Safety" is defined as "A

thing is provisionally categorized as safe if its risks are deemed known and, in the light of that knowledge, judged to be acceptable".

The most important ingredient in a safety program is the quality of the people and quality of their training. Safety is habit that can only be developed through repetition. Good habits are only developed by constant trainings in task in correct manner until the act is performed in a safe manner. It is therefore envisaged that stress shall be given on complying safety measures during construction and on-site training for the working staff.

6.1 Safety in Excavation and trenching

All trenches, 1.5 metres or more in depth shall at all times be supplied with at least one ladder for each 30 metres in length or fraction thereof.

(a) Ladder shall be extended from the bottom of the trench to at least 1 metre above surface of the ground. Sides of a trench which is 1.5 metres or more in depth shall be stepped back to give suitable slope, or securely held by timber bracing, so as to avoid the danger of sides collapsing. Excavated material shall not be placed within 1.5 metres of the edge of a trench or half of the depth of the trench, whichever is more.

(b) Cutting shall be done from top to bottom. Under no circumstances shall undermining or undercutting should be done.

(c) Minimum Check and Clear Edge of Trench -There is a tendency to dump the excavated material just on the edge of the trench when excavation is done manually. The material may slide back into the trench or apply additional load on shoring. A provision of clear berm of a width not less than one third of the final depth of excavation is recommended. In areas where this width of the berm is not feasible, the reduced berm width of not less than one metre should be provided. It is always better to provide substantial toe board to prevent 'roll back' into the trench.

6.2 Handling of Plant and Machinery

The excavation equipment should be parked at a distance of not less than the depth of the trench, or at least 6 metres away from excavated sides for trenches deeper than six metres.

(a) With the use of power shovels and draglines, the banks of trenches become Instable and thus dangerous for persons working nearby. These conditions should be watched and suitably remedied.

(b) The vehicles should not be permitted to be driven too close to the pit. Care should be taken for locating roads leading to or from the pit. While loading manually, the vehicle should not be taken too near the wall of the pit. Use of post legs will reduce the risk of accidents where the vehicle is reversed for loading.

(c) Workers should be provided with proper tools. Overlooking the importance of providing the right tools and protective gears for the job is perhaps the most serious risk to workers.

(d) Workers using tools should guard against the danger arising out of the sudden movement of material which may throw them off balance.

They should be adequately spaced to avoid being accidentally struck by tools of others working nearby.

6.3 Access and Escape

The workers should be able to escape fast in the event of any mishap during excavation. It is recommended that one ladder should be provided for every length If 15 metres or fraction thereof in the case of relatively less hazardous work.

Quite often the pathways become slippery due to accumulation of mud, sand or gravel. This should be avoided. Further, the pathways should be strong enough to withstand the intended use.

6.4 Additional Precautions

The precautions should be taken of the power lines, cables during excavation and other operation. The alignment should be checked properly prior to excavation for any power cable etc.

(a) Ignorance and carelessness are major causes of accidents. Tendency to employ cheaper unskilled workers for jobs requiring proficiency and skill can lead to accident. This should not be permitted.

(b) Water for construction activities, rain water and water flowing in the drains are major cause of slides. Proper arrangement of diversion/ bailing out of such water should be done.

6.5 Safety in Construction during Monsoon

Almost in all civil works, excavation and refilling of earth are common activities, which if not carefully executed may pose problems to the safety of works as well as passerby's and road users during the impending Monsoon. Normal to heavy rainfall event may affect our ongoing works in different manners. It should be our endeavor to ensure that such events do not prove to be problematic to people and structures in particular. A separate circular should be sent to all contractors to ensure safety of citizens and works during rainy season citing provisions of Agreement and BIS. During monsoon EE IPIU should ensure that any further excavation work is taken up only after ensuring that the earlier work is in safe stage. It is desired that ACM-DSC & EE IPIU should inspect all sites during rains. Some of the probable occurrences are discussed below.

i. The settlement in refilled trenches of sewerage and water supply lines may occur during monsoon. ACM of consultant and EE should inspect all sites and oversee the arrangements to effectively deal with the eventuality after a storm to identify such reaches and take immediate corrective action by refilling and compacting. The contractor should be asked to designate an engineer / supervisor by name to look after this activity during monsoon.

ii. The contractor's crew should be equipped with vehicle, gum boots, raincoats and T&P to tackle such situation during and after rains. Adequate quantities of earth, debris and gravel should be stacked at strategic places so that no time is lost in procuring such material.

iii. In trenches where pipe laying has been done and duly tested and approved, refilling should be done soon after and all surplus material

relocated to safe disposal sites such that it does not obstruct traffic or waterways.

iv. The execution of works having deep excavation in smaller lanes and congested areas should be completed well before monsoon. The works of deep excavation during monsoon should not be preferably taken up or extensive care should be taken for execution of such works.

v. All open ends of sewer lines should be firmly plugged to prevent debris from entering the line. Manhole covers of sewer lines should be fixed in place to avoid any harm to road users.

