Design Standards

For

Wastewater Treatment Works

1988

Intermediate Sized Sewerage Facilities

New York State/Department of Environmental Conservation
FOREWORD

Guidance for sewage treatment and disposal facilities in New York State falls into three categories: individual household, municipal, and intermediate-sized facilities. Intermediate-sized facilities include treatment works for institutional and commercial establishments, as well as cluster housing or other multi-home developments.

This publication has been prepared to assist design engineers, owners, managers, and any others who may require information and guidance for intermediate-sized sewerage facilities. Former editions of this document were subtitled Institutional and Commercial Sewerage Facilities.


Criteria for individual household systems have been adopted by the New York State Department of Health and are published under the title Waste Treatment Handbook - Individual Household Systems. Additional information is contained in Recommended Standards for Individual Sewage Systems (1980 Edition), developed by the Great Lakes - Upper Mississippi River Board of State Sanitary Engineers.

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Revised 1988
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A. INTRODUCTION

With the increased development of rural and suburban areas, the need for wastewater treatment systems to serve multi-home units and commercial/institutional establishments has grown. In many cases the expense of disposal through a centralized municipal system may be prohibitive. Onsite or cluster systems are now gaining recognition as a viable wastewater management alternative that can provide reliable service at a reasonable cost, while still preserving environmental quality.

This manual provides standards for a variety of treatment and disposal systems that may be used for institutional, commercial, and multi-home purposes. A septic tank followed by subsurface soil absorption is often the preferred method of treatment because it is reliable and requires a minimum of attention. Additional or alternative treatment options are also discussed herein, as characteristics of the site and/or wastewater may be such that a more complex system is necessary to meet public health and environmental criteria.

Where there is a potential for any facilities to be used in the future, as part of a sewage-works corporation system or municipal system, the standards for municipal sewerage facilities should be consulted. The GLUMRB Recommended Standards for Sewage Works (commonly known as Ten-State Standards) have been adopted by DEC as New York's official standards for municipal sewage treatment and collection facilities except where superseded by the Technical Information Pamphlets issued jointly by the Divisions of Construction Management and Water.

Pursuant to Article 17, Title 7 of the Environmental Conservation Law the following sewerage systems must be covered by a discharge permit issued through the State Pollutant Discharge Elimination System (SPDES):

1. All systems discharging to surface waters;

2. All systems for sewage effluent from residential buildings (without the admixture of industrial or other wastes) either housing three or more families, or more than ten people computed on the basis of twenty-four hour per day occupancy and having a discharge with flow greater than 1000 gallons per day (gpd).

For these facilities DEC is responsible for plan approvals, regulatory actions, and SPDES permit issuance. In certain cases for facilities with sewage flows up to 10,000 gpd without the admixture of industrial or other wastes, the NYS Department of Health is responsible for plan approval and regulatory actions except SPDES permit issuance.

Generally, the first step in the planning process is the submission of engineering, or wastewater facilities, report. After the report has been reviewed and approved, construction drawings and specifications, conforming in principle and detail to the approved engineering report,
should be submitted for review. In accord with the Education Law, these documents must be prepared by a professional engineer licensed in and by the State of New York. For certain facilities of a minor nature, these documents may be prepared by a licensed land surveyor.

It may be necessary to obtain approval of plans and specifications prior to issuance of the SPDES permit. Permission for construction of the facilities will be governed by the conditions of the permit.

Other permits may be required in accord with the following portions of the law. In each case information and procedures, including the implications of the State Environmental Quality Review Act, can be secured from the Department of Environmental Conservation headquarters office in Albany or any DEC regional office:

1. Article 15 - Stream Crossings

   Article 15 of the Environmental Conservation Law requires the Department to protect insofar as possible the beds and banks of all watercourses in the state, and prohibits, unless a permit for such has been duly applied for and issued, the disturbance of the bank or bed of any stream, lake, pond, etc. Crossing of streams with utility lines is included in this control.

2. Article 19 - Air Resources Permits

   Permits to construct sources of air contaminant emissions are required for stationary combustion installations, incinerators, and process exhaust or ventilation systems. Combustion installations with a maximum operating heat input of less than 1 million BTU per hour and stationary internal combustion engines under 400 horsepower are exempted.

3. Articles 24 and 25 - Wetlands

   Article 24 authorizes the Department to issue permits for construction activities in and adjacent to freshwater wetlands. Article 25 applies to tidal wetlands.

4. Article 27 - Solid Waste Transport and Management Permits

   Permits are required to transport and dispose of solid wastes, include septage and sewage sludge. The permits needed are a function of the facility size and the disposal method.

5. Article 36 - Development in Flood Hazard Areas

   Pursuant to this article, NYS has adopted regulations governing development of flood hazard areas (NYSCRR Title 6, Part 502). In addition, local governments should be consulted concerning Local Flood Plain Management Regulations before choosing a site or technique for waste treatment and disposal.
Where sewage treatment systems are to be located on the watersheds of public water supplies, the rules and regulations enacted by the New York State Department of Health for the protection of those water supplies must be observed. Where such works are to be located on the watershed of any stream or body of water from which the City of New York obtains its water supply, the approval of New York City's Department of Water Resources must be obtained.
B. PROJECT EVALUATION

SITE EVALUATION

Points to be considered when appraising a site for the location of a sewage treatment system include the location of nearby water sources and water lines, terrain or surface characteristics, subsurface conditions, nearness of habitation, odor control, possibility of flooding, room for expansion and the assimilative capacity of any potential receiving stream. Site characteristics may preclude the use of one type of system in favor of another.

Flood Protection

Flooding of a wastewater treatment plant or disposal site must be avoided. According to NYSCRR Title 6 Part 502 governing development of flood hazard areas:

502.4 (3) (ii)..."All public utilities and facilities, such as sewer, gas, electric and water system, are located and constructed to minimize or eliminate flood damage"...;

And 502.4 (6)..."New and replacement sanitary sewage systems and any other waste disposal systems shall be designed to minimize or eliminate infiltration of floodwaters into the systems, and discharges from the systems into flood waters, and new and replacement onsite waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding...

In addition, the following precautions are recommended for any installation located within a 100-year flood plain, to avoid or minimize flood damage to waste disposal facilities.

1. No part of a subsurface treatment and disposal system should be located lower than the 10-year flood elevation.

2. Backflow prevention devices should be installed ahead of septic tank/grease traps to prevent internal flooding of the building(s) being serviced.

3. Holding tanks should be installed for temporary usage during periods of flooding when a subsurface system or intermittent sand filter would be inoperative. Liquid holding capacity should be for a minimum of 7 days wastewater flow, and greater capacity may be necessary for slowly draining soils.

4. Filled areas such as subsurface systems or intermittent sand filters must be protected from high velocity flood waters (usually greater than 9 to 10ft/s), especially when located in a floodway or Coastal High Hazard Area. Erosion protection (rip-rap, vegetative cover, etc.) should be sufficient to prevent destruction of the system.
5. Materials and methods of construction should be selected to minimize infiltration. The use of slip-on or mechanical joint cast or ductile iron pipe, or PVC pressure pipe should be considered. These sewer lines should be pressure tested to assure water tightness.

6. All manholes and other access ports should be water tight or elevated to prevent flooding from ground or surface water flow up to the head or depth resulting from the 100-year flood.

7. All structures, including lift stations or pump houses, should be flood-proofed up to 100-year flood levels to prevent passage of surface or groundwater into the structure.

**Separation Distances**

Treatment plants should be located as far as possible from human habitation. Table 1 contains a list of minimum separation distances that must be maintained between treatment facilities and dwellings, public roads, or other areas of substantial use by the public unless special designs or considerations warrant a reduced distance.

<table>
<thead>
<tr>
<th>Table 1. Minimum Separation Distance from Treatment Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
</tr>
<tr>
<td>Aeration Tank</td>
</tr>
<tr>
<td>Aerated Lagoon</td>
</tr>
<tr>
<td>RBCs</td>
</tr>
<tr>
<td>Open Sand Filter</td>
</tr>
<tr>
<td>Buried or Covered Sand Filter</td>
</tr>
</tbody>
</table>

If there is doubt that the separation provided is sufficient to avoid odorous nuisance conditions, steps should be taken to minimize odors. Such steps include chemical addition, consideration of prevailing winds, and covering or enclosing the facilities. Enclosures may also be of value in preserving treatment efficiency in the northern or colder portions of New York.

Table 2 provides guidance for the minimum separation distances that should be met for subsurface disposal systems to protect water supply facilities, and to avoid sewage contamination and nuisance conditions. Factors such as system elevation, ground slope, direction of groundwater flow, well pumping rates, and existence of in-pervious barriers will affect the necessary separation distances. Increased separation distances may be required if warranted by local conditions. Decreased separation distances shall not be allowed unless sufficient proof is provided by the engineer to show that local conditions will prevent contamination at a closer distance.

An area equal in size to the proposed subsurface disposal facilities must be available for expansion or replacement purposes.
Table 2. Minimum Separation Distance (ft.) From:

<table>
<thead>
<tr>
<th></th>
<th>Septic Tank</th>
<th>Absorption Fields</th>
<th>Seepage Pits</th>
<th>Sewer Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled Well - Public</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>50 (a)</td>
</tr>
<tr>
<td>Drilled Well - Private</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>50 (a)</td>
</tr>
<tr>
<td>Dug Well</td>
<td>75</td>
<td>150</td>
<td>150</td>
<td>50 (a)</td>
</tr>
<tr>
<td>Water Line (Pressure)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10 (b)</td>
</tr>
<tr>
<td>Water Line (Suction)</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>50 (a)</td>
</tr>
<tr>
<td>Foundation</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td>Surface Water</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>25</td>
</tr>
<tr>
<td>Open Drainage</td>
<td>25</td>
<td>35 (c)</td>
<td>35 (c)</td>
<td>25</td>
</tr>
<tr>
<td>Culvert (Tight Pipe)</td>
<td>25</td>
<td>35</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>Culvert Opening</td>
<td>25</td>
<td>50</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Catch Basin</td>
<td>25</td>
<td>50</td>
<td>50</td>
<td>-</td>
</tr>
<tr>
<td>Interceptor Drain</td>
<td>25</td>
<td>35 (c)</td>
<td>35 (c)</td>
<td>25</td>
</tr>
<tr>
<td>Swimming Pool - In-Ground</td>
<td>20</td>
<td>35</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Reservoir</td>
<td>50 (d)</td>
<td>100 (d)</td>
<td>100 (d)</td>
<td>50 (a)</td>
</tr>
<tr>
<td>Property Line</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Top of Embankment or Steep Slope</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

a) 25 feet, if cast or ductile iron pipe when pipe is below frost zones, with tight joints and is not subject to settling.

b) Water (pressure) and sewer lines may be in the same trench if water line is placed on an undisturbed bench or shelf so that the bottom of the water main is at least 18 inches higher than the top of the sewer and the sewer is not subject to settling, vibration, superimposed loads, or frost action.

c) If bottom of drain is above finished grade at leaching facility; otherwise 50 feet.

d) For a public water supply reservoir, 100 feet to septic tank and 200 feet to absorption field or seepage pit.

SOIL EVALUATION FOR SUBSURFACE DISPOSAL

Soil profile observations must be made on all sites proposed for soil absorption systems. Large soil pits must be dug to allow accurate description of soil types and horizons, while soil borings may be used to determine soil variability over a large area. Soil pits should generally be as deep as the backhoe can excavate, and should only be dug at the perimeter of the expected soil absorption area.

An extensive soil evaluation must be performed for large subsurface absorption systems (greater than 5000 gpd) up to a depth of at least five feet below the bottom of the proposed absorption system. This type of extensive soil evaluation is also recommended for smaller systems,
especially those on critical sites. Critical sites include those with very slow percolation rates, steep slopes, and shallow depth to groundwater or impervious layers. The factors to be evaluated and reported are:

a) Thickness of layers or horizons.
   b) Texture (USDA), consistence, and structure of soil layers.
   c) General color and color mottling or variation (this should be done in natural light only).
   d) Depth to water, if observed and depth to estimated or observed seasonally high groundwater level.
   e) Depth to and type of bedrock, if observed.
   f) Other prominent features such as visible pores, stoniness, roots, or animal traces.

Variation in required depth or manner of observation may be allowed when a deep seepage pit is proposed to avoid unsafe conditions that might violate OSHA safety standards.

Soil evaluation should be based on finished elevations of the site. Any proposed cut or fill work that is to be done must be accounted for when determining the suitability of the site for soil absorption systems. This does not include fill work done only as part of building a fill-type or mound adsorption system. Depending on the type of fill and fill depth, as much as a full year may be necessary for natural settling before an accurate soil evaluation and percolation test can be performed. To reduce delays, the fill may be spread in thin layers and mechanically compacted. Care must be taken to avoid creating layers of different density, which may disrupt the operation of a subsurface absorption system.

The bottom of a conventional absorption field or seepage pit should be at least four feet above bedrock or impervious strata depending on soil permeability. The seasonally high groundwater level shall be at least two feet below an absorption field and at least three feet below the bottom of a seepage pit. The reviewing engineer may require greater depths in rapidly permeable soils to ensure that the necessary treatment is provided. If these distances cannot be met, the use of a fill or mound system should be considered before a surface discharge is allowed.

Groundwater mounding may occur under an absorption system in the presence of an impervious layer or over a zone of saturation. Operational problems and groundwater contamination may result if the mound approaches the base of the system, thus the potential for groundwater mounding should be investigated during the site evaluation. A mathematical analysis should be performed to predict the extent of groundwater mounding that would occur when the absorption system is in operation. In general, greater recharge from the absorption system, wider application widths, and slower horizontal saturated conductivities will result in the formation of higher groundwater mounds. An aerated zone of two feet for an absorption field and three feet for seepage pits is desirable between the base of the system and the top of the groundwater mound.
Hydraulic conductivity can be estimated using soil percolation tests. Percolation tests should be run in an area immediately adjacent to or in between the areas planned for absorption trenches if such details are known at the time. For mound system the percolation test must be run just within the estimated boundary of the basal area of the mound. Tests should be run during spring months, as system failure is more likely during wet months. At least two percolation tests for every 1000 sq. ft. of absorption area shall be performed in holes spaced uniformly throughout the site. If the soil conditions are highly variable, more tests may be required.

For a conventional trench or bed system, the percolation test should be performed at the depth of the proposed system. If a seepage pit is under consideration, percolation tests should be done at least at one-half depth and at full depth of the seepage pit. If different soil layers are encountered when digging the test hole for a seepage pit, a percolation test should be performed in each layer with the overall percolation rate being the weighted average of the test results based upon the depth of each layer. Layers with percolation rates slower than 30 min/inch must be excluded from these calculations. For mound systems percolation tests should be performed at a depth of 20 inches in slowly permeable soil, 12 inches in shallow soil over pervious bedrock, and 16 inches if the high water table is within 20 inches of the ground surface.

The procedure noted below should be followed when performing a percolation test:

1) Dig a hole with vertical sides having a diameter of approximately 12 inches, (see Figure 1). For deep holes, a larger excavation should be made for the upper portion of the hole with the actual test hole in the bottom.

2) Two inches of 1/2 to 3/4 inch gravel are placed in the hole to protect the bottom from scouring action when water is added.

3) Fill the test hole with water and allow it to completely seep away. This presoaking should be done continuously for at least 4 hours before the test. Soils with high clay content should be presoaked overnight. In sandy soils, soaking is not necessary. Instead, after filling the hole twice with 12 inches of water, if the water seeps away completely in less than ten minutes, the test can proceed immediately. After the water has seeped away, remove any loose soil that has fallen from the sides of the hole.

4) Pour clean water into the hole, with as little splashing as possible, to a depth of six inches.

5) Observe and record the time in minutes required for the water to drop one inch (from the six-inch to the five-inch mark).
FIGURE 1. SOIL PERCOLATION TEST ARRANGEMENT

- RULER OR MEASURING STICK INDICATING 5" AND 6" INTERVALS
- WATER LEVEL AT START OF TEST
- DEEP HOLE FOR SEEPAGE PIT TESTING
- 30" (APPROX.)
- 12" (APPROX.)
6) Repeat the test a minimum of three times, until the time for the water to drop one inch for two successive tests yields approximately equal results. The last test will then be taken as the stabilized rate for percolation. If different results are obtained from separate pits in the same general area, the slowest percolation rate is used in design.

**Note:** A percolation test whose results are inconsistent with the soil evaluation shall be disregarded, and the percolation test (s) shall be performed again.

**DESIGN FLOW**

Information on flow rate is necessary for the design of effective wastewater treatment and disposal system. The wastewater flow rates of existing facilities can often be measured. Table 3 can be used as a basis for the design of sewage treatment and disposal facilities for new developments, and for existing establishments when the hydraulic loading cannot be measured. Alternatively, water-usage data can be used to estimate wastewater flow, if it is available for an establishment. Adjustments should be made for infiltration, and for water that will not reach the sewer (ex. boiler water).

For commercial establishments variations in flow may be extreme. In these cases it is necessary to examine the significant delivery period of the wastewater and base the peak design flow upon this information to prevent an excessive rate of flow through the treatment system. It may be desirable to include an equalization basin prior to the treatment system.

Section 15-0314 of the Environmental Conservation Law mandates the use of water-saving plumbing facilities in new and renovated buildings. Hydraulic loading, as determined from reference to Table 3 may be decreased by 20 percent in those installations serving premises equipped with certified water-saving plumbing fixtures. A combination of new and old fixtures can be considered on a pro rata basis.

New toilets which use as little as 0.5 gallons of water per flush are becoming available on the market and the reduction of wastewater flow attributable to these and other new technologies shall be considered on a case-by-case basis. The reduction allowance shall depend in part upon the ability of the builder or owner to ensure adequate maintenance and/or replacement in kind when necessary.

