STATE OF WYOMING
DEPARTMENT OF PUBLIC HEALTH
FRANKLIN D. YODER, M.D., DIRECTOR
CHEYENNE

STANDARDS FOR SEWAGE WORKS

REVISED 1952

DIVISION OF ENVIRONMENTAL SANITATION

FOREWORD

The great interest on the part of the people in stream pollution abatement and the recognition by communities and industries of their responsibilities to the State and Nation in reducing pollution of our streams to a practicable minimum has stimulated many municipalities to retain engineers to prepare plans and specifications for sewage disposal plants. This awakening has been further encouraged by the passage by Congress of laws which provide for stream pollution investigations and for making non-interest bearing loans to political subdivisions for planning public works.

In making these "standards" available it is our intent to provide a guide for engineers that can be used for reference when preparing plans and specifications for approval by this Department in accordance with Chapter 63-204, Wyoming Compiled Statutes. In general, these standards should be followed. It is recognized many special problems will arise that are not covered herein. In such cases, it is recommended that these be brought to the attention of this Department before proceeding with final plans and specifications.

These standards have been taken from those prepared by the Committee on Development of Uniform Standards for Sewage Works for the Upper Mississippi and Great Lakes Boards of Public Health Engineers.

Departures from the original standards have been made where necessary to conform with local conditions and requirements.

L. O. Williams, Director

Div. of Environmental Sanitation

CONTENTS

PART I -- SUBMISSION OF PLANS

1. GENERAL

All reports, plans, and specifications shall be submitted to the State Department of Public Health at least 30 days prior to the date upon which action by the State Department of Public Health is desired.

The documents submitted for formal approval shall include:

A. General Layout
B. Detailed Plans
C. Specifications
D. Summary of Design Data

It is suggested that preliminary plans be submitted with the Engineer's Report for review prior to the preparation of final plans. However, no approval for construction can be issued until final complete, detailed plans and specifications have been submitted to the State Department of Public Health and found to be satisfactory.

2. ENGINEER'S REPORT

The engineer's report for sewage works shall where pertinent present the following information:

A. General Information: Describe the existing water and sewage facilities and the problems involved.

B. Extent of System: Describe the nature and extent of the area included in the present sewerage system, and the area and extent to which plans provide sewage facilities for future development. If the area to be served by existing and proposed sewers does not include the entire municipality or natural drainage area, a brief description should be given of that portion not included, together with information as to the probability of future development, and how this area can be served.

C. Alternate Plans: Where two or more solutions exist for a particular problem, each of which is feasible and practical, discuss the several solutions and reasons for selecting the one recommended. For example, if a sewerage system should require deep cuts to avoid pumping stations, the report should indicate that the comparative advantages of shallow and deep sewers have been given ample study.

D. Soil: State probable character of soil or strata through which the sewers are to be laid and describe portion of the system that will be below normal ground water level. Indicate any unusual soil or foundation conditions at the site of any sewage structures, the extent of soil investigations, and outline findings as they relate to probable construction problems or as they may affect portions of the system.

E. Sewage Flow: As a basis for sewage treatment plant design, discuss the population trend as indicated by available records, and give the

estimated population for the municipality or sewer district fifteen to twenty-five years hence, and for institutions, the present and maximum anticipated capacity. Describe briefly the method used to determine future population trends. Estimate the amount of domestic sewage, ground water, industrial wastes, etc.. that the collection system or various parts thereof may have to handle during a future period of not more than fifty years. Indicate basis of design of sewers.

F. Volume and Strength of Sewage Flow: Where there is an existing sewage works the designing engineer shall confer with the State Department of Public Health to determine the scope of volume and strength of sewage data necessary. Where data on the volume or volume and strength of sewage is required by the State Department of Public Health, the same shall accompany the report. These data must be obtained from actual flow measurements; preferably for both wet and dry weather periods when feasible, but in prolonged drouth or wet weather periods where unwarranted delay would exist from obtaining data on both extremes of flow, data for existing flows with a statement of conditions affecting the same and estimates of infiltration will be acceptable. The laboratory analysis must be made on composite samples taken over a continuous 24-hour period and data must cover a sufficient period of time to be representative of actual conditions. It is recommended that the designing engineer confer with the State Department of Public Health for details concerning the collection and analysis of samples.

G. Water Supply: Discuss the location of intake or wells, treatment plant, reservoirs, or other structures of public health significance with relation to various portions of the sewage works. If public supply is already in use, give approximate maximum, minimum, and average daily water consumption, and analysis of water as it might affect the character of the sewage.

H. Garbage Disposal: Describe present methods of garbage disposal and discuss the possibility of the future disposal of garbage wastes with sewage.

I. Industrial Waste: List all establishments producing industrial wastes and give quantity, producing periods, and character of industrial wastes in so far as they may affect the sewerage system or sewage treatment works. Quantity and character of wastes should be based on flow gauging and laboratory analysis of composite samples.

J. Sewage Treatment: Discuss the degree and type of treatment, reasons for adopting the proposed method, and the basis of design for each unit, both for present and future needs.

K. Site: Discuss the Various sites available and the advantages of the one to be recommended. Indicate the proximity of residences or developed areas to any treatment works, and discuss the relationship of maximum high water to the plant site and various plant units.

L. Financing: Give estimated cost of integral parts of system for the contemplated installation and a detailed estimated annual cost of operation. Methods of financing the proposed improvements should preferably be discussed.

M. Receiving Stream: Describe the stream or body of water into which the final effluent is to discharge, including its condition and uses. If a stream, give recorded or estimated minimum, maximum, and average daily flow and minimum weekly flow. State whether any unusual conditions exist which might affect the flow. If a lake, give approximate area, average depth in the vicinity of the outlet, and average inflow.

N. Recommendations: Include recommendations in detail concerning the proposed sewage works, and outline a plan for future extension of the works.

3. GENERAL LAYOUT

The general plans for sewage works shall show:

A. Miscellaneous: A suitable title and the name of the municipality, sewer district, or institution, the scale in feet, a graphical scale, the north point, date, and the name of the engineer and his professional registration number. The scale for general plans should not be less than 100 feet nor greater than 300 feet to the inch. The size of the plans should be 12" x 18", 24" x 36", or of such size as can be conveniently folded to those dimensions. The lettering and figures on the plans must be of appropriate size and of distinct outline. Surface elevations should preferably be placed just outside street lines opposite their respective positions. Datum used should be indicated.

Figure 1 is offered as an example of the lettering and symbols to be used.

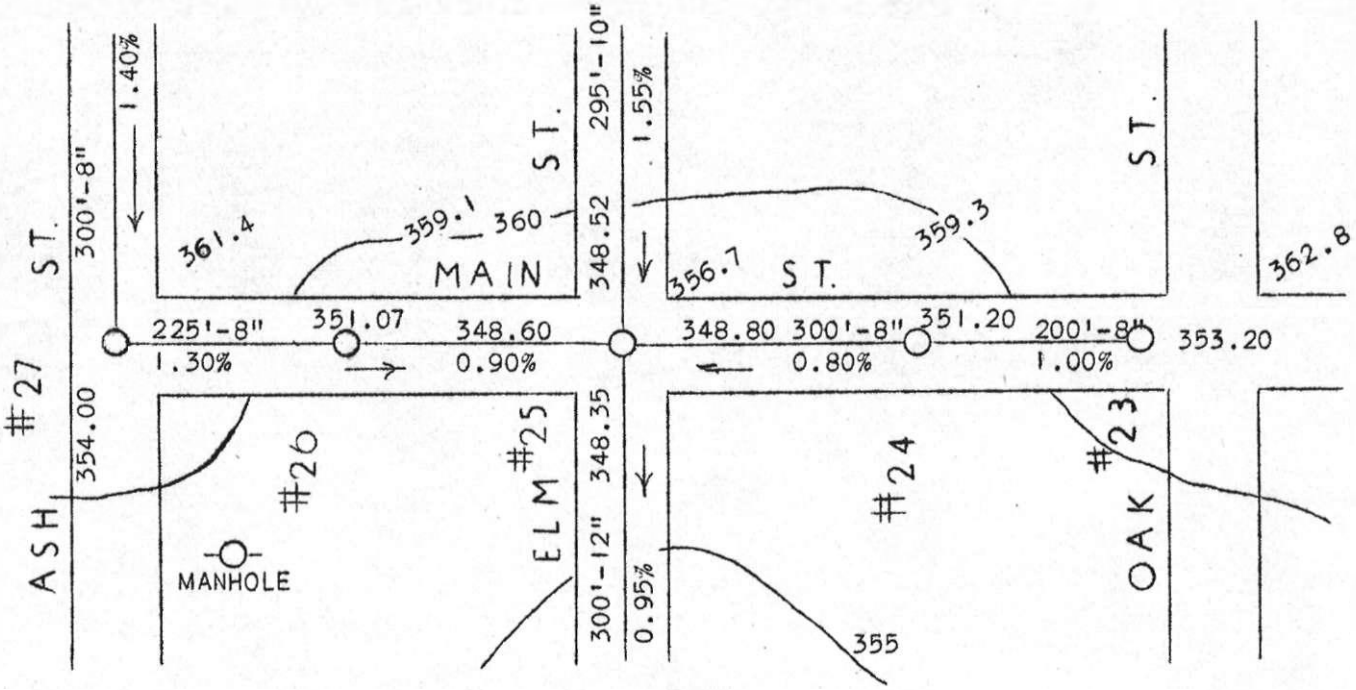


Figure 1

B. Boundaries: The boundary line of the municipality or sewer district to be sewered.

C. Existing Sewers: The location, size, length, slope and direction of flow of all existing sanitary and combined sewers affecting the proposed improvements.

D. Proposed Sewers: The location of all proposed sewers, with the size, grade, length, and direction of flow indicated. All manholes shall be numbered on the layout and correspondingly numbered on the profile.

E. Topography and Elevations: Existing or proposed streets and all streams or water surfaces shall be clearly shown. The elevations of all sewer inverts should be clearly and distinctly written close to the manhole, parallel with sewer line, and expressed to the nearest 0.01 feet. Contour lines should be included on the general plan at suitable intervals.

F. Stream Flow: The direction of flow in all streams and high and low water elevations of all water surfaces at sewer outlets and overflows.

G. Public Water Supplies: The location of wells, or other sources of public and semi-public water supply, water treatment plants, reservoirs, or other structures of public health significance.

Note: Water and sewer lines should not be laid in the same trench.

H. Sewage Works: The location of outlets, treatment plants, by-passes or overflows, manholes, lampholes, siphons, pumping stations and other accessories. Suitable symbols appropriately referenced shall be shown in the title for all such works.