7 LAYING OF PIPES

7.1 General

The laying of pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards / Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern.

Codes of practice

IS: 783	Code of Practice for Laying of Concrete Pipes.
IS: 311	Code of Practice for Laying of Cast Iron Pipes.
IS: 376	Safety Code for Excavation Work.
IS: 127	Code of Practice for Laying of Glazed Stoneware Pipes.
IS: 5822	Code of Practice for Laying of Welded Steel Pipes for Water Supply.
IS: 6530	Code of Practice for Laying of Asbestos Cement Pressure Pipes.

7.2 Carting and Handling

Wherever a section of pipe, or a fitting is to be lifted or moved, it shall be handled carefully with belt slings. The belts shall be constructed so that no metal bears against the pipe and so that the bearing is uniform. The width of the belts shall be adequate to prevent any damage to the pipe coating. The pipe section may at no time be dropped but shall be lowered carefully into position and may not be slided along the ground. If it is to be rolled, it may be done only on slides or ground specially prepared so as to prevent any damage to the coating.

7.3 Excavation

The excavation of trenches and pits for manholes / chambers shall be carried out in accordance with the Specification and shall be done such that it does not get far ahead of the laying operation as approved by Engineer.

At every 30 meters interval and at every change in the gradient, sight rails shall be provided and fixed by the Contractor at his own cost. The sight rails

and boning rods for checking the excavation and inverts of the pipes shall be of the quality approved by the Engineer. The road metal and also the rubble packing shall first be stripped off for the whole width of the trench / pit and separately deposited in such place or places as may be determined by Engineer.

The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit or as may be necessary to prevent the sides of the trench / pit to slip or fall or at such a distance and in such a manner so as to avoid covering fire hydrants, sluice values, manhole covers, etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organization or otherwise as Engineer may direct.

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures/pipelines of water, gas, sewage etc.

If the work for which the excavation has been made is not complete by the expected date of the setting in of monsoon which is First week of June or the setting in of rain whichever is earlier, or before the day fixed by Engineer for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling.

Wherever a socket or collar of pipe or fitting / special occurs a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand, all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been approved by Engineer.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by Engineer at Contractor's risk and cost and any claim or dispute shall not be entertained in this respect.

Refilling of trenches, where the excavation is in rock shall be with the surplus soft soil from pits located within 200meters from the reach in question.

7.3.1 Work included in Excavation

Unless otherwise directed on the project Specifications, all of the following items are included in the excavation:

1. Removing all surface obstructions including shrubs, jungle etc.,
2. Making all necessary excavations true to line and grade,
3. Furnishing and installing all shoring and bracing as necessary or as directed,
4. Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature,
5. Providing for uninterrupted surface water flow during work in progress,

6. Providing for disposing off water flows from storm, drains, nallas or other sources, suitably,

7. Protecting all pipes, conduits, culverts, railway tracks, utility poles, wire fences, buildings, and other public and private property adjacent to or in the line of work,

8. Removing all shoring and bracing which is not ordered to be left in place or not required by the project plans or Specifications to remain in place,

9. Hauling away and disposing of excavated materials not necessary or else unsuitable for back filling purposes. The extra excavated soil will have to be properly dressed in soil banks along with the trench as directed,

10. Back filling the trenches as directed or as per Specifications,

11. Restoring all property injured or disturbed by these construction activities to the condition as near its original condition as possible,

12. Restoring the surfaces and repairing of all roads, streets, alleys, walks, drives, working spaces, and rights of way to a condition as good as prior to excavation

7.4 Change of Trench Location

In case the Engineer orders that the location of trench be moved a reasonable distance, on account of the presence of an obstruction or due to such other cause or if a changed location is authorized at the Contractor's request, the Contractor shall not be entitled to extra compensation or to a claim for damage. If however such change is made at the orders of the Engineer, which involves abandonment of excavation together with the necessary back fill, will be measured, classified and paid for in the same manner as for other trench excavation and back fill of the same character. In case the trench is abandoned in favour of new location at the Contractor's request, after its approval, the abandoned excavation and back fill shall be at Contractor's expense.

7.5 Minimum earth cover

If a profile is not furnished for a pipeline, the main will be constructed with a minimum earth cover of 1000 mm from the top of the pipeline, unless otherwise indicated on plans and ordered by the Engineer.

7.6 Dewatering

During the excavation, if subsoil water is met with, Contractor shall provide necessary equipment and labourers for dewatering the trenches / pits by bailing out water or water mixed with clay. If pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer / drain, Contractor shall take necessary permission from the local authorities.

The Contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation. Failure to make such provisions which results in unsuitable subgrade conditions, and which will require any special foundations as directed by the Engineer, such foundations shall be placed at the entire cost of the Contractor and will not be measured or paid for as separate pay items. If the Contractor selects to under cut the trench and use gravel or tile bailing, drainage of well pointing, the additional work will be considered as incidental work and additional compensation will not be allowed

7.7 Shoring

Shoring shall be done in accordance with the relevant Specifications & as specified in section 5.5 above.