**Table 3. Expected Hydraulic Loading Rates**

<table>
<thead>
<tr>
<th>Type of Facility</th>
<th>Flow Rate Per Person (gal./day)</th>
<th>Flow Rate Per Unit (gal./day)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Airports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Per Passenger)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>(Per Employee)</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Facility</td>
<td>1 Bedroom</td>
<td>2 Bedroom</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Apartments</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>Bathhouse (Per Swimmer)</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Boarding House</td>
<td></td>
<td>75</td>
</tr>
<tr>
<td>Bowling Alley (Per Lane - No Food)</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Bowling Alley (With Food - Add Food Service Value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campgrounds (Recreational Vehicle - Per Site)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Campground (Summer Camp)</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Campground Dumping Stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campground Dumping Stations (Per Unsewered Site)</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Campground Dumping Stations (Per Sewered Site)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Camps, Day</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Carwashes, Assuming No Recycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carwashes, Assuming No Recycle Tunnel, Per Car</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Carwashes, Assuming No Recycle Rollover, Per Car</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Carwashes, Assuming No Recycle Handwash, Per 5 Minute Cycle</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Type of Facility</td>
<td>Flow Rate Per Person (gal./day)</td>
<td>Flow Rate Per Unit (gal./day)</td>
</tr>
<tr>
<td>Churches - Per Seat (With Catering - Add Food Service Value)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Clubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Resident Member</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Per Non-Resident Member</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Racquet (Per Court Per Hour)</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Factories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Person/Shift</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Add for Showers</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Food Service Operations (Per Seat)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinary Restaurant</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>24 - Hour Restaurant</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Restaurant Along Freeway</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Tavern (Little Food Service)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Curb Service (Drive-In, Per Car Space)</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Catering, or Banquet Facilities</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Hair Dresser (Per Station)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotels (Per Bed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hotels (Per Room)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add for Banquet Facilities, Theatre, Night Club, as Applicable</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Homes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Bedroom</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>2 Bedroom</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>3 Bedroom</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>4 Bedroom</td>
<td>475</td>
<td></td>
</tr>
<tr>
<td>5 Bedroom</td>
<td>550</td>
<td></td>
</tr>
<tr>
<td>Institutions (Other Than Hospitals)</td>
<td>125</td>
<td></td>
</tr>
<tr>
<td>Laundromats (Per Machine)</td>
<td>580</td>
<td></td>
</tr>
<tr>
<td>Mobile Home Parks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less Than 5 Units: Use Flow Rates for Homes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twenty or More Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Trailer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double Wide</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>Five to Twenty Units - Use Prorated Scale</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Motels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Living Unit</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>With Kitchen</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Type of Facility</td>
<td>Flow Rate Per Person (gal./day)</td>
<td>Flow Rate Per Unit (gal./day)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td><strong>Office Buildings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Employee</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Per Square Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dentist - Per Chair/Day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Parks (Per Picnicker)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restroom Only</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Showers and Restroom</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Schools (Per Student)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boarding</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Day</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Cafeteria - Add</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Showers - Add</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Service Stations</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Toilet (Not Including Car Wash)</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td><strong>Shopping Centers (Per sq. ft. - Food Extra)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per Employee</td>
<td>15</td>
<td>0.1</td>
</tr>
<tr>
<td>Per Toilet</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td><strong>Swimming Pools (Per Swimmer)</strong></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td><strong>Sports Stadium</strong></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td><strong>Theatre</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive-In (Per Space)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movie (Per Seat)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinner Theatre, Individual (Per Seat) with Hotel</td>
<td>20</td>
<td>10</td>
</tr>
</tbody>
</table>

**TREATMENT CONSIDERATIONS**

Detailed data regarding the character and quantity of the wastewater flow is necessary to facilitate the effective design of wastewater treatment and disposal systems.

Many commercial institutional facilities generate wastewater similar in character to residential wastes. For other facilities consideration of the waste-generating sources will allow an estimate of the character of the wastewater. This will also serve to indicate the presence of any problem constituents in the wastewater such as high grease levels from restaurants and lint fibers from laundromats.
Roof, footing and basement floor drains shall not be discharged to the sewage system. Similarly, cooling water shall be excluded. Industrial-type wastes should be segregated and treated separately as a general rule, but inclusion with sanitary wastes may be considered, if justified.

If subsurface disposal is to be used, the treatment process should remove nearly all settleable solids and floatable grease and scum to allow efficient operation of the disposal field.

Acceptability of any discharge to a receiving stream will be contingent upon the ability of the applicant to meet applicable criteria and standards for the stream at the point of discharge and any point downstream. Judgment will be made on the basis of the minimum average seven-day flow expected to recur once in 10 years (MA7CD10). Upstream discharges, as well as downstream discharges and uses must be considered. The minimum degree of treatment required for the discharge of sanitary sewage into surface waters is effective secondary treatment, which consists of:

1. 85% removal of biochemical oxygen demand and suspended solids, and
2. Effluent concentrations for biochemical oxygen demand and suspended solids no greater than 30 mg/l.

Additional treatment may be necessary to meet all applicable criteria and standards.

In New York State an intermittent stream is defined as 1) any stream that periodically goes dry at any point downstream of the proposed point of discharge, or 2) any stream segment below the proposed point of discharge in which the MA7CD10 stream flow is less than 0.1 cfs as estimated by methods other than continuous daily flow measurements.

Discharge to an intermittent stream will be allowed only when all other methods of disposal have been considered and judged unacceptable. Data should be supplied to show that the discharge from any sewage treatment facility would not contravene stream standards. As a minimum, discharges to intermittent streams must meet the limits shown in Table 4.

Table 4. Intermittent Stream Effluent Limits

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.O.D.</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>Less Than or Equal to 7.0 mg/l</td>
</tr>
<tr>
<td>Ammonia</td>
<td>Limit to be set by review agency</td>
</tr>
<tr>
<td>pH</td>
<td>Limit to be set by review agency</td>
</tr>
<tr>
<td>Chlorine Residual</td>
<td>Limit to be set by review agency</td>
</tr>
</tbody>
</table>

Maintenance and operation of small waste disposal systems is very important. Where possible, the system requiring the least attention should be given priority. In general, subsurface disposal should be the choice for smaller systems (30,000 gpd, or less), while surface discharge is more appropriate for larger systems.
C. SEWERS AND SEWAGE PUMPING STATIONS

Usually gravity sewers are used to convey wastewater. Alternative systems such as septic tank effluent, (gravity or pressure), grinder pump pressure, and vacuum sewers are proposed when cost reduction is important other factors such as low density of residences, adverse grades or soil conditions, or high rock elevations may make gravity sewers impractical and thus encourage the use of alternative systems.

Sewer systems should be designed for the estimated ultimate tributary population, which includes maximum anticipated capacity of institutions, industrial parks, etc.

Only separate sanitary sewers shall be used in new construction.

BUILDING SEWERS

The building drain is a pipe extending from the interior plumbing to a point at least three feet outside the foundation wall.

The building sewer connects the building drain to on-site treatment facilities. Building sewers shall have a minimum diameter of four inches and shall be laid on a firm foundation with a minimum grade of 1/4 inch per foot and straight alignment.

At least one cleanout should be provided for all building sewers. If bends of 45° or more are necessary, a cleanout fitting shall be provided.

CONVENTIONAL GRAVITY SEWERS

Design Factors

For small municipalities or cluster developments, no gravity sewer conveying raw sewage shall be less than 8-inches in diameter. These sewer systems using 8-inch or larger diameter pipe shall be governed by New York's municipal sewerage standards.

Systems conveying raw sewage from institutional/commercial facilities may use a minimum size 6-inch diameter collector sewer with a minimum slope of 1/8-inch per foot (1.0%). Trunk sewers shall be a minimum of 8-inch diameter with a minimum 0.4% slope. In very small installations, 4-inch diameter sewers may be used for raw sewage if a minimum slope of 1/4-inch per foot (2%) is maintained and a velocity of at least 2 feet/second is achieved when the sewer is flowing full. The use of smooth interior pipe is recommended.

Where velocities greater than 15-feet per second are expected, special provision shall be made to protect against displacement by erosion or shock.
**Materials**

Any generally accepted material for sewers will be given consideration, but the material selected should be adapted to local conditions, such as character of wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, and abrasion. Bituminous-fiber (Orangeburg) pipe is unacceptable for community collection systems.

All sewers shall be designed to prevent damage from superimposed loads. Structural reinforcing may be necessary for gravity sewers installed at depths of less than four feet. Proper allowance for loads on the sewer due to the width and depth of the trench shall be made. All flexible pipe (PVC, etc.) shall undergo deflection testing, as prescribed by New York's municipal standards.

**Water/Sewer Separation**

Whenever possible, sewers should be laid at least 10-feet horizontally from any existing or proposed water line. Should local conditions prevent a lateral separation of 10-feet, a sewer may be laid closer than 10 feet from a water main if:

a) It is in a separate trench, or

b) It is in the same trench with the water mains located at one side on a bench of undisturbed earth.

In either case the elevation of the crown of the sewer must be at least 18-inches below the invert of the water main.

Whenever sewers must cross under water mains, and the sewer cannot be buried to meet the above requirement, the water main shall be relocated to provide this separation or the sewer line constructed of slip-on or mechanical-joint, cast-iron pipe or PVC pressure pipe for a distance of 10-feet on each side of the water line and be pressure-tested to assure water-tightness. At least ten feet of separation must exist between the point of crossing and joints in the water line.

There must be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto, which would render possible the passage of any sewage or polluted water into the potable water supply. No water pipe shall pass through or care in contact with any part of a sewer manhole.

**Creek Crossings**

Permits are required for crossing or working adjacent to certain streams, as outlined in Section A. In the event no stream-crossing permit is required, the crossing shall be made in such a manner as to minimize disturbance of the streambed.
**Manholes**

Manholes shall be placed on conventional gravity sewers at all points of change of grade, size or alignment; at the end of all lines; and at distances not to exceed 400-feet.

If the topography is very uneven and frequent changes in alignment and slope are necessary, a limited number of inspection pipes may be substituted for manholes. Not more than one inspection pipe should be placed between two successive manholes and in no case shall manhole separation exceed 400-feet.

Cleanouts may be substituted for "end of line" manholes only where the length of run to a manhole does not exceed 150-feet. For pipes conveying settled sewage, cleanouts may be preferable to manholes except at the junction of two or more sewer lines.

Drop manholes shall be used for all sewers entering at an elevation of 24 inches or more above the manhole invert.

Sizing for manholes and other sewer appurtenances is given in Table 5. Non-standard manholes may be used on small diameter sewers (4 and 6 inch) if the system cannot be dedicated as a portion of a municipal system. There must be a smooth channel formed on the bottom and the pipe entrances shall be properly grouted.

Manholes shall be of pre-cast or poured in place concrete, and shall be waterproofed on the exterior. Exterior waterproofing may be omitted for pre-cast manholes when information proving water-tightness is provided. Inlet and outlet pipes shall be joined to the manhole with any watertight connection that allows for differential settlement to take place. Covers must be above grade or made watertight.

**Table 5. Minimum Size of Sewer Appurtenances**

<table>
<thead>
<tr>
<th>Fixture</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Manholes</td>
<td>42 inch</td>
</tr>
<tr>
<td>Non-standard Manholes</td>
<td>24 inch</td>
</tr>
<tr>
<td>Inspection Pipes</td>
<td>24 inch</td>
</tr>
<tr>
<td>Cleanouts</td>
<td>8 inch a</td>
</tr>
</tbody>
</table>

a) Cleanouts may be less than 8 inches if the pipe diameter is less than 8 inches.

**Construction factors**

Sewers shall be sufficiently deep to prevent freezing. Excavations shall meet OSHA requirements and conform to standard accepted practice. All pipes shall be properly bedded in accordance with standard accepted practice for the type of pipe being installed.
Backfilling shall be performed in steps. Backfill shall be placed in such a manner as not to disturb the alignment of the pipe, and shall be slightly mounded to allow for settling.

Conventional gravity sewer lines must be laid on straight alignment and uniform slope (using the minimum slope as described previously) between manholes. Special care shall be taken to insure the structural integrity of the sewer line at all road crossings.

Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots throughout the life of the system.

**Testing**

All sanitary sewers, manholes, and cleanouts shall be tested by any standard method after being flushed and before being used. Depending upon the groundwater table elevation, either the infiltration or exfiltration method may be used. The maximum rate of infiltration/exfiltration shall not exceed 100 gallons per inch diameter per mile per day.

Air testing in accordance with New York State standards is acceptable. The procedure is described in Appendix I.

**SEPTIC TANK EFFLUENT SEWERS**

Septic tank effluent sewers have been developed to convey septic tank effluent to a centralized location for further treatment. Gravity systems may be classified as septic tank effluent collection (STEC) system (constant downslope) and variable grade sewers (VGS). Septic tank effluent pump (STEP) systems may also be used. STEC systems should be designed in accordance with New York’s municipal sewerage standards (TIP No. 24). Because of a lack of experience with actual installations, VGS and STEP systems will be judged on a case-by-case basis, using substantiating information submitted by the engineer.

Sewers carrying septic tank effluent, which can be corrosive and odorous, should be constructed of ABS (ASTM F628), PVC (ASTM, D2729), polyethylene, vitrified clay, or fiberglass/polyester composite (ASTM D3754). Piping of other ASTM designations may be allowed provided that it can be shown to be adequate both structurally and chemically for the proposed conditions.

The use of drop manholes should be avoided in sewer lines carrying septic tank effluent.

**GRINDER PUMP PRESSURE SEWERS**

**Design Factors**

Grinder pump pressure sewer systems shall be laid out in a branched or tree configuration to avoid flow-splitting at branches.
The required pipe size shall be determined on the basis of three principal criteria, namely:

1. Velocities adequate to assure scouring should be achieved,

2. Size should be sufficient to handle the required flow rate, and

3. Head loss should not exceed pumping pressure capabilities.

The basis of cumulative flow within the system shall be used. Design shall be for peak sewage flow rates and negligible infiltration. A velocity of two to five feet per second must be achieved at least once and preferably several times per day based on design flows.

Head loss determination should be based on total dynamic head under the maximum flow expected to occur infrequently. Frictional head loss should be determined using the Hazen-Williams Coefficients given in Table 6.

**Table 6. Recommended Hazen-Williams Coefficients for Sewer Pipe**

<table>
<thead>
<tr>
<th>Pipe Description</th>
<th>Hazen-Williams Coef.,C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic</td>
<td>150</td>
</tr>
<tr>
<td>Concrete/Cement</td>
<td>120</td>
</tr>
<tr>
<td>Cast Iron</td>
<td>100</td>
</tr>
<tr>
<td>Welded Steel</td>
<td>100</td>
</tr>
<tr>
<td>Riveted Steel</td>
<td>90</td>
</tr>
</tbody>
</table>

**System Arrangement**

All pressure sewer pipes shall be installed at a depth sufficient to protect against freezing and mechanical damage. The required depth will be dependent on both latitude and altitude of the site.

Attention must be given to the necessity for providing automatic air release valves at major changes of slope. Release devices are required when the liquid flow velocity is insufficient to purge air bubbles.

Pressure and/or flow control values shall be installed at the end of all critical surge pipe runs in order to maintain a full pipe system and eliminate lift station flooding or plant washout.

The standard clearances for water/sewer crossings apply to pressure systems.
**System Pressures**

Operating pressures in general should be in the range of 40 to 60 psi and shall not exceed 60 psi for any appreciable amount of time. Provisions shall be made in both the system and grinder pumps to protect against the creation of any long-term high-pressure situations.

**Materials**

Many types of pipe may be used for pressure sewers. Maximum benefit can usually be achieved with non-metallic materials such as polyethylene, fiberglass reinforced plastic, and PVC.

**Service Connections**

Building service connections from individual grinder pumps to the collectors should be of 1-1/4 inch PVC pipe, and should include a full ported valve (such as a corporation stop or "u" valve) located in the service line to isolate the pump from the main. Check valves specifically suited to wastewater service should be provided at or near the pump, and at a convenient location in the pressure service line before it enters the main.

**Cleanouts and Fittings**

Pressure systems shall have cleanouts at intervals of approximately 400 to 500 feet, at major changes of direction, and where one collector main joins another main. Access for cleaning shall be provided at the upstream end of each main branch.

These cleanouts shall include an isolating valve, and a capped Y-branch fitting located on each side of the isolating valve and pointed both upstream and downstream for access during maintenance procedures.

All appurtenances and fittings shall be compatible with the piping system, and shall be full bore with smooth interior surfaces to eliminate obstructions and keep friction loss to a minimum.

**Pumping Equipment**

The pumping equipment shall be designed in a manner appropriate to wastewater service, and be manufactured of corrosion resistant materials. In addition it shall meet all applicable safety, fire, and health requirements arising from its intended use in or near residential buildings.

Proper system design and installation shall a assure that each grinder pump will be able to adequately discharge into the piping system during all normal flow situations including peak design flow. Combined static, friction, and miscellaneous head losses during peak design flows shall be maintained below the recommended operating head of any unit on the given path of flow.
The pumps shall have a head capability high enough to operate efficiently over the entire range of conditions anticipated in the system. Normally this will consist of a fixed static head component dependent on pump elevation with respect to the discharge point. The head capacity design point should be not more than 85 percent of the maximum attainable pressure.

The units must be capable of operating under temporary loads above the normal recommended system design operating pressure without a serious reduction of flow or damage to the motor. The pump should be of flooded-suction design to assure that it will be positively primed. The pressure sewer system shall contain integral protection against back siphonage.

Outside installations are preferable, and should be located at least ten feet from the building in an area readily accessible to service personnel outside installations shall be provided with an access from the surface which is suitably graded to prevent the entrance of surface water, and equipped with a vandal-proof cover for safety. Inside installations must be examined for freedom from noise, odors, and electrical hazards. Both free-standing and below-the-floor type installations are acceptable.

The electrical portions of non-submersible grinder/macerator pumps must be protected against entrance of surface water. This may require that a motor "breather" be run from the interior of the motor and control compartment to a protected location higher than the maximum anticipated water or snow level. Waterproof factory-installed wiring and tamperproof access covers on wiring compartments are required.

The grinder pumps shall operate at a noise level sufficiently low to be acceptable for installation inside a residential building. Generally, this should be no louder than other motor-operated devices normally found in homes (furnace blowers, sump pumps, etc.).

The grinder pump equipment shall comply with National Electrical Code and applicable local electrical inspection bureau requirements.

**Pump Types**

Both stable-curve centrifugal and progressing cavity semi-positive displacement pumps may be used in pressure sewer systems.

The stable-curve centrifugal, a pump having maximum head at no flow, may be considered for its ability to compensate with reduced or zero delivery against excessive high pressures, and the ability to deliver at a high rate during low flow situations in the system, thus enhancing scouring during low flow periods.

The progressing cavity semi-positive displacement pump may be considered for its relatively constant rate of delivery. The semi-positive displacement pump has no significant increase in delivery against low-flow conditions.
**Grinder**

The grinding pumping equipment must include an integral grinder capable of handling any reasonable quantity of foreign objects which customarily find their way into building drainage systems as a result of carelessness or accident on the part of building occupants without jamming, stalling, overloading, or undue noise. The particle size produced by the grinder must be small enough to insure that the processed solids will not clog the grinder, pump, or any part of the discharging pipe system. The grinder shall be of a configuration to provide a positive flow of solids into the grinding zone.

Open shafts shall not be exposed in the raw waste passageways, since this will cause cloth, string, etc. to become wrapped around the blades or shaft.

**Pump Tank**

The pump tank must be made of corrosion-resistant materials, which are suitable for contact with sewage and direct burial below grade without deterioration over the projected lifetime (at least 20 years).

The pump tank shall be furnished with integral level controls which reliably turn the pump on and off at appropriate and predictable levels. The level control shall be as trouble-free as possible with little care required for proper calibration. Mercury control, float-type, pressure-type, or probe-type switches are acceptable. An alarm unit with visible and audible alarms shall be provided on a separate electrical circuit or a self-contained power supply to indicate pump failure.

The tank shall be of a 50-gallon minimum capacity and be able to accommodate normal peak flows without exceeding its peak flow capacity. The volume between the on and off levels in the tank should be based on a sensible compromise between excessive unit operation and efficient removal of raw sewage into the system.

The tank shall be capable of accommodating connection to all normal building drainage piping systems. This would include three and four-inch sizes of PVC, cast iron, copper, vitreous clay, and asbestos-cement pipe.

The geometry of the tank bottom, and the pump suction currents generated when the grinder pump is in operation, must be adequate to scour solids from the bottom of the tank so that there is no significant long term accumulation of settleable solids on the tank bottom.