4. DETAILED PLANS

All detailed plans should be prepared as blue or white prints and shall be drawn to a suitable scale. Plans for modifications or extensions to existing systems or plants shall indicate clearly the connections or relation thereto, and, if not already on file submission of plans for the existing system or plant may also be required.

The detailed plans for sewage works shall show:

A. Miscellaneous: The scale in feet to which the plans are drawn, the north point, the date, and the names of the engineer and owner shall be indicated on each sheet. A suitable sub-title shall be shown on each sheet.

B. Plan and Profile: A plan and profile along the line of all sewers to be constructed. Such plan and profile shall show all special features such as inverted siphons, extra strength pipe, concrete encasements, and sewer bridges. All stream crossings and sewer outlets must be shown on the profiles with elevations of the stream bed and of the normal and extreme high and low water levels. Where reasonably accurate contour lines are indicated on the general layout, the profiles of future lines need not be shown. Profiles should have a horizontal scale of not more than 100 feet to the inch and a vertical scale of not more than 10 feet to the inch. Both scales must be clearly shown on the profiles.

C. Sewers: Figures showing the manhole stationing, size of sewers, surface and sewer invert elevations of manholes, and the grade of all sewers between each two adjacent manholes must be shown on the profiles.

Where there is any question of the sewer being sufficiently deep to serve any residence, the elevation and location of the basement floor shall be plotted on the profile of the sewer which is to serve the house in question. The engineer shall state that all sewers are sufficiently deep to serve adjacent basements except where otherwise noted on the plans.

D. Sewer Appurtenances: Details of all ordinary sewer appurtenances such as manholes, drop manholes, inspection chambers, inverted siphons as well as of any special appurtenances or structures, such as regulators, tide gates, sewer bridges, pumping stations, etc., must be submitted. These detailed plans must be drawn to such a scale as will show clearly the nature of the design of each of the structures referred to and its equipment. They should have marked upon them all dimensions, elevations, capacities and explanatory notes necessary to make them readily intelligible for examination and construction.

E. Cross Sections: Detailed plans and specifications of all sewer sections except standard pipe, clearly shown as such, must accompany the plans. Details of cradling and encasement must also be shown.

F. Flooding: Elevation of extraordinary high water shall be indicated on the profile of sewers subject to flooding.

G. Sewage Pumping Stations: Details.

H. Plat of Site: A plat of the property to be used for treatment works on which shall be indicated the topography and the arrangement of present and future treatment units. The contour interval for this plat shall not be greater than two feet.

I. Treatment Units: Complete details, including elevations, shall be given of all treatment units of the plant and of the high and low water levels of the stream or other body of water into which the effluent is to be discharged.

J. Hydraulic Profiles: Hydraulic profiles showing the sewage, supernatant liquor and sludge flow through the plant are required.

K. Schematic Diagrams: Schematic piping and lighting diagrams with all lines and appurtenances properly labeled. Direction of flow through piping shall be indicated.

5. SPECIFICATIONS

Complete detailed specifications for the construction of sewers, sewage treatment plant, and all appurtenances shall accompany the plans.

6. SUMMARY OF DESIGN DATA

Unless previously submitted, a summary of the design criteria, including information relative to population, methods of determining sewage flows, a

brief description of the basis of sewer design and basic calculations used in determining capacities of various units of the treatment works should accompany the plans and specifications.

7. REVISIONS TO APPROVED PLANS

Any deviations from approved plans or specifications affecting capacity, flow or operation of units must be approved in writing before such changes are made. Plans or specifications so revised should, therefore, be submitted well in advance of any construction work which will be affected by such changes to permit sufficient time for review and approval. Structural revisions or other minor changes not affecting capacities, flows, or operation will be permitted during construction without approval. "As built" plans clearly showing such alterations shall be placed on file with the State Department of Public Health at the completion of the work.

PART II -- DESIGN AND CONSTRUCTION OF SEWERS

1. GENERAL

A. Design Period: In general, sewerage systems should be designed for the estimated future tributary population up to fifty years hence, except in considering parts of the systems that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions. Minimum sizes of sewers which will carry the design flow should be used.

B. Materials: Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, special consideration being given to the character of the industrial wastes, possibilities of septicity, exceptionally heavy external loadings, abrasion, the necessity of reducing the number of joints, soft foundations, and similar problems.

C. Joints and Infiltration: The method of making joints and the materials used should be included in the specifications. Materials used for sewer joints shall have satisfactory records for preventing infiltration and the entrance of roots. Leakage tests should be specified and the leakage outward (with the trench dry) or the infiltration in the case of wet trenches should never be permitted to exceed 10,000 gallons per mile per day for any section of the system for systems containing pipe up to the 15" size. Special consideration will be given to leakage allowances in the case of larger sizes of pipe.

With pressure pipe sewers, the leakage allowance should not exceed 200 gallons per inch diameter per mile per day under a test head appropriate to the local conditions.

D. Water Supply Interconnections: There must be no permanent physical connection between a public or private potable water supply system and a sewer, sewage treatment plant, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable water supply.

E. Relation to Water Works Structures: While no general statement can be made to cover all cases, it is generally expected that sewers shall be kept remote from public water supply wells or other water supply sources and structures. The type and construction of sewers shall conform to the regulations governing water supplies. Sewer lines and water mains must not be laid in the same trench.

2. TYPE OF SYSTEM

In general, and except for special reasons, the State Department of Public Health will approve plans for new systems or extensions only when designed upon the separate plan, in which rain water from roofs, streets, and other areas, and ground water from foundation drains are excluded. Where "combined" sewers are necessary, they shall be arranged to facilitate the interception of sewage for treatment.

3. SIZE, DEPTH, AND VELOCITY OF FLOW

A. Size: No public sewer shall be less than eight inches in diameter.

B. Depth: Street sewers must be designed deep enough to drain basements unless the municipal authorities specifically request. Where for specific reasons shallow depths are necessary and can be justified the sewer must be protected to prevent its being damaged. "All sewers shall be designed to prevent cracking due to superimposed loads and weight of backfill material. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. When standard strength sewer pipe is not sufficient, the additional strength needed may be obtained by using extra strength pipe or special construction."

C. Velocity of Flow: All sewers shall be designed and constructed with hydraulic slopes sufficient to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Kutter's or Manning's formula. For 8" to 24" sewers, velocities should be determined using a value of "n" of 0.013 for pipe in 2' to 4' lengths, an "n" of 0.0125 for any smooth and durable pipe provided in 5' to 10' lengths, and an "n" of 0.012 for smooth and durable pipe in lengths of 11' or greater. If the pipe material is subject to corrosion, a smooth and durable lining may be required.

In general the following are the minimum slopes which should be provided, especially where the depth of flow may be small, and are desirable minima in all parts of the system:

LENGTH OF SEWER SECTIONS

Sewer Size	2' - 4'	5' - 10'	11' or more
	Minimum slopes in feet per 100 feet		
8"	0.40	0.36	0.32
10"	0.28	0.25	0.23
12"	0.22	0.20	0.18
14"	0.17	0.15	0.14
15"	0.15	0.13	0.12
16"	0.14	0.125	0.115
18"	0.12	0.11	0.10
21"	0.10	0.09	0.08
24"	0.08	0.07	0.065

Under special conditions, if full and justifiable reasons are given, slopes slightly less than those required for the 2' per second velocity when full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected the engineer must furnish with his report his computations of the depths of flow in such pipes at minimum, average and peak rates of flow. It is recognized that such flatter grades may cause additional sewer maintenance expense.

D. Increasing Size: When sewers are increased in size, or when a smaller sewer joins a larger one, the invert of the larger sewer should be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

E. Alignment: Sewers up to and including 24" diameter must be laid with uniform slope and alignment between manholes.

F. High Velocity Protection: In the case of sewers where the slope and volume are such that velocities of 12-15 feet per second are realized at average flow, special provision shall be made to protect against erosion and shock.

4. CAPACITIES

A. General: In determining the required capacities of sanitary sewers the following factors should be considered:

(1) Maximum hourly quantity of domestic sewage.

(2) Additional maximum sewage or waste from industrial plants.

(3) Ground water infiltration.

B. New Systems: New sewerage systems shall be designed on the basis of an average daily per capita flow of sewage of not less than 100 gallons per day and on that basis, lateral and sub-main sewers should be designed with capacities, when running full, of not less than 400 gallons per capita per day, and main, trunk, and outfall sewers should have capacities under the same conditions of not less than 250 gallons per capita per day with due allowance in each case for any additional sewage or waste from industrial plants.

The 100 g/c/d figure is assumed to cover normal infiltration, but an additional allowance should be made where conditions are especially unfavorable. This figure is likewise considered sufficient to cover the flow from cellar floor drains, but is not sufficient to provide any allowance for flow from foundation drains, roof leaders or unpolluted cooling water, which should not be discharged to sanitary sewerage systems.

In lieu of the above, a rational procedure may be used which would vary the per capita flow from that required when wide variations and extreme maximum peaks will occur, such as in laterials, to that required for the larger trunk sewers where the flow is more uniform, in proportion to the area or population served by the section in question. A brief description of the procedure used for sewer design should be included with the summary of design data at the time plans are submitted for approval.

C. Interceptors: Intercepting sewers in the case of combined sewerage systems should fulfill the above requirements for trunk sewers and have sufficient additional capacity to care for the necessary increment of

storm water. Normally no interceptor shall be designed for less than 250% of the gauged or estimated dry weather flow, but the percentage may have to be increased materially when the tributary area is large in comparison with the population or where flows under wet ground conditions greatly exceed those during dry weather.

Overflows from intercepting sewers should not be permitted at points where they will adversely affect the watercourse or the use of water therefrom, otherwise provision may have to be made for treating the overflow by providing storm water holding tanks or other facilities.

5. MANHOLES

A. Location: Manholes should be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18" to 30". Greater spacing may be permitted in larger lines and those carrying a settled effluent. Lampholes may be used only for special conditions and shall not be substituted for manholes nor installed at the end of laterials greater than 150 feet in length.

B. Drop Type: A drop pipe should be provided for a lateral sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches the invert should be filleted to prevent solids deposition.

C. Diameter: The minimum diameter of manholes shall be 42 inches; larger diameters are preferable.

D. Flap Gates: Manholes equipped with flap gates are desirable at the ends of laterals which are at minimum grades and which are not to be extended at an early date. Such gates are particularly needed if the laterals are at less than minimum grades.

E. Flow Channel: The flow channel through manholes should be made to conform in shape and slope to that of the sewers.

F. Watertightness: Solid manhole covers are to be used wherever the manhole tops may be flooded to an appreciable depth by street runoff or high water. Manholes of brick or segmental block should be waterproofed on the exterior with plaster coatings; supplemented by a bituminous waterproofing coating where ground water conditions are unfavorable.