Engineer may order portions of shoring to be left in the trenches / pits at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused to buildings, cables, gas- mains, water-mains, sewers, etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason, whatsoever for the shoring which may have been left in.

7.8 Boning staves and sight rails

In laying the pipes and fittings / specials the centre for each manhole / chamber or pipe line shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 mm X 100 mm X 1800 mm) at each manhole / chamber or junction of pipe lines at nearly equal distance from the peg and at sufficient equal distance there from to be well clear of all intended excavation, so arranged that a sight rail when fixed against the post will cross the centre of the manhole / chamber or pipe lines. The sight rail shall not in any case be more than 30m apart. Intermediate rails shall be put up if directed by Engineer.

Boning staves of 75 mm X 50 mm size shall be prepared by Contractor of various lengths, each length being of a certain whole number of metres and with a fixed tee-head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of this tee-head, at a distance equal to as the case may be, the outside diameter of the pipe or the thickness of the concrete bed to be laid. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe, etc. as the case may be.

The sight rail of size 250 mm X 40 mm shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of the sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee hands and cross piece of the boning staves shall be painted black.

For the pipes converging to a manhole / chamber at various levels, there shall

be rail fixed for every different level. When a rail comes within 0.60 m of the surface of the ground, higher sight-rail shall be fixed for use with the rail over the next point.

The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and Engineer gives permission to proceed with the backfilling.

7.9 Bedding

The bedding for pipe shall be provided as specified in the Drawings or as per direction of Engineer.

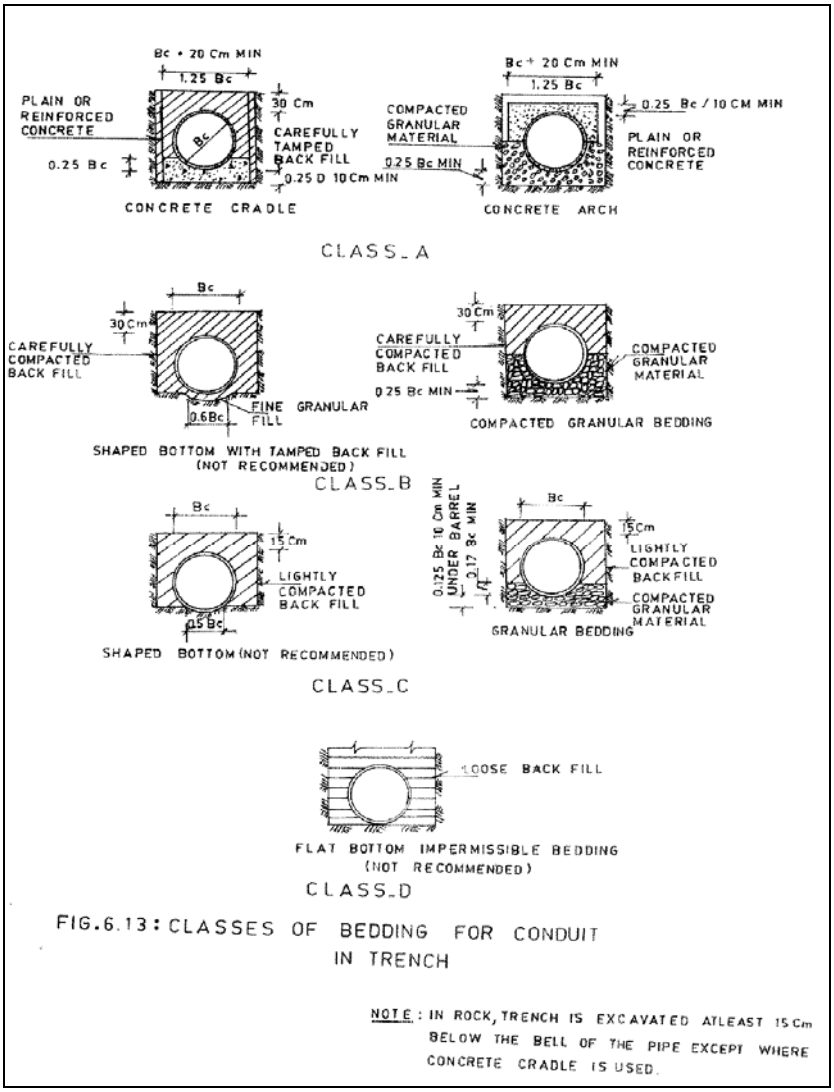


FIG.6.13: CLASSES OF BEDDING FOR CONDUIT IN TRENCH

NOTE: IN ROCK, TRENCH IS EXCAVATED ATLEAST 15 Cm BELOW THE BELL OF THE PIPE EXCEPT WHERE CONCRETE CRADLE IS USED.