In areas in which the groundwater table is high, tanks should be securely anchored to avoid floating.

The tank shall be vented so that air space above the wastewater is always at atmospheric pressure. Separate vents shall be provided if required by local codes, but normally the fill piping connected to the building drain will provide adequate venting.
Power Outages

Provisions must be made for periods of power failure. Alternatives are:

1. Dependence on built-in storage of tank and associated gravity piping,

2. Provision of additional storage capacity where power outages occur frequently (24-hour storage capacity is recommended) and

3. Provision of a mobile generator to connect to each household for a short term during an extended outage.

Service

A 24-hour repair time either by replacement or repair must be assured. The Department believes this can only be achieved with adequate certainty if the grinder pumps are owned, operated, and maintained by the municipality. Also, grinder pump units should be installed on property to which the municipality has clear title or right of access for maintenance purposes. Spare grinder-pump units shall be stocked according to Table 7.

Table 7. Stocking of Spare Grinder Pump Units

<table>
<thead>
<tr>
<th>Installations</th>
<th>Spare Unit (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>1</td>
</tr>
<tr>
<td>10-20</td>
<td>2</td>
</tr>
<tr>
<td>20-40</td>
<td>3</td>
</tr>
<tr>
<td>40-60</td>
<td>4</td>
</tr>
<tr>
<td>60-100</td>
<td>5</td>
</tr>
<tr>
<td>100-200</td>
<td>6</td>
</tr>
<tr>
<td>Over 200</td>
<td>3% of Installation</td>
</tr>
</tbody>
</table>

Instruction Manuals

The equipment must be furnished complete with detailed wiring diagrams, suggested piping installations, and detailed instructions, for use by the contractor at the time of installation.

Construction Factors for Pressurized Sewers

A sand bed shall be prepared at least 4-inches deep but not less than one (1) pipe diameter. The bedding shall be smoothed prior to pipe installation.

The excavation shall be backfilled to a depth of 18-inches above the pipe with sand. The sand shall contain no rock greater than 1-inch in diameter. Native materials may be used for the remainder of the backfill.
**Termination of Force Mains**

Force mains and pressure sewer trunks shall terminate in manholes using the following construction procedures:

1. The discharge shall be to the bottom of the manhole, in line with the flow if possible,

2. Where piping must be installed to bring the discharge to the bottom of the manhole, the pipe shall be adequately braced to prevent movement, shall be vented on the top, and shall allow access to the force main for cleaning purposes.

**Testing**

Pressure tests shall be made only after the completion of backfilling operations, and at least 36 hours after the concrete thrust blocks have been cast. All tests shall be conducted under the supervision of the engineer.

The duration of pressure tests shall be one hour, unless otherwise directed by the engineer. The test pressure shall be no less than 50psi, with a recommended pressure of 2-1/2 times the maximum system operating pressure.

The pipeline shall be slowly filled with water. Before applying the specified pressure, all air shall be expelled from the pipeline by making taps at the point of highest elevation. The specified pressure, measured at the lowest point of elevation, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the engineer. After completion of the test, the taps shall be tightly plugged.

**VACUUM SEWERS**

Vacuum, sewers may be considered an alternative to gravity or pressure sewers where the terrain is flat and either a high groundwater table or unsuitable soils are present, or where rock excavation is necessary. Due to ongoing improvements in equipment design and developments in overall design criteria for vacuum sewers, some variation from the following standards may be allowed on a case-by-case basis provided that substantiating information is submitted by the engineer.

**Piping System**

Design shall be for an operating vacuum range of 15 to 22 inches of mercury at mean sea level. Adjustments must be made for the altitude of the site.

Solvent-welded or vacuum suitable bell and spigot joints must be used on all plastic piping. Double o-ring slip joints should be considered to provide for temperature stresses. Solvent-welded pipe shall be checked for temperature expansion allowance before covering. Bituminous-fiber pipe (Orangeburg) shall not be used.
Gravity sections shall have a minimum slope of 0.20 percent irrespective of pipe size. Minimum pipe diameter shall be 3-inches. If collection system piping of less than four inches is used, special attention must be given during construction to providing adequate support to prevent flexing of the pipe.

Grease traps may be necessary to prevent malfunctions. Also, to reduce potential for sewer clogging, it is recommended that two 45 degree bends be used in lieu of 90 degree bends, or if not possible use long sweep 90 degree bends.

Shutoff valves shall be provided at every branch connection, and at intervals no greater than 2000 feet on min lines. Gate valves and butterfly valves shall not be used. Isolation valving shall be provided between the vacuum collection tank, vacuum pump(s), influent line, and raw sewage discharge pumps.

Access points equal to the line, sizes shall be provided at the end of every main or branch line, and at changes in line diameter.

Building sewers shall be constructed in the same manner as main lines. Air vents should be located adjacent to the building and be protected from freezing, snow, and flooding.

**Vacuum Valves**

Vacuum value pits should be designed to prevent entrance of water, although vacuum valves should be capable of operating when submerged under water or ice conditions. Electronically controlled vacuum valves should be avoided. Spare valves shall be stocked according to the schedule in Table 7 for grinder pumps.

The use of exterior valve breather tubes and vents should be avoided. If exterior vents must be used, they are to extend above maximum snow level and have moisture traps. Moisture traps should be provided on all breathers.

**Central Collection Station**

A vacuum pump shall be designed not to cycle more than six times in one hour during average daily flow conditions. A minimum running time of one minute per cycle is required. A standby pump capacity of 100 percent shall be provided to handle peak loadings, as well as one hundred percent standby power.

**SEWAGE PUMPING STATIONS**

Sewage pumping stations shall not be subject to flooding as described in Section B of this document. A suitable super structure is desirable to allow convenient access under all weather conditions. Below-grade dry-pit pumping stations should have a float switch mounted at floor level, which is connected to the "HIGH LEVEL" alarm.
If it is judged that grit will be a problem, pumps for raw sewage should be preceded by grit removal equipment. 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.

At least two (2) pumps or pneumatic ejector compressor/tank assemblies shall be provided except for unusual circumstances, which shall be reviewed individually. In the case where only two units are provided, each shall be capable of handling in excess of the expected maximum design flow and the two pumping units shall be identical. If three or more pumps are used, they should be designed such that with any one unit out of service the remaining units will have the capacity to handle the maximum design flow.

**Design Considerations**

Suitable and safe means of access shall be provided to dry wells, and to wet wells containing either bar screens or mechanical equipment. Access hatches shall be provided with handgrips. They shall be located directly over ladders or manhole steps and shall be equipped with two hold-open devices.

Personnel shall provide adequate positive or forced-air ventilation in dry pits or spaces, which require entry. The method of ventilation and air flow requirement will be dependent upon the type of pumping station, configuration, location, and other pertinent parameters. All intermittently operated ventilation equipment shall be interconnected with the lighting system for the space.

In general the pump installation shall be designed to handle a maximum design flow of four times the average daily flow. Certain applications may require a higher peaking factor.

Where applicable, with due consideration given to the particular wastewater characteristics or pump station design, the pump should be preceded by readily accessible bar racks with clear openings not exceeding 1-1/2 inches. Exceptions may be allowed if pneumatic ejectors are used or if special devices are installed to protect pumps from clogging or damage. Consideration should be given to duplicate racks or a suitable overflow bypass for use in emergencies. Where racks are located below ground, convenient facilities should be provided for handling screenings.

Except where grinder or cutter pumps are used, 3-inch pumps handling raw sewage shall be capable of passing spheres of at least 21 inches in diameter. Larger pumps should comply with New York's municipal standards. Pumps shall be so placed that under normal operating conditions they will operate under a positive suction head except for self- or vacuum-priming pump systems.

Electrical equipment in wet wells or in enclosed spaces where explosive gases may accumulate shall comply with the National Electrical Code for Class 1, Division 1, Groups C and D locations.
There shall be no electrical splices, junction boxes, or connections of any kind in sewage wet wells of any NEC rating. All NEMA 4 control panels should have a thermostatted heater to prevent condensation.

Suitable shut-off valves shall be placed on the suction line of each pump. A shut-off and a check valve shall be placed on the discharge line of each pump. In the case of submersible pumps, valves shall be located outside of the pump station unless they are accessible from grade without the need to enter the wet well. Where the wet well volume is less than the volume contained in the force main, consideration should be given to placing a shut-off valve on the force main to permit servicing of the valves. Where the wet well non-working or reserve volume is inadequate for emergency periods, consideration should be given to an easy bypass connection in the piping to connect an emergency pump.

There shall be no physical interconnection between any potable water supply and a sewage pumping station or any of its components, which under any conditions might cause contamination of the potable water supply. Potable water supply piping to a sewage pumping station shall be equipped with an acceptable backflow prevention device that is selected and installed according to New York's municipal sewerage standards.

**Types of Pumps**

Categories of sewage pumping units include submersible pumps, dry-pit pumps, pneumatic ejectors, vertical wet-pit pumps, suction-lift pumps and systems, and airlifts.

Submersible pumps shall be readily removable and replaceable without the need for personnel to enter the wet well and without interrupting the normal operation of the other pump(s). Vortex-type, open impeller, and cutter/grinder pumps are acceptable. Submersible pump stations shall meet the requirements outlined in New York's municipal sewerage standards except where superceded by the requirements of this document.

Underground pump station structures constructed of steel shall be coated with an acceptable corrosion resistant material. The structure shall be supplied with two (2) properly sized anodes for cathodic protection to be buried on opposite sides of the structure and electronically connected to the structure by heavy copper wire. To prevent corrosion, connectors should be compatible with the type of wire used. Pneumatic receiver pressure vessels shall be rated for 150% of the maximum pressure achievable in the station.

Suction-lift sewage pumping stations shall meet the requirements of New York's municipal sewerage standards, and the design should be confirmed with the pump manufacturer. For dry-pit sewage pumping stations, consideration should be given to providing pumps with a submersible motor drive.
Wet Wells

The wet well size, configuration, and control setting shall be such that heat buildup in the pump motor due to frequent starting, and septic conditions due to excessive detention time, is avoided. Generally, a holding period of between 10 and 30 minutes for the maximum design flow is recommended.

Level Controls

Level controls (float bulbs, bubbler tubes, wires, transducers, etc.) shall be located so as not to be unduly affected by turbulence from incoming flows and pump suction. In stations with duplicate units, provisions shall be made to automatically alternate the pumps in use, and consideration should be given to the use of running-time meters.

Alarm Systems

Alarm systems should be provided for all pumping stations. The alarm shall be activated in cases of power failure, pump failure, unauthorized entry, high level, pump failure or other cause of pump station malfunction. Stations which are not visited daily and are not equipped with running-time meters shall signal alarm upon operation of the lag pump or spare pump. If the alarm system is telemetered to a remote location, a separate alarm shall be provided to signal failure of the communication link.

Emergency Operation Provisions

 Provision for emergency operation shall be made whenever there may be a possibility of discharge other than through the force main. Emergency procedures include a second source electrical supply, a portable pump or generator (time delay and operator requirements must be considered), and adequate overflow tank age.

Overflows

The provision of a wet well overflow should be evaluated and consideration should be given to an adequately sized overflow/detention tank, which shall empty to the wet well when pumping operations resume. No discharge onto the ground shall be permitted. A wash down system must be provided for the detention tank. Aeration may be necessary if the holding period in the tank causes septic conditions.

Force Mains

At maximum design flow, a sewage velocity of at least 2 feet per second shall be maintained in the force main. Consideration should be given to achieving a solids pickup velocity of 4 feet per second. Velocity calculations must be based on the actual inside pipe diameter. Headloss determinations should be made using the Hazen-Williams Coefficients given in Table 6.
In general, 3-inch diameter pipe shall be the smallest used for raw sewage force mains. However, use of grinder pumps or similar equipment may allow use of smaller pipe. These instances will be reviewed on an individual basis.

It is recommended that automatic air-relief valves be installed in manholes at high points in the force main to prevent air locking. Long sewage-type valves with hose connections for regular flushing and freeze prevention should be used. Consideration will be given to alternate proposals with proper substantiation.

Force mains should enter a gravity sewer at a point no more than 2 feet above the flow line of the receiving manhole.

Force mains in systems that are located above the frost line and operate on a seasonal basis shall be provided with draining capability to avoid freezing problems. The Hazen-Williams Coefficient should be significantly reduced for these systems.

Where the force main is relatively short, consideration should be given to installing two force mains and eliminating valving.

**Gauges**

Installation of a pressure gauge calibrated in feet of water and equipped with a diaphragm seal, glycerin fill, snubber, and a spring-loaded shut-off valve that is located on the force main after the valves should be considered.
D.  TREATMENT METHODS

INTRODUCTION

When designed in accordance with the criteria presented, the biological treatment schemes discussed herein are considered capable of achieving secondary treatment limits as defined in Section B of this document. When greater levels of treatment are needed, in order for the amount of discharged contaminant to remain within the assimilative capacity of a receiving stream, or in order to otherwise meet stream requirements, combinations of the listed treatment methods may be used, or high-rate filtration may be added as a tertiary step. Substantiation of the ability of the process to achieve the needed level of treatment is the responsibility of the engineer. For some commercial wastewaters, alternative treatment techniques such as physical-chemical treatment (which is discussed herein) may be more appropriate than biological treatment.

Requirements for septic tanks, intermittent sand filters, and physical-chemical treatment methods are included in this publication. Criteria for the other treatment methods are presented in New York’s municipal sewerage standards. Except for requirements and allowances listed hereafter, which may be considered to supersede them, the municipal standards are referred to and shall be followed. A short discussion on holding tanks is also included herein, although they will be allowed only under exceptional circumstances.

Flow equalization should be provided for all treatment modes with the exception of septic tanks, intermittent sand filters, and lagoons.

Lack of description or criteria for a particular process is not intended to suggest that such a system should not be used, but only that consideration by the reviewing agency will be on the basis of information submitted with the design. It is incumbent on the design engineer to demonstrate fully that the process or equipment is capable of achieving the treatment objectives outlined herein.

FLOW MEASUREMENT

Some means of wastewater flow measurement or estimation shall be provided for all plants as follows:

1. For mechanical systems (including physical-chemical and high-rate filtration) plants of 100,000 gpd or more capacity shall be provided with devices for indicating, totalizing, and recording wastewater flow.

Plants of 20,000 to 100,000 gpd capacity shall have at least a totalizing flow device. Time-elapsed meters may be used where the waste is pumped. Where applicable the wastewater flow may be estimated by the use of a totalizing water meter on the water supply servicing the establishment(s) tributary to the plant.
Plants under 20,000 gpd capacity shall have a totalizing water meter as indicated above or at least a weir for manual flow determination. This facility shall be designed that a flow meter can be easily installed.

2. For intermittent sand filters and meter, dosage counter, calibrated meter are acceptable arrangements.

3. For septic tank system with subsurface disposal of the effluent, flow measurement is not necessary. Flow measurement is strongly recommended when the design flow is 5000 gpd or greater.

SEPTIC TANKS

Design and Installation

Septic tanks must be followed by subsurface disposal or by polishing treatment prior to surface discharge.

Table 8 shows the calculations that should be used to determine minimum effective tank capacity for commercial/institutional and multi-home wastewaters. Tanks larger than this minimum will show enhanced performance. No tanks shall have a capacity less than 100C gallons. For multi-home purposes, calculated flows must be based upon the maximum occupancy of the homes. For commercial/institutional purposes the tank must be able to treat continuous wastewater flows for 8 to 16 hours per day as well as expected peak loadings. It maybe necessary to increase tank size when a commercial or institutional facility has a short significant delivery period to prevent excessive rate of flow through the system.

Table 8. Septic Tank Sizing for Multi-home and Commercial/Institutional Applications

<table>
<thead>
<tr>
<th>Daily Flow, Q (gpd)</th>
<th>Tank Size (gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 5000</td>
<td>1.5Q</td>
</tr>
<tr>
<td>5000 – 15000</td>
<td>3750 + 0.75 Q</td>
</tr>
<tr>
<td>15000 +</td>
<td>Q</td>
</tr>
</tbody>
</table>

Where garbage grinders are to be used, tank capacity must be increased by 1/3 to accommodate the increased volume of solids per capita. Garbage grinders are not recommended for use with septic systems.

The use of raw sewage pumping stations is to be discouraged when the discharge is directly to a septic tank. Where they must be used, a daily flow (Q) shall be calculated based on the pumping rate (gallons per minute), rather than sizing the septic tank on flow volume averaged over the entire day. This will alleviate shock loads to the septic tank.
Tanks with greater surface area and shallower depth are preferred. A liquid depth of between 30 and 60 inches is required. Deeper tanks may be used to provide extra sludge storage, but no credit will be given towards design flow. Tank surface area may range from 2.7 to 5.3 sq. ft. per 100 gallons of tank capacity. Rectangular tanks are preferred, and the ratio of effective tank length to width should be in the range of 2:1 to 4:1. The minimum effective length shall be 6 feet.

Centered tee-type or baffled inlets and outlets are acceptable. When baffles are used; it may be desirable to provide sanitary tees as a backup, as baffles may corrode and "drop-off" allowing solids to escape the tank. There shall be a minimum difference in elevation of three inches between inverts of the inlet and outlet of the tank. For tanks with a liquid depth less than 40 inches, baffles or tees for the inlet and outlet should extend 12 and 15 inches, respectively, below the liquid surface. In deeper tanks, these depths should be increased to 15 and 18 inches for the inlet and outlet. The use of gas deflection baffles or devices on the tank outlet is strongly recommended.

Two compartment tanks are required when the length of the tank exceeds 10 feet, and are recommended for all installations. Two septic tanks in series may be used in lieu of a two-compartment tank. The inlet chamber or tank should have a capacity of 65 to 75 percent of the total capacity. For a two-compartment tank the dividing wall should extend from the tank bottom to six inches above the flow line. Elbows or a horizontal slot at least 4 inches high may be used to connect the two compartments. For the two-tank option, the tanks must be connected by a vent pipe at least four inches in diameter in addition to a connecting pipe for sewage transfer purposes. In either case, the connecting area for sewage should be at least equal to three times the area of the inlet to the tank. The invert of the connector should be located one-third of the distance from the outlet invert and the bottom of the tank.

A typical two-compartment tank is shown in Figure 2.

Tanks may be constructed of pre-cast or poured in-place concrete, polyethylene, fiberglass, or metal, and shall be watertight.

Metal tanks are not recommended, but will be considered acceptable if they are constructed and coated in accordance with the provisions of the Under Writers Laboratory Standard UL-70.

Polyethylene and fiberglass tanks must be factory assembled, with any proposed baffles in place. Care must be taken during installation and backfilling to avoid damaging the walls. After backfilling, the tank should be inspected and if any damage is present the tank should be repaired or replaced. When these tanks are installed in areas where high groundwater levels may be present, flotation collars should be used to prevent flotation when the tank is pumped.
FIGURE 2. TWO COMPARTMENT CONCRETE SEPTIC TANK
Concrete septic tanks should be coated with a bituminous coating to ensure water-tightness and prevent deterioration. Concrete tanks are not recommended for treatment of wastewater that is high in sulfur or sulfate.

The septic tank should be placed on a level layer of sand or pea gravel to provide adequate bedding.