6. INVERTED SIPHONS

Inverted siphons should have not less than two barrels, with a minimum pipe size not less than 6 inches and should be provided with necessary appurtenances for convenient flushing and maintenance; the manholes should have adequate clearances for rodding; and in general sufficient head should be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details must be arranged so that the normal flow is diverted to one barrel and so that either barrel may be cut out of service for cleaning.

PART III - DESIGN OF SEWAGE PUMPING STATIONS

1. GENERAL

Where sewage pumping stations are employed, care should be taken to so locate or construct the station that it will not be subject to flooding. A suitable building, preferably located off the right-of-way of streets and alleys, should be provided. The use of subsurface structures will not be approved except under unusual conditions. It is important that the station be readily accessible.

If it is necessary to pump sewage at a treatment works, settled sewage shall be pumped unless this arrangement would seriously penalize the design because of local conditions.

Where it may be necessary to pump sewage prior to grit removal, the design of the wet well should receive special attention and the discharge piping shall be designed to prevent grit settling in pump discharge lines of pumps not operating.

2. DESIGN

The following items should be given consideration in the design of sewage pumping stations:

A. Type: Sewage pumping stations should preferably be of the dry well type. If the wet well type of construction is used, motors should be above ground level and suitably housed. Wet well type of construction should be used only on the smaller installations ultimately serving 50 homes or less.

B. Structures

(1) Entrances: Where dry well type installations are used, wet and dry wells should be completely separated, with a separate entrance to each.

(2) Pump Removal: Provision should be made to facilitate removing pumps and motors.

(3) Stairways: Suitable stairways should be provided for convenient access to dry wells of pump stations and shall be provided to wet wells containing either bar screens or mechanical equipment requiring inspection or maintenance.

C. Pumps

(1) Duplicate Units: At least two pumps or ejectors should be provided. Where the pumping installation will serve not more than 50 homes, a single unit will be permitted, provided: (1) the station is of ample size and designed to permit the installation of a future duplicate pump with no structural changes, and (2) provided an overflow is permissible and the occasional discharge of sewage will not be unduly objectionable. If only two units are provided, they should have the same capacity. Each should be capable of handling flows in

excess of the expected maximum flow. Where three or more pumps are provided, they should be designed to fit actual flow conditions and of such capacity that with any one pump out of service the remaining pumps will have capacity to handle maximum sewage flows.

(2) Protection Against Clogging: Pumps handling raw sewage should be preceded by readily accessible bar racks with clear openings not exceeding 2 inches unless ejectors are used or the pumping equipment is of a special type with integral screens. Where the size of the installation warrants, a mechanically cleaned barscreen with grinder, or comminutor is recommended. Where screens are located below ground, convenient facilities must be provided for handling screenings. For the larger or deeper stations, duplicate units of proper capacity are preferred.

(3) Pump Openings: Pump suction and discharge openings should be at least 4 inches in diameter. Suction and discharge piping shall be at least 4 inches in diameter.

(4) Priming: Unless self-priming pumps are used, the pump should be so placed that under normal operating conditions it will operate under a positive suction head.

(5) Electrical Fixtures: Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriter's specifications for hazardous conditions.

(6) Intake: Each pump should have an individual intake. Wet well design should be such as to avoid turbulence near the intakes.

(7) Dry Well Dewatering: A separate sump pump shall be provided in dry wells to remove leakage or drainage with the discharge above the overflow level of the wet well. A connection to the pump suction is also recommended as an auxiliary feature. Water ejectors connected to a potable water supply will not be approved.

(8) Pumping Rates: The pumps and controls of main pumping stations, and especially pumping stations operated as part of treatment works, should be selected to operate at varying delivery rates to permit discharging sewage from the station to the treatment works at approximately its rate of delivery to the pump station.

D. Controls: Control float tubes should be so located as not to be unduly affected by flows entering the well or by the suction of the pumps. Float tubes in dry wells shall extend high enough to prevent overflow. In small stations with duplicate units provision should be made to automatically alternate the pumps in use.

E. Valves: Gate Valves shall be placed on suction and discharge lines of each pump. A check valve or equivalent shall be placed on each discharge line, between the gate valve and the pump.

F. Wet Wells

(1) Divided Wells: Where continuity of pump station operation is important, consideration should be given to dividing the wet well

into two sections, properly interconnected, to facilitate repairs and cleaning.

(2) Size: The effective capacity of the wet well below the inlet sewer shall provide a holding period not to exceed 10 minutes for the design average flow.

(3) Floor Slope: The wet well floor shall have a minimum slope of 1 to 1 to the intake.

G. Ventilation: Adequate ventilation shall be provided for all pump stations. Where the pump pit is below the ground surface mechanical ventilation is required, so arranged as to effectively ventilate the dry well and also the wet well if screens or mechanical equipment requiring maintenance or inspection is located in the wet well. The ventilation equipment should have a minimum capacity of 6 turnovers per hour under continuous operation. With intermittent operation a 2 minute turnover should be provided.

H. Flow Measurements: At larger pumping stations consideration should be given to installing suitable devices for measuring sewage flows and power consumption.

I. Water Supply Interconnection: There shall be no direct connection between any potable water supply and sewage pumps or piping.

3. POWER SUPPLY

Power supply should be available from at least two independent generating sources, or emergency power equipment should be provided. Where this is not feasible, an overflow should be provided at such an elevation as to prevent basement flooding or back water from stream affecting operation. Where power failure would result in objectionable conditions because of the resultant discharge or basement flooding, means for emergency operation should be provided.

PART IV -- DESIGN AND CONSTRUCTION OF SEWAGE TREATMENT WORKS

1. GENERAL

Treatment, the extent of which will depend upon local conditions, shall be provided in connection with all new sewer installations. Sedimentation shall be the minimum degree of treatment. Consideration shall be given to providing additional treatment facilities in connection with extensions to existing sewage works with unsatisfactory sewage treatment facilities. It is suggested that the engineer confer with the State Department of Public Health before proceeding with the design of detail plans.

Sewage treatment plants should be designed to provide for the estimated population fifteen to twenty-five years hence, except in considering those units which can be readily increased in capacity.

The following items should be taken into consideration in planning sewage treatment works:

A. Flow: Unless satisfactory justification can be given for using a lower per capita flow, plans for sewage treatment plants to serve a new sewerage system for a municipality or sewer district will be examined on the basis of an average daily flow of 100 gallons per capita, to which must be added industrial waste volumes. Plans for sewage treatment plants to serve existing sewerage systems will be examined on the basis of gaugings of the present flow from the sewers, plus allowance for the estimated future increase in population.

B. Design Loading

(1) Flow-Hydraulically: The design of treatment units shall be based on the average rate of flow of domestic sewage per 24 hours plus the average hourly rate of flow of industrial wastes during the maximum significant period. Where recirculation is employed through a unit, the recirculated effluent shall be added to the flow rate.

(2) Organic Loading: To be computed on the same basis used in determining design flow.

C. Type of Treatment: Careful consideration should be given to the type of treatment before making a final decision. A few of the important factors which should influence the selection of the type of treatment are: the location and topography of the plant site; the effect of industrial wastes likely to be encountered; operating costs; and the probably type of supervision and operation which the plant will have.

D. New Processes, Methods, and Equipment: The policy of the State Department of Public Health is to encourage rather than obstruct the development of new methods and equipment for the treatment of sewage wastes, however, any new development must have been thoroughly tested in a full-scale installation under competent supervision before approval of a plant utilizing this process or equipment can be issued, unless a municipality is amply protected by a performance bond or other acceptable

arrangement so that in case of failure any expenditure of public money will be refunded. The municipal authorities must agree in writing to the trial where it is necessary to revise or rebuild permanent plant structures in order to accommodate other mechanical equipment after the original installation has been rejected, the performance bond should include provisions to cover the cost of the alterations.

E. Installation of Mechanical Equipment: The specifications shall be so written that the installation and initial operation of major items of mechanical equipment will be supervised by a representative of the manufacturer.

F. Emergency Power Facilities: A standby power source shall be provided where the temporary discharge of raw or partially treated sewage may be reasonably expected to endanger the public health or cause serious damage.

G. Quality of Effluent: Effluent requirements for sewage treatment plants shall be based on the flow, character, and use of the receiving stream. The State Department of Public Health will establish the quality of effluent required in each particular case. The selection of the type of treatment or process involved must be such as to meet these requirements.

H. Plant Location: In general, to avoid local objections a sewage treatment plant site should be as far as practicable from any present built-up area or any area which will probably be built up within a reasonable future period. If a critical location must be used, special consideration must be given to the design. Plants should be located at an elevation which is not subject to flooding or adequately protected against flood damage. The plant should be readily accessible in all seasons.

I. Arrangement of Units: Component parts of the plant should be arranged for greatest operating convenience, flexibility, economy, and so as to facilitate installation of future units.

J. Industrial Wastes: Where appreciable amounts of industrial wastes are involved, consideration shall be given to the character of wastes in preparing the engineer's report.

Where it is necessary to provide preliminary treatment of industrial wastes or where they are of such a character that they should be excluded from the sewers, the municipality should be so advised by the engineer at the time the engineer's report is submitted so that the industry may be properly notified.

K. Sewage Flow Measurement: Equipment for measuring and preferably recording the volume of sewage shall be provided at the treatment works.

L. By-Passes: Except where duplicate units are available, properly located and arranged by-pass structures shall be provided so that each unit of the plant can be removed from service independently. Under certain circumstances, by-passes may be required even though duplicate units are provided.

M. Drains: Means should be provided to dewater each unit. Due consideration should be given to the possible need for hydrostatic pressure relief devices.

N. Laboratory Equipment: All treatment works should include a laboratory for making the necessary analytical determinations and operating control tests. Lists of equipment necessary for making various determinations are available from the State Department of Public Health upon request.

O. Fences, Railings, Etc.: All units or structures which may endanger human life should be enclosed by a suitable fence. Handrails shall be provided where there is a likelihood of accident to operating personnel or visitors.

P. Construction Materials: Due consideration should be given to the selection of materials which are to be used in sewage treatment works because of the possible presence of hydrogen sulphide and other corrosive gases, greases, oils, and similar constituents frequently present in sewage. This is particularly important in the selection of metals and paints.

Q. Painting: The use of paints containing lead should generally be avoided. In order to facilitate indentification of piping, particularly in the large plants, it is suggested that the different lines have contrasting colors. The following color scheme is recommended for purposes of standardization:

Sludge line - brown
Gas line - red
Potable water line - blue
Chlorine line - yellow
Sewage line - gray
Compressed air line - green
Water lines for heating digesters or buildings - blue with a 6" red band spaced 30" apart.