7.9.1 Concrete cushion, embedment and encasement

Concrete embedment and encasement wherever required, shall be constructed as per the details given in approved Drawings or as directed by the Engineer. Where concrete bedding is to be placed beneath the pipeline, the sub-grade shall be prepared to dimensions as shown in the Drawings. The bottom of the trench may be sloped on the sides or kerbed, but the thickness of concrete

shall be as specified in the Drawings or as directed by the Engineer. Dry mix will not be permitted.

For earth, granular material or concrete embedment,each pipe section shall have uniform bearing on the subgrade for the full length of the pipe barrel, suitable excavation shall be made to receive the pipe, bell or collar and allow adequate room for proper workmanship in making the joint. Adjustment to line and grade shall be made by scraping away or filling in with gravel or concrete and not by wedging or blocking up the bell. Pipe sockets and barrels shall be clean and free from dirt at the time of jointing.

The concrete for bedding portion will be mixed moist or damp to give a slump of not more than 25 mm and for sides and top portions of encasement, if specified, will be mixed to obtain a slump between 25 mm and 80 mm. All water in the trench must be disposed off prior to placing of concrete. There should be no cleavage line between the bedding concrete and the side embedment concrete. Clear out space shall be left for jointing and lowering pipe in place and bringing to grade by tamping under pipe or removing excess concrete under pipe. After the joint is made, the remainder of the concrete embedment may then be poured and thoroughly tamped to make bond with original concrete. Care must be exercised in tamping to prevent lifting of the pipe out of alignment or grade. Back filling shall be done in a careful manner and such time after the concrete cushion, embedment or encasement is placed, as not to damage the concrete in any way.

All pipes shall be so laid that the contact in the joint between the two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the Drawing, and the curves are flat, standard pipe will be used with the outside edge of the joint pulled away from the seat to make a smooth joint. Where curves are sharp, standard or specially made bends will be used. Openings at end of day's work openings in tees, deep cut connections, shall be capped and sealed. Details of bedding as per CPHEEO Manual.

7.10 Temporary stoppages of work

At times when pipe laying is not in progress, or at the end of the day’s work, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer. During the period that plug is on, the Contractor shall take proper precautions against floatation of the pipe owing to entry of water into the trench.

8 TESTING AND COMMISSIONING

Testing and Commissioning of pipes shall be done in accordance with the relevant Specifications & as specified in Section 4 above.

8.1 Water Tightness test

All hydraulic structures such as sewer lines, joints manholes etc., or any other liquid containers shall have to be tested for water tightness as specified at Section 4.6 above.

9 BACKFILLING

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipe line. The tamping around the pipe shall

be done by hand or other hand operated mechanical means. The water content of the soil shall be as near to the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Back filling shall be consolidated by watering, ramming, care being taken to avoid damage to the pipe line. In case of mild steel pipes / specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipe line to aid alignment, these timbers shall be removed before backfilling.

10 REINSTATEMENT OF ROAD / FOOTPATH

Reinstatement of road / footpath shall be done as per the requirements of local authorities and the relevant Specifications after the completion of work.

11 CLEARING OF SITE

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by Engineer and the construction site left clean to the satisfaction of Engineer.

Measurement for pipes and fittings / specials shall be in accordance with the relevant clause(s) of Specification for particular types of pipes.

Service lines if damaged during excavation shall be made good either by Contractor or by other agency as Engineer may decide and the cost of the same shall be borne by the Contractor wholly in either case.

Contractor shall not be paid any additional compensation for excess excavation over what is specified as well as for any remedial measures that are specified.

The excess excavated material shall be carried away from site of works as specified, failing which in view of public safety and traffic convenience Engineer may carry out the work by any other agency at Contractor's risk and cost.

12 MANHOLES

The following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the Codes and standards, this Specification shall govern.

IS: 111	Code of Practice for Ancillary Structures (Part I) - Manholes.
IS: 555	Cast Iron Steps for Manhole.
IS: 1077	Common Burnt Clay Building Bricks
IS: 3102	Classification of Burnt Clay Bricks.
IS: 395	Method of Sampling and Testing Clay Building Bricks.
IS: 2212	Code of Practice for Brick Work.

12.1 Location

Manholes shall be constructed at places as shown on Layout Plan Drawings and as directed by Engineer.

12.2 Bed concrete

The bed concrete shall be done in accordance with Chapter 9 of standard Specification of RUIDP.

All materials shall conform to the requirements laid in contract agreement. Erected and secured reinforcement shall be inspected and approved by Engineer prior to placement of concrete.

12.3 Brickwork

The brickwork shall be done in accordance with Chapter 10 of standard specification.

Bricks used in works shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ingrained particles and / or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The class and quality requirements of bricks shall be as laid down in IS: 3102.

The size of the brick shall be 23.0 X 11.5 X 7.5 cm unless otherwise specified; but tolerance up to ± 3 mm in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of Engineer to make up required wall length or for bending. Sample bricks shall be submitted to Engineer for approval and bricks supplied shall conform to approval samples. If demanded by Engineer brick sample shall be got tested as per IS: 395 by Contarctor at no extra cost to Engineer. Bricks rejected by Engineer shall be removed from the site of works within 2 hours.