At least one manhole of 20-inches in the shortest dimension is required in each compartment of a tank with a liquid depth of 48-inches or greater. For tanks with a liquid depth shallower than 48-inches, openings of minimum size 12-inches in the least dimension may be substituted. Manholes should be placed over the inlet and the outlet of the tank and should extend to the ground surface so that the tank may be inspected and sludge and scum removed conveniently. Septic tank access covers that are at grade should be provided with locking devices.

Kitchen facilities with large volumes of wastewater shall be served by a separate sewer line in which a grease trap is installed upstream from the treatment system. Ground garbage shall not be permitted in a line served by a grease trap. Trap location must be selected to insure maintenance, and to allow some cooling to facilitate separation while not allowing the grease to solidify before reaching the trap. Usual locations are outside the building near the wastewater source. Pump out should occur when 75 percent of the tank capacity has been used, with frequencies for restaurants ranging from weekly to once every three months.

The following two equations should be used for estimating the size grease trap necessary for restaurants and other types of commercial kitchens. The minimum size grease trap should be 750 gallons.

1. **Restaurants:**

\[
(D)(GL)(ST)(HR/2)(LF) = \text{Size of Grease Trap, Gallons Where,}
\]

\[
D = \text{Number of Seats in Dining Area}
\]

\[
GL = \text{Gallons of Wastewater Per Meal, Normally 5 Gallons}
\]

\[
ST = \text{Storage Capacity Factor (Minimum = 1.7, Onsite Disposal = 2.5)}
\]

\[
HR = \text{Number of Hours Open}
\]

\[
LF = \text{Loading Factor (Interstate Freeways = 1.25, Other Freeways and Recreational Areas = 1.0, Min highways = 0.8, Other Highways = 0.5).}
\]

2. **Hospitals, Nursing Homes, etc.:**

\[
(M)(GL)(ST)(2.5)(LF) = \text{Size of Grease Trap, Gallons Where,}
\]

\[
M = \text{Meals Per Day}
\]

\[
GL = \text{Gallons of Wastewater Per Meal, Normally 4.5 Gallons}
\]

\[
ST = \text{Storage Capacity Factor (Minimum = 1.7, Onsite Disposal = 2.5)}
\]
LF = Loading Factor (Garbage Disposal and Dishwashing = 1.25, Without Garbage Disposal = 1.0, Without Dishwashing = 0.75, Without Dishwashing and Garbage Disposal = 0.5).

Grease traps are available in single and double compartment versions. A typical one-compartment tank is shown in Figure 3. Optimum dimensioning calls for a depth approximately equal to the width of a rectangular tank or the diameter of a circular tank. Outlet tees must reach to within 12 inches of the tank floor.

Some commercial grease traps are available that are effective but are substantially smaller than the traps just discussed. Sizing is based on number and type of fixtures discharging to the trap. Grease retention capacity is the amount of grease (in pounds) that the trap can hold before its average efficiency drops below 90 percent, and should equal at least twice the flow capacity (in gallons per minute).

**FIGURE 3. GREAT TRAP**

**Operation and Maintenance**

Septic tank additives should not be used as some products, which claim to “clean” septic tanks, contain compounds, which provide temporary relief but may also result in permanent damage to the disposal field from premature clogging.
It is recommended that septic tanks be pumped out every two years. As a minimum, the tank should be inspected every two years to determine scum and sludge accumulation. Scum and sludge should be measured in the first compartment of a two-compartment tank, or in the first tank of a multiple tank system. Tanks must be pumped when the bottom of the scum layer is within 3 inches of the bottom of the outlet baffle or tee, or when the sludge level is within 8 inches of the outlet device. The tank should not be disinfected, washed, or scrubbed.

Pumped-out septic tanks often contain toxic gases. Only qualified personnel should attempt to enter or repair a septic tank. The average owner SHOULD NOT ENTER the tank.

**INTERMITTENT SAND FILTRATION**

Intermittent sand filters can be buried or open. Open filters may be single-pass or recirculating types. Intermittent filters can be used where the soil is impermeable, or where a highly polished effluent is desired. Discharge is generally to surface waters, but may also be to a soil absorption system. High-rate filters that are often used for effluent polishing are discussed later in this document.

Filters must be preceded by properly designed settling facilities. A septic tank is usually sufficient for this purpose, although aerobic pretreatment will extend the life of the system. Post aeration and/or disinfection may be necessary prior to discharge to surface waters. The need for a liner, curtain drain, or other appropriate measure to prevent infiltration or exfiltration in the filter should be evaluated, particularly where high groundwater levels, fractured bedrock, and soils with fast percolation rates are present. If the natural soil has a percolation rate faster than 60 minutes/inch it is recommended that the filter be lined, especially where groundwater contamination is a concern.

Buried intermittent filters shall not be used after package aerobic treatment plants because an upset may cause clogging.

In general, open filters are preferred over buried filters when the wastewater flow rate exceeds 30,000 gpd. Open filters generally may be used for wastewater flows up to 200,000 gpd. Where a gravity system can be used, single pass open filters are generally preferred over recirculating filters due to reduced energy costs. However, recirculating filters may cause fewer odor problems, may result in a more consistent effluent quality than single pass filters, and may be slightly smaller in size than single pass filters.

When multiple filter beds are used, a resting period of at least 60 days for every six months of operation is recommended to oxidize the clogging mat and increase the lifetime of the filter. The surface area of multiple filter beds should be adequate to handle the total design flow with at least one filter bed at rest. Winter start-up of filters should be avoided.
The filter media is usually sand and should be durable, insoluble in water, and have an organic content of less than 1 percent. A statement from a certified laboratory and/or from the sand source operator indicating that a sample has been analyzed, and that the indicated sand is the material that will be supplied, must be provided prior to construction. Sufficient media must be supplied for a minimum filter depth of 24-inches.

Ranges of media sizes are recommended for the different types of intermittent filters in the discussion to follow. The effective size of the media refers to the sieve size in millimeters that permits 10 percent by weight to pass. The Uniformity Coefficient (UC) is the ratio between the sieve size that will pass 60 percent by weight and the effective size.

In general, smaller media sizes combined with low loading rates will result in both a high quality effluent and enhanced nitrification. A properly operated filter (i.e., not overloaded) should be able to achieve nitrification of at least 80 percent of the applied ammonia.

While pea gravel and graded gravel are used in the construction of intermittent filters, the use of crushed stone should be avoided as it may contain fine materials that will clog the filter. Piping for sand filters may be of a variety of materials, although perhaps the most common is PVC (ASTM D3034). Materials should be appropriate for the anticipated loads and the chemical nature of the wastewater.

Gravity distribution of wastewater resulting in trickle flow to sand filters shall not be considered acceptable. System dosing via siphons or pumps must be provided for both buried and open filters. Provision should be made to prevent the flow of wastewater out through any vents when the system is being dosed.

**Buried Filters**

A buried filter should be constructed in accordance with Figure 4. Steps shall be taken to divert rainfall and runoff away from buried filters. Multiple filter beds are strongly recommended when filters are of the buried type, and are mandatory if the flow exceeds 2000 gpd.

**Media:** The recommended effective media size is 0.25 to 1.0 mm, and the uniformity coefficient shall be less than 4. If nitrification is not required, media size should be at least 0.5 mm.

**Loading:** The application rate for buried filters shall be no more than 1.0 gpd/sq. ft. for filters in continuous operation. Loading rates up to 2.0 gpd/sq. ft. may be allowed if a bed is operated such that it will rest for an amount of time equal to or greater than that for which it is in use on a yearly basis (i.e., seasonal operation). When nitrification is required, the application rate shall not exceed 1.0 gpd/sq. ft. Efficient nitrification cannot be expected with filters that operate on a seasonal basis.
FIGURE 4. BURIED SAND FILTER
**Base:** Approximately 2-inches of gravel shall be placed above and below the distribution lines and under drains. Gravel around the underdrains and distribution lines shall be 3/4 to 1-1/12 inch. Pea gravel should be 1/8 to 3/8 inches. The ground beneath the filter shall be sloped to the trenches in which lie underdrains are laid.

**Dosing:** Filters should be flooded at least twice per day, and the volume of each dose should be at least seventy five percent of the volume of the distribution lines. Distribution boxes should be used to direct sewage flow. Dosing siphons are acceptable for dosing buried filters although pressurized dosing systems that provide two feet of head at the distal end of the distribution system are strongly recommended.

**Arrangement:** Underdrains shall not be placed on greater than 12-foot centers, and at least two under drains must be provided. Underdrains must be sloped to the outlet. Distribution lines shall not be placed on greater than 3-foot centers. For installations with more than 800 feet of distributors, the filter shall be constructed in two or more section such that no section contains more than 800 feet of distributors. Dual siphons or pumps must be provided to alternate the flow to different sections.

**Construction:** The filter must be settled by flooding before the distributor is placed at final grade. Before backfilling, a barrier material should be placed above the graded gravel. The barrier material may be a synthetic drainage fabric (permeable geotextile) or untreated building paper. Backfilling should be done carefully, and the use of heavy machinery should be avoided.

Approximately 6-inches of topsoil should be mounded over the site with a 3 to 5 percent slope to direct rainwater away from the filter.

**Open Filters - Single Pass**

Single pass filters can be used as a secondary treatment method or for effluent polishing following package plants. A typical single pass filter is shown in Figure 5.

**Media:** The effective media size shall range from 0.25 to 1.00 mm, with a uniformity coefficient less than 4. If nitrification is not required, media size should be at least 0.5 mm.

**Loading:** The loading rate shall not exceed 5-gpd/sq. ft. from septic tanks and other primary settling tanks. From trickling filters and package activated sludge plants, application rates up to 10-gpd/sq. ft. are acceptable. Decreased loading rates are recommended when nitrification is required.
Base: Graded gravel must be placed to a depth of at least 10-inches around the underdrains, and shall be 3/4 to 1-1/2 inches in size. This shall be covered with at least 3 inches of pea gravel, which is 1/8 to 3/8 inches in size.

Arrangement: Multiple filter units must be provided to allow for maintenance, except for very small facilities (flow less than 2000 gpd).

Dosing: Filters should be flooded at least twice each day with a volume equal to a depth of 2-inches over the bed, or to a depth of 4-inches if the effective media size is greater than 0.5 mm. Adequate resting periods must be provided between doses.

Siphons or pumps shall have a discharge capacity city at minimum head of at least 100 percent in excess of the maximum rate of inflow to the dosing tank, and at the average head, at least 90 gallons per minute per 1,000 square feet.

The discharge lines to the beds shall have sufficient capacity to permit the full rate discharge of the siphons or pumps.

![FIGURE 5. SINGLE PASS SAND FILTER](image)

Distribution: Troughs, pipelines, central inlets, and spray nozzles may be used for distribution of the settled sewage over the filter surface, and shall be located so that the maximum lateral travel is not more than 20 feet. Ridge and furrow methods are recommended for winter operation.
The discharge pipe must be drained between doses to prevent frost damage. This can be done by providing small weep holes in the discharge pipe. At least 18-inches of sand must be present below the weep holes. For a pumped system the discharge pipe can be sloped back to the dosing chamber and the check valve at the pump eliminated. In this case the dosing volume must be sized to account for this backflow.

**Underdrains:** Underdrains must be sloped to the outlet, and shall not be placed on greater than 12 foot centers. At least two underdrains must be provided.

**Walls:** Provision must be made to prevent soil from washing onto beds. Walls that are exposed directly to the air in cold climates should be insulated.

**Covers:** Covers may be used to reduce odorous conditions or to protect against cold weather. If insulated covers are used, a space of 12 to 24 inches should be left between the cover and the filter surface. Covers are recommended during winter months if nitrification is necessary.

**Maintenance:** Winter start-up should be avoided. Open filters must be raked and weeded regularly.

**Open Filters - Recirculating**

Recirculation tank volume should be at least equal to one day's wastewater flow. A recirculation ratio of 3:1 to 5:1 should be maintained, and a loading rate of 5gpd/sq. ft. based on forward and not recirculated flow, shall not be exceeded.

Effluent from the filter should be returned to the recirculation tank, or discharged depending on liquid level in the recirculation tank. Acceptable recirculation ratios may be maintained by using flow splitter boxes, moveable gates, check valves, or a float valve arrangement as shown in Figure 6.

For small systems dosing should last 5 to 10 minutes every 30 minutes. For larger systems dosing should last up to 20 minutes every 2 to 3 hours. Filters should be flooded with a volume equal to a depth of 2-inches over the bed. Multiple filter units must be provided to allow for maintenance and adequate resting periods except for very small facilities (flow less than 2000 gpd).

The effective size of the media shall be 0.3 to 1.5 mm with a uniformity coefficient less than 4. The use of coarse media with a low uniformity coefficient is strongly recommended. The arrangement of the underdrain and distribution are similar to nonrecirculating open filters.
PHYSICAL-CHEMICAL

Colloid Removal

Systems employing the physical-chemical mode of treatment in lieu of biological treatment should include at least coagulation, settling, and filtration.

1. **Chemicals** - Coagulation of solids may be accomplished through use of lime, or aluminum or iron compounds (usually alum or ferric chloride). In the use of lime, neutralization of high pH may be required prior to discharge.

Polyelectrolytes (polymers) may be used alone as coagulants, or as aids to other coagulants. Coagulant aids may be used to optimize floc growth and hasten settling, and may allow the dosage of primary coagulant to be decreased. When polymer use is anticipated the potential effects on solids generation and handling should be considered during design. Treatment systems should have the flexibility to allow the use of polymer as a coagulant aid if it becomes necessary in the future.

The use of a liquid supply of metal salt instead of a dry form should be considered at small plants because handling requirements would be decreased, although transportation costs may be prohibitive.
Safety equipment appropriate for the chemical type and form must be provided. This may include dust masks, respirators, goggles, face shields, and protective clothing. If dry chemicals are used, it may be necessary to install dust collectors in storage and handling areas. Optimum chemical type and dosage should be determined by jar testing, preferably followed by pilot plant work. Dosage equipment should be sized to cover a range up to twice the recommended dosage, and should be constructed of materials that will resist the caustic or corrosive nature of the chosen chemical.

2. **Coagulation** - Provision for a complete mix of the chemical with the sewage as quickly as possible should be included. Detention time in this facility should be no longer than two minutes. Gentle agitation should be provided for at least 30 minutes, to allow flock to form.

3. **Settling** - Detention time in the settling facilities should be at least two hours. Facilities should be designed to achieve a surface settling rate no greater than 800 gpd/sq. ft. Sludge withdrawal mechanisms should be designed so as to prevent disruption to or loss of the floc blanket.

Inlets and outlets should be designed to dissipate velocity, to distribute and receive flow equally, and to prevent short-circuiting. A baffle should be provided at the outlet end to retain oils, creases, and other floatable material.

4. **Filtration** - Filtration may be of either the high rate or intermittent type. Filter criteria are presented in other sections of this publication. Filter dosage may be up to 5-gpm/sq. ft. for high rate filters and 10-gpd/sq. ft. for the open intermittent type.

**Phosphorus Removal**

1. **Chemicals** - Aluminum or iron compounds and lime will react with orthophosphate to form insoluble phosphate colloids. Alum is generally preferred as lime may generate excessive sludge and iron compounds may result in iron leakage into the effluent.

2. **Dosing** - Chemical addition may occur prior to primary clarifiers (including septic tanks), secondary treatment tanks, or final clarifiers either in a separate mixing basin or in a turbulent portion of the system. If nitrification is desired during biological treatment, dosing should occur prior to primary settling, to reduce BOD load on the biological system. If a high percentage of the total phosphorus is present as polyphosphate or organic phosphate, dosing should occur after biological conversion to orthophosphate. When high levels of detergents are present, dosing with aluminum or iron compounds should occur after biological treatment to avoid competing side reactions of the detergent with the metal ion.
Jar tests for dosage estimation should simulate treatment plant conditions. Mixing speed should be adjusted to match the hydraulic regime in the plant, and the duration of mixing should be the same. To approximate settling conditions the mechanism should not be motionless, but should turn very slowly. If possible, jar tests should be followed by 30-day pilot plant or full-scale tests.

Phosphorus levels show significant diurnal variations, so it is recommended that the dosage be adjusted regularly (normally 3 to 5 changes in dose rate per day during initial phases of application). Overdosing will prevent floc growth and settling. Flow equalization may be provided to reduce the number of necessary dosage adjustments.

3. **Optimization** - To maintain effluent quality, pH adjustment is necessary. Addition of metal salts or lime can be followed by addition of polyelectrolyte to improve settling. Multimedia filtration is recommended if consistently low phosphorus levels (below 1 mg/l) are necessary.

4. **Sludge** - During design, consideration must be given to the generation and disposal of additional sludge from chemical treatment.

**EXTENDED AERATION**

As pointed out at the beginning of this section, New York's municipal sewerage standards shall govern, except for requirements and allowances listed herein, which shall be considered to supersede them:

1. The extended aeration process can be utilized where a highly nitrified effluent is required. Its use should be governed by the realization that it is a delicate biological process subject to distress caused by surge loadings, variations in organic content, and periods of low or no flow. It takes approximately three months from start up to stabilization of effluent quality within design parameters. Therefore, it is not recommended that extended aeration facilities be used for schools or seasonal facilities.

2. Duplicate units are not mandatory, but the piping should be arranged to permit at least primary sedimentation in the event that any of the treatment units must be taken out of operation. Additional flexibility should be built into the system to allow switching to the contact stabilization mode of operation, particularly if the wastewater flow rate or quality will have significant seasonal variations.

3. Water depths in aeration tanks may be less than 10 feet, in accord with lesser design flow. Tank width to depth ratio shall be between 1.0 and 1.7. Minimum ratio of tank length to width shall be 2.0. A minimum of 18 inches of freeboard shall be provided.
4. Total aeration tank volume shall equal the design capacity of the plant or 1,000 cubic feet per 15 pounds of BOD 5 applied on a daily basis, whichever results in the greater volume.

5. The air diffuser system and supply piping shall be capable of supplying 2,000 cubic feet of air per pound of BOD.

6. Air blowers may be of the positive displacement or of the centrifugal type. Air requirements may be met by two interconnected blowers, each capable of supplying normal air requirements. Three blowers, each capable of supplying one-half of the normal air requirement are recommended. Consideration should be given to providing dedicated blower(s) for air lift pumps, to allow separation of aeration and sludge return operations.

7. Return activated sludge facilities shall be capable of returning from 50 to 150 percent of the plant design flow. Return shall be to the head of the plant. Provision shall be made for rate regulation and measurement.

8. Provision shall be made to control the mixed liquor suspended solids in the aeration tank by wasting return activated sludge.

9. A sludge holding tank, preferably with decant capability, shall be provided. A minimum, of 1,000 gallons capacity per 15,000 gallons design flow is recommended. There must be access to the sludge draw off piping on small systems, sludge wasting from the sludge holding tank is generally necessary every 8 to 12 months. Disposal of waste sludge must be in accord with currently accepted practice as described in Section G of this document.

CONTACT STABILIZATION

As pointed out at the beginning of this section, New York's municipal sewerage standards shall govern, except for requirements and allowances listed herein, which shall be considered to supersede them:

1. Shall be considered only when the design flow is at least 50,000 gallons per day. Process efficiency for dilute wastes, and waste waters with high levels of soluble BOD is questionable.