R. Conduits: All piping and channels should be designed to carry the maximum expected flows. The incoming sewer should be designed for free discharge. Bottom corners of the channels should be filleted. Pockets and corners where solids can accumulate should be eliminated. Suitable gates should be placed in channels to seal off unused sections which might accumulate solids.

S. Water Supply: An adequate supply of safe potable water under pressure should be provided for use in the laboratory and general cleanliness around the plant. No piping or other connections shall exist in any part of the treatment works which under any conditions might cause the contamination of a potable water supply.

T. Operating Equipment: The specifications should include a complete outfit of tools and accessories for the plant operator's use, such as squeegees, wrenches, valve keys, rakes, shovels, etc. A portable pump is desirable. Storage space and a work bench should be provided.

U. Grading and Landscaping: Upon completion of the plant, the ground should be graded. Concrete or gravel walkways should be provided for access to all units. Where possible, steep slopes should be avoided to prevent erosion. Surface water should not be permitted to drain into any unit. Particular care should be taken to protect trickling filter beds, sludge

beds, and intermittent sand filters from surface wash. Provision should be made for landscaping, particularly when a plant must be located close to residential areas.

V. Safety: Adequate provision should be made to protect the operator and any visitors from unnecessary hazards. The use of various safety devices should be considered. First aid equipment is desirable.

W. Sanitary Facilities: Sanitary facilities such as toilet, shower, and lavatory should be provided.

PRELIMINARY TREATMENT UNITS

2. SCREENING DEVICES

A. Bar Screens

(1) Where Required: It is recommended that all sewage treatment plants provide protection for pumps and other equipment by installing coarse bar screens or screens used in conjunction with mechanical shredders. All equipment should be readily accessible for maintenance. A bar rack should precede mechanically cleaned grit chambers.

(2) Location

a. In Deep Pits: Hand-cleaned screens located in deep pits shall be provided with stairway access, adequate lighting and ventilation, and convenient and adequate means for removing screenings. (See Part III, 2, G, page 13)

b. In Buildings: Screening devices installed in a building where other equipment or offices are located should be separated from the rest of the building by partitions and provided with adequate means of ventilation. (See Part III, 2, G, page 13)

(3) Spacing of Bars

a. Non-Mechanical Screens: Clear openings between bars should be from one to two inches. Construction of bar screens should be such that they can be conveniently raked.

b. Mechanical Screens: Clear openings for mechanically cleaned screens may as small as five-eights of an inch.

(4) Effective Area

a. Velocities: For hand raked bar screens the screen chamber should be designed to provide a velocity through the screen of one foot per second at average rate of flow. Maximum velocities during wet weather periods should not exceed 2.5 feet per second for mechanically cleaned screens.

b. Effective Area: The effective velocity shall be determined by considering a vertical projection of the screen openings of the

screen from a point on the screen level with the invert of the channel up to the flow line at screen design flow.

c. Invert: The screen channel invert should be 3" to 6" below the invert of the incoming sewer.

(5) Slope: Hand-cleaned screens except those for emergency use should be placed on a slope of 30 to 45 degrees with the horizontal.

(6) Channels: The channel preceding and following the screen shall be filleted to prevent stranding and sedimentation of solids.

(7) Safety Devices

a. All mechanical units which are operated by timing devices should be provided with auxiliary float controls which will set the cleaning mechanism in operation at predetermined high water marks. These auxiliary controls should operate independent of the regular controls.

b. Electrical Fixtures: Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriter's specifications for hazardous conditions.

(8) Screenings

a. Handling: Where hand-cleaned screens are installed, ample facilities must be provided for the removal, handling, and disposal of screenings.

b. Platform: Hand-cleaned screening facilities should include an amply-sized, accessible platform from which the operator may rake screenings easily and safely.

c. Drainage: Suitable drainage facilities should be provided both for the platform and for such devices as may be necesary to store the screenings.

d. Storage: Suitable storage facilities should be provided where the temporary storage of screenings is necessary.

e. Disposal: Definite provisions should be made for the satisfactory disposal of screenings. Shredding devices are recommended for use with mechanically cleaned screens. The use of such grinding devices in conjunction with hand-cleaned screens is encouraged.

B. Comminuting Devices

(1) Channels: Design of approach channels should provide for gates or similar devices to shut off the flow or divert the flow from any one comminuter without interrupting the flow to other comminutors if such additional units exist. Drains should be provided in each comminutor trap to allow for dewatering such traps when necessary.

(2) Auxiliary Screens: Where mechanically operated screening devices or shredding-screening devices are employed, auxiliary units should be provided, such units being either of the mechanical or hand-cleaned type, and arranged in such a manner as to provide for automatic diversion of the sewage flow should the regular units fail.

C. Fine Screens: The use of fine screens in lieu of primary treatment alone is not permitted. In special cases where it can be domonstrated that the features peculiar to this equipment may be used to advantage, the merits of such proposed installations shall be determined individually by the State Department of Public Health.

3. GRIT CHAMBERS

A. Where Required: Grit chambers are required at all sewage treatment plants which receive sewage from combined sewers. Grit chambers are also advocated for plants treating sewage from sanitary systems where grit may be anticipated.

B. Location

(1) General: It is recommended that grit chambers be located ahead of of pumps and comminuting devices. In such cases, coarse bar racks should be placed ahead of mechanically cleaned grit chambers.

(2) Inlet: The grit channel should be designed to minimize inlet turbulence.

C. Number of Units: Grit chambers used in plants treating wastes from combined sewers should have duplicate hand-cleaned units or a single mechanically cleaned unit with by-pass. Mechanically cleaned grit chambers are recommended. Single hand-cleaned channels with by-pass are acceptable for sewage treatment plants serving sanitary sewerage systems.

D. Design Factors

(1) Velocity and Detention: Channels should be designed to provide velocities of not less than one-half foot per second and as close as possible to one foot per second with a detention period of 20 seconds to one minute.

(2) Velocity Control: Provisions should be made for the regulation of velocity to minimize deposition of organic matter.

(3) Grit Washing: All chambers not providing positive velocity control should include grit washing devices for the further separation of organic and inorganic materials.

(4) Drain: Provisions should be made for draining each unit.

E. Grit Removal: Grit chambers located in deep pits should be provided with facilities for hoisting grit to ground level, access by stairway, adequate ventilation, and adequate lighting. (see Part III, 2, G, page 13)

F. Grit Disposal: Means for grit disposal should be provided.

4. PRE-AERATION AND FLOCCULATION

A. General: Flocculation of sewage by air or mechanical agitation, with or without chemicals, is worthy of consideration when the raw sewage is strong or when it is desired to reduce the strength of sewage to such a degree that subsequent treatment units can produce a satisfactory plant effluent.

B. Arrangement: A unit should be designed so that it may be removed from service without affecting any settling unit.

C. Detention Period

(1) Coagulation: When air or mechanical agitation with chemicals is used to coagulate or flocculate the sewage, the detention period should be about 30 minutes but never less than 20 minutes at the design flow.

(2) B.O.D. Reduction: When air or mechanical agitation (either with or without the use of chemicals) is for the additional purpose of obtaining increased reduction in B.O.D., the detention period should be at least 45 minutes at design flow.

D. Stirring Devices

(1) Paddles: Paddles should have a peripheral speed of $1\frac{1}{2}$' to $2\frac{1}{2}$' per second to prevent depos ition of solids.

(2) Mechanical Aerators: Mechanical aerators should provide self-cleansing velocities across floor of tank.

(3) Air: Diffused air mix may utilize any of the types of equipment used for activated sludge aeration tanks. The quantity of air should be sufficient to provide self-cleansing velocities. The rate of application of air should be adjustable.

E. Details: Inlet and outlet devices should be designed to insure proper distribution and to prevent short circuiting. Convenient means should be provided for removing grit.

F. Quick Mix: At plants where there are two or more flocculation basins utilizing chemicals, provision shall be made for a quick mix of the sewage with the chemical so that the sewage passing to the several flocculation basins will be of the same composition. The detention period provided in the quick-mix chamber should be very short -- 1/2 to 3 minutes.

SEDIMENTATION

5. SEDIMENTATION BASINS

A. General Features

(1) Inlets: Inlets should be designed to dissipate the inlet velocity, diffuse the flow equally across the entire cross section of the .

settling chamber, and prevent short circuiting. Channels should be designed to maintain a velocity of at least 1 foot per second at 0.5 design flow. Corner pockets and dead ends should be eliminated and corner fillets or channeling used where necessary.

(2) Length of Flow: The minimum length of flow from inlet baffle to outlet should be 10 feet.

(3) Skimming Baffles: Skimming baffles shall be provided ahead of outlet weirs on all primary settling basins. They are encouraged on all non-mechanical final settling basins for small installations not equipped for continuous sludge return.

(4) Weirs: Overflow weirs shall be adjustable. On circular tanks the weir should be equivalent in length to a weir extending around the entire periphery of the tank. Weir loadings shall not exceed 10,000 gallons per linear foot per day for plants designed for average flows of 1.0 M.G.D. or less. Special consideration will be given to weir loadings for plants designed for flows in excess of 1.0 M.G.D., but such loadings should preferably not exceed 15,000 gallons per linear foot per day.

(5) Submerged Surfaces: The tops of troughs, beams, and similar construction features which are submerged shall have a minimum slope of 1.4 vertical to 1 horizontal. The underside of such features should have a slope of 1 to 1 to prevent the accumulation of scum and septic solids.

(6) Multiple Tanks: Consideration should be given to the use of multiple units in installations large enough to warrant such, or when the removal of a single unit from service for a short period will result in objectionable conditions or material damage.

(7) Protective and Servicing Facilities: All settling basins shall be adequately equipped to provide easy access for maintenance and for protection to operators. Such features include stairways, walkways, handrails, etc.

B. Mechanically Cleaned Sedimentation Basins

(1) Surface Settling Rates

a. Primary Settling Tanks

1. Allowable B.O.D. removals by primary settling tanks treating normal sewage shall be determined from Figure 2, Page 22. Allowable B.O.D. removals by sedimentation of industrial wastes will be dependent upon type of wastes contributed.

2. Surface settling rates for primary tanks not followed by secondary treatment shall not exceed 600 gallons per square foot per day for plants having a design flow of 1.0 M.G.D. or less. Higher surface settling rates may be permitted for larger plants.