12.4 Cement mortar

Mortar for brick masonry shall be prepared as per IS: 2250 , standard specifications & contract specifications. For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

12.5 Workmanship

All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work of manholes shall be in the proportion specified. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be leveled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in

vertical planes. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed at an angle not exceeding 5o. But in no case the level difference between adjoining walls shall exceed 1.25 m. Workmanship shall conform to IS: 2212.

Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plaster or pointing to be done. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid. No extra payment will be made for raking joints.

12.6 Cement plaster work

All joints in masonry shall be raked to a depth of 12 mm with a hooked tool made for the purpose when the mortar is still green and in any case within 8 hours of its laying. The surface to be rendered shall be washed with fresh clean water to make it free from all dirt, loose material, grease, etc. and thoroughly wetted for 6 hours before plastering work is commenced.

Plastering shall be done on inside / both faces of brick masonry, as directed by the Engineer, in CM 1:3 and 15 mm thick for ordinary manholes and in CM 1:2 and 20 mm thick for scraper manholes.

20 mm plastering work shall be carried out in 2 layers, the first layer being 10 mm (1:3) thick and the second layer being 10 mm (1:1) thick. The first layer shall be dashed against the prepared surfaces with a trowel to obtain an even surfaces. The second layer shall then be applied and finished leaving an even and uniform surfaces, trowel finished unless otherwise directed by Engineer. For detail specification standard specification of RUIDP shall be referred.

12.7 C.C. Channel

Cement concrete channel be constructed in C.C. of M150 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) 20 mm. thick and formed to a slope of not flatter than 1 in 12 to the channel.

12.8 Pipe entering or leaving manhole

Whenever a pipe enters or leaves a manhole, bricks on edge must be out to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar 1:2 13 mm thick between it and the bricks.

12.9 C.I. Frame and cover

Cast Iron frame and cover shall be as per IS: 1726. The frame shall be fixed in cement concrete of M150 grade all around and finished with neat cement.

The manhole frame shall have 560 mm Ø clear opening and shall weigh not less than 208 kg. including cover. In case of rectangular C.I. frame and cover of 900 mm X 600 mm clear opening, the total weight shall not be less than 275 kg. C.I. cover shall be marked with year, sewer, KUWS&DB and arrow showing direction of flow or as specified in the Drawings. The manhole cover and frame shall be painted with 3 coats of anticorrosive paint after fixing in position. In case of scraper manhole the frame shall have clear opening of 1200 mm X 900 mm and shall weigh not less than 900 kg. including covers.

12.10 Fibre reinforced frame and cover

Heavy duty fibre reinforced concrete manhole covers and frames shall be provided capable of withstanding loads of 35 tones. The frame shall be fixed in cement concrete of M150 grade all around and finished with neat cement. The fibre reinforced frame shall have a clear opening 102 kg. The cover will have a minimum thickness of 100 mm and an approximate weight of 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm metallic threads. For the cover sheet lapping is provided by M.S. Flat of 18 gauge to avoid damage to the edge and is painted with black paint.

12.11 C.I. Steps

Cast iron steps shall be as per IS: 555. Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be built in the brick work at the interval of 30 cm vertically and 38 cm horizontally. C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm X 375 mm overall dimensions. In case of pipe diameter greater than 600 mm box type C.I. steps weighing 19 kg. each shall be provided in channel of the manhole as per Drawing.

12.12 Measurement for manhole

The depth of manhole shall be measured from the top of cover to the invert level of the deepest outgoing sewer from the manhole. The rate quoted in schedule of Quantities and Rates for manhole shall include all items such as brick masonry, plastering on both sides, bed concrete and channel, concrete at top, fibre reinforced or C.I. frame and cover, C.I. steps, etc. inclusive of excavation and backfilling, bailing and pumping out water and shoring. The measurement shall be as per number basis and as per the actual depth of manhole constructed.

13 VENT SHAFTS

Generally Vent shafts shall be erected at places shown on the Drawings of longitudinal sections of the sewers or as directed by Engineer.RCC Vent Shafts.

RCC vent shaft shall be of 100 mm Ø and 6.0 m height from ground level with inside core 150 X 150 at top & 200 X 200 at bottom in PCC M150 foundation including flue chamber in brick masonry CM 1:4 with 20 mm thick cement plastering CM 1:3. This shall be connected to the nearest manhole shaft by 150 mm diameter GSW pipe or as directed by Engineer.

13.1 Measurement for Vent Shaft

The rate quoted in Schedule of Quantities and Rates for Vent shaft shall be deemed to include the cost of RCC vent shaft, necessary excavation to manhole inclusive of concrete encasement, erecting, etc. complete. The measurement for vent shaft shall be on per number basis.