2. Primary settling is not usually necessary.

3. Total contact plus sludge reaeration tank volume shall provide not less than 1,000 cubic feet per 505 pounds of BOD applied to the aeration tanks on a daily basis, or a total volume equivalent to six hours detention time based on rated design capacity, whichever results in the greater value.

4. The number of tanks and flow pattern shall be such that 2/3 of the total volume will be available for sludge reaeration and 1/3 for contact with sewage at the design rate.
Tank duplication requirements will be satisfied by three tanks arranged so that any one may be dewatered for service while one of the remaining tanks is used for sludge reaeration and one is used for sewage contact. Additional flexibility should be built into the system to allow switching to the extended aeration mode of operation, particularly if the wastewater flow rate or quality will have significant seasonal variations.

**ROTATING BIOLOGICAL CONTACTORS**

As pointed out at the beginning of this section, New York's municipal sewerage standards shall govern, except for requirements and allowances listed herein, which shall be considered to supersede them:

1. **Pretreatment** - RBCs should be preceded by properly designed settling facilities. Fine screening is also acceptable as pretreatment, provided compliance with removal and effluent requirements can be demonstrated. Efficient grease and scum removal devices should be provided, especially when influent grease loads are high. Flow equalization must be provided when the ratio of peak (maximum instantaneous) to average daily flow exceeds 2.5.

2. **Staging** - At least 4 stages shall be provided for secondary treatment applications. Additional stages may be necessary for nitrification and further BOD removal. For small installations, up to 4 stages can be provided on a single shaft by installing interstage baffles in the tank, with the direction of flow parallel to the shaft.

3. **Media** - On a normal 27 ft. shaft with media diameter of 12 ft., standard density media is considered to be 100,000 sq. ft. of surface area, and high density is 150,000 sq. ft. of surface area. High-density media should not be used in the first two stages of the system. At least 35% of the media should be submerged.

4. **Organic Loading** - First stage loadings may range from 2.5 to 4.0 lbs of soluble BOD/day/1000 sq. ft., but loadings less than 3.0 lbs of soluble BOD5/day/1000 sq. ft. are recommended. Higher loading rates require increased process control to avoid structural overloading and/or operational problems.

5. **Nitrification** - Four or more stages are usually necessary when nitrification is desired in addition to BOD removal, because maximum nitrification rates will not be obtained until the level of soluble BOD drops to 10 mg/l or less. For design purposes the average maximum removal rate should not exceed 0.3 lb NH3-N/day/1000 sq. ft. of media.

Where large and/or frequent peaks in flow or organic loading are anticipated, consideration should be given to providing either additional media or flow equalization to ensure consistently low ammonia nitrogen levels.
The temperature of the system should be maintained at or above 550°F. If this is not possible, additional media should be provided to compensate for reduced removal rates. The system pH must be held between 7.1 and 8.6. If the wastewater is poorly buffered the system should have the capacity for the addition of alkaline chemicals.

6. **Pilot Plant Studies** - When possible, full-scale diameter media should be used for pilot plant studies. If small diameter units are used, each stage should be loaded at or below the oxygen transfer capability of a full-size diameter unit to minimize scale-up difficulties.

7. **Monitoring** - Load cells for measuring total shaft weight must be provided for at least the first and second stages. Electronic strain gauge load cells are preferable, but hydraulic load cells may also be used.

Dissolved oxygen levels should be monitored in at least the first stage of the RBC system.

8. **Enclosures** - Either permanent buildings or covers may be used to protect the RBC units from sunlight and winter weather. Enclosures must provide ready access to the RBC units for observation and minor repairs. Buildings shall have adequate ventilation, heating, and humidity control, and an internal hoisting device is recommended for removal of the shaft/media assembly. Covers should be made in removable sections, or have some other means of allowing removal and replacement of the shaft/media assembly.

9. **Equipment** - Drive systems should be variable speed and may be mechanical or air drive, although mechanical systems are preferred. Air drive systems should have positive airflow metering and control to each RBC unit.

Bearing units shall be self-aligning and should be located outside of media covers to allow easy access for lubrication and maintenance.

Provision for auxiliary power during power outages is recommended as overloads may occur when the discs do not rotate.

10. **Design/Configuration** - Operation and maintenance requirements (including biofilm control, drive train and radial support arm maintenance and repair, and media/shaft repair and replacement) must be considered in the design and layout of RBC treatment systems. Provision should be made for positive flow control to each stage, allowing flexibility in feeding and discharge. Tank depth/configuration should be such that solids are not deposited in the tank. Also, provision should be made for draining the tank.

Large installations with closely space RBC units may need a crane for shaft/media removal. System layout must account for crane reach and size.
11. **Flexibility** - Overloads generally can be avoided if flexibility is designed into the RBC system. Flexibility can be achieved by having variable rotational speed, the ability to periodically reverse rotational direction, supplemental aeration, and the potential for chemical addition (ex.: hydrogen peroxide or chlorine). Capability for step feeding or the ability to increase the surface area in the affected stage (by the addition of new units or changes in flow routing) should also be considered.

12. **Settling** - Final settling shall provide a detention time not less than 90 minutes, with maximum surface settling rate of 600 gpd/sq. ft. and weir overflow rate not greater than 5000 gpd/lineal ft. Higher surface settling and weir overflow rates may be used if the contactor is to be followed by tertiary treatment.

**OXIDATION DITCHES**

As pointed out at the beginning of this section, New York's municipal sewerage standards shall govern, except for requirements and allowances listed herein, which shall be considered to supersede them:

1. Raw sewage shall be comminuted or fine-screened prior to discharge into the oxidation ditch.

2. Design of the ditch or ditches shall be based upon 24-hour retention of the design flow or 1,000 cubic feet per 15 pounds BOD 5 applied, whichever results in the greater volume.

3. Aerators are usually of the partially submerged rotating-brush type. When provided with this type of aeration the submergence shall be adjustable, and at least two complete units shall be provided (either located in the ditch or stocked as a spare unit). Alternative aeration schemes may be acceptable, but only upon demonstration of proper aeration and mixing capabilities by the engineer.

4. Final settling shall be designed to provide a detention time of not less than four hours, a weir overflow rate not greater than 10,000 gpd/lineal ft., and a surface settling rate not greater than 1,000 gpd/sq. ft.

5. Pumps or airlift may be used for return sludge. Pumps should have at least 2-1/2 inch suction and discharge openings. Return piping should be at least 3 inches in diameter. Airlifts should be at least 3 inches in diameter.

6. Waste sludge storage for at least six months volume should be provided.

7. Duplicate units are not mandatory.
A modification of the oxidation ditch called the intrachannel clarifier (a.k.a. BMTS system) combines aeration and clarification in one basin. Design shall be based on a 10-hour hydraulic detention, thus reducing basin volume. Because of limited experience, each system will be judged on a case-by-case basis.

**LAGOONS**

As pointed out at the beginning of this section, New York's municipal sewerage standards shall govern, except for requirements and allowances listed herein, which shall be considered to supersede them:

1. A comminutor or bar screen shall be provided upstream from the influent line conveying raw sewage or waste into an aerated pond system.

2. Minimum separation from habitation or other occupied area for an aerated pond should be 1,000 ft.

3. Multiple cells designed to permit both series and parallel operation are recommended for all aerated ponds. For unaerated ponds, series operation is preferable to parallel operation.

4. For very small installations, a dike top width of less than 8 feet may be considered.

5. Influent lines or interconnecting piping to secondary cells of multiple-celled ponds operated in series may consist of pipes through the separating dikes.

6. The use of multiple inlets/outlets, baffles, and dikes is encouraged to prevent short circuiting. Influent lines to rectangular ponds should terminate at approximately the third point farthest from the outlet structure, if only a single inlet or outlet are provided.

7. For unaerated ponds, interconnecting piping for multiple unit installations operated in series should be valved or provided with other arrangements to regulate flow between structures and permit flexible depth control. The interconnecting pipe to the secondary cell should discharge horizontally near the lagoon bottom to minimize need for erosion control measures and should be located as near the dividing dike as construction permits.

8. Control manholes or other such flow-splitting facilities should be provided between cells of aerated ponds to provide a positive visual means of directing and controlling the flow.

9. Overflow structures should consist of a manhole or box so designed that flow from the pond during ice-free periods could be taken from below, but near, the water surface so as to select for release the best quality effluent available and insure the retention of floating solids.
For unaerated ponds the draw off lines or an adjustable overflow device should permit pond operation at depths of 2 to 5 feet, with the lowest draw off 12-inches above the bottom to control eroding velocities and avoid pick-up of bottom deposits.

10. A locking device should be provided to prevent unauthorized access to and use of the level control facilities. Wherever possible, the outlet structure should be located on the windward side to prevent short circulating. Consideration must be given in the design of all structures to protect against freezing and ice damage.

11. Stream hydrograph controlled release lagoons (HCRs) discharge effluent according to the current assimilative capacity of the stream. Release is usually based on stream flow, but water quality and temperature also may be considered. A review of site specific stream information and predicted effluent quality will be necessary to determine at what stream flow rates a discharge will be allowed.

12. In a multiple cell facility with a diffused air aeration system and submerged air headers, consideration must be given to arranging the overflow structure and piping to allow for independent drainage of each cell down to or below the level of the air header.

**HIGH-RATE EFFLUENT FILTRATION**

Granular media filters may be used for secondary treatment or as a tertiary treatment device for the removal of residual suspended solids from secondary effluents. A pretreatment process such as chemical coagulation and sedimentation or other acceptable process should precede the filter units where: (1) effluent suspended solids requirements are less than 10 mg/l, (2) secondary effluent quality can be expected to fluctuate significantly, or (3) filters follow a treatment process that generates significant amounts of algae. Care should be given to the selection of pumping equipment ahead of filter units to minimize shearing of floc particles. Consideration should be given to providing flow equalization facilities to moderate filter influent quality and quantity.

Because operation and maintenance requirements may be significant, high-rate filters shall not be allowed for intermediate-sized treatment facilities except where it can be demonstrated that the required supervision will be provided.

**Filter Units**

Filters may be of the gravity type or pressure type. Pressure filters shall be provided with ready and convenient access to the media for treatment or cleaning. Where greases or similar solids which result in filter plugging are expected, filters should be of the gravity type.
**Filtration Rates**

Filtration rates shall not exceed 3 gpm/sq. ft. when used as tertiary treatment and 1 gpm/sq. ft. when used as secondary treatment (based on the maximum hydraulic flow rate applied to the filter units). Total filter area for secondary treatment shall be provided in two or more units. Filtration rate shall be calculated on the total available filter area with one unit out of service, except when justified by volume and size of installation.

**Backwash**

The backwash rate shall be adequate to fluidize and expand each media layer a minimum of 20 percent based on the media selected. Provision shall be made for a minimum backwash period of 10 minutes. Pumps for backwashing filter units shall be adequate to provide the required rate with the largest pump out of service. Filtered water should be used as the source of backwash water. Waste filter backwash water shall be treated.

**Filter Media**

Selection of proper media size will depend on the filtration rate selected, the type of treatment provided prior to the filter, filter configuration, and effluent quality objectives. In dual or multimedia filters, media size selection must consider compatibility among media.

Table 9 provides a listing of the normally acceptable range of media sizes and minimum media depths. The uniformity coefficient of the media shall be 1.7 or less. The designer has the responsibility for selection of media to meet specific conditions and treatment requirements relative to the project under consideration.

**Table 9. Media Sizes and Minimum Depths**

<table>
<thead>
<tr>
<th>Media</th>
<th>Single Media</th>
<th>Dual Media</th>
<th>Multi-Media</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Size (mm)</td>
<td>Depth (inch)</td>
<td>Size (mm)</td>
</tr>
<tr>
<td>Anthracite</td>
<td>-</td>
<td>-</td>
<td>1.0-2.0</td>
</tr>
<tr>
<td>Sand</td>
<td>1.0-4.0</td>
<td>48</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>Garnet or Similar</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Filter Appurtenances**

Gravity filters shall be equipped with washwater troughs, surface wash or air scouring equipment, means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, positive means of shutting off flow to a filter being backwashed, and filter influent and effluent sampling points.
If automatic controls are provided, there shall be a manual override for operating equipment, including each individual valve essential to the filter operation. The underdrain system shall be designed for uniform distribution of backwash water (and air, if provided) without danger of clogging from solids in the backwash water. Provision shall be made for periodic chlorination of the filter influent or backwash water to control slim growths.

Pressure filters shall be equipped with means of measurement and positive control of the backwash rate, equipment for measuring filter head loss, valving to isolate filter being backwashed, filter influent and effluent sampling points, and sight glass on backwash discharge line. Provision for manual override of automatic controls, facilities for uniform distribution of backwash water, and provision for chlorine application, must be supplied for pressure filters as specified for gravity filters.

**Reliability**

Each filter unit shall be designed and installed so that there is ready and convenient access to all components and the media surface for inspection and maintenance without taking other units out of service. The need for housing of filter units shall depend on expected extreme climatic conditions at the treatment plant site. As a minimum, all controls shall be enclosed, and the structure housing filter controls and equipment shall be provided with adequate heating and ventilation equipment to minimize problems with excess humidity.

**Backwash Surge Control**

Backwash shall be returned to the head of the plant. The rate of return of waste, filter backwash water to treatment units shall be controlled such that the rate does not exceed 15 percent of the design average daily flow rate to the treatment units. The hydraulic and organic load from waste backwash water shall be considered in the overall design of the treatment plant. Surge tanks shall have a minimum capacity of two backwash volumes, although additional capacity should be considered to allow for operational flexibility. Where waste backwash water is returned for treatment by pumping, adequate pumping capacity shall be provided with the largest pump out of service.

Surge tanks may be eliminated if flow equalization, with proper capacity, is used in the treatment scheme in which case backwash should discharge directly to the equalization tank.

**Effluent Clearwell**

An effluent clearwell, or other unit following filtration, having a minimum capacity of one backwash volume per filter shall be provided as a backwash water supply for multiple filter systems. If flow equalization is used, volume shall be 1/2 of the above. For single filters, volume for two backwashes must be provided.
Proprietary Equipment

Where proprietary filtration equipment not conforming to the preceding requirements is proposed, data which supports the capability of the equipment to meet effluent requirements under design conditions must be provided. Such equipment shall be reviewed on a case-by-case basis at the discretion of the regulatory agency.

HOLDING TANKS

Holding tanks will not be allowed for year-round usage on a permanent basis. Holding tanks may be approved on a case-by-case basis for seasonal operations or temporary usage while building or repairing permanent treatment facilities. Evidence of an agreement with a professional hauler for disposal of the waste (see Section G of the document) is necessary prior to approval of holding tank installation. Also, if the holding tank waste is to be treated at a wastewater treatment plant, the plant must provide a written statement to this effect prior to approval. The holding tank must have a capacity equal to at least twice the volume of waste to be generated between anticipated removal dates, with a minimum volume of 1000 gallons. Installation of a high water alarm positioned to allow storage of at least three days volume of waste after activation is recommended. A cover over the tank or other method of odor control may be necessary. If winter usage is planned, the tank must be protected from freezing.
E. SUBSURFACE TREATMENT AND DISCHARGE

INTRODUCTION

Subsurface disposal via soil absorption system will not be allowed if the required depths from the bottom of the system to seasonally high groundwater, creviced or porous bedrock, or impervious strata given in Section B of this document are not available. Standards for uncommon types of absorption systems (gallies, gravelless trenches, varieties of raised beds and nitrifying systems) are not presented here. These systems will be judged on a case-by-case basis by the reviewing engineer.

The minimum pretreatment allowed prior to an absorption system is settling in a septic tank, although a greater degree of treatment may prolong the life of the system and may be necessary for unusual types of wastewater. All stormwater runoff shall be diverted away from the absorption system both during and after construction. Roof, foundation, cellar, and garage floor drainage shall not be allowed to enter a subsurface disposal system.

Planting of shrubs (especially evergreen types), lawn grass, and other shallow-rooted plants over the disposal field area is recommended. Trees shall not be planted over an absorption system. Also, no building shall be done (including driveways) and no heavy equipment (cars, tractors, trucks) shall be allowed over an absorption system, or down-slope from a system where system failure from soil compaction or effluent daylighting may occur.

APPLICATION RATES

Design of soil absorption systems should be based on the results of the site evaluation as outlined in Section B. Recommended maximum sewage application rates for various percolation rates are shown in Table 10. The soil types listed in Table 10 are included as a guide to potential percolation rates, although local factors such as soil structure and surface topography may cause actual percolation rates to differ from this ideal. Percolation test results that do not agree with local characteristics established during the soil/site evaluation may not be used for sizing an absorption system. It may be necessary to reduce wastewater application rates for difficult wastes such as kitchen wastewaters, and to avoid problem with groundwater mounding.
Table 10. Recommended Sewage Application Rates

<table>
<thead>
<tr>
<th>Percolation Rate (min/inch)</th>
<th>Soil Type</th>
<th>Application Rate (gal/day/sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1</td>
<td>Gravel, Coarse Sand</td>
<td>Not suitable a</td>
</tr>
<tr>
<td>1-5</td>
<td>Coarse-Medium Sand</td>
<td>1.20</td>
</tr>
<tr>
<td>6-7</td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>8-10</td>
<td>Fine Sand, Loamy Sand</td>
<td>0.90</td>
</tr>
<tr>
<td>11-15</td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>16-20</td>
<td>Sandy Loam, Loam</td>
<td>0.70</td>
</tr>
<tr>
<td>21-30</td>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td>31-45</td>
<td>Loam, Porous Silt Loam</td>
<td>0.50</td>
</tr>
<tr>
<td>46-60</td>
<td></td>
<td>0.45b</td>
</tr>
<tr>
<td>61-120,</td>
<td>Silty Clay Loam, Clay Loam</td>
<td>0.20</td>
</tr>
<tr>
<td>&gt; 120</td>
<td>Clay</td>
<td>Not Suitable</td>
</tr>
</tbody>
</table>

a) May be suitable if either a modified absorption system or enhanced treatment prior to discharge is utilized.

b) Careful site analysis is necessary to show that these soils will transmit the flow of wastewater. Extreme caution must be used to avoid damage to the site during construction or the system will fail. Surface discharge of the wastewater may be preferable in many cases.

Conventional absorption systems preceded solely by septic tanks should not be used for rapidly permeable soils with percolation rates faster than 1 min/inch as treatment provided may not be sufficient to protect nearby water supplies from contamination by nitrates, detergents, or other chemicals. Information submitted by the engineer must demonstrate that a modified absorption system will provide the degree of treatment necessary for the target compound(s). Also, conventional absorption systems should be avoided if the percolation rate is slower than 60 min/inch, especially if other difficult factors are present such as steep slopes, depressions, or high groundwater or bedrock. Conventional absorption systems shall not be permitted if the percolation rate is slower than 120 min/inch.

If it can be reasonably expected that the site will be served by public sewers within five years, higher application rates may be allowed. This allowance will be judged on a case-by-case basis by the reviewing engineer.