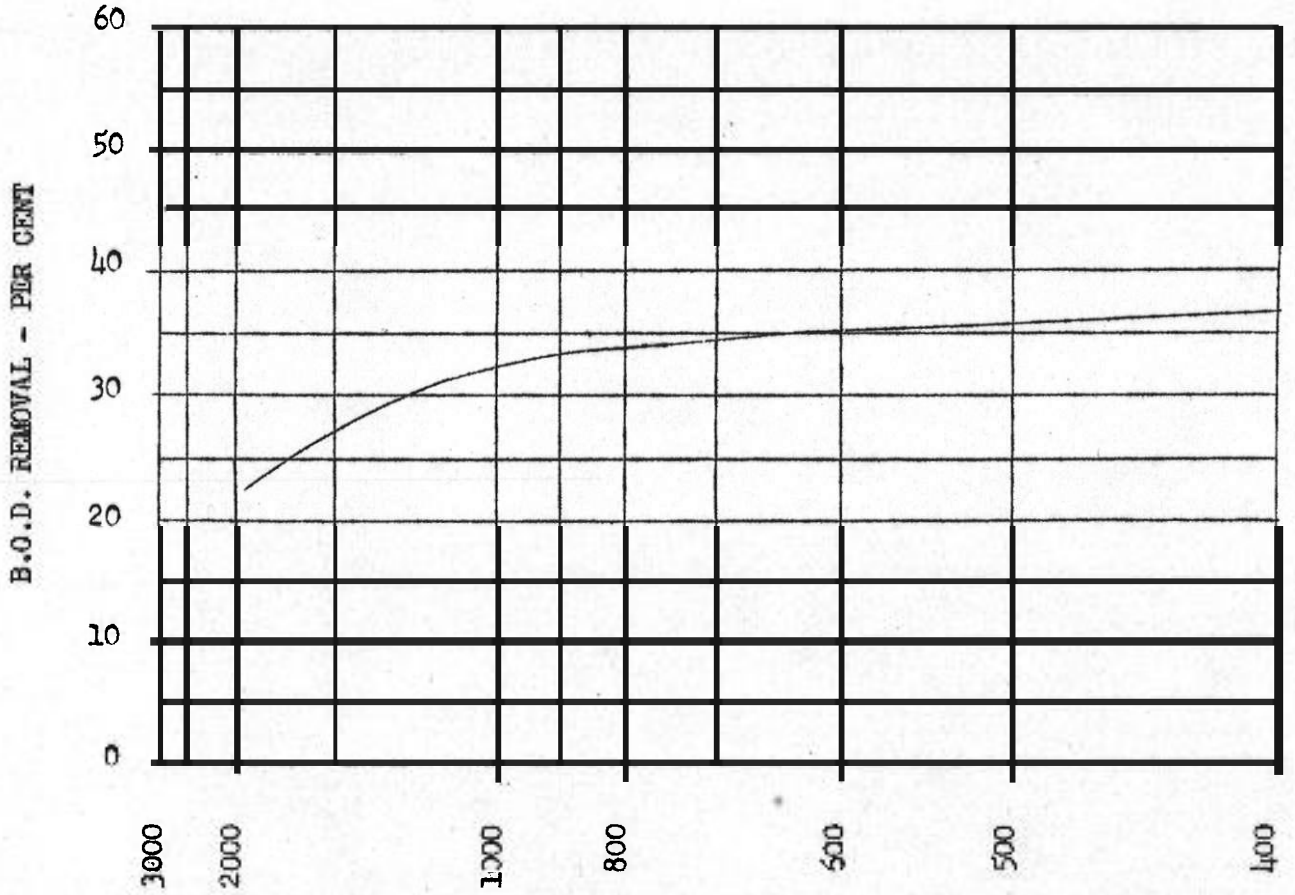


Figure 2

Settling Rate - Gallons Per Day Per Sq. Ft. Tank Area (Design Flow)

b. Intermediate Settling Tanks: Surface settling rates for intermediate settling tanks should not exceed 1000 gallons per square foot per day based on the design flow.

c. Final Settling Tanks: Surface settling rates for final settling tanks, based on the design flow shall not exceed the following:

Type Treatment	Size Plant	Surface Settling Rates Gal/sq.ft./day
Standard trickling filters	---	1000
High rate trickling filters	---	800
Activated sludge	2.0 M.G.D. or less	800
Activated sludge	Over 2.0 M.G.D.	1000

(2) Scum Removal: Scum removal equipment shall be provided ahead of the outlet weirs on all primary settling basins and should be considered for final sedimentation basins following trickling filters. The equipment should be automatic or provide for easy scum removal. The equipment should discharge to a sludge well for pumping to the digester.

(3) Sludge Removal: Provision for continuous sludge removal from final settling basins is encouraged when the sludge is returned to a primary settling basin. Where sludge is removed from a settling basin to the digester, a sludge well should be provided or appropriate equipment installed for viewing and sampling the sludge.

(4) Depth: The depth of mechanically cleaned sedimentation basins shall be as shallow as practical but with a minimum water depth of 7 feet. Final clarifiers for activated sludge should have a minimum water depth of 8 feet.

(5) Hopper Slopes: The minimum slope of the side walls of sludge hoppers shall be 1.7 vertical to 1 horizonital.

C. Non-Mechanical Sedimentation Basins: The use of non-mechanical sedimentation basins is, in general, discouraged except for installations too small to warrant the use of mechanically equipped tanks. Except for combined aerator-clarifier units, non-mechanical basins will not be permitted for the final settling of activated sludge.

(1) Inlets: In non-mechanical radial flow hopper bottom final clarifiers, the inlet should be at least 6' below the water surface and 5' from the bottom of the hopper. A baffle should be provided for dissipating the velocity of the incoming sewage.

(2) Sludge Hoppers: Sludge hoppers in non-mechanical sedimentation basins shall have a minimum slope of 1.7 vertical to 1 horizontal, to be measured along the side wall in pyramidal hoppers. Conical hoppers shall have a minimum slope of 1.5 vertical to 1 horizontal.

(3) B.O.D. Removals and Surface Settling Rates: See Section (1) under Mechanically Cleaned Sedimentation Basins.

D. Imhoff Tanks

(1) General: Imhoff tanks are not considered suitable for the treatment of milk wastes or other acid producing industrial wastes, nor for the treatment of domestic sewage which contains a high percentage of such wastes. Because of the possibility of odor nuisance, they must be suitably isolated.

(2) Detention Period: Based on the design flow, the detention period should be 2.5 hours.

(3) Surface Settling Rate: The maximum surface settling rate shall be 600 gallons per square foot per 24 hours at average dry weather flow with consideration being given to excessive daytime flows or rates.

(4) Freeboard: Tanks should be provided with at least 18 inches of freeboard. The water level should not be more than 24 inches below the walkways or operating level.

(5) Bottom Slopes: The bottom slope of the flowing through chambers shall be 1.4 vertical to 1 horizontal.

(6) Slot Opening: The slot opening shall be six inches minimum measured on the slope of the hopper wall.

(7) Slot Overlap: The slot overlap shall be six inches minimum measured on a horizontal plane.

6. COMBINED UNITS

A. Septic Tanks: Septic tanks are not approved except for residential and other very small installations.

B. Other Types: The use of combined sedimentation-digestion units other than those covered herein will be given consideration only where full-scale units have been in operation for a sufficient period of time to provide data concerning the efficiency and operating costs and to assure that mechanical and maintenance problems have been worked out. Experimental units will be approved only when the city has been fully advised of the experimental nature of the unit and is agreeable to its installation (See Part IV, 1, D, page 14).

SLUDGE DIGESTION AND DISPOSAL

7. IMHOFF TANK SLUDGE COMPARTMENTS

A. Capacity: Capacity should be provided in accordance with the table given on page 26. The volume of the sludge compartment should be calculated as the space 18" below a horizontal plane at the point of maximum effective overlap of the slot in the bottom of the settling chamber and planes having a slope of 30° from the horizontal upward from the end of the sludge withdrawal pipe to the point of intersection with the vertical walls.

B. Sludge Hoppers: Imhoff tanks with more than one sludge hopper should be equipped for reversal of flow or provision for equalizing sludge levels in sludge compartments by pumping. Each sludge hopper shall have an individually valved sludge withdrawal line.

C. Gas Vents: The total gas vent area should be at least 20 per cent of the area of the sludge compartment. One gas vent shall be at least 24 inches wide. Gas collection covers or submerged roofs over gas vents are not recommended.

D. Sludge Withdrawal: For gravity withdrawal, sludge lines should not be less than 8 inches in diameter. If sludge is to be pumped, 6-inch pipe may be used except for the rodding line which should be 8 inches. A net static head of 6 feet should be provided for gravity withdrawal and 2 feet for pumping. Piping should be arranged to facilitate cleaning and should be sloped so that it will drain. Entrances to sludge withdrawal piping should be designed to prevent clogging. Valves should be located outside the tank for accessibility.

8. SEPARATE SLUDGE DIGESTION TANKS

A. General

(1) Multiple Units: Multiple digestion tanks are recommended. Where this is not practical, it is desirable to have a lagoon or open tank for emergency use so that the digester can be taken out of service without unduly interrupting plant operation.

(2) Depth: The proportion of depth to diameter should be such as to allow for the formation of a reasonable depth of supernatant liquor.

(3) Maintenance Provisions: To facilitate emptying, cleaning, and maintenance the following features are desirable:

a. Slope: The digester bottom should slope at least three inches per foot toward the withdrawal piping unless the tank is provided with sludge collection mechanism.

b. Access Manholes: At least two access manholes should be provided in the top of the digester in addition to the gas dome. One opening should preferably be large enough to permit the use of mechanical equipment to remove grit and sand.

c. Safety: Non-sparking tools, rubber soled shoes, safety harness, gas detectors for inflammable and toxic gases, and gas masks of the hose or oxygen helmet type should be provided.

(4) Sludge Inlets: Provision should be made for the recirculation of sludge. One inlet should discharge above the liquid level and be located at approximately the center of the tank unless mechanical scum breakers are employed. The raw sludge inlet line should discharge at a point at least the radius of the digester from the supernatant drawoffs.

B. Capacity

(1) Solids Basis: Where the composition of the sewage has been established, digestion tank capacity may be computed from the volume and character of sludge to be digested. Due allowance should be made for sludge storage and supernatant.

(2) Population Basis: Where these data are not available, the following unit capacities should be used for plants treating domestic sewage. The capacities should be increased by allowing for the suspended solids population equivalent of any industrial wastes in the sewage, and may be reduced if the sludge is dewatered mechanically. Volumes should be calculated on the basis of the bottom having planes sloping thirty degrees from the horizontal upward from the end of the withdrawal pipe unless sludge moving equipment is installed.

Type of Plant	Cubic Feet per Capita	
	Heated	Unheated
Imhoff tanks		3 to 4
Primary	2 to 3	4 to 6
Primary ∕ standard filter	3 to 4	6 to 8
Primary ∕ high-rate filter	4 to 5	8 to 10
Activated sludge	4 to 6	8 to 12

For small installations (population 5,000 or less) consideration should be given to using the larger values. Additional capacity shall be provided where garbage solids are anticipated.