14 JOINTING OF STONEWARE PIPES

The spigot and socket joints of stoneware pipes shall be of rigid type and shall be caulked with tarred gasket (prepared ready for use before being brought on the work in one length for each joint and sufficiently long to entirely surround the spigot end of the pipe. The gasket to be driven as far as possible by means of a suitable instruments. After the pipes area thoroughly cleaned and moistened, mixture of one part of cement and one part of clean fine sand tempered with just sufficient water to have a consistency of semi-dry condition should be forced into the joint and well rammed with caulking tools, so that whole space around the spigot and socket is completely filled with lightly chalked mortar and the joints shall be finished off with a splayed fillet sloping at 5 degrees to the side of the pipe.

15 SEWAGE TREATMENT PLANT

Construction of STP at the end of collection and conveyance system is essential. Large quantity of untreated sewage if discharged into surface water body it may grossly pollute it, endangering the health of downstream users. Wastewater after secondary treatment can be disposed of into surface water body and with proper precaution can be used in agriculture. As per the prevailing water polluting laws also, discharge of wastewater not conforming to prescribed standards is not permissible.

15.1 Important Definitions

Wastewater: Consists of both Sewage generated from communities and Effluent from industries

Sewage: Wastewater of a community. It may be purely domestic in origin or may contain some industrial or agricultural wastewater.

Sewerage: The entire system from collection of wastewater, its transportation &disposal is called sewerage

Biochemical Oxygen Demand (BOD_5): It represents the strength of biodegradable organic matter in the wastewater.

Biochemical Oxygen Demand is primary measure of strength of waste water

It is an important parameter. It is measured by measuring the amount of Oxygen absorbed by a sample of waste water in the presence of micro organisms during a specified period generally 5 days, at a temp. of 20 degree of Celsius. It is internationally accepted standard.

For Example

If sample waste is diluted in ratio of 1:100(one part of waste & 99 part of fresh water having a good strength of dissolved Oxygen. If DO is 9 PPM at initial stage & after 5 days on $20C^0$ if it come down to 6 PPM ,then BOD = (9-6) dilution ratio =3X100=300* ***PPM(mg/lit)***

COD: Chemical Oxygen Demand- It is also a measure of the oxidation requirement of a sample under prescribed conditions as determined by using strong chemical oxidants i.e. dichromate.

pH: It is a measurement of the concentration of hydrogen ions(H^+). It is measured on a scale of 0 to 14. The scale is a reverse logarithmic scale. i.e. a solution with a pH of 8 has 10 times less H^+ ions than a pH of 7.

pH= 7 is neutral

pH< is acidic

pH> is basic

Total suspended solids TSS and VSS (volatile suspended solids): A measure of non-soluble material in a sample and reported in mg/lit. TSS measured after drying at 1030C. VSS measured after burning at 5500C.VSS is an estimate of the organic fraction of TSS.

F:M ratio- Food to Microorganism ratio: Mass of food (COD orBOD) fed daily to a reactor divided by the microorganism mass in the reactor. Microorganism mass generally estimated from VSS. Define as Kg COD or BOD fed per day per Kg of microorganism(VSS)

Sludge Volume Index (SVI): Index of the settleability of MLSS: Measured in ml of sludge after 30 minutes of settling per gram per litre of MLSS. Generally well settling sludge has an SVI of 100. Bulking sludge (poor settling) generally has a SVI value > 200

Sludge: Wastewater Sludge consists of either primary sediments, secondary solids or both and is of organic & inorganic in nature. It is removed by a variety of treatment operations consisting of chemical, physical and biological methods. Wastewater sludge has moisture content from 90 - 99.5% depending on the operations & processes used.

15.2 What is sewage treatment?

The ART and SCIENCE of purifying and reclaiming contaminated water, rejected from communities and commercial establishments for safe disposal to environment or reuse.

15.3 Why to treat sludge

To stabilize putrescible matter in the sludge as it is composed of substances responsible for the offensive character of untreated wastewater. To reduce volume by reducing moisture content for easier transportation and disposal.To decompose the organic matter present in it. To kill disease causing micro-organisms & disinfect the sludge.