**ADVISORY FOR FAST SOILS IN SPECIFIC AQUIFER AREAS**

The application rates given in Table 10 may not be sufficient to protect groundwater in soils with percolation rates faster than 10 min/inch which overlie aquifers designated by New York State as Primary Water Supply Aquifers and Principal Aquifers. In these areas, extra protection may be
required to prevent degradation of groundwater quality. When the design population density exceeds 2 to 4 dwelling units/acre (6 to 11 persons/acre) it is probable that recharge water to the aquifer from conventional subsurface disposal systems will exceed the nitrate standard for drinking water. Although NYSDEC does not make zoning regulations, it is recommended that population densities be kept below this level unless local factors are such that it can be shown that the project will not result in groundwater degradation either alone, or in combination with other discharges (including fertilizers and pesticides that are leached from the ground surface).

If the population density exceeds 11 persons/acre, absorption system design should be modified to provide enhanced treatment of the wastewater by the soil system, or additional treatment should be provided prior to subsurface discharge.

The average population density may be calculated based upon the total land area of the development. For example, in addition to land that dormitories are on, playing fields would be included when determining the average population density for a boarding school.

**DISTRIBUTION NETWORKS**

**Methods of Distribution**

Gravity distribution is the most commonly used type of network and results in trickle flow as effluent is displaced from the pretreatment unit. For distribution by dosing, the effluent is collected and dosed through a gravity flow network using pumps or siphons. Dosing is recommended on level sites to prevent premature clogging of portions of the absorption system. A pressurized network is necessary to achieve uniform application, and should be used for rapidly permeable soils with percolation rates less than 10 min/inch. A dosed or pressurized distribution system shall be used if the percolation rate is slower than 60 min/inch, or if the system contains a total of over 500 feet of pipe, or if laterals are over 100 feet long.

**Network Types**

1) Single line networks can be used in trenches with gravity flow or dosing. If the line is greater than 100 ft. long, the inlet from the pretreatment unit should be at the midpoint of the line. No line shall be longer than 200 feet.

2) Closed loop networks can be used for bed or trench systems with the infiltrative surface all at one elevation. Spacing between lines should be at least 3 feet. Dosing of these systems is strongly recommended.

3) Distribution boxes can be used for gravity flow or dosing in multitrench or bed system, but should be restricted to sites with slopes less than 5 percent. The invert of the inlet should be at least 1 inch above the outlet inverts.

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All outlets should be at the same elevation and the slope of the outlet lines should be the same for 10 feet beyond the box. It is recommended that outlet inverts be placed at least two inches above the floor of the box so that water placed in the box can be used for leveling purposes. Baffles may be necessary to prevent short-circuiting, especially in dosed systems.

4) Drop boxes are recommended for gravity distribution on slopes greater than 5 percent, as they are less likely to result in surface seepage than distribution boxes. The invert of the overflow should be at the same level, or up to 2 inches above the crown of the distribution line outlet. The inlet invert should be at the same level or above the overflow.

5) An inverted network is similar to conventional gravity flow except that the holes are placed at or near the crown of the pipe. A watertight sump should be located at both ends of an inverted line to facilitate periodic removal of accumulated solids. These systems must be dosed, and should have provision for drainage back to the dosing chamber. Because maintenance requirements are significant, inverted networks shall not be allowed except where it can be demonstrated that the required maintenance will be provided.

6) Pressurized distribution uses small diameter pipe with perforations. The volume of water that flows out each hole must be approximately equal. This requires that 75 to 85 percent of the head loss in the network must be lost when the water passes through the holes. On sloped sites, the difference in total head within each lateral must be taken into account.

Hole size should be within the range of 1/4 inch to 5/6 inch; the maximum allowable hole spacing is 10 feet, but no more than 6 feet is recommended. The perforation at the end of the lateral should be drilled horizontally in the endcap near the crown of the pipe to facilitate venting. In beds with pressure distribution the lateral spacing should be approximately equal to the perforation spacing, and holes on adjacent laterals should be staggered so that they lie on the vertices of equilateral triangles.

The dosing volume for pressure distribution should be 5 to 10 times the network pipe volume. If duplicate pumps are not provided, the dosing chamber should have a reserve capacity above the active dosing volume equal to one day's average flow.

**Materials and Construction**

For nonpressurized systems, 4-inch perforated pipe of concrete or plastic is recommended. A wide variety of PVC or ABS pipe designated by ASTM as sewer or drainpipe may be considered. A pressurized system should use 1 to 3 inch PVC (ASTM D 2665) or ABS (ASTMD 2661) pipe. A minimum in-line pressure of 2.5 feet will allow for deviations from level of up to 3 percent. Pressurized system must be placed so that the laterals and manifold drain after every dose.
Watertight distribution boxes are available in fiberglass and plastic, but concrete is recommended. The box must be placed level, with a layer of sand or pea gravel 12 inches deep below the box, and around the sides. A slope of at least 1/8 inch per foot must be maintained from the pretreatment unit to the box.

Dosing chambers must be watertight, and may be constructed of concrete, fiberglass, or plastic. Automatic dosing devices or pressurized distribution must be used in system having a total of over 500 feet of distribution pipe or in which laterals are longer than 100 feet.

Installations with more than 1000 feet of trench shall be constructed in two or more sections such that no section contains over 1000 feet of pipe. The capability to dose each section separately shall be provided. Either a pump or dosing siphon may be used and shall have a capacity sufficient to fill at least 75 percent of the interior volume of the lines being dosed. A dosing device should have a capacity of at least 125 percent, and preferably 200 percent, of the maximum rate of inflow to the dosing chamber.

Dosing tanks should be arranged for convenient access and inspection. If possible, dosing devices should be designed to function by gravity in case of mechanical or power failure.

If multiple dosing devices are used, valving should be provided to allow each section of the system to be dosed by any one of the dosing devices.

Dosed systems (pressure and siphon types) should have provisions to prevent the flow of wastewater out of vents in the piping network.

**ABSORPTION TRENCHES/BEDS**

Absorption trenches are used to disperse sewage over a wide area to enhance treatment and disposal by seepage into the ground. In order to distribute the sewage evenly over the entire bottom area of the trench the perforated pipe is laid in a layer of washed gravel or crushed stone. A typical absorption trench layout is shown in Figure 7. Absorption beds are similar to absorption trenches, except that they are wider, and contain more than one distribution lateral as shown in Figure 8.

Trenches are strongly recommended instead of beds, especially in soils with high clay content or where groundwater flow patterns are horizontal. Long distribution laterals parallel to the site contour are recommended. Trenches may be placed on slopes of up to 20%, but beds should be limited to sites with slopes no greater than 5%. If it can be demonstrated that the site has the necessary assimilative capacity, trench systems may be built on slopes steeper than 20%. Under these conditions, special construction techniques (e.g., terracing or hand digging) may be necessary.

Trenches must be sized in accordance with the application rates given in Table 10. Application rates for beds shall be no more than 75% of the rate allowed for trenches on the same site. The effective area for disposal will be the bottom area of the trenches or beds.
Design trench width shall be 2 feet, while beds shall be wider than 3 ft. The width of an absorption bed should not exceed 15 feet. Trench depth should be between 18 and 30 inches; in most cases depths of less than 24-inches are preferred.

Traditionally, severe restrictions have been imposed upon trench length because of fears of root penetration, uneven settling, or pipe breakage disrupting the flow. However it has been shown that the aggregate actually transmits the wastewater, and so laterals up to 100 ft. shall be considered acceptable. Longer lengths may be permitted if site conditions allow. Pressurized distribution or dosing are recommended if laterals are longer than 60 feet, and shall be required if laterals are longer than 100 feet.

The minimum distance between walls of adjacent trenches should be 4 feet. Separations of 6 feet are desirable to provide a reserve absorption area.

Trenches must be laid out parallel to the site contours. When stepped trenches are used, it is important that the first length of all distribution lines leading from the distribution box to the trenches be laid with the same slope. The bottom of the trench shall be dug level in the longitudinal and transverse directions, and should be raked prior to placement of the washed gravel or crushed stone. In a dosed or pressurized trench system the distribution lines shall be level; otherwise a slope of between 1/32 and 1/16 inch/foot (0.25 to 0.5%) should be maintained. The ends of the laterals must be capped. For beds, center-to-center spacing of distribution pipes shall be 5 feet or greater. The floor of the bed and the distribution lines shall be level and the ends of the laterals shall be interconnected. Distribution systems should be hand-leveled.

At least 6-inches of graded gravel shall be placed beneath the distribution pipes, and an additional 2 inches shall be placed above the pipes. A barrier material must be placed above the stone to prevent the backfill from clogging the aggregate. This material may be synthetic drainage fabric (permeable geotextile) or untreated building paper. Backfill over the barrier material shall be at least 6-inches and no more than 12-inches deep, and should consist of natural soil.

Absorption trenches/beds shall not be built under paved areas. Also, every effort should be made during construction to avoid smearing or compacting the bottom area or sidewalls. Backfilling should be done carefully to avoid pipe breakage.

Consideration should be given to constructing the absorption system in three sections, with each section capable of handling 50 percent of the design flow. The third section should be alternated into service on a semianual or annual schedule. This will extend the life of the system, and provide a standby unit in case of failure. The reviewing engineer may allow a 20 percent reduction in total absorption area for alternating systems.
FIGURE 7. CONVENTIONAL ABSORPTION TRENCH

(a) SLOPING GROUND

(b) LEVEL GROUND

(c) DETAILS

OVERFILL TO ALLOW FOR SETTLEMENT

GRANED GRAVEL 3/4" - 1 1/2"

BACKFILL

BARRIER MATERIAL

DISTRIBUTION PIPE

FROM S.T.

DISTRIBUTION BOX

TIGHT PIPE

4" LATERALS

MAX. SLOPE 1/16" PER FOOT

48" MIN.

24" MIN.

ENDS MUST BE GAPPED

FROM S.T.

DISTRIBUTION BOX

TIGHT PIPE

48" MIN.

24" MIN.
FIGURE 8. CONVENTIONAL ABSORPTION BED
SALLOW ABSORPTION TRENCHES

Shallow trenches are particularly useful in areas where permeable soil is present above moderately high groundwater, porous or creviced bedrock, and/or an impermeable layer. The site evaluation (see Section B) must show that there will be sufficient depth to these boundary conditions from the bottom of the proposed system. Construction and sizing shall be the same as for conventional absorption trenches, except that the trench shall be only 6 to 12 inches deep as shown in Figure 9. Backfill above the system should be of, or similar to, the native soil. Side slopes of the resulting hummock shall be no steeper than 3 feet horizontal to 1 foot vertical.

FIGURE 9. SHALLOW ABSORPTION TRENCH

Fill Systems

Fill system may be useful when:

1. Slowly permeable soils such as clay or clay loam overlie more permeable soils, or

2. Soils are so rapidly permeable that insufficient treatment will occur before the wastewater reaches porous or creviced bedrock or groundwater.

The site evaluation (see Section B) must show that it is possible to maintain the required depths to seasonally high groundwater, porous or creviced bedrock, and/or an impermeable layer beneath the proposed system. The necessity of installing curtain drains, underdrains, or vertical drains to prevent the flow of water into the filled area from shallow, laterally flowing groundwater or perched water tables should be investigated. Figure 13 shows some examples of these drainage methods.

When slowly permeable soil overlies more rapidly permeable soil, the slowly permeable soil should be stripped away and replaced with a fill that is similar in texture to the underlying soil. To enhance treatment in fast soils, the fill should have a percolation rate of 10 to 30 minutes/inch,
and should extend to a depth of at least two feet below the bottom of the proposed trench. The filled area should extend at least 5 feet in each direction from the sidewalls of the proposed trenches as shown in Figure 10, to allow some lateral movement of the wastewater.

![Figure 10. Fill System](image)

**FIGURE 10. FILL SYSTEM**

If the fill depth is greater than 4 feet, the fill must be allowed to settle before construction. Depending on the fill type and depth, as much as a full year may be necessary for natural settling. To avoid delay the fill may be spread in thin layers and mechanically compacted, but care must be taken to avoid creating layers of different density.

Coarse sands and gravels (up to a maximum size of 1-1/2 inches) should settle to at least 85 percent of the standard proctor density. Fine sands, silty sand, sandy clay, and sandy loam should settle to at least 90 percent of the standard proctor density. The percent standard proctor density can be determined by measuring the in-place dry density of the fill (using ASTM Test Method D 1556) and dividing the result by the maximum dry density of the fill (ASTM Test Method D 698). An alternative testing method for soil density (as specified by ASTM) may be acceptable if it can be shown to be more appropriate to local conditions.

Construction and sizing of the trenches in the fill shall be the same as for conventional absorption trenches. The application rate should correspond to the natural percolation rate of the fill. The texture of the backfill material used to cover the system shall be no more coarse than the fill material. The original slowly permeable soil may be used.

Dosing or pressure distribution is encouraged to achieve uniform distribution throughout the absorption area and thus ensure adequate treatment of the wastewater.
MOUND SYSTEMS

A mound is a soil absorption system that is elevated above the natural soil surface in fill material. Mounds may be used when conditions preclude the use of conventional absorption system. These conditions include slowly permeable soils, shallow soils over pervious or creviced bedrock, and soils with high water tables. The use of mounds is not encouraged, and will only be allowed when no other method of subsurface disposal is feasible.

The design of a mound is complicated and should be done only by a qualified engineer, preferably one who is experienced in designing mounds. The services of a qualified hydrogeologist or other soil scientist may also be necessary. Guidelines provided by the University of Wisconsin Small Scale Waste Management Project should be considered when designing a mound, although the requirements and allowances herein shall be considered to supercede them.

Failure or success of a mound is highly dependent on construction quality. It is strongly recommended that the design engineer make provision for continual surveillance of construction activities.

Site Evaluation

Table 11 lists site criteria for severe and nonsevere sites. Experience with mounds is limited on severe sites. The use of mounds on severe sites is not recommended, but may be allowed on an experimental basis provided that the owner and/or developer is aware of the potential risks involved.

Mounds can be separated into large and small system. Systems less than 5000 gpd on nonsevere sites shall be considered small. System less than 5000 gpd on severe sites, and systems greater than 5000 gpd shall be considered large, and require a more detailed design technique.

Soils and site testing must be sufficient to characterize the hydraulic capacity of the site to treat and transmit the flow, to determine the ultimate destination of the groundwater (wells, surface water, etc.), and to demonstrate that the groundwater and its ultimate use will not be adversely impacted. For all mound system a minimum of two percolation tests shall be performed within the basal area of the mound. At least one backhoe pit must be dug to accurately establish the nature of the subsurface layers and maximum groundwater level. If soil stratigraphy is variable across the site, core samples may be required to verify the soil conditions shown in the backhoe pit (s).
Table 11. Site Criteria for Mounds

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Nonserve Sites</th>
<th>Severe Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape Position</td>
<td>Well drained level or sloping areas. Crests of slopes or convex slopes are preferred. Avoid depressions, bases of slopes, and concave slopes.</td>
<td>Depressions, bases of slopes, concave slopes may be considered if suitable drainage is provided</td>
</tr>
<tr>
<td>Percolation Rate</td>
<td>0-60 min/inch</td>
<td>60-120 min/inch</td>
</tr>
<tr>
<td>Slope</td>
<td>0-6% If percolation rate slower than 30 min/inch</td>
<td>Up to 20%</td>
</tr>
<tr>
<td>Depth to Water Table (Minimum)</td>
<td>12 inches</td>
<td>&gt; 0 inches</td>
</tr>
<tr>
<td>Depth to Pervious or Creviced Bedrock (Minimum)</td>
<td>24 inches</td>
<td>24 inches</td>
</tr>
<tr>
<td>Depth to Impermeable Barrier (Minimum)</td>
<td>3 feet ^a,b</td>
<td>3 feet^a</td>
</tr>
</tbody>
</table>

a) Slowly permeable soils, cold climates, and square mounds require greater depth.

b) Less than three feet may be allowed for very small facilities (less than 2000 gpd) if substantial proof that the site has the hydraulic capacity to treat and transmit the flow is provided by the engineer.

An extensive site evaluation is required for large mound systems, and shall be sufficient to establish surface water conditions, infiltration rate, vertical and horizontal saturated hydraulic conductivity, zones of permanent and perched water tables, and groundwater conditions for each of the soil horizons present. The hydraulic conductivity of the expected clogging layer should also be considered. It is recommended that this data be used to model wastewater flows using the lower confidence limits for soil hydraulic characteristics.

Materials

The fill should be a sand that is coarse or on the coarse side of medium according to the USDA classification system (0.35 to 1.mm). The aggregate should be 3/4 to 2-1/2 inch nondeteriorating rock or crushed gravel. Drainage fabric is preferred as a barrier material. Untreated building paper may also be used. The cap should be of a finer grained material such as topsoil, silt loam, or clay loam. A good quality topsoil should be used to cover the entire mound.
**Mound Design - General**

Beds or trenches shall be oriented along the site contour, or along the contour of the bedrock if it is shallow and sloped differently from the ground surface. Trenches shall be used in slowly permeable soils. Trench/bed bottoms must be level. Figure 11 shows the configuration of a typical mound.

The fill shall be placed so as to maintain a minimum of 3 feet of unsaturated flow depth including natural soil. This distance shall be increased to 4 feet over impermeable rock.

To form the absorption area, at least 6-inches of aggregate shall be placed below the distribution pipe, and at least 2-inches shall be placed above the pipe. The size of the absorption area shall be based upon the daily wastewater flow and the recommended infiltration rate of the fill material. The width of the absorption area should not exceed 15 feet.

The barrier material should be placed above the fill and aggregate. The cap and topsoil should be at least 1.5 feet thick at the center of the absorption area, and at least 1 foot deep over the edges of the absorption area. The topsoil should be at least 6-inches deep over the entire mound. The mound slopes shall be no steeper than 3 horizontal to 1 vertical.

Multiple disposal fields are recommended for all systems, and shall be required for all large systems. Three mound areas should be built, each designed to carry 50 percent of the design flow.

The use of groundwater monitoring wells and observation vents in the gravel bed should be considered for monitoring system performance.

**Mound Design - Small Systems**

The important design feature is the basal area, which is the total area beneath the mound for level sites \((L \times W)\), and the down-slope area for sloped sites \((B \times (A+I))\). The required basal area shall be determined by the infiltration rate of the natural soil, but may need to be increased to maintain appropriate side slopes. The recommended loading rates from Table 10 should be used for sizing the basal area. If actual flow data is available for design purposes, the application rates in Table 10 should be reduced by 50 percent. If an impermeable barrier is present within 5 feet of the ground surface, the application rate should be reduced to 0.1 gal/day/sq. ft. unless substantial proof is provided that the site has the hydraulic capacity to treat and transmit the flow at a higher rate.
FIGURE 11. MOUND CONFIGURATION
(SIDE AND SLOPE ARE NOT DRAWN TO SCALE)
**Mound Design - Large Systems**

Large system design is based on determining the maximum acceptance of the land, and designing within this limit. Steps to be followed are:

1. Evaluate the site to identify predicted wastewater flow zones in the soil.

2. Establish the horizontal and vertical boundaries of the system, and determine the boundary acceptance rates.

3. Determine the vertical wastewater application width based on the vertical and horizontal boundary acceptance rates.

4. Determine the linear loading rate based on vertical and horizontal acceptance rates. This is the maximum acceptance rate per linear foot, and must not be exceeded.