C. Gas Collection, Piping and Appurtenances

(1) General: All portions of the gas system including the space above the digester liquor, storage facilities and piping should be so designed that under all normal operating conditions, including sludge withdrawal, the gas will be maintained under pressure. All points where any gas leakage might conceivably occur should be adequately ventilated and separated from areas where extraneous sparks, fires, or lights might occur. The use of a common wall between a digester and a general control building is not recommended.

(2) Safety Equipment: All necessary safety facilities should be incorporated where gas is produced. Pressure and vacuum relief valves and flame traps are essential. Water seal equipment should not be installed.

(3) Gas Piping and Condensate: Gas piping should be at least 2½ inches in diameter and should slope to condensation traps at low points. The use of float controlled condensate traps is not permitted.

(4) Gas Utilization Equipment: Gas burning boilers, engines, etc., should be located at ground level and in well ventilated rooms. Gas lines to these units shall be provided with suitable flame traps.

(5) Electrical Fixtures: Electrical fixtures in enclosed places where gas may accumulate shall comply with the National Board of Fire Underwriter's specifications for hazardous conditions.

(6) Waste Gas: Waste gas burners should be located at least 25 feet away from any plant structure if placed at ground level, or may be located on the roof of the control building if sufficiently removed from the digesters. In remote locations it may be permissible to discharge the gas to the atmosphere through a return-bend screened vent terminating at least ten feet above the walking surface provided the assembly incorporates a flame trap.

(7) Ventilation: Any underground enclosures connecting with digesters or containing sludge or gas piping or equipment shall be provided with forced ventilation which should be in operation, preferably automatically, during occupancy.

(8) Meter: A gas meter with by-pass should be provided.

D. Digester Heating

(1) Insulation: Wherever possible digestion tanks should be constructed above the ground-water level and should be suitably insulated with dirt embankments or by other means.

(2) Heating Facilities: Hot water coils for heating digesters should be at least two inches in diameter and the coils as well as the support brackets should be of cast or wrought iron. The use of dissimilar materials should be avoided to minimize galvanic action. The high point in the coils should be vented to avoid air lock. Consideration should be given to heating installations embodying heat exchangers or some form of heating device which can be readily removed from the tank for maintenance. Other methods of heating digesters which may be developed will be considered on their individual merits.

(3) Heating Capacity: Sufficient heating capacity should be provided to maintain the sludge at 85° to 95° or more at all times.

(4) Mixing Valves: A suitable automatic mixing valve should be provided to temper the boiler water with return coil water so that the inlet water to the coils can be held to a temperature of 140° F. or less. Manual control should also be provided by suitable by-pass valves.

(5) Boiler Controls: The boiler should be provided with suitable automatic controls to maintain the boiler temperature at 180° F. or more to minimize corrosion and to shut off the main gas supply in the event of pilot burner or electrical failure.

(6) Thermometers: Thermometers should be provided to show temperatures of the sludge, hot water feet and hot water return.

E. Supernatant Withdrawal

(1) Piping Size: Supernatant piping should not be less than six inches in diameter.

(2) Withdrawal Arrangements

a. Withdrawal Levels: Piping should be arranged so that withdrawal can be made from three or more levels in the tank. A positive unvalved overflow shall be provided.

b. Withdrawal Selection: On fixed cover digesters the supernatant withdrawal level should preferably be selected by means of interchangeable extensions at the discharge end of the piping.

c. Supernatant Selector: If a supernatant selector is provided, provision shall be made for at least one other draw-off level located in the supernatant zone of the tank, in addition to the unvalved emergency supernatant draw-off pipe.

(3) Sampling: Provision should be made for sampling at each supernatant draw-off level. Sampling pipes should be at least 1 1/2" in diameter.

(4) Emergency Supernatant Disposal: An emergency disposal method for the supernatant liquor in the form of a lagoon or an additional sand bed should be provided for use in case supernatant is not suitable or other conditions make it advisable not to return it to the plant. In large plants consideration should be given to supernatant conditioning.

9. SLUDGE PUMPS AND PIPING

A. Sludge Pumps

(1) Capacity: Pump capacities should be adequate but not excessive. Provision for varying pump capacity is desirable.

(2) Duplicate Units: Duplicate units shall be provided where failure of one unit would seriously hamper plant operation.

(3) Type: Screw feed or plunger pumps should be provided for handling raw sludge.

(4) Minimum Head: A minimum positive head of 24 inches shall be provided at the suction side of centrifugal type pumps and is desirable for all types of sludge pumps. Maximum suction lifts should not exceed 10'.

(5) Sampling Facilities: Unless sludge sampling facilities are otherwise provided, quick closing sampling valves shall be installed at the sludge pumps. The size of valve and piping should be at least 1 1/2".

B. Sludge Piping

(1) Size and Head: Sludge withdrawal piping should have a minimum diameter of eight inches for gravity withdrawal and six inches for suction. Sludge pump discharge piping should be at least 4" in diameter. Where withdrawal is by gravity, the available head on the discharge pipe should be at least four feet and preferably more.

(2) Slope: Gravity piping should be laid on uniform garde and alignment. Slope on gravity discharge piping should not be less than 3 per cent. Provision should be made for draining and flushing discharge lines.

10. SLUDGE DRYING BEDS

A. Area: The sludge drying bed area needed for dewatering digested sludge is dependent upon weather conditions. In the northern part of the United States, where the summers are short, more drying bed area is required than in more temperate areas. The following per capita areas have been found satisfactory for Wyoming.

Type of Treatment	Area in Square Feet/Capita Open Beds	Covered Beds
Primary	1.00	0.75
Intermittent Sand Filter	1.00	0.75
Standard-rate Filter	1.25	1.00
High-rate Filter	1.50	1.25
Activated Sludge	1.75	1.35
Chemical Precipitation	2.00	1.50

B. Media

(1) Gravel: The lower course of gravel around the underdrains should be properly graded and should be 12" in depth, extending at least 6" above the top of the underdrains. It is desirable to place this in two or more layers. The top layer of at least 3" should consist of gravel 1/8" to 1/4" in size.

(2) Sand: The top course should consist of at least 9 inches of clean coarse sand. The finished sand surface should be level.

C. Underdrains: Underdrains should be bell and spigot vitrified clay pipe at least 4" in diameter laid with open joints. Underdrains should be spaced not more than 20 feet apart.

D. Walls: Walls should be water-tight and extend 15 to 18 inches above and at least 6" below the sand surface. Outer walls should be curbed to prevent soil from washing on the beds. On glass covered beds, walls and walkways should be designed to minimize shading on beds.

E. Sludge Removal: Not less than two beds should be provided and they should be arranged to facilitate sludge removal. Concrete truck tracks should be provided for all sludge beds. Pairs of tracks should be on 20' centers.

F. Sludge Influent: The sludge pipe to the beds should terminate at least 12 inches above the sand surface, and be so arranged that it will drain. Concrete splash plates should be provided at sludge discharge points.

G. Drainage Disposal: Drainage from beds should be returned to the raw or settled sewage, if possible. Where chlorination is required, the filtrate shall be returned to a point preceding the chlorination process.

11. OTHER SLUDGE DEWATERING FACILITIES

A. Shallow Sludge Lagoons: The use of shallow sludge drying lagoons in lieu of drying beds is permissible subject to the following conditions:

(1) Soil and Ground Water Conditions: The soil must be reasonably porous and the bottom of the lagoons must be at least 18 inches above the maximum ground water table.

(2) Depth: Lagoons should not be more than 24 inches in depth.

(3) Area: The area provided should be at least twice that required for sand sludge drying beds for comparable conditions.

B. Other Dewatering Facilities: If it is proposed to dewater or dispose of sludge by other methods, a detailed description of the process and design data should accompany the plans. Suitable guarantees should be obtained covering the performance of the process.

SECONDARY TREATMENT FACILITIES

12. TRICKLING FILTERS

A. General

(1) Applicability: Trickling filters may be used for treatment of sewage and industrial wastes of a type amenable to purification by biological processes. Normally, trickling filters shall be preceded be effective sedimentation tanks equipped with scum collecting devices.

(2) Classification: Trickling filters will be classified as "standard rate" or "high rate" units, on the basis of volume of flow per unit of surface area and biochemical oxygen demand loading per unit of media volume. Generally "standard rate" filters shall be dosed at less than four million gallons per acre per day with an applied biochemical oxygen demand of less than 15 pounds per 1000 cubic feet per day. "High rate" filters shall be dosed at 10 to 30 million gallons per acre per day with biochemical oxygen demand loading generally in excess of 30 pounds per 1000 cubic feet per day.

(3) Effluent Comparison: In comparing effluents from high-rate filters with effluents from standard filters for the purpose of establishing stream requirements, all available oxygen including nitrite-nitrate oxygen shall be considered. In practice this comparison may be accomplished by reducing the observed 5-day B.O.D. of the effluent by the oxygen equivalent of the nitrite and nitrate contained in the effluents and comparing the results.

(4) Design Basis: The filters shall be designed so as to provide the reduction in biochemical oxygen demand required to maintain satisfactory conditions in the water course into which the effluent will be discharged, or to properly condition the sewage for subsequent treatment processes.

(5) Dosing Equipment

a. Distribution: The sewage may be distributed over the filter by rotary distributors, or other suitable devices.

b. Dosing: The distribution devices may be actuated by siphons or pumps, or by gravity discharge from preceding treatment plant units when suitable flow characteristics have been developed.

c. Hydraulics: All hydraulic factors involving proper distribution of sewage on the filters should be carefully calculated. For reaction type distributors, a minimum head of 12 inches between low water level in siphon chamber and center of arms is desirable.

d. Uniformity of Distribution: The sewage should be distributed as uniformly as possible, and so that at least 95% of the surface area receives sewage directly. At dry weather design flow or at a rate as near the dry weather design flow as is possible to obtain at the time of testing, the deviation from a calculated uniformly distributed volume per unit area of the area receiving sewage directly shall not exceed plus or minus 5 per cent on the outer 90 per cent of the filter area and plus or minus 10 per cent on the inner 10 per cent of the filter area.

e. Clearance: A minimum clearance between media and distributor arms of six inches shall be provided. Greater clearance is essential where icing occurs.