15.4 Sequence of Treatment

1. Preliminary Treatment
2. Primary Treatment
3. Secondary Treatment
4. Tertiary Treatment
5. Sludge Handling

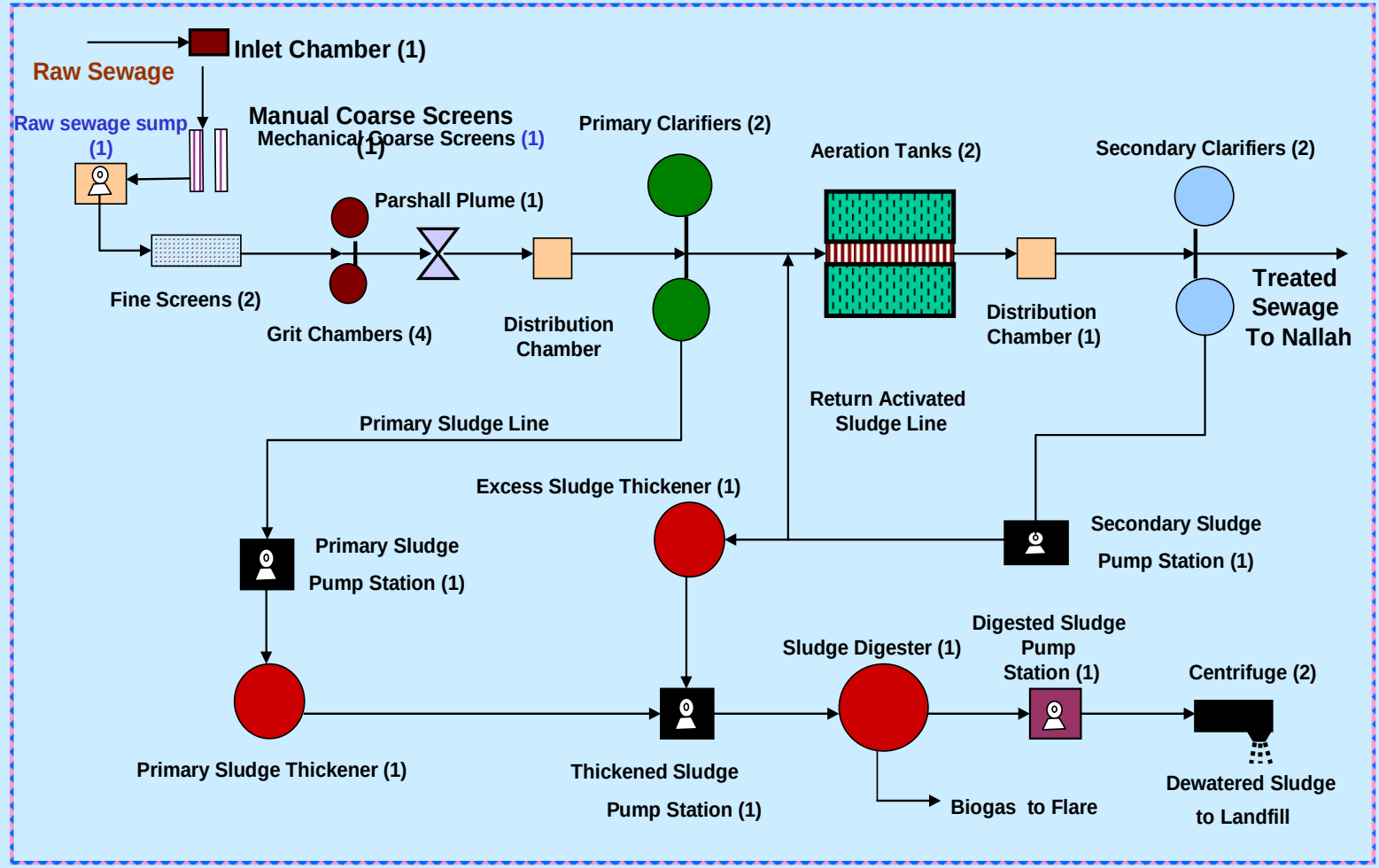
15.5 Type of Process for treatment of Sewage

- Aerobic Process
- Anaerobic process
- Combination of Aerobic & Anaerobic
- Based on Growth
- Attached Growth
- Suspended growth

Land & power requirement for different treatment processes- General Guide line

S.No.	Treatment process	land req (sqm / person)	Per lacs pop. land req(in Hacte)	Town design pop.	Approx land req. (in Hectare)	Power req (Kwh/per person - year)	Total power req. (per year) for one lac pop.	monthly power requirement of process (Kwh)	Sewage generated / lac pop.n (135 LPCD) in MLD	Per MLD land (in Hactares)	Per MLD / month power charges (Rs.) (latest technology in India)
1	Conventional ASP	0.16	1.60	1.00	**1.60**	12	1200000	100000	10.8	**0.15**	**35648**
2	Extended Aeration	0.25	2.50	1.00	**2.50**	13	1300000	108333	10.8	**0.23**	**38619**
3	Waste stabilization pond	1.00	10.00	1.00	**10.00**	NIL	0	0	10.8	**0.93**	**0**
4	Facultative aerated lagoons	0.15	3.50	1.00	**3.50**	12	1200000	100000	10.8	**0.32**	**35648**
5	Up-flow Anaerobic Sludge Blanket (UASB) + followed by Facultative Pond	0.11	1.05	1.00	**6.50**	2	200000	16667	10.8	**0.60**	**5941**
6	Trickling Filter	0.20	2.00	1.00	**2.00**	13	1300000	108333	10.8	**0.19**	**38619**
		Ref- S.J. Archivala Waste water Treatment and Disposal									