5. Determine the basal width of each horizon beneath the mound based on the, linear loading rate and the vertical acceptance rate of each horizon. The basal width of the surface horizon will determine the placement of the mound toe. The ground above the widest basal width must be unused for additional water absorption and unrestricted by driveways, ditches, foundations, etc.

6. Determine the absorption trench/bed width based on the linear loading rate and mound fill infiltration rate.

7. Determine the trench/bed length based on the design flow rate and the linear loading rate.

An example of this procedure using appropriate design equations is given in Appendix III.

**Distribution Systems**

Pressure distribution networks are recommended for all sites, and are mandatory for a large system. The pump should be able to provide 2 feet of head at the distal end of the laterals.

Table 13 lists allowable lateral lengths for several pipe diameters and hole spacing. There shall be one lateral per trench, and no more than 3 laterals per bed.

Mounds should be dosed 2 to 4 times per day, and the dosing volume should be at least 10 times the lateral pipe volume.
Table 13. Allowable Lateral Lengths (Feet):

<table>
<thead>
<tr>
<th>Hole Spacing (inches)</th>
<th>Hole Diameter (1 inch)</th>
<th>1 inch</th>
<th>Pipe Diameter</th>
<th>1-1/2 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>3/16</td>
<td>34</td>
<td>52</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>7/32</td>
<td>30</td>
<td>45</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>1/4</td>
<td>25</td>
<td>38</td>
<td>50</td>
</tr>
<tr>
<td>36</td>
<td>3/16</td>
<td>36</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>7/32</td>
<td>33</td>
<td>51</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>1/4</td>
<td>27</td>
<td>42</td>
<td>54</td>
</tr>
</tbody>
</table>

**Construction Techniques**

Soil moisture at about 7-inch depth should be checked before construction. If the soil can be rolled into a ribbon between one's hands it is too wet, and construction must be postponed.

Trees should be cut to the ground leaving stumps in place. Excess vegetation should be mowed.

The mound site should be plowed perpendicular to the slope with a mold board or chisel plow to a depth of 7 to 8 inches. Rototillers shall not be used except on sandy soils.

The fill should be placed on the upslope and side edges of the mound site, and pushed into place using a small track-type tractor with a blade immediately after the site is plowed. A minimum of 6-inches of fill shall be kept beneath the tracks at all times to minimize soil compaction.

Fill should be placed to the desired depth and the side slopes shaped. The trench/bed can then be formed with the tractor blade. The bottom of the absorption area shall be hand-leveled before the aggregate is placed.

Every effort must be made to minimize traffic on the construction site, especially on the down-slope areas. No truck wheels shall be allowed on the plowed area.

**SEEPAGE PITS**

Seepage pits are usually used for subsurface disposal of sewage where the soil below a depth of 2 or 3 feet is more porous than above this depth, where the subsoil is fairly well drained, and/or where the land area is too limited for other systems. Seepage pits must be preceded by treatment at least equivalent to a septic tank. Figure 12 shows a typical seepage pit.

Seepage pits should not be used where drinking water is obtained from shallow wells, or where the percolation rate is slower than 30 minutes/inch. If the percolation rate is faster than 5 min/inch seepage pits should not be allowed unless extensive pretreatment is provided. Required pretreatment may include biological treatment and disinfection.
FIGURE 12. SEEPAGE PIT

PLAN VIEW

OUTSIDE OR EFFECTIVE DIAMETER

INLET PIPE

12" CLEAN GRAVEL

20" SQUARE OR 24" ROUND MANHOLE

LINING OF 8" x 8" x 16" CONCRETE BLOCKS (Laid without mortar)

SECTION VIEW

GROUND SURFACE

CONCRETE COVER

JOINT WATER tight ABOVE INLET PIPE

INLET PIPE FROM PRETREATMENT

BARRIER MATERIAL

12" THICK RING OF CLEAN GRAVEL AROUND LINING

BLOCK LAID AS SHOWN FOR FOOTING

6" COARSE GRAVEL

36" MIN TO GROUND WATER

EFFECTIVE DEPTH

RISER

12"
The site evaluation must show that it is possible to maintain the required depths (see Section B) to seasonally high groundwater, porous or creviced bedrock and/or an impermeable layer beneath the proposed system.

It is recommended that pits have an effective diameter at least equal to the depth of the pit. The effective diameter shall not be less than 6 feet. Only the sidewall area of the pit structure may be used for sizing the absorption area. Application rates for sizing the necessary sidewall area are given in Table 10. Soil layers with percolation rates slower than 30 minutes/inch must be excluded from the effective depth. Table 14 enumerates the effective absorption area of pits of various dimensions.

**Table 14. Sidewall Areas of Circular Seepage Pits (square feet)**

<table>
<thead>
<tr>
<th>Diameter of Seepage Pit (feet)</th>
<th>Effective Strata Depth Below Inlet (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>9.4</td>
</tr>
<tr>
<td>4</td>
<td>12.6</td>
</tr>
<tr>
<td>5</td>
<td>15.7</td>
</tr>
<tr>
<td>6</td>
<td>18.8</td>
</tr>
<tr>
<td>7</td>
<td>22.0</td>
</tr>
<tr>
<td>8</td>
<td>25.1</td>
</tr>
<tr>
<td>9</td>
<td>28.3</td>
</tr>
<tr>
<td>10</td>
<td>31.4</td>
</tr>
<tr>
<td>11</td>
<td>34.6</td>
</tr>
<tr>
<td>12</td>
<td>37.7</td>
</tr>
</tbody>
</table>

For depths greater than 10 feet, find the area by adding sections.

**Example:**
Area of 15 foot deep pit = Area of 10 foot pit + Area of 5 foot pit.

Where more than one seepage pit is required the pits should be arranged in groups running generally parallel to the site contour lines. The separation distance from sidewall to sidewall between seepage pits shall be at least equal to three times the diameter of the largest pit. The piping from the septic tank must be so arranged as to distribute the sewage uniformly among the pits. The use of a distribution boy, with separate laterals each feeding no more than two pits, is recommended. The pits may not be dosed in series, although an equalization pipe between them is considered desirable. Equalization pipes must be laid level, and should be located in the lower half of the pit.

All seepage pits should meet the following construction requirements:

1. During excavation, smearing and compaction of the sidewall shall be avoided.
2. A layer of coarse gravel 6 to 12 inches deep shall be placed in the bottom of the pit prior to placement or construction of the chamber.
3. Precast concrete rings with large perforations are often used for pit lining. Alternatively, good quality building block can be used as the pit lining. Rectangular block may be used but curved block is preferable. The thickness of the seepage pit lining should be at least eight inches. The walls should be laid close, with no attempt to provide openings between the units. The unevenness of the edges will provide all the space necessary for the sewage to seep into the surrounding soil. Pits with no wall openings are more structurally stable than those with appreciable spaces between units. Fieldstone lining (12-inches thick with open joints) is acceptable.

4. When using eight inch curved block, the bottom of the seepage pit should not be more than 15 feet below ground surface; with 8-inch rectangular block, not more than 10 feet below ground.

5. Below the inlet pipe the space between the pit lining and the earth wall should be filled with clean crushed stone or washed gravel to a thickness of at least 12-inches; stone shall be 1-1/2 to 2-1/2 inches in diameter. Any area between the lining and the wall that is filled with media smaller than 1-1/2 inches shall not be included as part of the effective diameter. A layer of synthetic drainage fabric or untreated building paper should be placed on top of the gravel before soil is backfilled.

6. The cover and walls above the inlet should be watertight. The cover should have the strength to support soil cover and any anticipated load, and must extend at least 12-inches horizontally beyond the excavation. Access to the pit should be provided via a locking watertight manhole extending to the ground surface.

**ARTIFICIALLY DRAINED SYSTEMS**

Artificial drainage lowers high water tables and allows the use of subsurface disposal techniques. Successful design depends on the correct diagnosis of the drainage problem. Four general types of drainage problems are possible. They are: 1) free water tables, 2) water tables over leaky artesian aquifers, 3) perched water tables, and 4) lateral groundwater flow. The initial site evaluation must be extensive enough to distinguish between these problems.

Drainage of an artesian fed water table should not be attempted. Also, sites with slow moving free water tables are not usually practical to drain because closely spaced underdrains with pumped discharges are often necessary.

Shallow, lateral flow problems are the easiest to correct. Curtain drains or vertical drains can be used for this situation. Perched water problems can be corrected using vertical drains or curtain drains. Vertical drains shall only be used if the restrictive soil layer is thin and overlies permeable soil. Vertical drains are not generally recommended because of concern for groundwater quality of deeper aquifers. Figure 13 shows some examples of these drainage methods.
FIGURE 13. SUBSURFACE DRAINAGE METHODS
It is recommended that the drainage system be installed, and its effectiveness tested, prior to approval of sewerage plans. Effectiveness should be tested during spring months.

The minimum horizontal separation distances given in Table 1 for interceptor drains must be maintained between the drain and the absorption system.

Outlets of drains must be protected from entry by small animals, and should prevent entrance of floodwaters where submergence may occur. Outlets should be designed to prevent erosion.

Porous media such as gravel must be placed in drains to a level above the high water table. Fill material at the ground surface should be fine textured to prevent entrance of surface water. Surface inlets via pipes must be avoided wherever possible.

It may be necessary to surround drainage pipes with an envelope filter to prevent clogging. The envelope filter may be an aggregate (gravel and/or sand) filter or a geotextile (fabric filter). Aggregate size or pore size for the geotextile will be critical to the functioning of the filter. Also, geotextiles should be chemically compatible with local conditions.

Relief pipes and/or breathers may be necessary on long curtain or underdrains.
F. SURFACE WATER DISCHARGE

DISINFECTION

The purpose of disinfection is to reduce or eliminate pathogens from sewage that is to be discharged to surface waters used for human contact purposes -i.e., sources of potable water supply, bathing, and shellfish propagation. The most important disinfectants for on-site use are chlorine, iodine, ozone, and ultraviolet light. The use of ozone or ultraviolet light is recommended, as no residual products will be introduced into the wastewater. Prior to approval of a disinfection system it must be demonstrated that the proper supervision and maintenance will be provided.

Requirements

Disinfection shall be provided on a year-round basis for discharges to or adversely impacting all surface waters classified AA, A, and SA, and on a seasonal basis for Class B and SB waters. Specific disinfection needs, including the period of treatment, will be indicated in the SPDES permit for the particular discharge.

Disinfection of wastes discharged into other water classes will not be allowed unless there is a demonstrated actual public health need.

Discharge of chlorinated wastes into waters classified for protection of cold or warm water fisheries will be governed by a maximum in-stream concentration of total chlorine residual of 0.005 mg/l, and 0.05 mg/l respectively. In addition, outfall structures shall be constructed so as not to result in full-channel mixing zones exceeding the 0.005 mg/l total chlorine residual.

Where New York State is a member of an interstate compact, the State will conform with the interstate commissioner's rules on disinfection if they are more restrictive than state requirements.

Chlorination

Disinfection usually is accomplished with liquid chlorine, calcium or sodium hypochlorite, or chlorine dioxide. The chemical should be selected after due consideration of waste flow rates, application and demand rates, pH of waste, cost of equipment, chemical availability, and maintenance problems. Chlorine in a liquid form is usually recommended for on-site system.

Feed systems can be stack or tablet feed, liquid feed, or saturators. Tablet feed systems generally require the least maintenance, and may be preferable for small systems flow rate under 30,000 gpd). Clogging may occur if moisture enters the chamber or if tablets that are too small in size are used. Storage reservoirs should provide ample volume for several weeks of operation.
Equipment capacity should be adequate to produce a concentration of residual chlorine in the effluent so as to dependably and consistently reduce the coliform concentration to that specified in the permit for the installation.

After thorough mixing a minimum contact period of 15 minutes at peak hourly flow or maximum rate of pumpage shall be provided.

Normally a 0.5 mg/l total chlorine residual present after 15 minutes of contact time will be sufficient to reduce the coliform concentration to the acceptable level. Effluent monitoring will indicate if higher levels should be maintained.

The chlorine contact tank should be constructed so as to reduce short-circuiting of flow to a practical minimum. Over-and-under or end-around baffling shall be provided for this purpose. Provision for draining the contact tank for cleaning purposes shall be included. The drain should be valved.

Piping systems should be as simple as possible, specially selected and manufactured to be suitable for chlorine service, and with a minimum number of joints. Piping should be well supported and protected against temperature extremes.

Platform scales of corrosion-resistant material shall be provided for weighing cylinders at all plants using chlorine gas for disinfection.

A bottle of ammonium hydroxide should be available for detecting leaks, where gaseous chlorine is used.

If gas chlorination equipment and chlorine cylinders are to be in a building used for other purposes, a gas-tight partition shall separate this room from any other portion of the building. Doors to this room shall open only to the outside of the building, and shall be equipped with panic hardware. Such rooms shall be at ground level, and should permit easy access to all equipment. Storage areas should be separated from the feed area. Floor drains from the chlorine room shall not be connected to floor drains of other rooms. A clear, gas-tight window in an exterior door or interior wall shall be installed to permit the room to be viewed without entering. The extent of pressurized chlorine gas lines and the need for chlorine evaporators should be limited to avoid accidents.

Hypochlorite liquids and powders may be as dangerous as gaseous chlorine, and similar precautions should be followed. Liquid feed lines should be placed so they will not freeze. Powdered hypochlorite may explode when it contacts an organic material.

All chlorination facilities shall be maintained at a temperature of at least 60°F. Lower temperatures are acceptable where necessary for the proper operation of drop-feed tablet chlorinators. Also all chlorination facilities shall be protected from excessive heat.
Forced mechanical ventilation shall be installed which will provide one complete air change per minute. The entrance to the air exhaust duct from the room shall be near the floor and the point of discharge shall be so located as not to contaminate the air inlet to any buildings or inhabited areas. Air inlets shall be so located as to provide cross ventilation with air and at such temperature that will not adversely affect the chlorination equipment. The vent hose from the chlorinator shall discharge to the outside atmosphere above grade.

All electrical conduits shall be sealed at outlets and fixtures to prevent accidents in the event of a chlorine leak. Consideration should be given to the installation of automatic gas detection and related alarm equipment.

Fresh water shall be available to flush any skin areas that contact liquid or powdered chlorine. A face shield should be worn when working with liquid chlorine, and a breathing mask and face shield shall be used when working with powder.

If a chlorine leak is suspected, no less than two people shall enter the area, and all shall use approved breathing apparatus.

Respiratory protection equipment (air-pac), meeting the requirements of the National Institute for Occupational Safety and Health (NIOSH) shall be available where chlorine gas is handled, and shall be stored in a convenient location, but not inside any room where chlorine is used or stored. Instructions for using, testing, and replacing mask parts, including canisters, shall be posted. The units shall use compressed air or oxygen, have at least 30 minutes capacity, and be compatible with the units used by the local fire department.

Periodic analysis of the chlorine residual after contact shall be conducted. Occasional bacterial analyses are also recommended.

**Dechlorination**

Dechlorination may be necessary to protect the receiving stream, and may be achieved by aeration, activated carbon, and chemical treatment. Sulfur dioxide has been the most common form of chemical treatment, but other chemicals such as sodium sulfite, sodium bisulfite, and sodium thiosulfate may also be used. Dechlorination chemicals should be applied in an area where the flow is turbulent and short-circuiting is minimal, just prior to discharge of the effluent. A contact period of 1 to 5 minutes should be sufficient for reaction to occur.

Sulfur dioxide systems use the same type of equipment as gaseous chlorination systems. Chlorinator control valve diaphragms may not be used for sulfur dioxide. Special sulfonator control valve diaphragms that can handle sulfur dioxide must be used. If metal valves are used in the system piping, they should be of 316 stainless steel with teflon seals. Plastic valves such as PVC may also be used.
Safety precautions similar to those for chlorination systems are appropriate, including the provision of self-contained breathing apparatus. Steps should be taken to prevent accidental interconnection of chlorine and sulfur dioxide lines to avoid explosion hazards.

**Iodine**

The use of iodine is very similar to chlorine treatment, although it is not used as frequently. Iodine is normally used in a crystalline form, and is best applied with a saturator.

Dosages are dependent upon the particular wastewater, and iodine demand ranges from 3 to 7 times that of chlorine. No toxic by-products from the use of iodine have been noted at this time.

Monitoring requirements are the same as for chlorination.

**Ozonation**

Ozone is a powerful disinfectant, but it is unstable and must be generated on site. Ozone is also highly corrosive and toxic, and its generation and use must be carefully monitored and controlled. The use of ozone at small treatment system is not recommended.

Dosage is dependent upon the wastewater, and contactor efficiency. Turbidity above the level of 5 JTU's can severely decrease treatment efficiency. The normal dosage range is from 5-15 mg/l. Wastewaters that have high concentrations of organic or inorganic compounds will require higher dosages of ozone for disinfection.

The contact time varies from 8 to 15 minutes for bubble diffusers to 10 to 30 seconds for packed columns and positive pressure injection systems.

Because of instability, the ozone residual only lasts for a short time. Routine ozone monitoring shall be performed, and occasional bacterial analyses are recommended.

**Ultraviolet Light**

Ultraviolet light (UV) has seen its widest application for homes, commercial facilities, and some industries. UV denaturizes nucleic acids, and therefore is particularly effective against, viruses.

The transmittance or absorbance properties of water are critical for UV to be effective. Turbidity should be less than 10 JTU and color should be less than 15 units. Pretreatment by intermittent sand filtration is recommended.
Water should be passed over the UV source in a thin film, and the maximum depth of penetration should be no greater than 2-inches. The greatest germicidal effect occurs at a wavelength of 253.7 nm. A minimum dose of 16,000 kw-sec/m³ is recommended. The contact time is dictated by water absorbance and film thickness.

UV systems should be designed to maximize mixing in the direction perpendicular to the flow direction, and minimize mixing in the direction parallel to the flow direction.

Self-contained UV units are commercially available. The lamps should be chemically cleaned semiannually if automatic wipers are present, or 3 to 4 times yearly without automatic wipers. A UV intensity meter should be installed at the maximum depth from the source with an alarm to alert operators when the UV level falls below acceptable levels.

The UV unit must be protected from dust, excessive heat, and freezing temperatures. Adequate ventilation of heat-generating electrical components should be provided. A logbook of required maintenance should be kept.

Other Methods

Alternate methods of disinfection are available, although specific standards for these methods have not been developed. Consequently, acceptability will be judged on an individual basis for the planned installation.

POST-AERATION

General

Post aeration may be used when the level of dissolved oxygen in the effluent is required to be higher than is available from the process and/or when it is required that the chlorine level be reduced prior to discharge. Post-aeration must be accomplished in its own unit and cannot be combined with the chlorination facilities.

Diffused or Mechanical Aeration

A detention time of at least 30 minutes at peak flow shall be provided. Air shall be provided at a minimum of 20 SCFM for each 1000 gallon capacity in the unit.

Three types of aeration units may be used: floating aerator, fixed aerator, or diffused air. Mechanical aeration requires a shallow tank with a larger surface area. Diffused air allows the use of deeper rectangular tanks. When using diffused air, a side-roll is preferred over an end-roll effect.