(6) Media

a. Quality: The media may be crushed rock, slag, or specially manufactured material. The media shall be resistant to spalling or flaking and be relatively insoluble in sewage. The top 18 inches shall have a loss by the 20-cycle, sodium sulfate test of not more than 10%, the balance to pass a 10-cycle test using the same criteria. Slag media shall be free from iron.

b. Size: Rock or slag media shall be of a size that will pass a 4" screen and be retained on a 2" screen. It shall be free from dust, clay, sand, or fine material. The media should be approximately cubical in shape and free from flat or elongated pieces.

c. Placing Media: The media shall be screened or forked at the sewage treatment plant site to remove all fines. The media shall be placed in the filter by hand-operated equipment or by belt conveyor, and so as to minimize abrasion.

(7) Underdrainage System

a. Arrangement: The underdrainage system shall cover the entire floor of the filter. Inlet openings into the underdrains shall have an unsubmerged gross combined area equal to at least 5% of the surface area of the filter.

b. Slope: The underdrains shall have a minimum slope of 1%. Effluent channels shall be designed to produce a minimum velocity of 2' per second at average daily rate of application to the filter

c. Flushing: Provision should be made for flushing the underdrains. In small filters, use of a peripheral head channel with vertical vents is acceptable for flushing purposes. An inspection gallery is advisable.

d. Ventilation: The underdrainage system, effluent channels, and effluent pipes should be designed to permit free passage of air. the size of drains, channels, and pipes should be such that not more than 50% of their cross sectional area will be submerged under operation of the filter at a rate of 30 million gallons per acre per day.

B. Standard Rate Filters

(1) Efficiency

a. Allowable reductions in biochemical oxygen demand through a standard rate filter and subsequent settling tank shall be determined from Figure 3.

b. For installations where critical stream conditions may occur in the winter period, the filter load shall be reduced sufficiently to assure the required effluent. Covered filters may be required at such locations.

(2) Depth: The filter media shall have a minimum depth of 5' above the underdrains and should not exceed 7' in depth.

(3) Dosing Interval: The rest interval between the application of sewage to the filter at design rate should generally not exceed 5 minutes.

(4) Recirculation: Consideration should be given to a piping arrangement which will permit recirculation.

(5) Special Features

a. Flooding: Consideration should be given to the design of filter structures so that they may be flooded.

b. Maintenance: All distribution devices, underdrains, channels, and pipes should be installed so that they may be properly maintained, flushed, or drained.

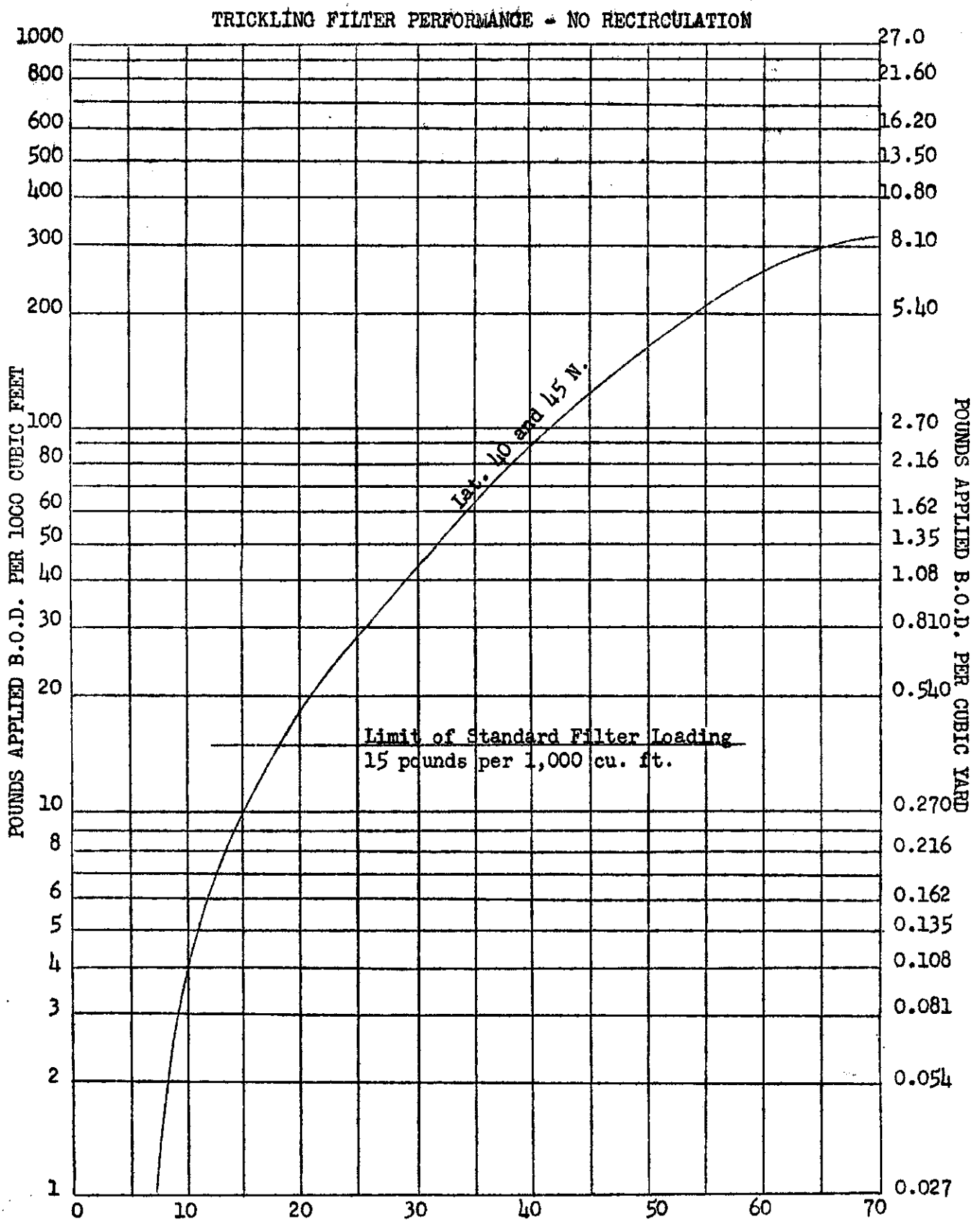
C. High Rate Filters

(1) General

Following completion of construction of a filter, tests of distribution of flows onto the filter should be made by a series of adjacent pans consisting of watertight compartments 6 inches by 12 inches in plan. These pans should be placed along an entire radius of the filter, with the 12-inch length perpendicular to that radius. The flow discharged against the 12-inch section of the filter wall should be drained into the end pan. With armed distributors, the duration of the test shall be any whole number of revolutions. Where disc distributors are used, tests should be made along two radii approximately 90° apart. Where feasible, the tops of the pans should be flush with the surface of the filter media. Results of test should be reported to the State Department of Public Health.

a. Recirculation: A controlled recirculation system should be provided to maintain continuous dosing at a rate always equal to or in excess of ten million gallons per acre per 24 hours.

Figure 3



lbs/c.y. x 1613.3 = lbs/acre ft.

b. Distribution: The distribution system should provide continuous discharge onto the filter. The rest period during which any unit area received no sewage should not be in excess of 15 seconds.

c. Flow Measurement: Devices should be provided to permit measurement of flow to filter, or recirculated effluent, whenever recirculation is used.

(2) Types A and B: The use of high rate filters Types A and B will be considered where a settled effluent with a 5-day B.O.D. of 30 parts per million or more is acceptable, and where the applied load, recirculation included, does not exceed 110 pounds of 5-day B.O.D. per 1000 cubic feet of filter media per 24 hours.

a. Type A: Sewage filters used with conventional primary settling tanks. The recirculation system shall supply sufficient dilution to the settled sewage so that the B.O.D. of the influent to the filter, recirculation included shall not exceed three times the B.O.D. of the required settled effluent.

b. Type B: Sewage filters used after fine screens. The B.O.D. of the filter influent, recirculation included, shall not exceed three and one-third times the B.O.D. of the required settled effluent.

(3) Type C: Sewage filters (roughing filters) designed for pretreatment of unusually strong sewage. Filter loadings in excess of 110 pounds 5-day B.O.D. per 1000 cubic feet of filter media may be used. The reduction in B.O.D. by filtration and subsequent settling may be assumed to be up to 64%, provided no reduction in excess of of 110 pounds of 5-day B.O.D. per 1000 cubic feet of media per 24 hours is assumed. The maximum allowable B.O.D. removal for filters of this type not followed immediately by sedimentation shall be 50%.

(4) Type D: Two-stage filters. The use of second stage filters will be considered as a means of reducing the 5-day B.O.D. of settled effluent below 30 parts per million on the following basis:

a. The B.O.D. load applied to the second stage filter, recirculation included, shall not exceed two times the B.O.D. expected in the settled effluent.

b. When the effluent of the first stage filter is applied directly to the second stage filter without intermediate settling, the assumed B.O.D. removal by the first stage filter shall not exceed 50%.

13. ACTIVATED SLUDGE

A. General

(1) Applicability: The activated sludge process may be used where the sewage entering the aeration tanks is amenable to biological

treatment. This process is recommended for use only where competent operating supervision will be made available; in general, requiring a minimum of eight hour attendance. For design flows less than 0.5 m.g.d. the activated sludge process will be considered only where, in the opinion of the State Department of Public Health, local conditions are favorable for its use.

(2) Unusual Installations: Design data outlined herein are presumed to achieve a removal of 90% or more of B.O.D. and suspended solids susceptible to treatment from sewage of normal characteristics and do not apply where only partial removals are intended. Plans for plants contemplating abnormal concentrations of sewage, unusual aeration period or special equipment or arrangements will be reviewed on their merits and may be conditionally approved for construction upon presentation of appropriate supporting data demonstrating the efficacy of the design for the specific project.

(3) Reaeration: Consideration should be given to reaeration of the return sludge if conditions are anticipated which would justify the additional cost.

B. Settling Tanks: In addition to requirements of Section 5, the following items should be considered in preparing plans for activated sludge plants:

(1) By-Pass: Where only one primary settling tank is provided, a by-pass to the aerators should be installed.

(2) Final Tanks: Multiple units capable of independent operation shall be provided in all plants where the total tank volume requirement for final settling exceeds 2500 cubic feet.

C. Aeration Tanks

(1) Number of Units: Total aeration tank volume required shall be divided among two or more units, capable of independent operation, where the total volumetric capacity required exceeds 5000 cubic feet.

(2) Capacity: The capacity of the aeration tanks shall be the larger volume established by the following criteria:

a. For design flows (exclusive of return sludge) from 0.2 to 0.8 m.g.d. the tank volume shall provide a detention time of 7.5 hours; in excess of 1.0 m.g.d. the tank volume shall provide a detention time of 6 hours; and between 0.8 and 1.0 m.g.d. the tank volume shall provide a detention time varying from 7.5 hours at 0.8 m.g.d. to 6.0 hours at 1.0 m.g.d., the detention time decreasing in proportion to the increase in design flow within these limits.

b. Tank volume of 30 cubic feet per pound of 5-day B.O.D. in the aerator influent (exclusive of return sludge).