FLOW DIAGRAM OF TREATMENT PLANT



15.6 Construction of STP

Involves the civil, mechanical, Electrical & Instrumentation work

15.7 Civil work-

Civil Work should be carried out as per the specifications specified in the contract agreement & as per Standard specification of RUSDIP. Following construction activities are involved

- Excavation
- Concreting
- Building work
- Road work
- Drainage work
- Plantation & land Scaping
- Other miscellaneous
- Pipe line work

15.8 Mechanical Work

Following activities are involved

- Fabrication
- Installation of machinery such as pumps screens grit separator units, Blowers
- Air pipe line fabrication
- Installation of valves & gates
- Installation of pumps & motors
- Testing of all Mechanical works

15.9 Electrical Work

Following activities are involved

- Electric Cabling work
- Panel/ Starters installation
- Installation of motors & pumps
- 2pole/ 4 pole installation work
- Building electrification work
- Campus Electrification
- Testing of all electrical machinery

15.10 Instrumentation Work

Following activities are involved

- Instrumentation Cabling Panel/ Starters installation
- Installation of PLC if proposed
- Instrumentation connectivity
- Testing of all instrumentation work

16 WHO GUIDE LINES FOR THE USE OF TREATED WASTEWATER IN AGRICULTURE

Table 1. The 1989 WHO guidelines for the use of treated wastewater in agriculture[a] (*1*)

Category	Reuse conditions	Exposed group	Intestinal nematode[b] (arithmetic mean no. eggs per litre)[c]	Faecal coliforms (geometric mean no. per 100ml)[c]	Wastewater treatment expected to achieve the required microbiological guideline
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	≤ 1	≤ 1000	A series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	≤1	No standard recommended	Retention in stabilization ponds for 8-10 days or equivalent helminth and faecal coliform removal
C	Localized irrigation of crops in category B if exposure to workers and the public does not occur	None	Not applicable	Not applicable	Pretreatment as required by irrigation technology, but not less than primary sedimentation

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.

[b] *Ascaris* and *Trichuris* species and hookworms.

[c] During the irrigation period.

[d] A more stringent guideline (≤ 200 faecal coliforms per 100 ml) is appropriate for public lawns, such as hotel lawns, with which the public may cone into direct contact.

[e] In the case of fruit trees, irrigation should cease two weeks before fruit is picket, and no fruit should be picked off the ground. Sprinkler irrigation should be used.

17 GENERAL STANDARDS FOR DISCHARGE OF TREATED SEWAGE

		Standards for discharge into:			
S.N	**Parameter**	**Inland surface waters**	**Public sewers**	**Land for Irrigation**	**Marine costal areas**
1	Suspended solids mg/l,	100	600	200	a) For process wastewater - 100 b) For cooling water 10 % above inlet TSS
2	Size of suspended solids	Shall pass 850 micron sieve	-		a) Floatable solids, max., 3mm b) Settleable solids, max, 850 microns
3	pH value	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0	5.5 - 9.0
4	Temperature	Shall not exceed 5oC above the receiving water temperature	-		Shall not exceed 5oC above the receiving water temperature
5	Oil & Grease mg/l,	10	20	10	20
6	Total residual chlorine mg/l,	1		-	1
7	Amm. Nitrogen (as N), mg/l,	50	50	-	50
8	TKN (as NH_3) mg/l,	100		-	100
9	Free Ammonia (as NH_3) mg/l,	5	-	-	5
10	BOD_5, mg/l,	30	350	100	100
11	COD, mg/l,	250	-	-	250
12	Arsenic, mg/l,	0.2	0.2	0.2	0.2
13	Mercury, mg/l,	0.01	0.01	-	0.01
14	Lead, mg/l,	0.1	1	-	2
15	Cadmium, mg/l,	2	1	-	2
16	Hexavalent chromium, mg/l,	0.1	2	-	1
17	Total chromium, mg/l,	2	2	-	2
18	Copper, mg/l,	3	3	-	3
19	Zinc, mg/l,	5	15	-	15

		Standards for discharge into:			
S.N	**Parameter**	**Inland surface waters**	**Public sewers**	**Land for Irrigation**	**Marine costal areas**
20	selenium, mg/l	0.05	0.05	-	0.05
21	Nickel, mg/l	3	3	-	5
22	Cyanide, mg/l	0.2	2	0.2	0.2
23	Fluorides, mg/l	2	15	-	15
24	Sulphide, mg/l	2	-	-	5
25	Phenolic compounds (as $C6H_5OH$), mg/l	1	5	-	5
26	Bio-assay test-% survival after 96 hrs. in 100% effluent	90%	90%	-	90%
27	Manganese, mg/l	2	2	-	2
28	Iron, mg/l	3	3	-	3
29	Vanadium, mg/l	0.2	0.2	-	0.2
30	Nitrate Nitrogen, mg/l	10	-	-	20

References:-

- Manual on Sewerage & sewage treatment issued by Ministry of Urban Development New Delhi
- Guide lines issued by RUIDP
- Book by S.J. Archivala Waste water Treatment and Disposal

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