The inlet must be raised sufficiently to allow for the expansion created by the addition of air. The outlet must be properly baffled to minimize the discharge of foam generated by aeration.
Cascade Aeration

Step or cascade aerators are especially useful when the needed dissolved oxygen increment is small or moderate. Cascades consist of a series of weirs or concrete or metal steps over which the effluent flows in a thin sheet. The edges of metal steps may have low weirs. The objective of a cascade is to maximize turbulence thus increasing oxygen transfer. As the number of descents increases for a given head loss, the quality of exposure may decrease because the tendency of droplets to break away from jets of falling water as soon as the jets strike air decreases.

Head requirements generally vary from 3 to 10 feet, and effluent pumping may be necessary if the required head is not available. Normally less than 100 sq. feet of surface area is needed per mgd capacity.

The following equation may be used to obtain an estimate of aeration potential.

\[
h = \frac{r - 1}{0.11ab(1 + 0.046T)}
\]

Where,
- \( h \) = Height through which water falls, feet
- \( r \) = Deficit ration = \( (C_s - C_o) / (C_s - C) \)
- \( C_s \) = DO saturation concentration of wastewater at temperature \( T \), mg/l
- \( C_o \) = DO concentration of influent to cascade, mg/l
- \( C \) = Required DO level after aeration, mg/l
- \( T \) = Water temperature, °C
- \( a \) = Water quality parameter equal to 0.8 for wastewater treatment plant effluent
- \( b \) = Weir geometry parameters

The parameter \( b \) should be set equal to 1.0 for free weirs, 1.1 for concrete steps, and 1.3 for step weirs unless analysis of a particular design shows that individual characteristics justify use of a different value.

OUTFALLS

Plant outfalls shall be designed with a size and slope that will prevent surcharge and/or interference with prior treatment processes when the receiving water is at its highest anticipated level, and should include diffusion facilities.

Diffusers should be:

1. Located in the streambed so as to be submerged at low flow,
2. Structurally protected against erosion, displacement, and sedimentation, and
3. Designed to mix effluent and receiving waters thoroughly.

Shoreline outfalls are not acceptable except in extreme situations. In such instances, dispersion of the discharged wastes must be established.

Access to a suitable effluent sampling point must be provided.

**CONTROLLED RELEASE**

**General**

Controlled release may be employed when the discharge is to a stream meeting the definition of an intermittent stream, and it is not economically feasible to treat to dry-stream standards. Prior to holding and discharge, a minimum of secondary treatment must be provided and the effluent must meet secondary limits when discharged.

The amount discharged or rate of discharge shall be governed by the stream to waste flow ratio. A controlled release program must always include the use of stream flow-gaging equipment.

**Design Parameters**

The holding lagoon must be constructed in accordance with standard lagoon criteria.

Minimum holding capacity is 200 days, with a recommended capacity of one year.

Proper baffling is required to prevent the discharge of floating algae and duckweed. It is recommended that the draw off be from the lower half of the liquid depth.

The valves used to allow discharge must be durable, protected from freezing, accessible, and capable of being secured to prevent discharge by unauthorized personnel.

The discharge pipe must be secured by a headwall with splash plate. Energy dissipation may be required to prevent erosion.

**Stream Gaging**

Discharge will be allowed only when the stream flow is in excess of 1 cfs. Mechanical or non-mechanical methods of stream gaging may be employed as long as their reliability is demonstrated in the engineering report.
G. RESIDUALS DISPOSAL

Residual solids from wastewater treatment facilities may contain pathogenic organisms, nutrients, and oxygen-demanding materials. Proper handling and disposal is necessary to protect public health and prevent degradation of groundwater and surface water quality.

The contents of residential septic tanks are considered to be septage. Most septic tanks should be pumped out every 2 to 5 years or whenever the bottom of the scum layer is within three inches of the bottom of the outlet device. The septage should be removed by a professional hauler and either taken to a larger sewage treatment plant or disposed of in an approved manner. The hauler must possess a valid Part 364 permit to transport the septage.

The solids from community septic tanks, aerobic biological treatment, or physical-chemical treatment should be removed periodically by a professional hauler. All haulers of sewage sludge must have a valid Part 364 permit. At aerobic or physical-chemical treatment facilities storage should be provided for twice the volume of sludge to be generated between anticipated removal dates. Storage may be under either aerobic or anaerobic conditions, and provision should be included to control any possible odors. The sludge can be hauled to a larger sewage treatment plant, or disposed of in an approved manner such as land spreading, land filling, or composting.

If the sewage sludge is to be disposed of in a sanitary landfill the sludge must be dewatered to at least 20 percent solids, and the sanitary landfill must be approved by the NYSDEC. If the treatment plant is larger than 0.1 mgd, a Part 360 permit is necessary for land spreading or composting if the treatment plant is smaller than 0.1 mgd, a Part 364 permit is valid for land spreading.

For open sand filter treatment facilities, the scum or solids mat should be raked off the filter at least every six months. Disposal of this sludge must also be in an approved manner as described above.
H. CONSTRUCTION INSPECTION AND CERTIFICATION

Construction of the approved facilities shall be supervised by a licensed professional engineer, in order to provide certification of construction compliance.

While full-time presence of a construction inspector may not be warranted for plants of the size for which the design features of this bulletin are intended, the construction site should be visited often enough for the construction supervisor to insure that the plant is being constructed in accord with the approved drawings and specifications. Full-time supervision of mound system construction is strongly recommended.

Should a change to the approved plans be necessary for proper construction, approval of the permit-issuing agency shall be secured.

When construction is complete, the licensed engineer who supervised construction shall certify to the Department, in writing, that the works have been constructed in accordance with the approved plans and specifications. As-built drawings shall be provided if changes to the approved plans were found to be necessary.
I. OPERATION, MAINTENANCE AND CONTROL

General

Operation and maintenance of treatment facilities is as important as proper design and construction. To insure proper operation and maintenance, an operating manual shall be provided with all treatment plants.

Operator Required

A sewage treatment plant must be under the responsible supervision of an approved operator at all times. Systems not subject to this requirement include: (1) septic tanks followed by subsurface leaching facilities with eventual discharge to the groundwaters, (2) septic tanks followed by open or covered intermittent sand filters, with a design capacity of less than 50,000 gallons per day, and (3) lagoons of less than 50,000 gpd capacity. Grades of operators needed at various types of plants are listed in Table 15.

Table 15. Necessary Operator Grades

<table>
<thead>
<tr>
<th>Type</th>
<th>Plant Capacity (MGD)</th>
<th>Operator Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extended Aeration Contact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilization, Oxidation Ditch</td>
<td>Less Than 0.1</td>
<td>III A</td>
</tr>
<tr>
<td></td>
<td>0.1 to 1.5</td>
<td>II A</td>
</tr>
<tr>
<td>Physical Chemical</td>
<td>Greater Than 1.5</td>
<td>I A</td>
</tr>
<tr>
<td>Sand Filtration Rotating Biol.</td>
<td>0.05 and greater</td>
<td>III B</td>
</tr>
<tr>
<td>Contractor Lagoons</td>
<td>Less Than 2.5</td>
<td>III B</td>
</tr>
<tr>
<td></td>
<td>0.05 to 5.0</td>
<td>III C</td>
</tr>
</tbody>
</table>

Information as to qualification and certification, along with the necessary application form, can be secured from any Department of Environmental Conservation regional office.

Contents of Operating Manual

The operating manual shall contain the following information:

1. Approved Design Report
2. Hydraulic Profile
3. Basic Electrical Schematic
4. Basic Plant Piping Schematic
5. Unit operating Theories and Procedures
6. Recommended Operating Ranges
7. Maintenance Check List
8. Program for Residuals Disposal
9. Parts List
10. Copies of All Warranties and Guarantees
11. Trouble-Shooting Guide
12. Permit Requirements
13. Laboratory Requirements and Testing Schedule
14. Operator Requirements and Hours
15. Emergency or Breakdown Procedures

Identification and correction of failures is a necessary part of the maintenance program.
APPENDIX I

LOW-PRESSURE AIR TEST

The proper procedure for air testing of sanitary sewers is described in the ASTM C-828-80, entitled "Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Lines (4-12 inches). Although the document title is specific for vitrified clay pipe, sizes 4 to 12 inches, this same general procedure may be used for any other sanitary sewer pipe material and is not limited to a maximum diameter of 12 inches. The parameter to be measured is the rate of air loss based on an average test pressure of 3.0 psig above any backpressure due to any groundwater that may be over the pipe.

It is extremely important that the various test plugs be properly installed and braced to prevent blowouts. It is also important to maintain adequate pressure relief valves to prevent over-pressurizing the system. A maximum relief pressure of 10 psi is suggested in most literature.

Although line testing may be done at any time during the construction phase, there are two time periods when testing is of special value - - (1) prior to placement of paving materials, in order to avoid unnecessary expense in locating and repairing leaks, and (2) at as late a date as possible, after work has been completed and some settlement has had a chance to occur. This latter period is the appropriate time for the final line acceptance test, since significant damage can occur after backfill from subsequent settling.

All portions of a new sewerage system should be tested, including any building sewers that may be constructed in conjunction with the main lines.

Manholes, which cannot be properly air tested, should be visually inspected and leakage tested using internal or external hydrostatic pressure.
### APPENDIX II

#### CONVERSION FACTORS

<table>
<thead>
<tr>
<th>Multiply</th>
<th>By</th>
<th>To Obtain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acres, ac</td>
<td>0.405</td>
<td>Hectares, ha</td>
</tr>
<tr>
<td>Feet, ft.</td>
<td>0.3048</td>
<td>Meters, m</td>
</tr>
<tr>
<td>Inches, in</td>
<td>2.54</td>
<td>Centimeters, cm</td>
</tr>
<tr>
<td>Gallons, g</td>
<td>0.003785</td>
<td>Cubic Meters, m^3</td>
</tr>
<tr>
<td>Gallons, g</td>
<td>3.785</td>
<td>Liters, l</td>
</tr>
<tr>
<td>Square Feet, sq ft</td>
<td>0.0929</td>
<td>Square Meters, m^2</td>
</tr>
<tr>
<td>Square Inches, sq in</td>
<td>6.45</td>
<td>Square Centimeters, cm^2</td>
</tr>
<tr>
<td>Million Gallons/Day, mgd</td>
<td>0.0438</td>
<td>Cubic Meters/Second, m^3/s</td>
</tr>
<tr>
<td>Million Gallons/Day, mgd</td>
<td>3785</td>
<td>Cubic Meters/Day, m^3/d</td>
</tr>
<tr>
<td>Gallons/Minutes, gpm</td>
<td>0.06308</td>
<td>Liters/Second, 1/s</td>
</tr>
<tr>
<td>Cubic Feet/Second, cfs</td>
<td>0.02832</td>
<td>Cubic Meters/Second, m^3/s</td>
</tr>
<tr>
<td>Cubic feet/Minute, cfm</td>
<td>0.000472</td>
<td>Cubic Meters/Second, m^3/s</td>
</tr>
<tr>
<td>Gallons/Day/Square Foot, gpd/ sq ft</td>
<td>0.04074</td>
<td>Cubic Meters/Day/Square Meter, m^3/m^2.d</td>
</tr>
<tr>
<td>Gallons/Minute/Square Foot, gpm/sq ft</td>
<td>0.67902</td>
<td>Liters/Second/Square Meter, lm^2/s</td>
</tr>
<tr>
<td>Feet/Second, fps</td>
<td>0.3048</td>
<td>Meter/Second, m/s</td>
</tr>
<tr>
<td>Gallons/Day/Lineal Foot, gpd/lin ft</td>
<td>0.01242</td>
<td>Cubic Meters/Day/Lineal Meter, m^3/m.d</td>
</tr>
<tr>
<td>Pounds of BOD/100 Cubic Feet, lb/1000 cu ft</td>
<td>10,020</td>
<td>Kilograms of BOD/Cubic Meter Kg/m^3</td>
</tr>
<tr>
<td>Pounds/Square Inch, psi</td>
<td>0.0703</td>
<td>Kilograms/Square Centimeter, Kg/cm^2</td>
</tr>
<tr>
<td>Gallons/Min/1000 Square Feet, gpm/100 sq ft</td>
<td>679.02</td>
<td>Liters/Second/Square Meter, lm^2/s</td>
</tr>
<tr>
<td>Cubic Foot of Air/Pound BOD, cu ft/lb BOD</td>
<td>0.06243</td>
<td>Cubic Meters/Kilogram BOD, m^3/kg BOD</td>
</tr>
</tbody>
</table>
APPENDIX III

MOUNT DESIGN EXAMPLE

Design a mound for a site with a percolation rate of 60 min/inch. The slope of the land is 15 percent, so the site may be classified as severe. The design flow rate is 5000 gpd of aerobically treated wastewater. Figure A 1 shows a schematic for this example.

1. Evaluate The Site.

The soil horizon consists of an 18-inch layer of loam (the A-horizon), and a 12-inch layer of fine silt loam (the B-horizon) overlying a slowly permeable clay layer (the C-horizon). The vertical and horizontal unsaturated hydraulic conductivities are listed in Table 1. Evidence of seasonally high groundwater exists at 15 inches below the ground surface.

<table>
<thead>
<tr>
<th>Horizon</th>
<th>Unsaturated Hydraulic Conductivity (gpd/sq. ft.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vertical</td>
<td>Horizontal</td>
</tr>
<tr>
<td>A</td>
<td>0.7</td>
<td>60</td>
</tr>
<tr>
<td>B</td>
<td>0.6</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>0.25</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Boundary Conditions.

a) If we assume that the clogging mat will be insignificant because of the extent of pretreatment, the vertical acceptance rates (VARs) can be considered equal to the vertical unsaturated hydraulic conductivities. The vertical boundary is at the C-horizon with a VAR of 0.25 gpd/sq. ft.

b) The horizontal boundary will be at or down-slope from the base of the mound. Using:

\[
\text{HAR} = K A \frac{dH}{dx}
\]

Where,

\[
\text{HAR} = \text{Horizontal Acceptance Rate}
\]

\[
K = \text{Horizontal hydraulic conductivity} = 60 \text{ gpd/sq. ft. in the A-horizon and gpd/sq. ft. in the B-horizon.}
\]

\[
A = \text{Area of horizontal flow} = 1 \text{ sq. ft.}
\]

\[
\frac{dH}{dx} = \text{Hydraulic gradient} = 0.15
\]

Thus \( \text{HARA} = 9.0 \text{ gpd/ft.} \) and \( \text{HARB} = 6.0 \text{ gpd/ft.} \)
Since horizontal flow can be expected, the area down-slope must be evaluated for any restrictions such as a stream, change in slope, etc., that will act as a horizontal boundary.

3. **Determine The Vertical Wastewater Application Width.**

The horizontal and vertical loading rates must not exceed HAR and VAR. The application width is width over which the vertical flow is applied in the C-horizon upslope from the horizontal boundary. To keep the toe of the mound from getting too wet, there should be no horizontal flow in the A-horizon. The basal loading for the A horizon must not exceed the basal loading for the B-horizon, thus HARB is used in these calculations.

\[
AWC = \frac{HARB}{(VARB – VARC)}
\]

\[
AWC = \frac{6 \text{ gpd/ft.}}{(0.6 – 0.25) \text{ gpd/sq. ft.}}
\]

\[
AWC = 17.1 \text{ ft.}
\]

Thus, unless a restriction exists upslope from this point, the horizontal boundary will be at the edge of the application width.

4. **Determine The Linear Loading Rate (LLR) of The Wastewater.**

\[
LLR = VARC (AWC) + HARB
\]

\[
LLR = (0.25 \text{ gpd/sq. ft.}) (17.1 \text{ ft.}) + 6 \text{ gpd/ft.}
\]

\[
LLR = 10.3 \text{ gpd/ft.}
\]

5. **Determine The Basal Width of Each Horizon.**

a) Basal Width of A

\[
BWA = \frac{LLR}{VARA} = \frac{10.3 \text{ gpd/ft.}}{0.7 \text{ gpd/sq. ft.}}
\]

\[
BWA = 14.7 \text{ ft.}
\]

Thus, the toe of the mound will end 2.4 feet upslope from the horizontal boundary. To allow a 3:1 slope, this can be extended to 24.5 ft.

b) Basal Width of B

\[
BW B = \frac{LLR}{VARB} = \frac{10.3 \text{ gpd/ft.}}{0.6 \text{ gpd/sq. ft.}}
\]

\[
BW B = 17.1 \text{ ft.}
\]
c) Basal Width of C

\[ \text{BWC} = \frac{\text{LLR}}{\text{VARC}} = 10.3 \text{ gpd/ft.} / 0.25 \text{ gpd/sq. ft.} \]

\[ \text{BWC} = 41.2 \text{ ft.} \]

**6. Determine Width of Adsorption Area.**

\[ \text{A} = \frac{\text{LLR}}{\text{Fill Infiltration Rate}} \]

Sand Fill Infiltration Rate = 1.2 gpd/sq. ft

Therefore, \( A = 8.6 \) feet.

**7. Determine Length of Absorption Area.**

\[ \text{B} = \frac{\text{Design Flow Rate}}{\text{LLR}} \]

\[ \text{B} = \frac{5000 \text{ gpd}}{10.3 \text{ gpd/ft.}} \]

\[ \text{B} = 485 \text{ feet} \]

**8. Mound Height**

The fill depth and natural soil should provide at least 3 feet of unsaturated soil below the distribution lines. Thus, a minimum of 21 inches of fill is necessary. Assuming a 1-inch pipe, the bed depth would be 9 inches. The cap and topsoil are 18 inches deep over the center of the absorption area and 12 inches deep over the edges. When allowances are made for the 15% slope, the mound height at the upslope edge of the absorption area is 3.5 feet, at the center is 4.6 feet, and at the down-slope edge is 4.8 feet.

**9. Mound Width Accounting For 3:1 Slide Slopes**

Upslope Width,

\[ J = (\text{Mound Depth at Upslope}) (3) \text{ Slope Correction Factor} \]

\[ J = (3.5) (3) (0.66) \]

\[ J = 6.9 \text{ ft.} \]
Downslope Width,
\[ I = (\text{Mound Depth Downslope}) \times (3) \times (\text{Slope Correction Factor}) \]
\[ I = (4.8 \times 3) \times (1.68) \]
\[ I = 24.2 \text{ ft.} \]

Since the absorption area is 8.6 feet wide, the total mound width is 39.7 feet.

Thus, the toe of the mound will end 8.4 feet upslope from the edge of the basal width in the C horizon (BWC).

Because of its length, this mound should be constructed in several segments. At least 8.4 feet should be allowed between the toe of one mound and the upslope edge of another to prevent overlapping of the basal areas. Additional space should be included to allow maneuvering of construction equipment.

10. In Contrast To A Mound System

Design of a mound system takes advantage of the horizontal movement of the wastewater as well as vertical movement. If a system were to be designed for this site on the basis of vertical transport only, it would need to be much longer. The loading rate would be limited by the vertical acceptance rate of the C-horizon. Assuming that the width of the absorption area is the same as for the mound system, then:

\[ \text{LLR} = (\text{VARC}) \times (A) \]
\[ \text{LLR} = (0.25 \text{ gpd/sq. ft.}) \times (8.6 \text{ ft.}) \]
\[ \text{LLR} = 2.15 \text{ gpd/ft.} \]

Since the wastewater flowrate is 5,000 gpd, the total system length would be 2,326 feet.
FIGURE A1. MOUND EXAMPLE