In the absence of supporting data required by paragraph 13. G., tank volumes for mechanical aeration shall be 50% greater than

those determined for diffused air aeration in a and b given above. Where volumetric rates or concentrations of aerator influent is anticipated to be in substantial variation from 100 g/c/d and 125-150 p.p.m. 5-day B.O.D., appropriate adjustment in aerator volumes, satisfactory to the State Department of Public Health, shall be made. Designs predicated upon reaeration of return sludge or upon controlled ratios of mixed liquor concentrations to the plant loadings may be accepted, where adequate supporting data, satisfactory to the State Department of Public Health substantiating the adequacy of the design is furnished.

(3) Dimensions: Dimensions and proportions of each independent unit shall be such as to:

a. Maintain effective mixture and utilization of air,

b. Prevent unaerated sections, noticeable channeling,

c. Maintain velocities sufficient to prevent deposition of solids. Ordinarily liquor depths will be not less than ten nor more than fifteen feet.

(4) Inlets and Outlets

a. Controls: Inlets and outlets for each aeration tank unit will be suitably equipped with valves, gates, stop-planks, weirs or other devices to permit controlling the flow to any unit and to maintain a reasonably constant water level. The hydraulic properties of the system shall be such as to permit the maximum instantaneous hydraulic load to be carried with any single unit out of service.

b. Ports: The velocity through ports shall be as low as practicable to meet the objectives of the design. Between bays of tanks and for like purposes, it shall not exceed 0.5 feet per second.

c. Channels: Channels, and pipes carrying liquids with solids in suspension, shall be so designed as to maintain self-cleansing velocities or be equipped with mechanical means of continuously and automatically keeping such solids in suspension in the liquid at all rates of flow within design limits.

D. Measuring Devices: Devices for indicating rates of flow of primary effluent, return sludge, and air to each tank unit shall be installed. Preferably these devices shall also totalize and record as well as indicate flows. Where the design provides for all return sludge to be mixed with the primary effluent at one location, then the mixed liquor to each unit may be measured.

E. Air Supply

(1) Application: The design shall provide for the introduction of air in sufficient volume and in such manner as to:

a. Maintain at least two p.p.m. of dissolved oxygen under all conditions of loading, in all parts of the aeration tanks except immediately beyond the inlets.

b. Maintain sufficient velocity of movement or turbulence as to bring sludge particles into intimate contact with all portions of sewage.

c. Prevent deposition of solids in any part of the aeration unit.

(2) Air Diffusion and Piping Capacity: The air diffusion system shall be so designed as to be capable of delivering 150% of normal requirements. Normal requirements are assumed to be 1000 cubic feet per pound of B.O.D. per day to be removed from the primary effluent; in any event, the requirements of Section E (1) shall be met.

(3) Blowers or Compressors: Nominal blower or compressor capacity shall be provided to deliver air equal to the volume required by paragraph E (2) above. To this volume shall be added whatever may be required to supply channels, sludge pumps, or other air-use demand. Blowers shall be provided in multiple units, so arranged and in such capacities as will meet the maximum air demand with the single largest unit out of service. The design should provide for variation in the volume of air to be delivered, in at least three steps, and, as near as practicable, following the load demand of the plant.

Where special designs are employed (see Section A (2) and Section C (2)) blower capacities and arrangements shall be adjusted accordingly but in such manner as to meet the intents and purposes of this section as to adequacy and reliability of performance.

(4) Air Cleaners: Air filters shall be provided in numbers, arrangements and capacities, so as to dependably furnish at all times an air supply having dust content of not more than 0.5 mg per 1000 cubic feet in all air delivered to porous diffusers.

F. Air Diffusers

(1) Removal of Diffusers: Aeration plates, tubes or jets used for introduction of air to mixed liquor shall preferably be so designed as to permit removal for inspection, maintenance and replacement without necessity of dewatering the tank; in installations having one aeration unit, such provision shall be mandatory if the temporary discharge of primary effluent may be reasonably expected to have serious consequences; in large installations having a considerable number of aeration tanks, the provision is correspondingly of lesser importance.

(2) Air Control Valves: Individual assembly units of diffusers shall be equipped with control valves preferably with indicator markings, for throttling or complete shut-off. Diffusers in any single assembly shall have a substantially uniform pressure loss.

G. Mechanical Aerators

(1) Other Aeration Facilities: Where designs provide mechanical apparatus other than or supplementary to compressed air as a means of flocculating, oxidizing and aerating the mixed liquor, the same objectives as heretofore specified in subsections E (1) and E (2) under "air supply" shall be provided for. Such devices shall maintain these objectives when operating under all load conditions.

(2) Duplicate Units: Where mechanical units of the circulating pump type are employed, a spare mechanism should be furnished where the number of units is more than one and less than five. Where the temporary discharge of primary effluent may be reasonably expected to have serious consequences, a spare mechanism shall be furnished for single unit installations.

H. Drains: Aeration tank drains shall be provided for all units. Such drainage shall be discharged to primary tank inlets, other aeration units or to final settling tanks. Where pumping is necessary to meet this requirement, regular plant equipment may be utilized where possible.

I. Sludge Handling Equipment

(1) Pump Capacities: For installations proposing to treat sewage of normal characteristics, return activated sludge pumps shall be provided with variable combined capacity ranging from 10% to 50% of the design flow. In addition, a standby unit equal in capacity to the largest single pump shall be provided. For other wastes of unusual sewage concentrations, appropriate adjustment of this value will be required.

(2) Installation Detail: A positive head should be provided on the pump suctions. Pumps should have at least a three inch and preferably a four inch suction and discharge. Piping should be at least 4 inches in diameter. Larger piping should be of such size as to maintain a cleansing velocity.

(3) Waste Sludge Facilities: Waste sludge control equipment and piping should have a maximum capacity of not less than 25% of the average rate of sewage flow (This is in addition to requirements in I (1).) and fuction satisfactorily at rates of 0.5% of average sewage flow or a minimum of 10 g.p.m., whichever may be the larger. Devices for indicating rate of waste sludge discharge shall be provided. Indicating, recording and totalizing devices are desirable and should be included in 5 m.g.d. or larger plants.

(4) Return Sludge Facilities: Suitable devices for readily observing, sampling, controlling, and apportioning activated sludge shall be provided.

(5) Disposal of Waste Sludge: Waste activated sludge may be returned either to the primary tanks, concentration tanks, digestion tanks, or vacuum filters, or any practicable combination of such units.

14. INTERMITTENT SAND FILTRATION

A. General: Secondary treatment by sand filters is generally considered feasible only for institutional or relatively small municipal treatment works. The use of subsurface or covered sand filters is not recommended.

B. Loading on Open Sand Filters

(1) Normal Settled Sewage: With acceptable primary treatment of normal sewage, loading should not exceed 165 pounds of 5-day B.O.D. or 125,000 gallons per acre per day, whichever is lower.

(2) Strong Settled Sewage: For strong settled sewage, loading should not exceed 50,000 gallons per acre per day.

(3) Trickling Filter Effluent: For trickling filter and secondary settling tank effluent, the loading should not exceed 500,000 gallons per acre per day.

(4) Part-Time Installations: For schools, camps and institutions not having a full-time operating staff, loading should not exceed 100,000 gallons per acre per day for primary tank effluent.

C. Media

(1) Gravel Base: Clean graded gravel, preferably placed in at least three layers, should be placed around the underdrains and to a depth of at least 6 inches over the top of the underdrains. Suggested gradings for the three layers are 1 1/2" to 3/4", 3/4" to 1/4", and 1/4" to 1/8".

(2) Depth: At least 24 inches of sand with an effective size of 0.3 to 0.6 mm and a uniformity coefficient of not more than 3.5 shall be provided.

D. Dosing

(1) Duplicate Units: Two or more units are necessary

(2) Volume: The dosing tank volume shall be such that any filter bed will be covered to a depth of 2 to 4 inches by each dose.

(3) Siphons: Siphons shall have a discharge capacity, at minimum head, at least 100% in excess of the maximum rate of inflow to the dosing tank, and at average head, at least 1 cubic foot per second per 5000 square feet of each filter bed.

(4) Siphon Discharge Lines: The siphon discharge lines to the beds shall have sufficient capacity to permit the full rated discharge of the siphons through the drawing head range.

E. Distribution

(1) Arrangement: Troughs or piping used for distribution of the settled sewage over the filter surface should be so located that the maximum

lateral travel is not more than 20 feet. Provision should be made at each discharge port for adjustment of the flow.

(2) Splash Slabs: Splash slabs are needed at each point of discharge.

(3) Drain: A drain opening from troughs or discharge piping is essential.

F. Underdrains: Open-joint or perforated vitrified clay or concrete pipe underdrains may be used. They should be sloped to the outlet and spaced not to exceed 10 feet centers.

G. Earth Base: The earth base of the filters should be sloped to the trenches in which the underdrains are laid.

15. OTHER SECONDARY TREATMENT PROCESSES

The use of secondary sewage treatment processes other than those listed above will be considered by the State Department of Public Health on the merit of the process involved. (See Part IV, 1, D, page 14)

16. DISINFECTION, ODOR CONTROL, ETC.

A. General: Where a public health hazard may otherwise be created, provision for the disinfection of sewage plant effluents will be required. The use of chlorine or other chemicals may be required for other purposes.

The following items should be given consideration where the installation of chlorination equipment is proposed:

(1) Equipment: The use of equipment designed to feed chlorine gas in solution is recommended.

(2) Housing: The chlorinator building or room should have ample forced air ventilation. When necessary, heating facilities should be installed. If gas chlorination equipment is to be placed in a building used for other purposes, a tight partition should separate the room housing the equipment from any other portion of the building and the doors should open only to the outside of the building.

(3) Capacity of Chlorinator: Chlorinator capacities required will vary, depending on the use and point of application of the chlorine. For disinfection, the capacity should be adequate to produce a residual of 2.0 p.p.m. in the final effluent. For normal domestic sewage the following dosing capacity will usually be sufficient.

Type Treatment	Dosage (based on Design Average Flow)
Raw sewage	25 p.p.m.
Primary sedimentation effluent	20 p.p.m.
Trickling filter plant effluent	15 p.p.m.
Activated sludge plant effluent	8 p.p.m.
Sand filter effluent	6 p.p.m.

For odor control, provision should be made for the application of at least 20 p.p.m.

(4) Contact Period: After thorough mixing, a minimum contact period of 15 minutes at peak hourly flow or maximum rate of pumpage shall be provided for disinfection. In primary plants chlorine should preferably be applied ahead of the sedimentation tank.